GEK-86100D

INSTRUCTIONS

SBC9000

STATIC BREAKER FAILURE

AND

POSITIVE SEQUENCE OVERVOLTAGE RELAY

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SBC9000

STATIC BREAKER-FAILURE RELAY

INTRODUCTION

The Type-SBC9000 family of 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; that is, high security and capability for fast clearing times. These relays can be applied with any of the bus/breaker arrangements in general use today, and over a wide range of fault conditions. One Type-SBC9000 relay is required for each breaker. Models of the SBC9000 relay are available for use with breakers incorporated in single-pole as well as three-pole tripping schemes.

In addition to the breaker-failure function, two auxiliary timers and a positive-sequence overvoltage relay may be contained in the SBC9000 shelf. The overvoltage unit is an independent function that includes its own power supply, magnetics module, and test receptacle. The auxiliary timing module shares the breaker-failure relay's power supply, but is otherwise independent from the breaker-failure function.

The Type SBC9000 relay is contained in a four-rack-unit-high case (one rack unit equals 1-3/4 inches), suitable for mounting in a standard 19 inch rack. The case outline and dimensions are shown in Figure 30. Both the electronics and the magnetics are contained in pluggable modules, which are removable from the front of the unit.

The logic diagram for the three-pole SBC9300 is shown in Figure 7; the elementary is shown in Figure 8. The logic and elementary for the single pole SBC9100 are shown in Figures 9 and 10. The logic and elementary diagrams for the optional positive-sequence overvoltage relay are shown in Figures 22 and 23.

BREAKER-FAILURE RELAY APPLICATION

GENERAL

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 the current transformers that measure the current in the associated breaker. The trip outputs must be routed to initiate the tripping (or tranferrred tripping) of all breakers necessary to clear the fault upon failure of the breaker associated with the SBC relay. This routing will depend on the bus and breaker arrangement.

The listing in Table I covers the bus arrangements that are in common use: single-bus single-breaker, double-bus double-breaker, breaker-and-a-half, and ring-bus arrangements. They are shown in Figures 1, 2, 3 and 4, respectively. Each listing in Table I indicates the assumed fault location, the breaker assumed to have failed, the contact initiation that activates the SBC, and which breakers or lockout relays should be tripped by the Breaker-Failure Trip (BFT) contacts. For example, for backing up breaker #2 in a single-bus single-breaker arrangement (Figure 1), 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 shown in Figure 4. If breaker #1 is to be backed up, the SBC 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 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 breakers #2 and #6.

Setting the main timer is probably the most important consideration when applying SBC relays. Figure 5 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 the damage to the faulted equipment as much as possible. On the other hand, the time must be long enough to permit the primary relaying and primary breaker to operate and clear the fault with margin. In general, a good practice is to set the SBC timer so that the overall time of operation (including the pickup time of the current detector and operating time of the BFT output relay) provides for ample margin without infringing on the stability limit in the event of a breaker failure. The IEEE Relay Committee recommends at least three (3) cycles of margin.

It is apparent from Figure 5 that for any given total operating time of the SBC relay, reducing the dropout time of the current detector will increase the margin. Therefore, the current detectors used in the SBC have been designed to have a short dropout time (3.0 milliseconds for 60 hertz relays, 3.6 milliseconds for 50 hertz relays). Note that because of the short dropout time, as the current into the level detector is slowly increased, the current detector will first produce a pulse output; then, when the current is increased, a continuous output. Since the breaker failure timer will reset after each pulse, the pickup setting is the current that will produce a continuous output from the current detector, thus allowing the breaker-failure timer to time out.

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. 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.

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 interupted, and 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, permitting a shorter time setting on the main SBC timer.

TABLE I

BUS & 3REAKER ıRRANGE- MENT	FIGURE #	FAULT LOC.	FAILED BKR	CUR. FROM ASSOC. BKR	CONT. INIT. FROM	BFT CONTACT #1 TRIPS	BFT CONTACT #2 TRIPS	BFT CONTACT #3 TRIPS
ıingle Bus ıingle Bkr	1	F1	2	2	Line B	Bus lock-out Relay	---	----
ouble Bus Double Breaker	2	F1 or F2	3	3	Line B or North Bus	North Bus Lockout Relay	Breaker 4	Lockout relay that transfer trips line B and blocks reclosing of Bkr 4
ouble Bus Double Breaker	2	F1 or F3	4	4	Line B or South Bus	South Bus Lockout Relay	Breaker 3	Lockout relay that transfer trips line B and blocks reclosing of Bkr 3
eaker-and a-half	3	F1 or F3	4	4	Line A or North Bus	North Bus Lockout Relay	Breaker 5	Lockout relay that transfer trips Bkr 10 and blocks reclosing of Bkr 5
eaker-and a-half	3	F1 or F2	5	5	Line A or Line B	Breaker 4	Breaker 6	Lockout relay that transfer trips Bkrs 10 + 11 and blocks reclosing of Bkrs 4 and 6
eaker-and a-half	3	F1 or F4	6	6	Line B or South Bus	South Bus Lockout Relay	Breaker 5	Lockout relay that transfer trips Bkr 11 and blocks reclosing of Bkr 5
Ring Bus	4	F1 or F2	1	1	Line A or Line B	Breaker 2	Breaker 6	Lockout relay that transfer trips Bkrs 7 and 8 and blocks reclosing of Bkrs 2 and 6

Under normal conditions, the SBC relays do not have DC applied to the output relays, and the breaker-failure timers are blocked from timing. Thus, the SBC is normally immune to any responce to electrical transients. The DC is applied to the output relays and the timers are unblocked only when the BFI (breaker-failure initiation) or 62X contacts close, indicating that a fault has occurred on a line associated with the breaker being backed up. The BFI/62X contact converter input circuit is designed so that the applied DC voltage must exceed 60% of nominal rated voltage in order for the relay to operate. This feature prevents false trips that might result from the voltage divider effect of the ground fault lamps on the DC bus, should the input to the contact-converter terminal of the SBC be accidentally grounded.

Note that most, if not all, static line-relaying systems include a seal-in function. The BFI contact input to the SBC will provide a continuous input for the fault duration, even in the event of a zero-voltage fault; therefore a separate seal-in contact is not provided. If the associated line relays do not include a seal-in function, one contact from the retrip (RT) relay can be wired in parallel with the BFI contact to provide the seal-in function. **Use this seal-in advisedly,** as it can reduce the security of the scheme during testing if the current detectors are set to pick up below load current magnitudes.

An output contact from the retrip relay (RT) can also be used to apply a separate independent trip signal to the breaker associated with the SBC, increasing the overall security of the scheme. This separate trip signal provides an alternative means to trip the breaker correctly in the event of a failure in the trip circuit from the protective relays, thus avoiding unnecessary tripping of the backup breakers. Furthermore, this feature increases security during testing, because an error in testing that results in initiating SBC operation will cause tripping only of the breaker associated with the SBC. This is because when the associated breaker is tripped by the retrip relay, the current detectors will reset, and prevent the SBC from timing out.

SBC9300 - THREE-POLE TRIPPING SCHEME

The SBC9300 relay is intended for use in three-pole tripping schemes. There are four current inputs to the SBC9300: three phase currents (IA, IB, IC) and the neutral current (3Io). Two current-level detectors are included, one for the three phase currents, and a separate adjustable one for the neutral current. The SBC9300 relay includes two timers (TL1 and TL2), three contact converters, three telephone relays (BFT, BFT2, and RT) and switches to select various logic options. The logic and elementary diagrams are shown in Figures 7 and 8, respectively.

Timer TL1 is the main breaker-failure timer. Timers TL1 and TL2 cannot begin to time out until the breaker-failure initiation contact (BFI) input to the SBC contact converter 3 (CC3) has operated. The purpose of the two timers (TL1, TL2) is to provide two different tripping times, depending upon the input conditions (CC1 and current level) and the position of switches SW2 and SW3. Timer TL1 is energized by an output from the current detector. Timer TL2 is energized by an output from AND1. With switch SW2-2 closed, AND1 will produce an output only when both contact converter CC1 and the current detector produce outputs. With switch SW2-1 closed, AND1 will produce an output whenever contact converter CC1 is energized.

With switch SW2-2 closed and a breaker auxiliary switch, 52/a, providing the input to CC1, timer TL2 can be used to provide a short tripping time if the breaker mechanism fails to operate. The current detector should be set sensitively enough to detect all faults for which the breaker is tripped. If the breaker mechanism operates, but the breaker fails to interrupt the fault, slightly longer tripping times would be provided by timer TL1, which is energized by the current detector. The longer tripping times can be tolerated, since it is highly probable that the continuing fault is the result of the failure of only one pole of the breaker, and hence is a single-line-to-ground fault. There would be no output from timer TL2 for this case because the auxiliary switch would open and de-energize contact converter 1 (CC1), thereby preventing an output from AND1. However, the current detector would keep timer TL1 energized, and after its time delay, TL1 would produce an output that would cause the BFT contacts to operate to initiate tripping of the backup breakers.

With switch SW2-1 closed, AND1 will produce an output whenever contact converter CC1 produces an output. This arrangement provides two different paths to energize the BFT contacts. One path is via the level detector and timer TL1, the other, via contact converter CC1 and timer TL2. This arrangement is used in applications where a second means, other than the current detector, is required to detect a breaker-failure condition. This scheme is commonly used to provide protection for a breaker that is shared by a line and a system transformer, as shown in Figure 6. The fault currents on the two circuits adjacent to breaker 1 in Figure 6 may vary greatly in magnitude. The current detector can be set high so that it will operate for faults on line A and high-current faults in the transformer. Because the current magnitude for some transformer faults may not be sufficient to operate the current detectors, a transformer differential relay auxiliary contact, 87X, can be used to energize the breaker-failure scheme via contact converter CC1. Breaker-failure timer TL1 can be set to provide short tripping times for high-current faults, while timer TL2 can be set to provide somewhat longer trip times for fault-current levels that are too low to operate the current detector.

The logic arrangement obtained by closing switch SW2-1 may also be used to obtain shorter breaker-failure times when used with circuit breakers that insert resistors into the circuit when clearing a fault. In this application, the SBC current detector would be set below the resistor current, and would remain picked up until the resistor current is interrupted; hence, the setting of breaker-failure timer TL1 must be proportionally longer. The input to contact converter CC1 should be sealed-in by an external current detector that is set above the resistor current. Thus, the input to CC1 will reset when the main breaker contacts open, thereby permitting a shorter time setting to be used on TL2.

NOTE: SW2 and SW3 are located on the KIM301 module.

SBC9100 - SINGLE-POLE TRIPPING SCHEME

The SBC9100 relay is intended for use in single-pole tripping schemes. There are three current inputs to the SBC9100, one per phase (IA, IB, IC). A common setting and level detector are used for the three currents. The SBC9100 relay also includes two timers (TL1 and TL2), five contact converters (CC1 through CC5), three telephone relays (BFT, BFT2, and RT) and a link to select various logic options. The logic and elementary diagrams are shown in Figures 9 and 10, respectively.

The SBC9100 relay is designed specifically for those applications where a single pole of a three-phase breaker may be opened to clear a single-lined-to-ground fault, while the other poles continue to carry load current. Because the load current in the two unfaulted phases may be greater than the setting of the current detector, it is neccessary that only the current in the phase to be opened be applied to the current detector. A separate breaker-failure initiation contact must be supplied for each phase to accomplish this: BFI-ØA, BFI-ØB and BFI-ØC. These contacts are supplied to contact converters CC3, CC4 and CC5, respectively. A fourth breaker-failure-initiation contact, BFI-3Ø, is used to energize contact converters CC3, CC4 and CC5 simultaneously, when it is desired that all three breaker poles open, such as for a multi-phase fault.

In order to explain the operation of the scheme, first assume that a single-line-to-ground fault has occurred on phase A. The associated line relaying will close the BFI-ØA contact, energizing the input to contact converter CC3. This output from CC3 will supply one of the three inputs to AND1, and will also energize the analog switch in the phase A current, causing the phase A current to be applied to the current detector. Phase B or C current will not be applied to the current detector, because neither BFI-ØB, BFI-ØC nor BFI-3Ø will operate for this A-phase-to-ground fault. If the phase A current remains above the setting of the current detector until timer TL1 picks up, indicating that the pole has failed to open, the retrip relay, RT, will be energized via SW7-1 and OR1. The contacts of the RT relay can be used to attempt a three-pole trip of the associated breaker. If this three-pole-trip attempt fails to clear the fault, after the current detector has been picked up for the additional time delay of timer TL2, the breaker-failure trip relay will be energized.

If a multi-phase fault rather than a single-line-to-ground fault is assumed, the associated line relaying will close all three phase-identified breaker-failure initiation contacts (BFI-ØA, BFI-ØB and BFI-ØC), or it will close the three-phase breaker-failure initiation contact, BFI-3Ø. In either case, contact converters CC3, CC4 and CC5 will be energized; in turn, they will energize all three inputs to AND1 and all three analog switches. If either the phase A, B, or C current is greater than the setting of the current detector, then the input to timer TL2 will be energized via AND2 and OR2. In addition, if switch SW7-2 is closed, the retrip relay (RT) will be energized by an output from OR2. After the pickup time delay of timer TL2, the breaker-failure-trip relay (BFT) will be energized.

Note that the total breaker-failure-timer setting for a single-pole trip is the sum of the settings of TL1 and TL2, while for a three-pole trip it is only the setting of TL2. The longer break-failure time for single-pole trips is required to prevent undesired breaker-failure operations during evolving faults. The use of two timers in the SBC9100 series allows the time-delay setting on TL2 to provide a shorter breaker-failure time on three-pole trips, while the sum of the pickup delays of TL1 and TL2 provide a longer, more secure, time delay on single-pole trips. To illustrate the operation on an evolving fault, assume that the intinal fault is AG and evolves to ABG just before the A-phase pole of the breaker opens. Also assume that the breaker operates correctly, initially tripping single-pole to clear the AG fault and later, three-pole to clear the continuing BG fault. Timer TL1 will produce an output, even though the initial A-phase fault is correctly cleared. This occurs because the continuing BG fault provides an interrupted input to TL1. However, a breaker-failure-trip signal cannot occur until timer TL2 also times out, thus allowing the breaker to clear the fault successfully. If only one breaker-failure timer were used, it would need to be set to a time equal to the sum of the pickup delay of TL1 and TL2, and this time delay would be introduced for both single-pole and three-pole operations. The pickup time delay of TL2 must be set in accordance with the breaker-failure-time chart of Figure 5 to provide the proper total breaker-failure clearing time on three-phase faults. The pickup delay of timer TL1 should be set to the same time delay as TL2. This will provide sufficient time to clear an evolving fault successfully before initiating a breaker-failure trip. The retrip function, after the TL1 time, permits a three-pole retrip after a three-pole trip is initiated; or after a single-line-to-ground fault fails to clear in one breaker-clearing time. This allows for a second three-pole retrip to ensure pole selection during evolving faults, thus eliminating the action of tripping backup breakers in case of trip-circuit wiring errors or tripping the wrong phase.

<u>NOTE</u>: SW7 is located on the KIM101 module.

RATINGS

Temperature Range:

The SBC relay is designed for use in an environment where the air temperature outside the relay case is between −20°C and +65°C.

Hipot:

Per IEC and ANSI/IEEE C37.90-1978.

Current Ratings:

AC - Continuously rated 10 amperes (5 amp model)
2 amperes (1 amp model)

AC - One Second Ratings: 500 amperes (5 amp model)
100 amperes (1 amp model)

Burden:

AC - 0.026 ohm at 4.5° (5 amp model)
0.063 ohm at 39° (1 amp model)

Contact Converter Inputs - 48 volts - 3,250 ohms
125 volts - 8,250 ohms
250 volts - 16,250 ohms nominal

DC Voltage Rating:

Jumper selectable, 48, 110/125, 220/250 volts DC
Jumpers on power supply, timer and SBC cards

Power Required: 6 watts untripped (nominal)
11 watts tripped (nominal)

Operating Range: 80-115% of nominal

Voltage Required at BFI Input for Pickup:

60% of maximum control voltage for selected voltage range

Magnetics Module: 1A-5A. Different modules for 50 hertz and 60 hertz.

Three-Pole SBC Module:

Phase operate level – 0.1 to 1.5 times rated current in 0.1 steps
3Io operate level – 0.05 to 0.75 times rated current in 0.05 steps
Operate time on two timers – 0 to 0.99 second in 0.01 second steps

Single-Pole SBC Module:

Operate Level – 0.1 to 1.5 times rated current in 0.1 steps
Operate time on two timers – 0 to 0.99 second in 0.01 second steps

Contact Current Rating: (BFT and RT)

Make for trip duty - 30 amperes
Carry continuously - 3 amperes

Target Indicator:

Front panel LED on SBC cards. Front panel reset-test pushbutton. Remote reset available at card connector.

Dual Auxiliary Timer:

Contact ratings - 8 amperes at 250 volts AC, resistive

CHARACTERISTICS

Pickup Time: From AC Input

Ten milliseconds, ±5 milliseconds, plus time setting ±3% typical, measured from the time the AC input crosses the threshold (Electronic pickup time less than the 2-millisecond time setting).

Dropout Time:

6-12 milliseconds (2.9 - 3.4 milliseconds electronics alone)

Reset Time:

10 milliseconds (electronics)

Dropout Ratio:

90% or more

Variation in Operate Level:

With temperature - Less than ±3% typical

Variation in Operate Time:

With temperature - Less than ±3% typical

Operate Time from BFI Input:

10 - 20 milliseconds

Dropout Time from BFI Input:

5 - 20 milliseconds

Pickup and Dropout Time of Contact Converters:

Auxiliary Timers

Pickup Time – setting ±5% typical
Dropout Time – 8-16 milliseconds (5-10 milliseconds minimum)
Variation in operate time: With temperature ±3% typical.

Contact Converter Operation by Capacitive Discharge:

Maximum circuit capacitance to avoid operation (BFI input)

Control Voltage	Maximum Capacitance
48 VDC	3.5 microfarads
125 VDC	1.0 microfarads
250 VDC	0.5 microfarads

These values are obtained by discharging a capacitor, charged to the supply voltage, directly into the input.

Breaker-Failure-Relay Case Wiring (Figure 11 - From-To List)

The same case wiring is used whether the relay is a single-pole or a three-pole unit. Similarly the magnetic modules, dual auxiliary timer board, power supply and test device are the same for either configuration. Changing the SBC module from KIM101 to KIM301 changes the unit from a single-pole to a three-pole breaker-failure relay, and vice-versa.

MODULE SETTINGS

SBC MAGNETIC-MODULE SETTINGS

MGM105, MGM108

There are two versions of the SBC magnetic (mag) module. Model MGM105 is for 50 hertz, and MGM108 is for 60 hertz. Each version is capable of being used on either one or five amperes (1 or 5 amps) by means of transactor tap changes. See Figure 13 for the location of the terminal board for the tap changes.

KIM101 - Single-Pole Breaker-Failure Module (Figure 14)

This board contains circuitry that senses when the current in one or more selected phases exceeds the operate setting. The operate signal starts one of the two timers on the board. This timer's output, alone or with inputs to contact converters, starts a second timer, whose output, in combination with the first timer, generates BFT and BFT AUX board outputs. The first timer's output, singly or with other signals, may generate a retrip output. A BFT output sets a latching reed to provide target indication via a front panel LED. The target indication is reset by a front panel pushbutton. The board front panel contains the following indicators and controls.

Front Panel Light-Emitting Diode

Identity	Color	Indication	Description
BF Trip	Red	BFT Output	Lights when a BFT output occurs.

Front Panel Switches

Identity	Type	Function	Description
1 POLE TM	Double digit thumbwheel	Single Pole Trip Time	Set single-pole operate time.
3 POLE TM	Double digit thumbwheel	Three Pole Trip Time	Set three-pole operate time.
IØ	4-stage miniature toggle	Phase Current Trip Setting	Sets the trip current multiplier from 0.1 to 1.5. Actual trip current is multiplier times I_N, set in mag module.
RESET	Pushbutton	Reset Target	Resets the latching reed that drives the TRIP LED. LED lights when reset is pressed.

Internal Switches

Identity	Type	Function	Description
SW7-1 SW7-2	4-stage miniature toggle	Sets on-board logic	Setting determines whether RETRIP results from single-pole timer output alone or also from simultaneous ØA, ØB and ØC contact-converter inputs. See **APPLICATION** section for settings.
SW7-3		Sets operating frequency	Controls fill-in timer duration to match 50 or 60 hertz.

CAUTION: Switch 7 positions 1 and 2 should not be closed at the same time; one should always be open.

Internal Links

Identity	Function	Description
DC Voltage Link	Selects Control (DC) voltage	Link position selects 48, 110/125, 220/250 volts DC control voltage for contact converters.
BP4	Routes Contact-Converter Logic	Permits recloser input to start timer 2.
BP5		Inhibits recloser input to start timer 2.

KIM301 - Three-Pole Breaker-Failure Module (Figure 15)

This board contains circuitry that senses when any phase current exceeds the phase operate setting. It also contains circuitry to sense when the 3Io current exceeds its threshold setting. It contains two timers: one is used to set the operate time for the BFT1 output; the configuration of the other timer is user-selectable. In addition, there are three contact-converter inputs. One of these inputs (BFI) enables the breaker-failure function. The other two inputs are logically combined with the remaining timer output to provide BFT2 and RETRIP outputs. Any output (BFT1, BFT2 or RETRIP), sets a latching reed that operates a front-panel LED. The latching reed is reset by a front-panel pushbutton switch. The board front-panel contains the following indicators and controls.

Front Panel Light-Emitting-Diode

Identity	Color	Indication	Description
BF Trip	Red	BFT1, BFT2 or RETRIP output	Lights when any output going to the mag module telephone relays occurs.

Front Panel Switches

Identity	Type	Function	Description
TM1	Double-digit thumbwheel	Timer 1 time setting	Sets BFT1 output operate time.
TM2	Double-digit thumbwheel	Timer 2 time setting	Sets BFT2 output operate time. Initiate source selectable by on-board switches.
IØ	4-stage miniature toggle	Phase Current Trip setting	Sets the trip-current multiplier from 0.1 to 1.5. Actual trip current is multiplier times I_N, set in mag module.
3IØ	4-stage miniature toggle	3IØ Current setting	Sets the trip-current multiplier from .05 to .75. Actual trip current is multiplier times I_N, set in mag module.
RESET	Pushbutton	Reset target indicator LED test	Resets the latching reed that drives the TRIP LED. Lights LED when pressed to test LED.

Internal Switches

Identity	Type	Function	Description
S2	5-stage miniature toggle	Sets on-board logic	Varies the logic configuration for different applications. See **APPLICATION** section for settings.
S3	5-stage miniature toggle	Sets operating frequency and board logic	One stage selects 50 or 60 hertz operation for the fill-in timer. The other four positions control the board logic. See **APPLICATION** section for settings.

Internal Link

Identity	Function	Description
DC Voltage Link	Selects Control (DC) voltage	Link position selects 48, 110/125 220/250 volts DC control voltage for contact converters.,

KTM 201 - Dual Auxiliary Timer Module (Figure 16)

This board contains two independently adjustable timers with a timing range from zero (0) to 9.9 seconds in 0.1 second steps. Inputs to the timers are through reed-relay contact converters to provide electrical isolation. The timer outputs are contacts on miniature relays mounted on the printed-circuit board. There are two output contacts per timer at the card connector.

Front Panel Switches

Identity	Type	Function	Description
TM1	Double-digit thumbwheel	Timer 1 time setting	Set timer 1 operate time.
TN2	Double-digit thumbwheel	Timer 2 time setting	Set timer 2 operate time.

Internal Link

Identity	Function	Description
DC Voltage Link	Selects Control (DC) voltage	Link position selects 48, 110/125, 220/250 volts DC control voltage for contact converters.

ACCEPTANCE TESTS - BREAKER-FAILURE RELAY

Before placing the equipment in operation, it should be tested as described in this section. Current and times are specified for these tests, which are suitable if specific values have not been determined. If specific values for the application are availble, it is suggested that they be used in these tests.

SBC HIGH-POTENTIAL TEST (UNIT TEST)

CAUTION: When hipot testing, it is necessary to remove the jumpers between terminals BD13 and BD14. This removes the grounding connection between the surge capacitors and case ground. Failure to do so could result in damage to the filter capacitors on the PSM module.

CONNECT	
BA1, BA2, BA3, BA4, BA5, BA6, BA7, BA8, BA9, BA11, BA12, BB1, BB2, BB3, BB4, BB5, BB6, BB7, BB8, BB9, BB10, BB11, BB12, BC1, BC2, BC3, BC4, BC5, BC6, BC7, BC8, BC9, BC13, BC14, BD1, BD2, BD3, BD4, BD5, BD6, BD7, BD8	HIPOT TO CASE
BA1, BA2, BA3, BA4, BA5, BA6, BA7, BA8, BA9	HIPOT TO ALL OTHER STUDS AND CASE
BC13, BC14	"
BA11, BA12	"
BA13, BA14	"
BC7, BC8, BC9	"
BB1, BB2	"
BB3, BB4	"
BB5, BB6	"
BB7, BB8	"
BB9, BB10	"
BB11, BB12	"
BC1, BC2	"
BC3, BC4	"
BC5, BC6	"
BD1, BD5	"
BD2, BD6	"
BD3, BD7	"
BD4, BD8	"

If output contacts are to be hipot tested, do not exceed rating.

THREE-POLE UNIT TEST FOR SBC9300

Set the SBC portion as follows:

Mag module - Set to 1A taps (see Figure 13)

NOTE: For 5 amp models, use current values in ( ) parentheses.

KIM301 Front Panel Settings:

Time 1 - 0.50
Time 2 - 0.20
Phase Current - IØ - 1.0
3Io Current - 0.5

KIM301 On-board settings:

Voltage jumper to DC voltage used
S2-1 closed
S2-2 open
S2-3 open
S2-4 open
S2-5 closed
S3-1 open
S3-2 closed
S3-3 to match test frequency: Open for 60 hertz
Closed for 50 hertz
S3-4 closed
S3-5 open

Refer to the test diagram, Figure 17.

Set SW1 to A. Turn on SW2. Increase the input current until the three BFT1 LEDs come on. The input current at this point should be 0.8-1.2 amp (4.0-6.0 amps).

Repeat with SW1 set to B, and then set to C.

Set SW1 to 3Io and repeat. Input current required should be 0.4-0.6 amp (2.0-3.0 amps).

Turn off the AC input current. Leave SW2 on, turn SW3 on. The three "RETRIP" LEDs should come on.

Turn off SW3, leave SW2 on. Turn on SW4. The three BFT1 LEDs and three BFT2 LEDs should come on when input current (3Io) is 0.4-0.6 ampere (2.0-3.0 amps).

Set SW1 to A. Set input current to 1.5 amp (7.5 amps). Set SW6 to BFT1. Set SW5 to BFI position. Turn on SW2. Measure time to BFT1 output. Time should be 0.5 second, plus 0.02-0.005 second.

Set SW1 to A. Set input current to 1.5 amp (7.5 amps). Set SW5 to EXT TRIP position. Turn on SW2. Set SW6 to BFT2. Turn on SW3. Measure operate time to BFT2 output. Time should be 0.2 second, plus 0.02-0.005 second.

SINGLE-POLE UNIT TEST FOR SBC9100

Set the SBC portion as follows:

Set power supply voltage jumper to test voltage

Mag Module - 1A tap

NOTE: For 5 amp models, use current values in ( ) parentheses.

KIM101 Front Panel Settings

Time 1 - 0.50
Time 2 - 0.99
Phase current - 1.0

KIM101 On-Board Settings

Voltage jumper to DC voltage used

Set Berg jumper to BP5
SW7-1 open
SW7-2 closed
SW7-3 open for 60 hertz
closed for 50 hertz

Refer to the test diagram, Figure 18.

Set SW1 to A. Close SWA (other switches off). Increase the input current until all LEDs come on. The input current at this point should be 0.8-1.2 amps (4.0-6.0 amps).

Set SW1 to B. Open SWA and close SWB. Repeat the above test.

Set Sw1 to C. Open SWB and close SWC. Repeat the above test.

With SW1 at C, Open SWC and close SW3. Repeat the previous test.

Leave SW1 at C, AC input off, open SW3, close SWRT. Only the RETRIP LEDs should come on.

The TARGET LED will come on during each of the tests, except for the last. The target should be reset, using the front panel pushbutton, after each test. Verify that the next test sets it.

Set SW1 to A. Set the input current to 1.5 amps (7.5 amps). Close SWA. Measure the operate time to the BFT output. Operate time should be 1.5 seconds plus 0.1-0.05 second.

AUXILIARY-TIMER-UNIT TEST FOR SBC9100 AND SBC9300

Refer to Figure 19.

Apply positive (+) supply voltage to BA8 by closing SW5. A delayed closure will occur at BA11 and BA12. The time is adjusted by TM-1 on the KTM201 module.

Repeat for auxiliary timer 2. Open SW5. Close SW6. A delayed closure will occur at BA13 and BA14. The time is adjusted by TM-2 on the KTM201 module.

Make sure the input for the timer **not** under test is **open**.

POSITIVE-SEQUENCE OVERVOLTAGE RELAY APPLICATION

DESCRIPTION

The optional positive-sequence overvoltage relay, contained in VPM and MGM106/7 modules, is a totally independent function that may be mounted in the same case as the breaker-failure relay. The positive-sequence overvoltage relay includes its own magnetics module, power supply, test plug and two separately adjustable overvoltage functions: an instantaneous unit and a definite-time overvoltage unit. The instantaneous unit can be set to respond to either the positive-sequence voltage at the relay location, V_{A1}, or the compensated positive-sequence voltage, $V_{A1} - I_{A1}Z_R$, or both. The compensated voltage is intended to reproduce the positive-sequence voltage present on the line Z_R ohms from the relay location. Refer to Figure 20. The definite-time overvoltage unit can be set to respond to either V_{A1} or $V_{A1} - I_{A1}Z_R$, but not both simultaneously.

APPLICATION

The compensated positive-sequence overvoltage function is intended to provide tripping of transmission lines when the line voltage becomes so high as to endanger system operation. The SBC9000 series compensated overvoltage function provides an instantaneous and a time-delayed trip on either the local positive-sequence voltage (V1) or on the compensated positive-sequence voltage ($V1 - I_1Z_R$). The postive-sequence voltage, V1, is intended to measure the voltage at the relay location while the compensated positive-sequence voltage (V_1-I_1Z_A) is intended to approximate the voltage at the far end of the line when Z_R is set to reflect the rise in the line due to capacitance charging.

These functions can provide the following advantages:

1) A local measurement of the balanced voltage.

2) A remote measurement of the voltage at the far end of the line, which can:

   a) Detect high voltage due to an open line and trip the energized end. This is especially important, because with high voltage, more corona may exist on the line and inhibit the proper reception of a carrier transfer-trip signal.

   b) Detect the line that is open, creating the bus high voltage, and provide a selective tripping of the proper line.

This function must be set high enough to allow safe normal operation while tripping for high voltages. Because of the transients involved in line energization, the instantaneous function should be set at least 15% higher than that voltage obtained or calculated for a steady-state line energization.

If the relay reach, Z_R, is set equal to one-half (1/2) of the line impedance, the compensated voltage ($V_{A1} - I_{A1}Z_R$) will be approximately equal to the positive-sequence voltage at the remote end of the line due to the Ferranti effect when the remote terminal is open. A more accurate setting of Z_R may be made if the positive-sequence charging current (I_C) and the voltages at both the near and remote line ends (V_N and V_R) resulting from an open breaker are known. The desired reach setting would be

$$Z_R = \frac{V_R - V_N}{I_C}$$

RATINGS

Temperature Range:

Operating – 20°C to + 65°C.

Hipot Capability:

Per IEC and ANSI/IEEE C37.90-1978

Current Rating:

AC - Continuosly rated 10 amperes (5 amp model)
2 amperes (1 amp model)

AC - One-Second Ratings: 500 amperes (5 amp model)
100 amperes (1 amp model)

DC Voltage Rating:

Jumper selectable, 48, 110/125, 220/250 volts DC
Jumpers on power supply

Power Required: 6 watts untripped (approximately)
11 watts tripped (approximately)

Operating Range: 80-115% of nominal

Adjustment Ranges:

Mag Module - I nominal: 1 ampere or 5 amperes by changing the magnetics module
V nominal: 63.5 volts/50 hertz, or 69 volts/60hertz, selected (line-to-neutral) by links inside magnetics module.

Pickup voltages for instantaneous and time-overvoltage units are separately adjustable by means of front-panel switches. Adjustment ranges are 60 to 120 volts, in 1 volt steps.

Reach for compensated units is adjusted by "REACH" switches on the VPM module, and a tap block inside the magnetics module. The reaches are adjustable as follows:

I nominal Rating	Magnetics Module Tap Block	Board Switches Reach Range (ohms)	Steps (ohms)	Multiplier of Board Marking
5 ampere	short (S)	0.2 - 5	0.02	1
5 ampere	long (L)	2 - 50	0.2	10
1 ampere	short (S)	1 - 25	0.1	5
1 ampere	long (L)	10 - 250	1.0	50

Links on the board module (L201 and L202) permit the customer to select either "V1" or "V1-I1Z," or both for the operating quantity for the instantaneous unit.

The operating quantity for the time overvoltage unit can be customer selected as either "V1" or "V1-I1Z" by means of another link; (L203) on the board module.

The time overvoltage unit is definite time with a range of 0.22 to 5.1 seconds in 0.08 second steps. The time is adjusted by means of the "TIME" internal switches on the VPM module, and is equal to 0.06 plus the sum of the switches whose toggles are to the right.

Trip Indicators

Front-panel light-emitting diodes (with latching reed-relay drivers to hold trip status) are provided for the instantaneous (I) and time (T) overvoltage units.

A third light-emitting diode (without latching means) indicates when the time overvoltage unit is timing (P).

The instantaneous and time-overvoltage light-emitting diodes are reset by means of a front-panel pushbutton switch. Contact-current rating for the instantaneous and time-overvoltage units are:

Make for trip duty - 30 amperes

Carry continuously - 3 amperes

CHARACTERISTICS

Overvoltage Time Delay:

Pickup time - 0.22-5.1 second, adjustable in 0.08 second steps

Dropout time - 64 milliseconds, nominal

Output-Relay Operate Times:

Pickup time - 5 milliseconds

Dropout time - 8 milliseconds

POSITIVE-SEQUENCE OVERVOLTAGE MODULE SETTINGS

MGM106, MGM107

There are two versions of this magnetic module. MGM106 is for 1 ampere models and MGM107 is for 5 ampere models. Each version can be set for either 50 hertz or 60 hertz. See Figure 24 for the location of these links. Each version can be set for either long (L) or short (S) reach. See Figure 25 for the location of these tap terminals.

Positive-Sequence Overvoltage Module, VPM101 and VPM102 (Refer to Figure 26)

This module contains circuitry to obtain the positive-sequence components of the voltage, V1, and current, I1. The gain of the positive-sequence-current circuit I1 is adjustable in steps to set the reach (Z). Provision is made to sum V1 and I1 to produce a signal, V1 – I1Z. The signals V1 and V1 – I1Z are rectified and applied to two threshold detectors. The thresholds are set by front-panel switches.

One threshold detector is the instantaneous threshold. Board jumpers (L201 and L202) are provided so it can be driven by V1, V1 – I1Z, or both V1 and V1 – I1Z. When the chosen signal or signals exceed the instantaneous threshold, a signal goes to the instantaneous-trip relay in the magnetics module.

The time-threshold circuit can be driven with either V1 or I1Z, but not both, using board jumper L203. When the threshold is exceeded, a timer is started. When it times out, a signal goes to the time trip-relay in the magnetics module. The timer is settable.

Three LED indicators are provided on the front panel. The trip indicators can be reset by a front-panel pushbutton labeled "RESET". This pushbutton both resets the indicators and lights the red LEDs when actuated, so it also serves as an LED test.

These controls and indicators are tabulated below:

Front-Panel Light-Emitting Diodes

Identity	Color	Indication	Description
P	Amber	Time threshold exceeded	Provided for operator convenience
I	Red	Instantaneous Trip	Instantaneous trip occurred
T	Red	Time Trip	Time trip has occurred

Front-Panel Switches

Identity	Type	Function	Description
I	6-stage miniature toggle	Instantaneous trip level set	Instantaneous trip level (volts) equal sum of ON switch values, plus 60.
T	6-stage miniature toggle	Time trip level	Time trip level (volts) equals sum of ON switch values plus 60.
Reset	Pushbutton	Reset target LEDs Also LED test	Resets the latching reeds that drive the TRIP LEDs. Lights the TRIP LEDs when pressed.

Internal Switches

Identity	Type	Function	Description
Reach	8-stage miniature toggle	Sets reach	Reach is sum of ON switch value, + 0.2 (5 amp). Reach value is modified by mag module current rating and tap setting. Multiplier is:

RATED CURRENT (I_N)	MAGNETIC MODULE TAP	MULTIPLIER
5	S	1
5	L	10
1	S	5
1	L	50

Internal Switches (cont'd)

Identity	Type	Function	Description
Time	6-stage miniature toggle	Sets time trip delay	Time delay is sum of ON switch values, plus 0.06 second.

Internal Link

Identity	Function	Description
L201	Selects V1 as a source for instantaneous trip	IN position connects V1 to instantaneous output circuit.
L202	Selects V1-I1Z as a source for instantaneous trip	IN position connects V1 – I_{1Z} to instantaneous output circuit.
L203	Selects either V1 or V1-I1Z as a source for time trip	Jumper has two positions, each selecting marked signal.

ACCEPTANCE TESTS - POSITIVE-SEQUENCE OVERVOLTAGE RELAY

It is recommended that the following tests be performed on receipt of the equipment, and before installing the equipment if it has been in storage for a time before use.

The test conditions chosen are not particularly significant and other values can be used. If the values for a particular installation are known, they can be used to test the relay for that installation. In testing the voltage functions, only one of the three phase voltages is varied. The positive-sequence voltage with unequal voltages can be calculated as:

$$V1 = \frac{1}{3}(VA + VBa + VCa^2)$$

assuming VA, VB and VC have the specific 120° phase relationship.

DIELECTRIC TESTS

CAUTION: **When hipot testing, it is necessary to remove the jumpers between terminals BD13 and BD14. This removes the grounding connection between the surge capacitors and case ground. Failure to do so could result in damage to the filter capacitors on the PSM module.**

A. Common-Mode Tests

1. Remove all modules. Tie all studs together (except AD13 and AD14) and hipot at 2.5 kV for one second to the case.
2. Install the PSM and MGM modules, and again hipot all studs to the case.
3. Install the VPM module and hipot all studs to the case a third time.

B. Transverse-Mode Tests

Form the following hipot groups by jumpering together the indicated studs. Hipot between the groups.

1. AB1, AB2
2. AB3, AB4
3. AB5, AB6
4. AB7, AB8
5. AB9, AB10
6. AB11, AB12
7. AC1, AC2, AC3, AC4
8. AC7, AC8, AC9
9. AD1, AD5
10. AD2, AD6
11. AD3, AD7
12. AC13, AC14

FUNCTIONAL TESTS (Refer to Figure 27 and 28)

A. Initial Relay Settings:

Module	Type of Adjustment	No. of Adjustments	Name of Adjustment	Initial Position
MGM106/MGM107	LINK	3	50/60	Rated Frequency
"	TAP BLOCK	3	L/S	S
VPM102	LINK	1	L201	IN
"	"	1	L202	OUT
"	"	1	L203	V1
"	BOARD SWITCH	1	REACH	5
"	" "	1	TIME	5.12
"	FRONT PANEL SWITCH	1	I	120
"	" " "	1	T	120

B. Test Connections and General Instructions

1. Connect the relay per Figure 27. Turn on the DC power supply and check that the green lamp on the PSM module is lit.
2. Red LEDs "I" and "T" on the front panel of the VPM module are latching type and should remain lit after pickup conditions are removed. The front panel "RESET" pushbutton must be operated to turn these LEDs off. This pushbutton switch also tests these LEDs, so both the "I" and "T" LEDs should be lit whenever the "RESET" pushbutton switch is operated.
3. Amber LED "P" does not latch and should only be lit when the "TIME" level detector is at or above pickup. This LED is more convenient for checking the "TIME" unit pickup, to avoid waiting for the time delay.

4. Test-circuit LEDs "INST" and "TIME" are non-latching and should be lit only when the inputs are at or above the pickup settings of the "INSTANTANEOUS" and "TIME" units, respectively.

5. The input current, "I_A", should only affect the pickup of the "INSTANTANEOUS" unit when L202 is in the IN position.

6. The input current, "I_A", should only affect the pickup of the "TIME" unit when L203 is in the "V1-I1Z" position.

NOTE: When MGM106 is used (1 amp system) the current values in ( ) parentheses should be used.

C. Performance Tests

1. Open the I_A switch. Set VB and VC to 120 volts rms. Raise VA in one-volt increments until front-panel LEDs "I" and "P" and test-circuit LED "INST" are all lit (see step B2). None of these LEDs should light before VA reaches 102 volts, and all three should be lit before VA reaches 138 volts rms. If the pickup conditions are maintained for approximately five (5) seconds, front-panel LED "T" and test-circuit "TIME" LED will also light.

2. Change "I" and "T" front panel switches to 90 volts. Set VB and VC to 90 volts RMS. Repeat step C1, except limits for VA are 76 to 104 volts rms.

3. Change "I" and "T" front panel switches to 60 volts. Set VB and VC to 60 volts rms. Repeat step C1, except limits for VA are 51 and 69 volts rms.

4. Close the I_A switch and set the current to 4 (0.8) amps with a phase angle that leads VA by 95°. Repeat step C3.

5. Change VPM module links L201 to "OUT," L202 to IN," and L203 to "V1-I1Z." Repeat step C4, except limits for VA are 31 to 49 volts rms.

6. Change the phase angle of I_A to lag VA by 85°. Repeat step C5, except the limits for VA are 71 and 89 volts rms.

7. Change the tap block in the MGM module to "L". Set the I_A current to 0.4 (0.08) amperes and repeat step C6.

8. Set the I front-panel switch to 120 volts. Set the T front-panel switch to 70 volts. Set VA, VB and VC to 60 volts. Set the I_A current at 2 (0.4) amperes at a phase angle that leads VA by 95°. Close the I_A switch and check that the trip time is between 4.9 and 5.4 seconds.

9. Change the test connections to those shown in Figure 28. Set the I and T front-panel switches to 60 volts. Set I_A, I_B and I_C for 0.4 (0.08) amperes with I_A leading VA by 95°, I_B lagging VA by 25° and I_C lagging VA by 145°. Raise VA until the I and P LEDs are lit. Neither LED should be lit before VA reaches 102 volts rms, and both should be lit before VA reaches 138 volts.

10. Set VA to zero (0) volts. Set I_A, I_B and I_C to 2 (0.4) amperes, with the same phase relationship used in C9. Check that the I and P LEDs do not light.

POWER SUPPLY - PSM211/212/213

These power supplies are high-efficiency DC-to-DC converters. They include short-circuit and overvoltage protection. They are also internally fused. A form-c relay, whose contacts are brought out to the card edge connector, indicates an overvoltage or undervoltage condition.

Due to the good regulation and high efficiency of the supply, it draws essentially constant power from the source when delivering constant output power. For this reason, input current increases with decreasing source voltage.

Ratings

Input Voltages: 48, 110/125, 220/250 volts DC, (Depending on model)

Outputs: + 12 volts, – 12 volts, + 25 volts, with same common. Any supply can deliver up to one (1) ampere within the 40 volt-ampere total limit for the supply.

25 volts at 0.2 ampere isolated

Maximum volt-ampere output rating - 40 volt-amperes

Description (Refer to Figure 29)

Front Panel Light-Emitting Diode

Identity	Color	Indication	Description
Regulated Output Voltage	Green	Regulated output is present	Indicates when the power supply is ON.

Front Panel Switches

Identity	Type	Function	Description
On-Off	Toggle	Turns power supply on and off	Permits local control of supply operation.

Voltage	Ratings
PSM211	48VDC
PSM212	110/125 VDC
PSM 213	220/250 VDC

CONSTRUCTION

The SBC9000 systems consist of plug-in modules housed within an aluminum case. A case can include an optional positive-sequence overvoltage function, and either a single-pole (SBC9100) or three-pole (SBC9300) breaker-failure relay.

ALUMINUM CASE ASSEMBLY

Construction

The case is fabricated from sheet Aluminum. Overall case dimensions are given in the **SPECIFICATIONS** section.

The front cover consists of plate glass with an aluminum frame. It is hinged on the top, and opened from the bottom by way of two spring-loaded plastic latches. The case is painted with a textured-finish baked enamel.

The modules are mounted vertically. The sockets within the case (towards the rear) serve as mechanical supports as well as the means of electrical connection. They hold the modules firmly in position. In addition, the front cover, when closed, provides further restraint on the modules. Proper alignment is maintained by slotted plastic guides, one above and one beneath each module (with the exception of the MGM modules, which require two guides above and two beneath).

Electrical Connections and Internal Wiring

External connections are made to eight terminal blocks mounted on the rear cover plates. Each block contains 14 terminal points, which consists of a Number 6 screw threaded into a flat contact plate. Plastic covers are included over every terminal block. These reduce electrical-shock hazard and protection against inadvertent short circuits between terminals. These covers are held on by plastic clips and are easily removed by hand (no tools necessary). There are slots in the covers above and below each terminal point to guide the incoming wire dress. In addition, there are small holes in the covers directly in front of each terminal point, which allow probes to be inserted so that points may be tested without having to remove the protective cover.

Connection to the printed-circuit-board modules is made by means of 60-pin edge connectors. Connection to the MGM modules (two in each case if the positive-sequence overvoltage option has been selected) is made by means of two connector sockets: an 8-contact current block and a 104-pin signal block. The current-block contacts are rated to handled current-transformer (CT) secondary currents.

Test Connections

Connections for the periodic tests should be made using the XTM test plugs described below. The test circuits are identical to those used for the acceptance tests, except that test-plug terminal points are substituted for rear-cover terminal points.

XTM TEST PLUGS

Description

The XTM test plugs are designed specifically for post-installation testing of the SBC9000 system. There are two plugs; XTM28L1 (left-hand plug) and XTM28R1 (right-hand plug), each providing access to fourteen relay and fourteen system points. The system points are located on the outer edge. The plugs are keyed by the contact-finger arrangement so that there may be no accidental interchange between the left-hand and right-hand plugs.

The plugs are fitted with a sliding handle that swings out to facilitate wiring to the terminals. The terminals consist of number 8 screws threaded into flat contact plates. The handles each have a tab on the outside to guide the wire dress of the test leads.

Terminal Designation

The test receptacle and connection plugs are located to the left of the SBC magnetics module (extreme left-hand position). Their terminals are labeled 1 through 28 with 1 through 14 corresponding to the left-hand side and 15 through 28 corresponding to the right-hand side. These points are designed on the elementary diagram as TP1 through TP28.

The left-hand test plug (XTM28L1) terminals are labeled 1R through 14R and 1S through 14S for the relay side and system side, respectively, with the system side labeled in red. Similarly, the right hand test plug (XTM28R1) terminals are labeled 15R through 28R and 15S through 28S.

XTM Test Circuit Connections

Test circuit connections, designated as TP points in the diagrams, should be made to the relay side of the test plug. Where it is desired to use available system quantities for testing, e.g., DC control power, jumpers may be inserted between system side and relay side test plug terminals.

CAUTION: Appropriate precautions should be taken when working with station battery DC.

Connections should be made to the test plugs prior to their insertion into the SBC9000. As mentioned earlier, wiring is facilitated by the slide-out, swing-away handles.

Test-Plug Insertion

To insert the test plugs, the two connection plugs must first be removed. In so doing, electrical continuity is broken between the power system and the SBC9000 for those signals that are wired through the test receptacle (refer to TP points on elementary diagrams). For the terminals connected to the current-transformer secondaries, shorting bars are included on the system side of the test receptacle. These are clearly visible through the transparent plastic face plate on the receptacle. The shorting bars make contact before the connection-plug contacts break during removal, so that the CT secondaries are never open-circuited.

Both test plugs may be inserted at the same time. Otherwise, if using only one test plug, the connection plug may remain in the other half of the receptacle.

When the test plugs are inserted into the receptacle, the power system remains isolated from the SBC9000 in so far as the test signals are concerned.

WARNING

IT IS CRITICAL THAT JUMPERS BE INSERTED ON THE SYSTEM SIDE TEST PLUG TERMINALS THAT ARE CONNECTED TO THE CT SECONDARIES.

IF THESE JUMPERS ARE INADVERTENTLY LEFT OUT, THE RESULTING HIGH VOLTAGES DEVELOPED PRESENT A SERIOUS HAZARD TO PERSONNEL AND MAY SEVERELY DAMAGE CONNECTED EQUIPMENT.

Again refer to the elementary diagram for the proper TP points.

DC Disconnect

The primary DC control power feeding the power-supply module (PSM) may be disconnected by removing the magnetics module.

The printed-circuit-board edge connectors and the MGM-module connector sockets are mounted on the same backplane assembly, approximately 23 centimeters (nine inches) from the front of the case. The receptacle for the connection plugs and test plugs (i.e., the test receptacle) on the other hand, is mounted only four (4) centimeters (1.6 inches) from the front of the case.

With the exception of the leads that carry the CT secondary currents, internal wiring from module connectors to the test receptacle, and to the rear-cover terminal blocks, utilizes the wire-wrap method. For wiring between the module connectors, the pattern is random except for signal paths sensitive to coupling. The sensitive wires are arranged in harnesses and the harnesses are routed such that they cross at right angles in order to minimize the electrostatic and electro-magnetic coupling effects. All wires connecting to the test receptacle and to the rear terminal blocks are arranged in harnesses. The internal wires leading to the interconnection cable sockets are also arranged in harnesses.

All the current inputs are brought in on the two lower rear-cover terminal blocks (lower blocks, rear view). These blocks are rated to handle the CT secondary currents. The internal current leads are made from substantially heavier-gage wire than the remainder of the internal wiring. They are held to the shortest length practical to minimize the resistive burden on the CT's. Connection is made via crimped-on terminals. These leads are arranged in their own harnesses and are segregated as much as possible from the other wiring. Again this is done to minimize the coupling of the fields associated with the current-carrying conductors onto the low-level-signal conductors. Insofar as possible, the breaker-failure modules are at the left, and positive-sequence-overvoltage-function modules are at the right (viewed from the front).

It should be noted that certain standard internal-wiring arrangements are used in the construction of SBC9000 systems. This of course means that in some instances internal wiring is not used because a particular functional module is not included. The use of standard wiring permits simple additions of features in the field.

Identification

The SBC9000 system model number is indicated on a label located on the inside of the front cover in the lower left-hand corner.

A marking strip that indicates the name and position of every module in a given case is included on the lower inside edge of the front cover. It is placed to be read when the front cover is fully opened.
The terminal blocks are identified by two letter codes, which are given on labels directly beneath the left-hand edge (rear view) of each block. There are eight terminal blocks on the back of the case, each of which have a unique code (AA through BD) in order to avoid confusion when making external connections.

On each terminal block, the screw terminals (1 through 14) are labeled top and bottom by stamped numbers. The numbers are visible even when the protective covers are in place.

PRINTED-CIRCUIT-BOARD MODULES

Basic Construction

Each module consists of a printed-circuit board and attached front panel mounted perpendicular to the board. Two knobs are provided on the front panel for removing and inserting the module. Electrical connection is made by contact pads at the back edge of the board.

In those cases where the circuit modules do not fill the available space, dummy modules are inserted. These consist simply of a blank board and a blank front panel.

Identification

Each module has its own model number, consisting of a three-letter code followed by a three-digit number. These are given at the bottom of each front panel and may be read only when the case cover is opened.

RECEIVING, HANDLING AND STORAGE

The SBC9000 system is shipped in one carton. Immediately upon receipt, the equipment should be unpacked and examined for any damage sustained in transit. If damage resulting from rough handling is evident, file a damage claim at once with the transportation company and promptly notify the neatest General Electric Sales Office.

If the equipment is not to be installed immediately, it should be stored indoors in a location that is free from moisture, dust, metallic chips, and severe atmospheric contaminants.

INSTALLATION

ENVIRONMENT

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

MOUNTING

The SBC9000 case has been designed for standard rack mounting. The case measures four rack units (4RU) in height. Refer to the outline diagram, Figure 30.

The units may also be flush mounted on a panel with an appropriate cutout. Refer to Figure 30 for the required dimensions.

Provision has been made for surface-panel mounting as well. This is accomplished by removing and reversing the side brackets so that the mounting wings are in the rear. For surface mounting, cutouts must be made in the panel to allow for the terminal blocks and interconnection cable(s).

EXTERNAL CONNECTIONS

External connections are made according to the elementary diagrams, Figures 8 or 10 and 23. This is a general diagram incorporating all of the available options. Connections need not be made to those terminals associated with options not included in the equipment purchase.

PERIODIC CHECKS AND ROUTINE MAINTENANCE

It is recommended that relays in operation be tested once a year by repeating the acceptance test procedures. Relays stored for a year or more should be tested, using the acceptance test procedures, prior to installation.

SERVICING

Should the relay fail to operate, check that the power-supply indicator is on. If it is not, there may be no DC control voltage applied to the relay. If DC is present, the power-supply board may be defective, and a new one should be tried. The two power supplies in the rack are identical, and may be interchanged.

The simplest troubleshooting technique is to substitute boards until the bad board is found. If this method does not resolve the problem, then it is likely that the trouble is in the external wiring. It is possible to have a problem in the case wiring, but this is not common.

An extender board is available to facilitate servicing. Order Board Extender 0138B7406.

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.

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 buses. The repaired area must be recovered with a suitable high-di-electric plastic coating to prevent possible breakdowns across the printed-circuit buses 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 in printed-circuit cards that 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 part wanted, and give the complete model number of the relay for which the part is required.

LIST OF FIGURES

Since the last edition, Figure 29 has been revised.

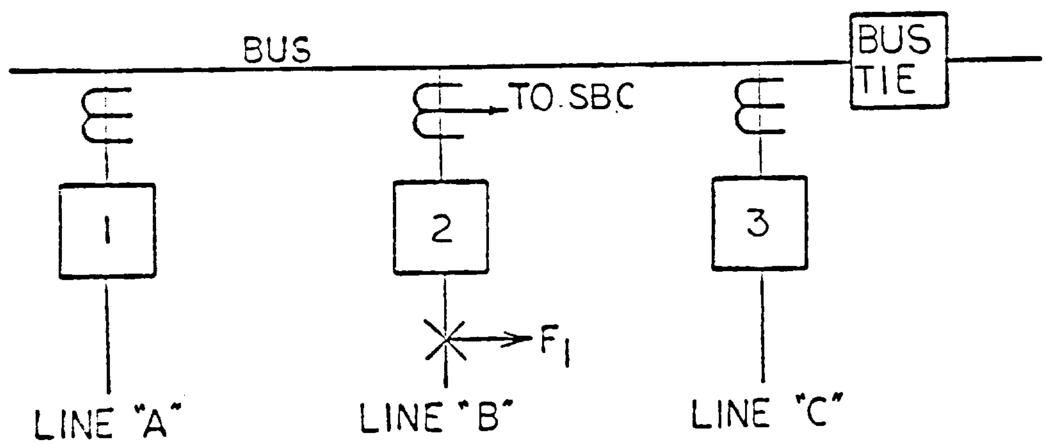


Figure 1 (0246A2279-1) Bus Arrangement: Single Bus/Single Breaker

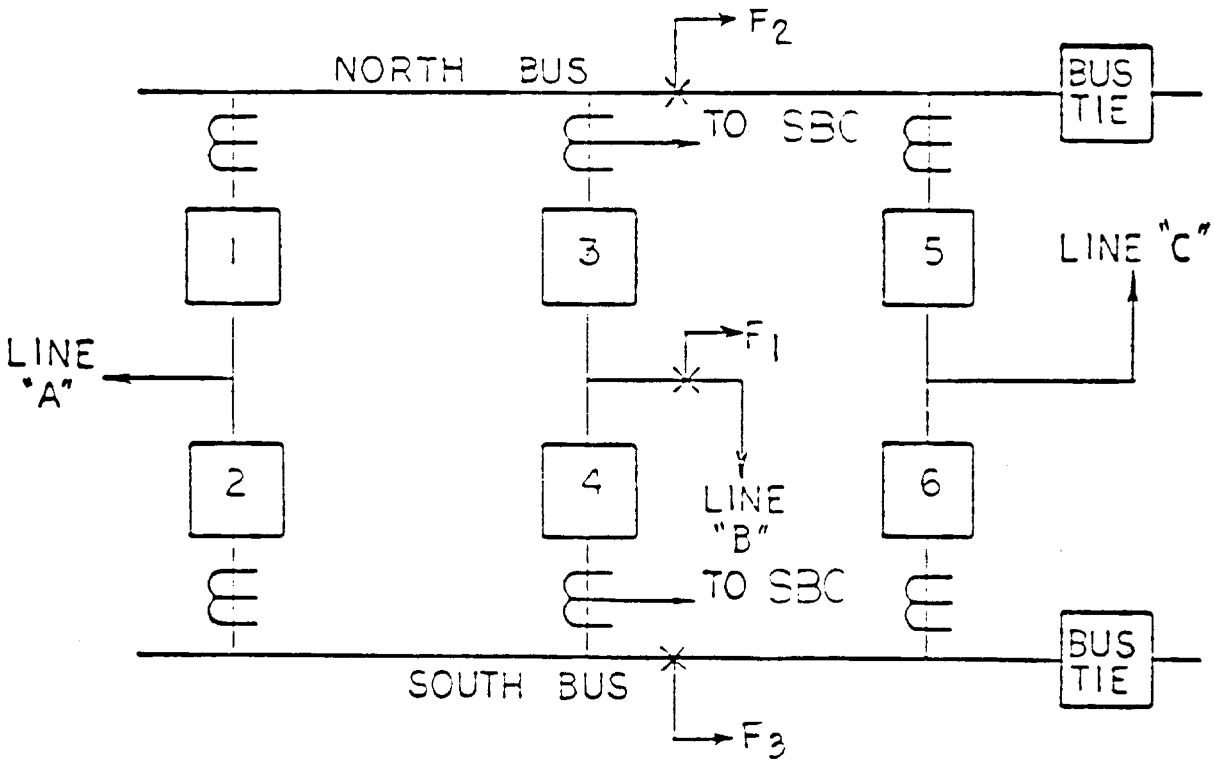


Figure 2 (0246A2277-2) Bus Arrangement: Double Bus/Double Breaker

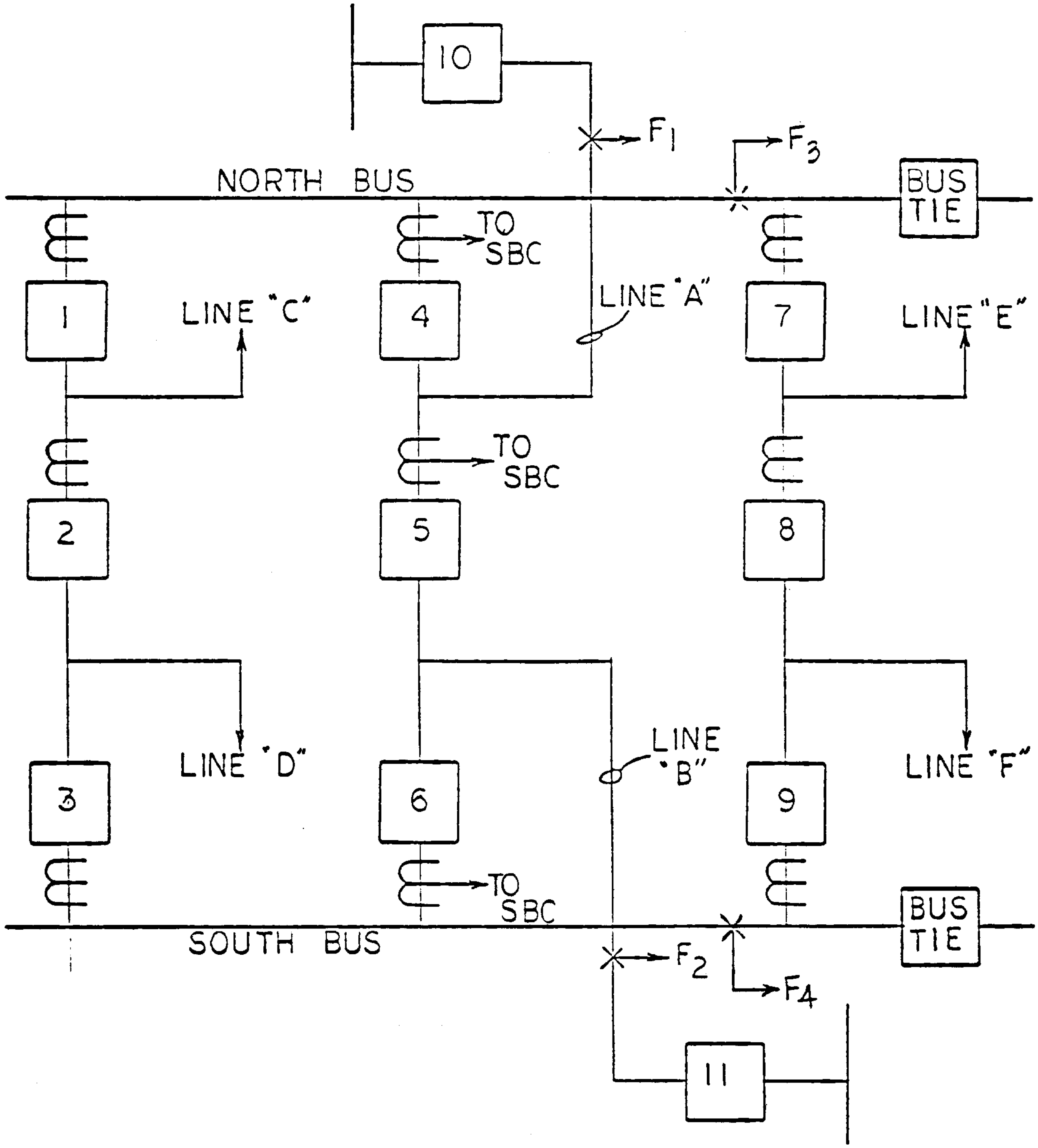


Figure 3 (0246A2280-2) Bus Arrangement: Breaker and a Half

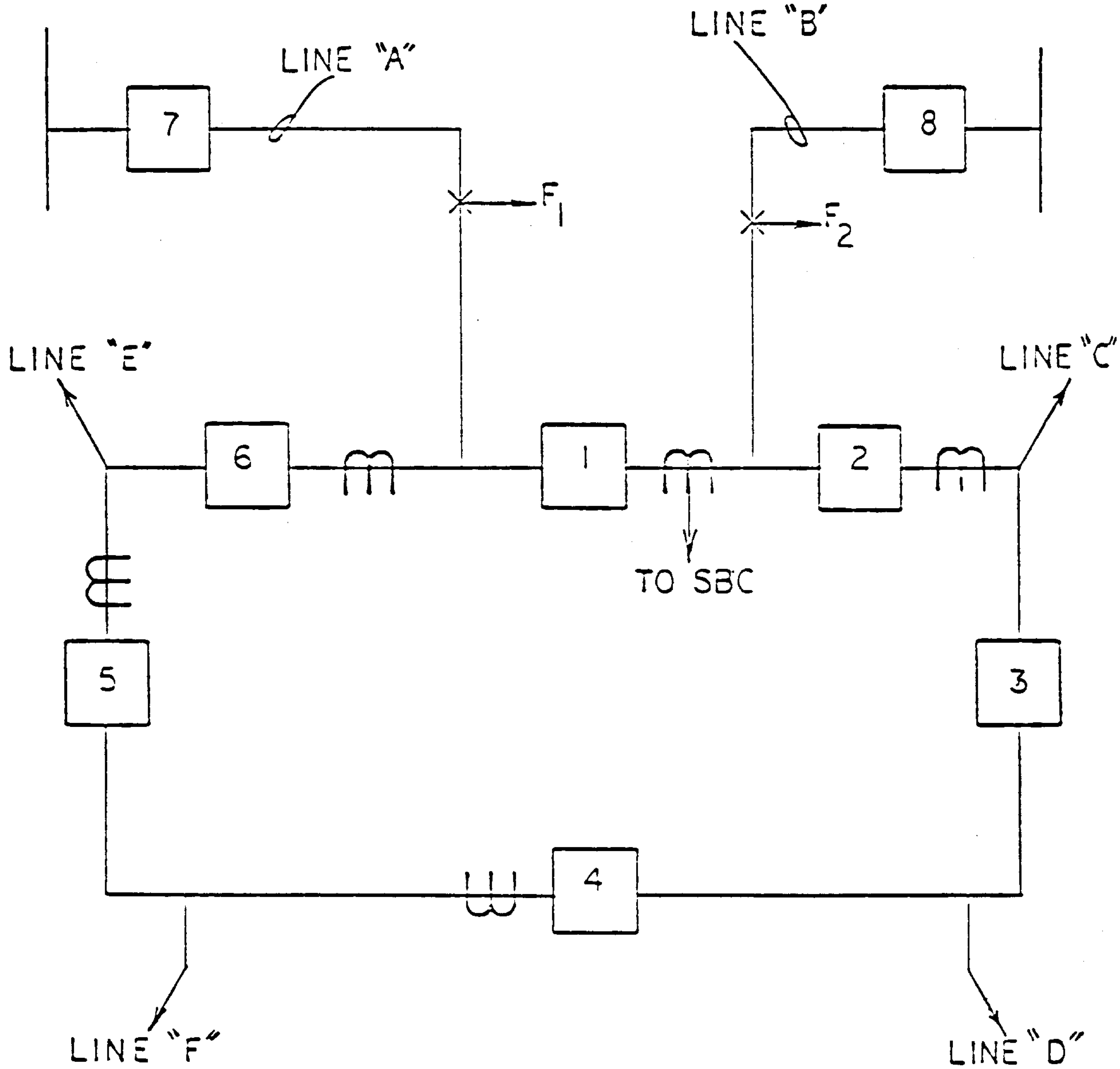


Figure 4 (0246A2278-1) Ring Bus Arrangement

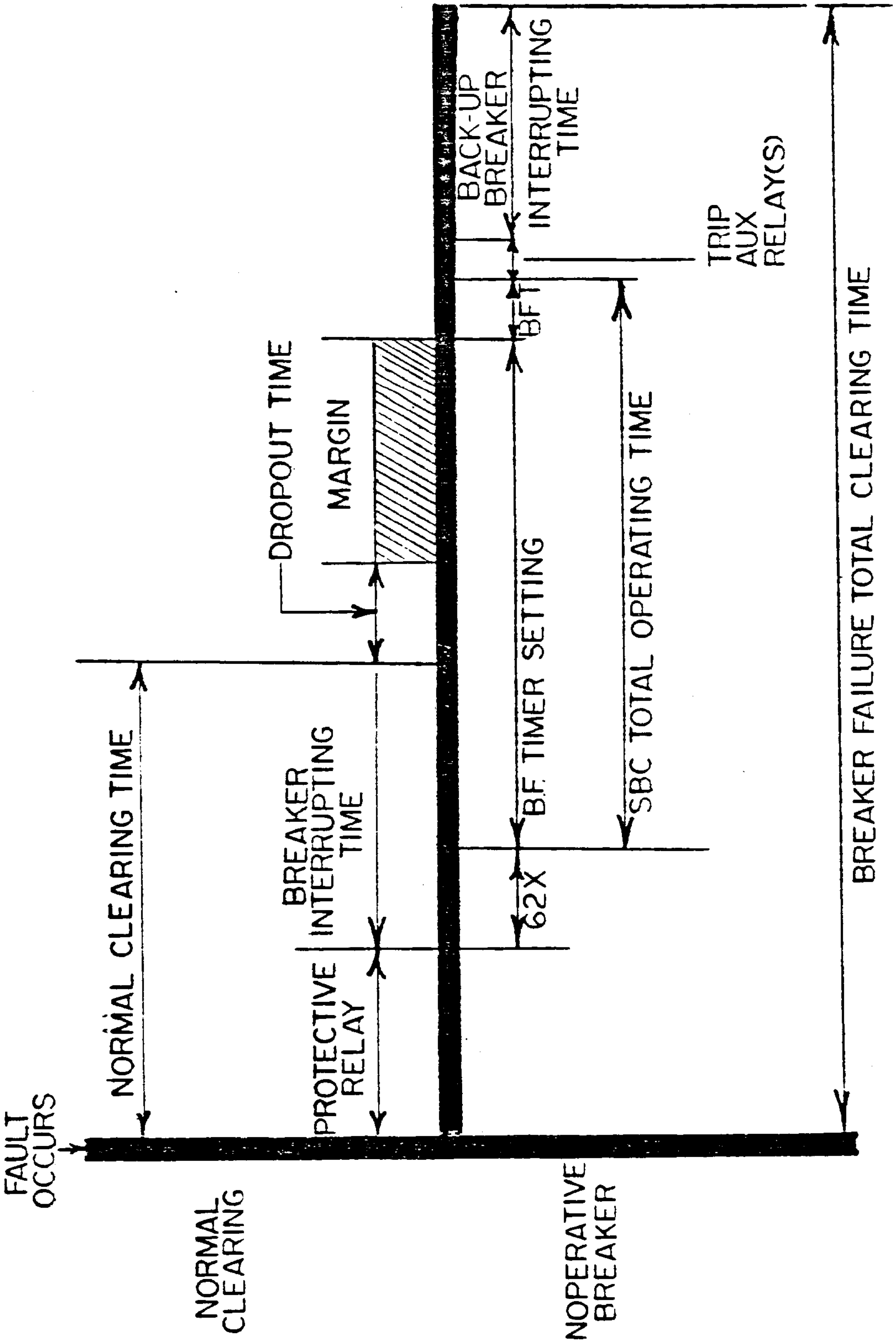
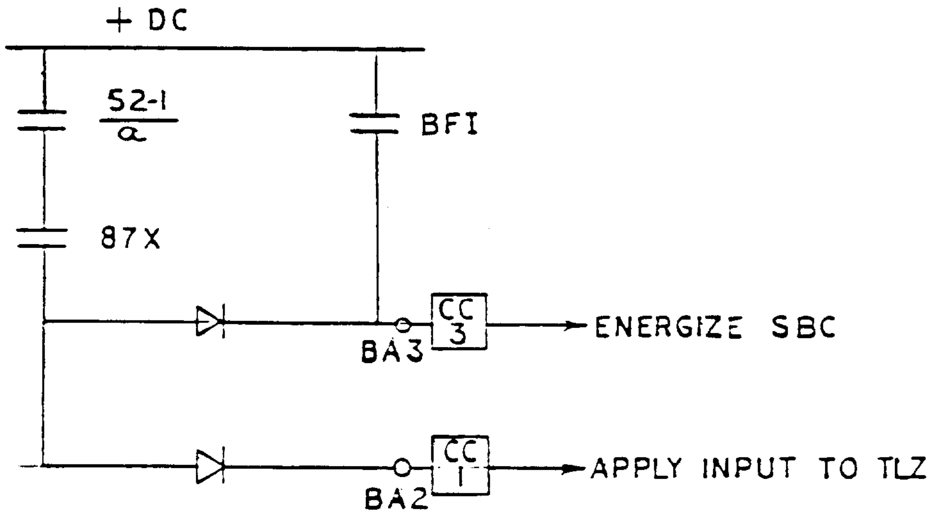


Figure 5 (0285A8160) Breaker-Failure Timer Settings



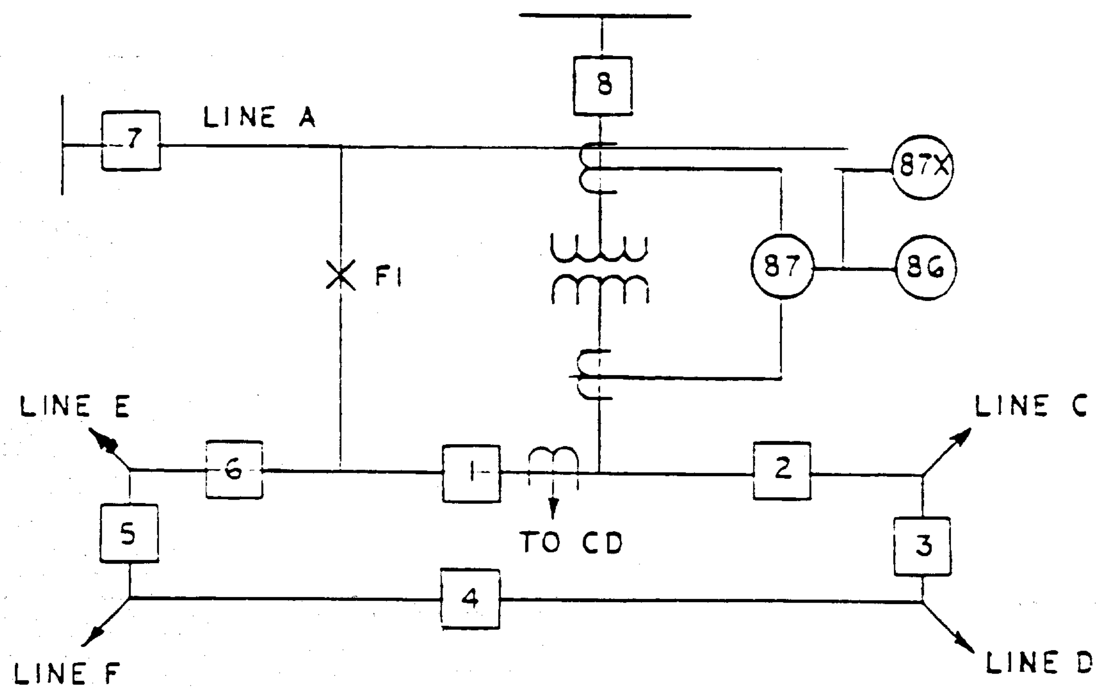


Figure 6 (0285A8123) Protection Scheme for a Breaker Shared by Line and System Transformer

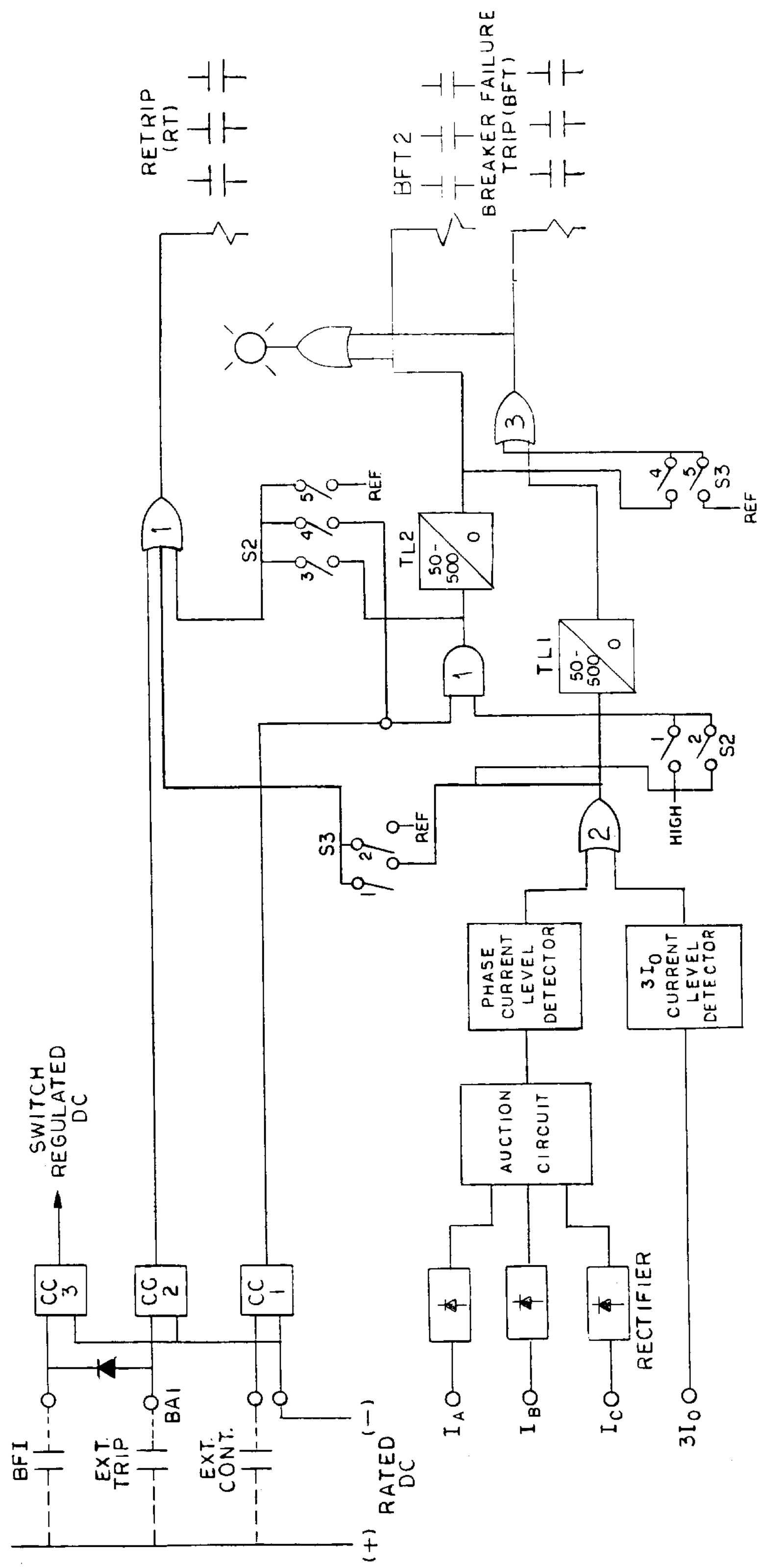


Figure 7 (0138B7779-2) Logic Diagram for Type-SBC9300 Relay

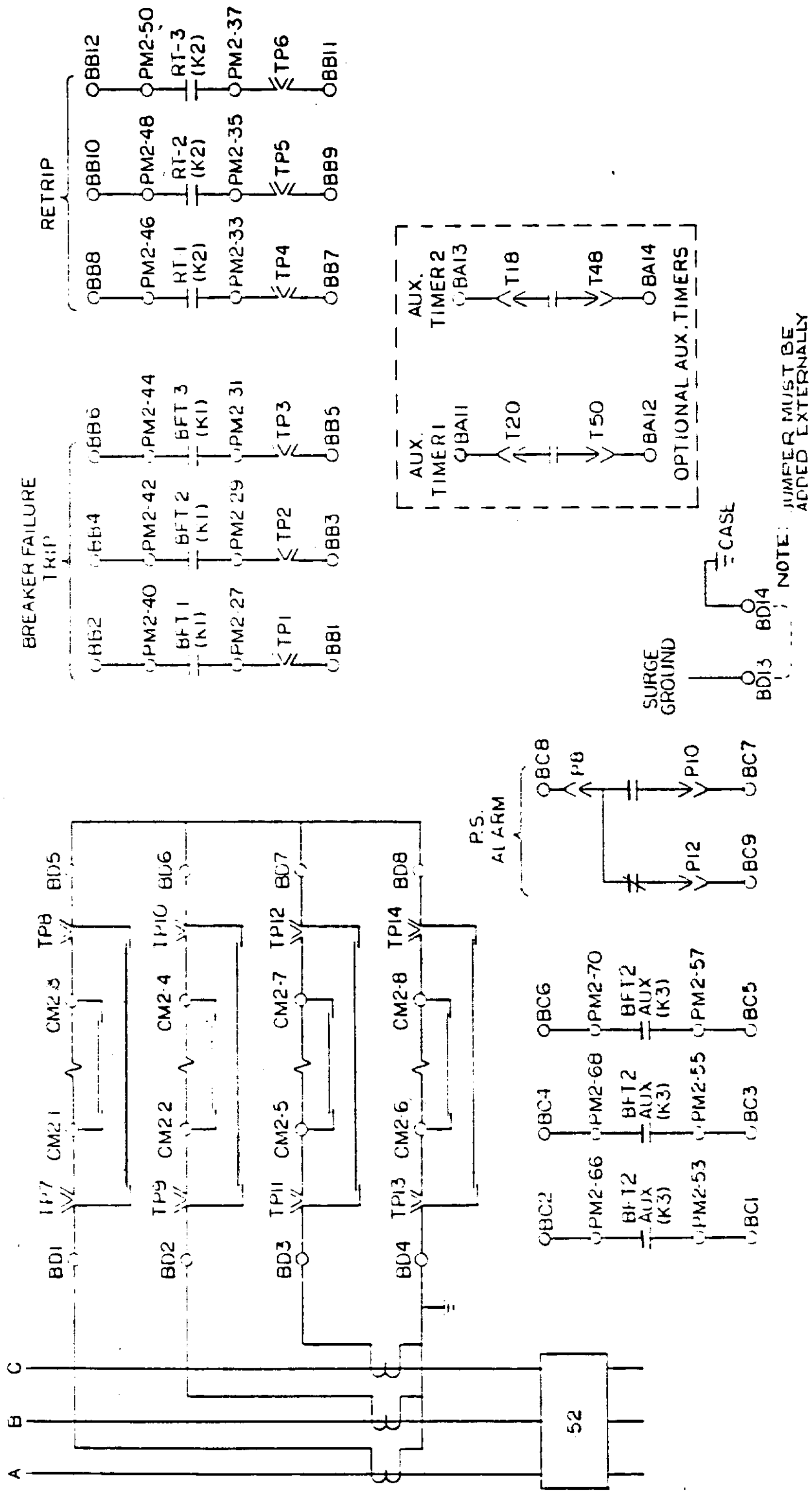


Figure 8A (0138B7782 Sh.1 2) Elementary Diagram for Type-SBC9300 Relay

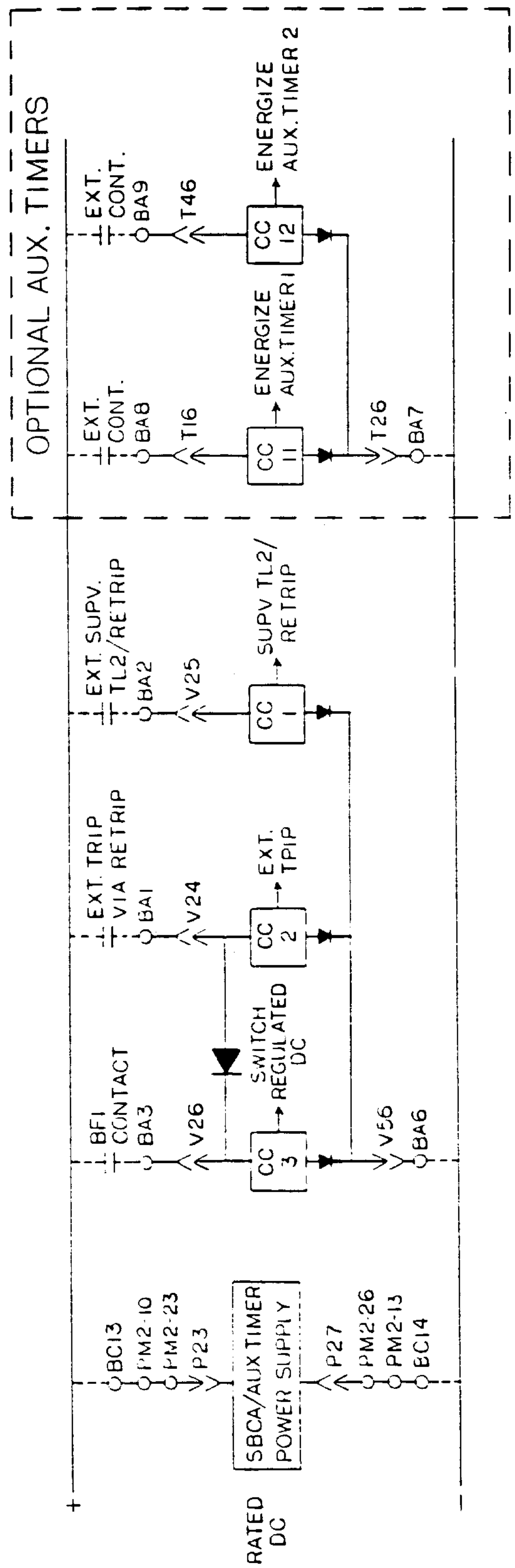


Figure 8B (0138B7782 Sh.2 1) Elementary Diagram for Type-SBC9300 Relay

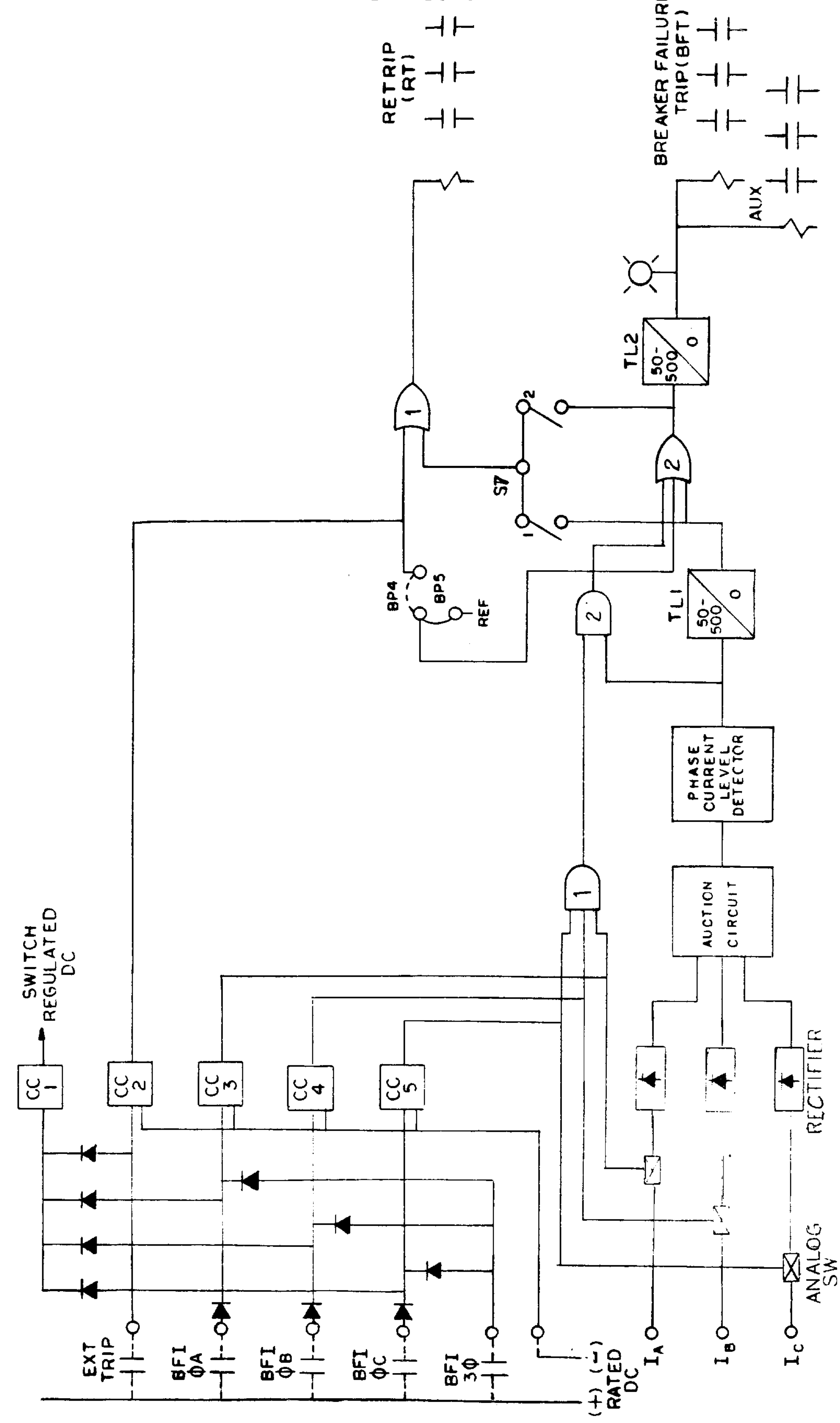


Figure 9 (0138B7780 [3]) Logic Diagram for Type-SBC9100 Relay

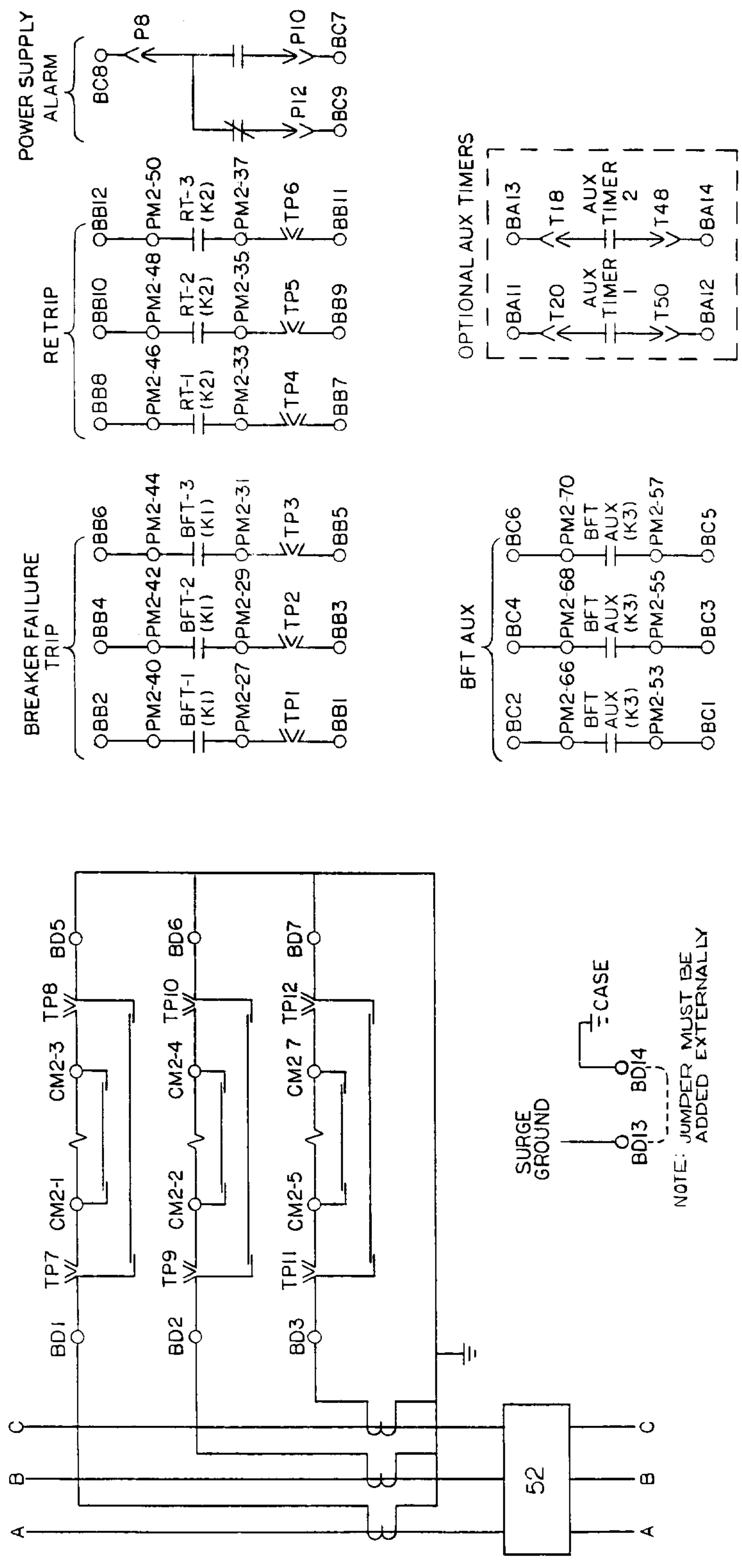


Figure 10A (0138B7784 Sh.1 2) Elementary Diagram for Type-SBC9100 Relay

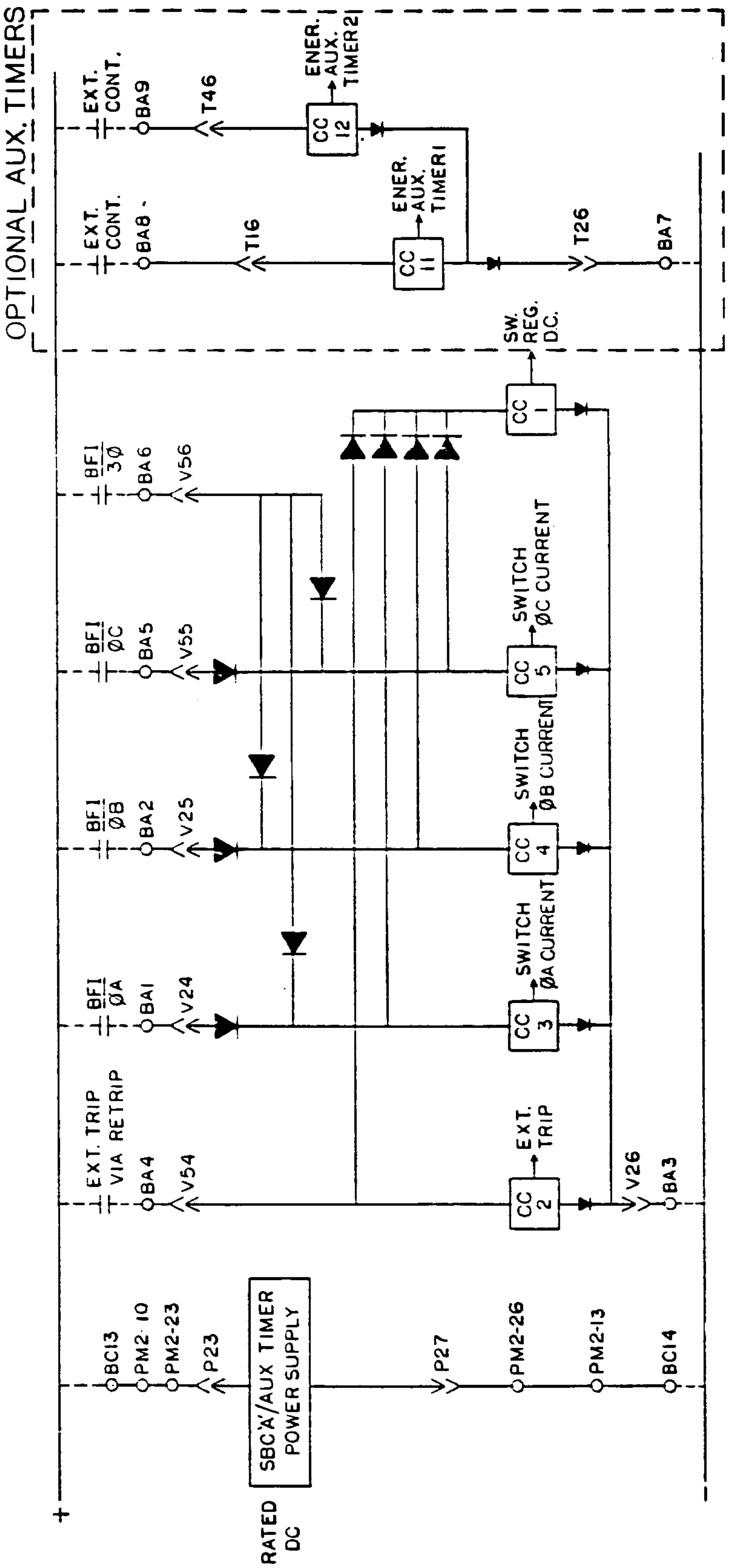


Figure 10B (0138B7784 Sh.2 2) Elementary Diagram for Type-SBC9100 Relay

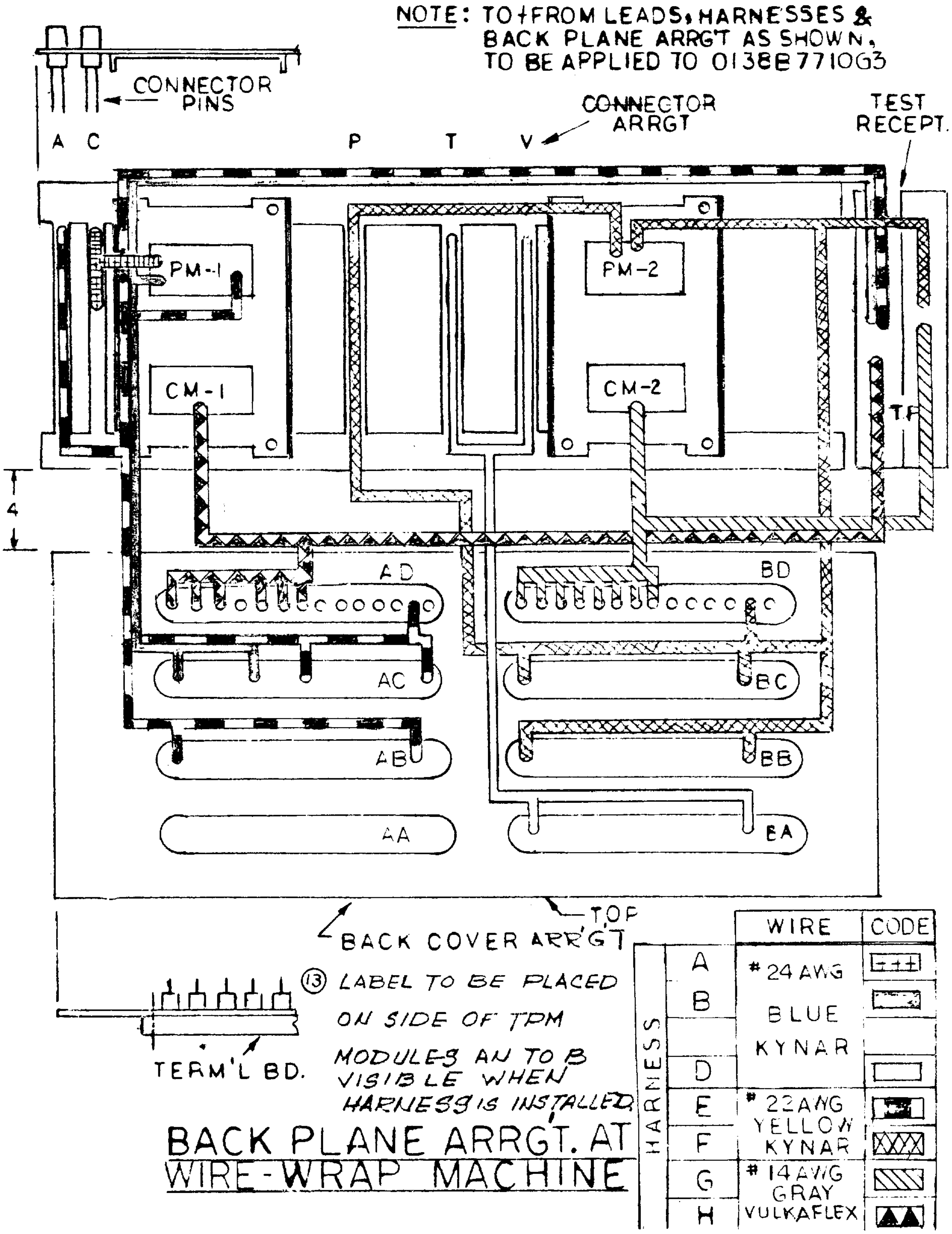


Figure 11A (0285A7113 Sh.2 2) Breaker-Failure Relay - Case Wiring, From-To List

SHORTEST ROUTING

ALL LEADS PT-4 (# 24AWG-BLUE-KYNAR) FROM PARTS LIST, THIS DRAWING, SHEET NO.1

FROM	TO	
A-31	A-60	
A-34	C-28	
C-10	C-12	
C-9	C-10	
C-11	C-42	
C-12	C-13	
C-11	C-15	
C-19	C-25	
C-39	C-41	
C-43	C-22	
A-31	GRD	[D]
C-30	PM1-104	
A-21	PM1-103	
A-25	PM1-102	
A-4	A-34	
A-6	A-36	
A-8	A-38	
A-10	A-40	
A-12	A-42	
A-21	A-51	
A-23	A-53	
A-25	A-55	
A-27	A-57	

FROM	TO	
V-1	PM2-89	
V-4	PM2-87	
V-10	PM2-10C	
V-14	PM2-88	
V-16	PM2-101	
P-34	V-28	
T-28	V-28	
V-11	PM2-79	
V-15	PM2-92	
V-12	PM2-80	
V-17	PM2-93	
P-31	GRD	[D]
V-30	PM2-104	
P-4	P-34	
P-6	P-36	
P-8	P-38	
P-10	P-40	
P-12	P-42	
P-23	P-53	
P-27	P-57	
V-31	V-60	

FROM	TO
A4	PMI-93
A23	PMI-23
A27	PMI-26
C23	PMI-79
C55	PMI-92

Figure 11B (0285A7113 Sh.3 4) Breaker-Failure Relay - Case Wiring, From-To List

ALL NO. 24 AWG * — COLOR CODE: [X] B [ ] G [ ] Y

HARNESS -A-

FROM		TO
C-1	WIRE PART NO. 4 FROM PARTS LIST THIS DWG SHEET NO.1	PMI-98
C-5		PMI-85
C-6		PMI-100
C-7		PMI-88
C-31		PMI-89
C-33		PMI-95
C-34		PMI-84
C-36		PMI-87

HARNESS -B-

FROM		TO
AC-1	WIRE PART NO. 4 FROM PARTS LIST THIS DWG SHEET NO.1	TP-35
AC-2		TP-29
AC-3		TP-31
AC-4		TP-33
PMI-1		TP-30
PMI-3		TP-32
PMI-5		TP-34
PMI-14		PMI-16
PMI-16		PMI-18
PMI-18		TP-36

HARNESS -C-

FROM		TO
	WIRE PART NO. 4 FROM PARTS LIST THIS DWG SHEET NO.1	

(*) B=BLUE KYNAR; G=GRAY VULKAFLEX; Y=YELLOW KYNAR

NOTE: HARNESS ROUTING PER THIS DWG SHEET NO. 2

Figure 11C (0285A7113 Sh.4 1) Breaker-Failure Relay - Case Wiring, From-To List

Harness D

ALL NO. 24 AWG * COLOR CODE: B (marked) G Y

WIRE PART NO. 4 FROM PARTS LIST THIS DWG SHEET NO. 1

FROM	TO
T-16	BA-8
T-18	BA-13
T-20	BA-11
T-46	BA-9
T-48	BA-14
T-26	BA-7
T-50	BA-12
V-24	BA-1
V-25	BA-2
V-26	BA-3
V-54	BA-4
V-55	BA-5
V-56	BA-6

Harness E

ALL NO. 22 AWG * COLOR CODE: B G Y (marked)

WIRE PART NO. 3 FROM PARTS LIST THIS DWG SHEET NO. 1

FROM	TO
AB-1	TP-37
AB-2	PM1-40
AB-3	PM1-29
AB-4	PM1-42
AB-5	PM1-31
AB-6	PM1-44
AB-7	TP-47
AB-8	PM1-46
AB-9	PM1-35
AB-10	PM1-48
AB-11	PM1-37
AB-12	PM1-50
AC-7	A-10
AC-8	A-8
AC-9	A-12
PM1-27	TP-38
PM1-33	TP-48
AC-13	TP-39
AC-14	PM1-13
PM1-10	TP-40
(Δ) A6 [3.70]	AD-15

(Δ) SPL LEAD 0138B1577G8

Harness F

ALL NO. 22 AWG * COLOR CODE: B G (marked) Y

WIRE PART NO. 3 FROM PARTS LIST THIS DWG SHEET NO. 1

FROM	TO
BB-1	TP-1
BB-2	PM2-40
BB-3	TP-3
BB-4	PM2-42
BB-5	TP-5
BB-6	PM2-44
BB-7	TP-7
BB-8	PM2-46
BB-9	TP-9
BB-10	PM2-48
BB-11	TP-11
BB-12	PM2-50
BC-1	PM2-53
BC-2	PM2-66
BC-3	PM2-55
BC-4	PM2-63
BC-5	PM2-57
BC-6	PM2-70
BC-7	P-10
BC-8	P-8
BC-9	P-12
~~BC-10~~	
~~BC-11~~	
~~BC-12~~	
BC-13	PM2-10
BC-14	PM2-13
P-23	PM2-23
P-27	PM2-26

(*) B-BLUE KYNAR; G-GRAY VULKAFLEX; Y-YELLOW KYNAR

NOTE: HARNESS ROUTING PER THIS DWG SHEET NO. 2

Figure 11D (0285A7113 Sh.5 2) Breaker-Failure Relay - Case Wiring, From-To List

(#) B-BLUE KYNAR; G-GRAY VULKAFLEX; Y-YELLOW KYNAR

ALL NO. 22 AWG (#) COLOR CODE B G Y.

HARNESS — F — CONT'D

WIRE PART NO. 3 FROM PARTS LIST THIS DWG SHEET NO. 1

FROM	TO
PM2-27	TP-2
PM2-29	TP-4
PM2-31	TP-6
PM2-33	TP-8
PM2-35	TP-10
PM2-37	TP-12
P-6 [37] (Δ)	BD-13

(Δ) SPL LEAD 0138B7577G5

ALL NO. 14 AWG (#) COLOR CODE B G Y

HARNESS — G —

WIRE PART NO. 2 FROM PARTS LIST THIS DWG SHEET NO. 1

FROM	TO
BD-1	TP-13
BD-2	TP-17
BD-3	TP-21
BD-4	TP-25
BD-5	TP-15
BD-6	TP-19
BD-7	TP-23
BD-8	TP-27
CM2-1	TP-14
CM2-3	TP-16
CM2-2	TP-18
CM2-4	TP-20
CM2-5	TP-22
CM2-7	TP-24
CM2-6	TP-26
CM2-8	TP-28

ALL NO. 14 AWG (#) COLOR CODE B G Y

HARNESS — H —

WIRE PART NO. 2 FROM PARTS LIST THIS DWG SHEET NO. 1

FROM	TO
AD-1	TP-43
AD-2	TP-49
AD-3	TP-53
AD-5	TP-45
AD-6	TP-51
AD-7	TP-55
CM1-1	TP-44
CM1-3	TP-46
CM1-2	TP-50
CM1-4	TP-52
CM1-5	TP-54
CM1-7	TP-56

NOTE: HARNESS ROUTING PER THIS DWG SHEET NO. 2

Figure 11E (0285A7113 Sh.6 1) Breaker-Failure Relay - Case Wiring, From-To List

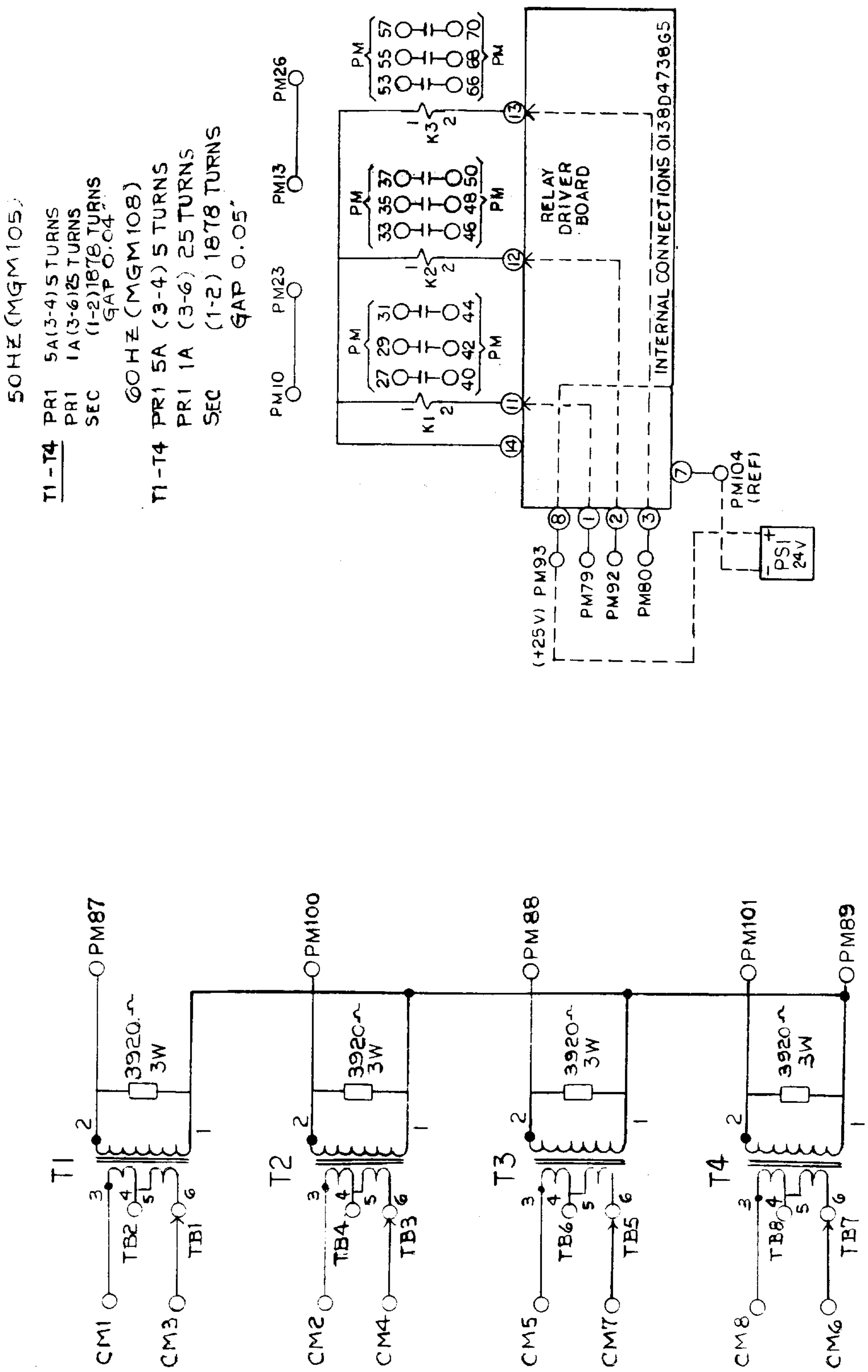


Figure 12 (0138B7752) Internal-Connections Diagram, Magnetics Module, MGM105, MGM108

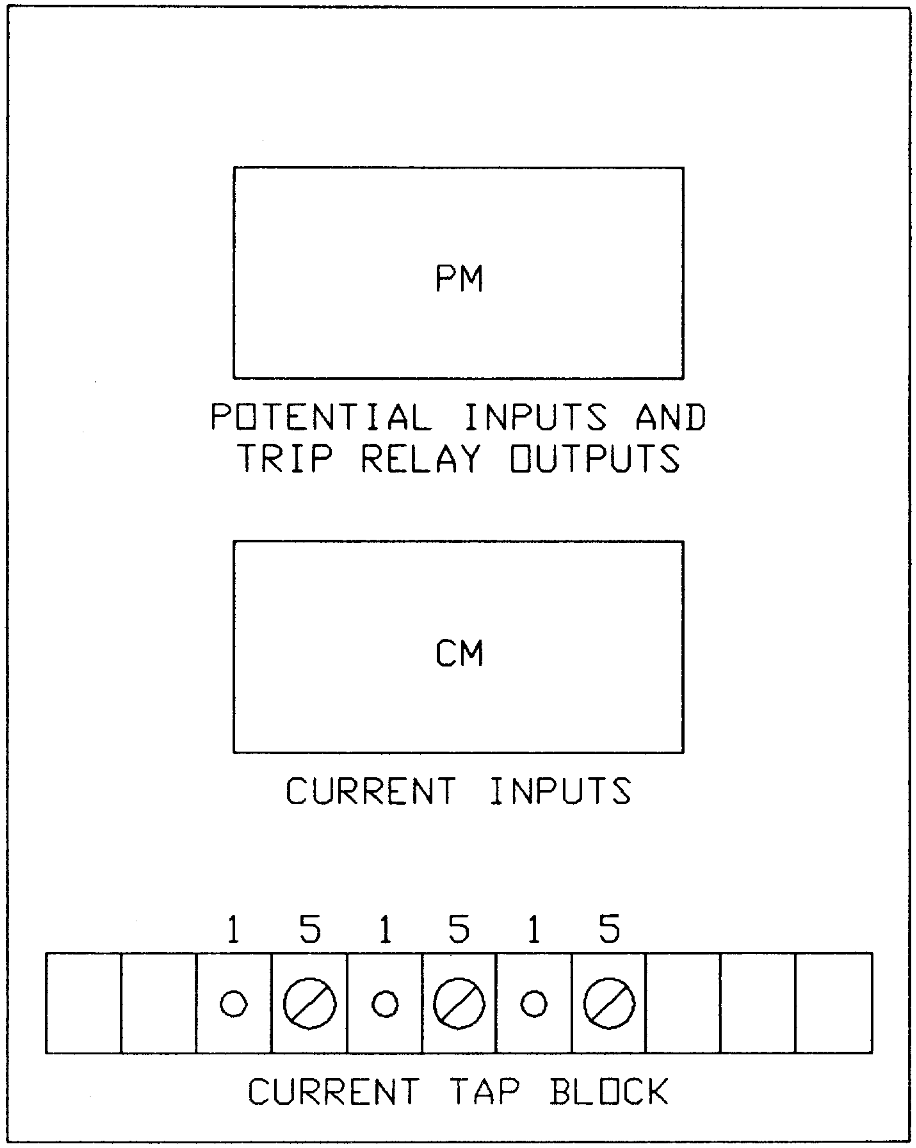


Figure 13 (0285A8169 [4]) MGM105, MGM108 Magnetics-Module Tap Positions

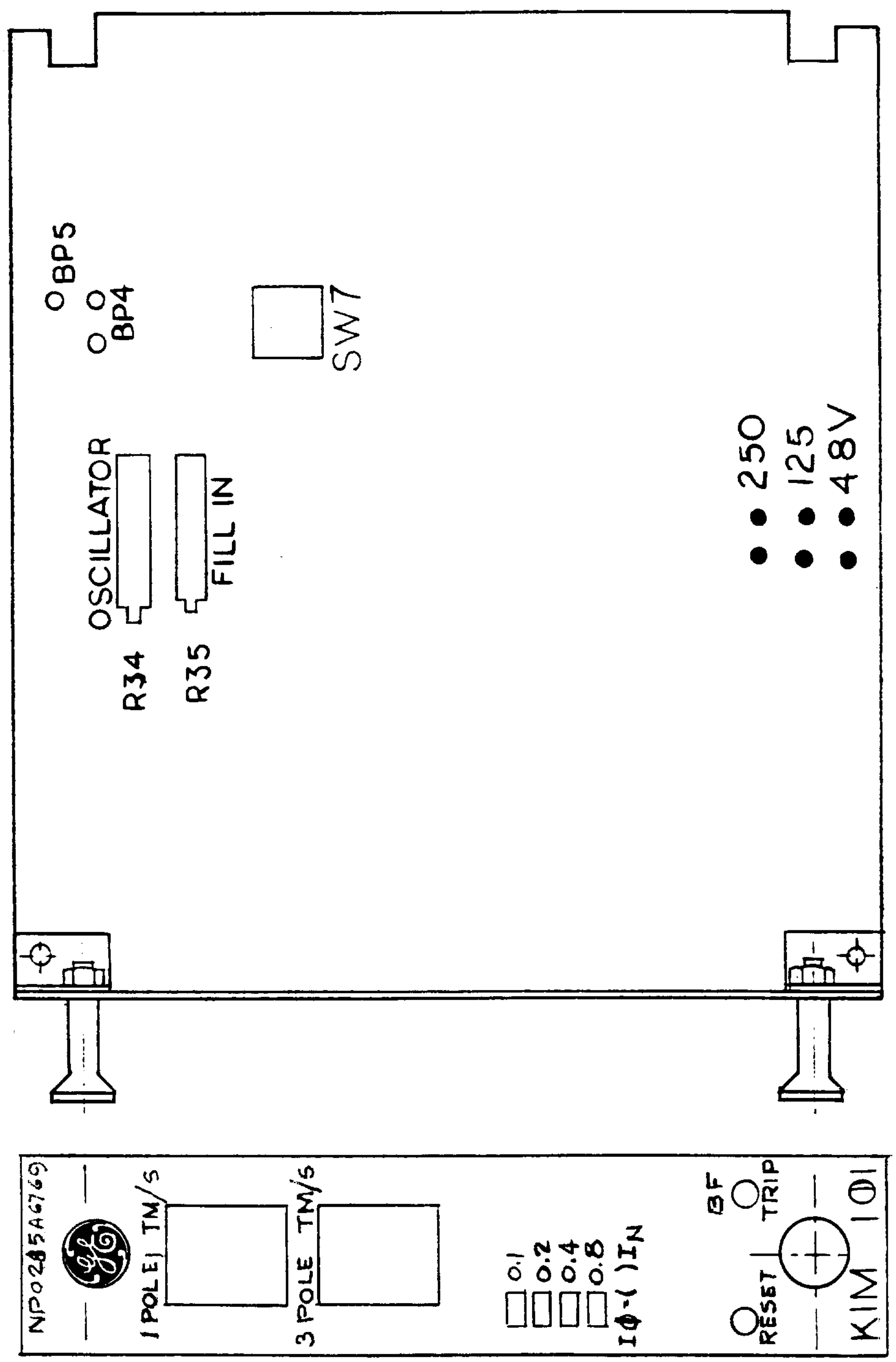


Figure 14 (0285A8984-1) KIM101 Printed-Circuit-Board Switch Locations

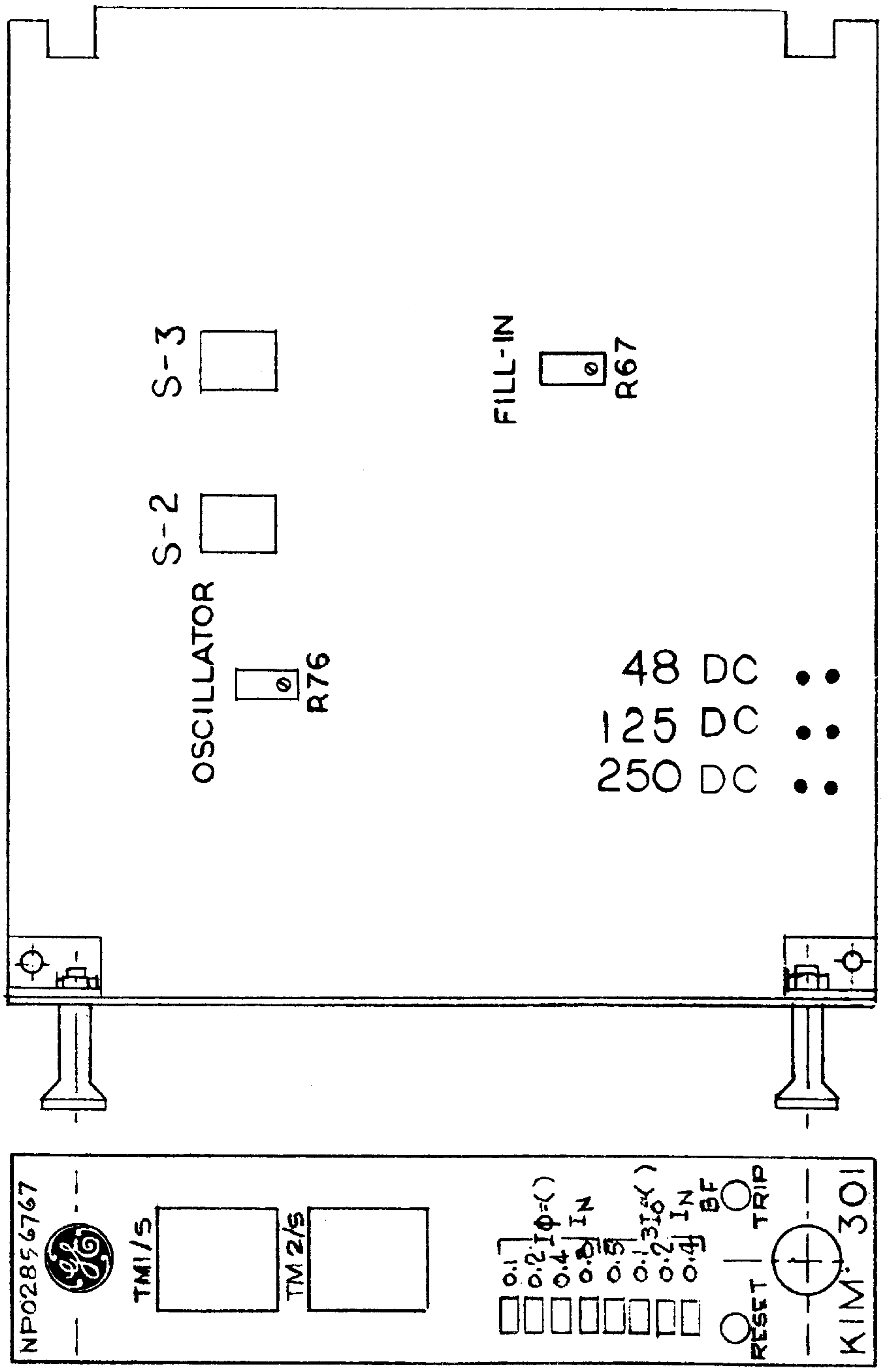


Figure 15 (0285A8982 [1]) KIM301 Printed-Circuit-Board Switch Locations

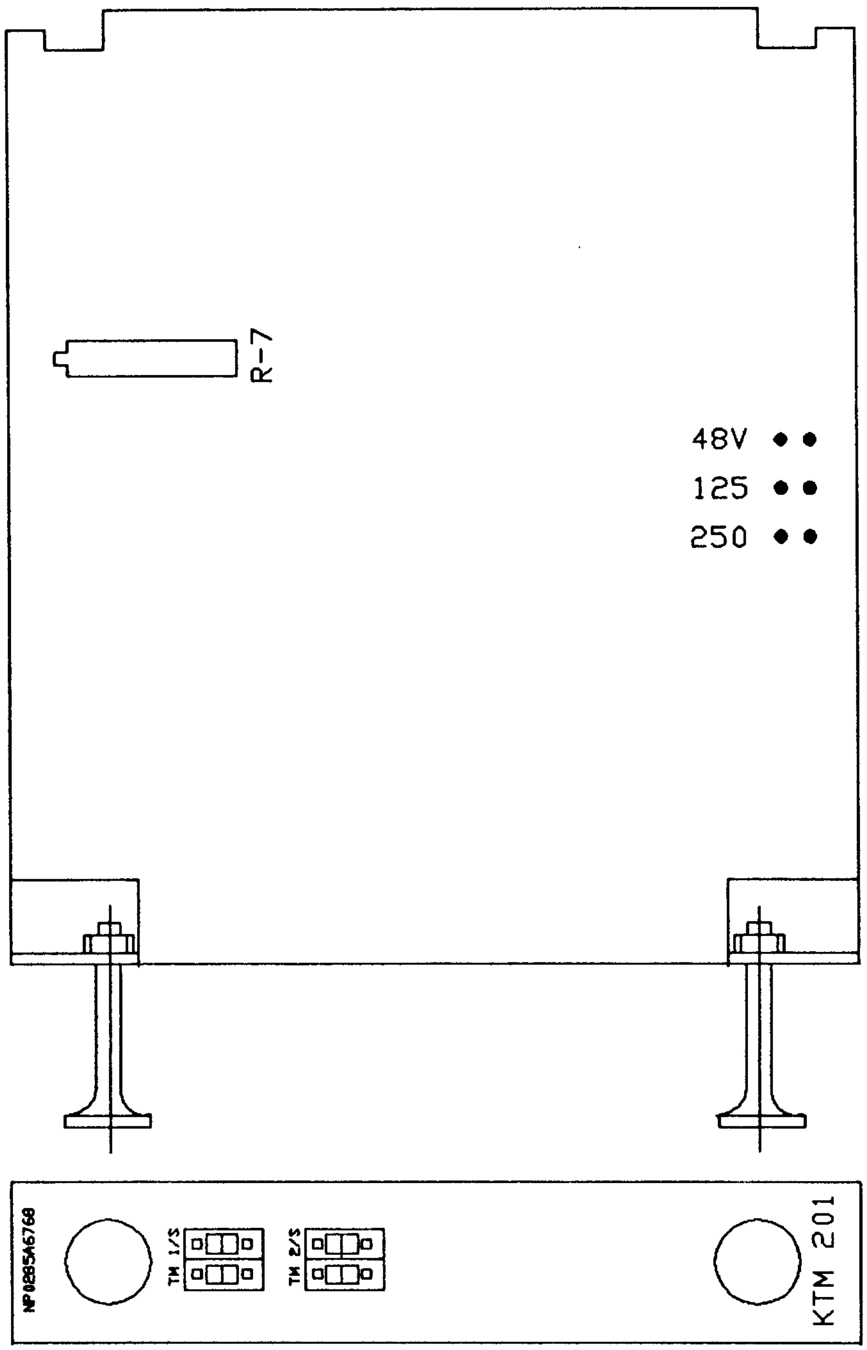


Figure 16 (0285A8983 [1]) KTM201 Printed-Circuit-Board Switch Locations

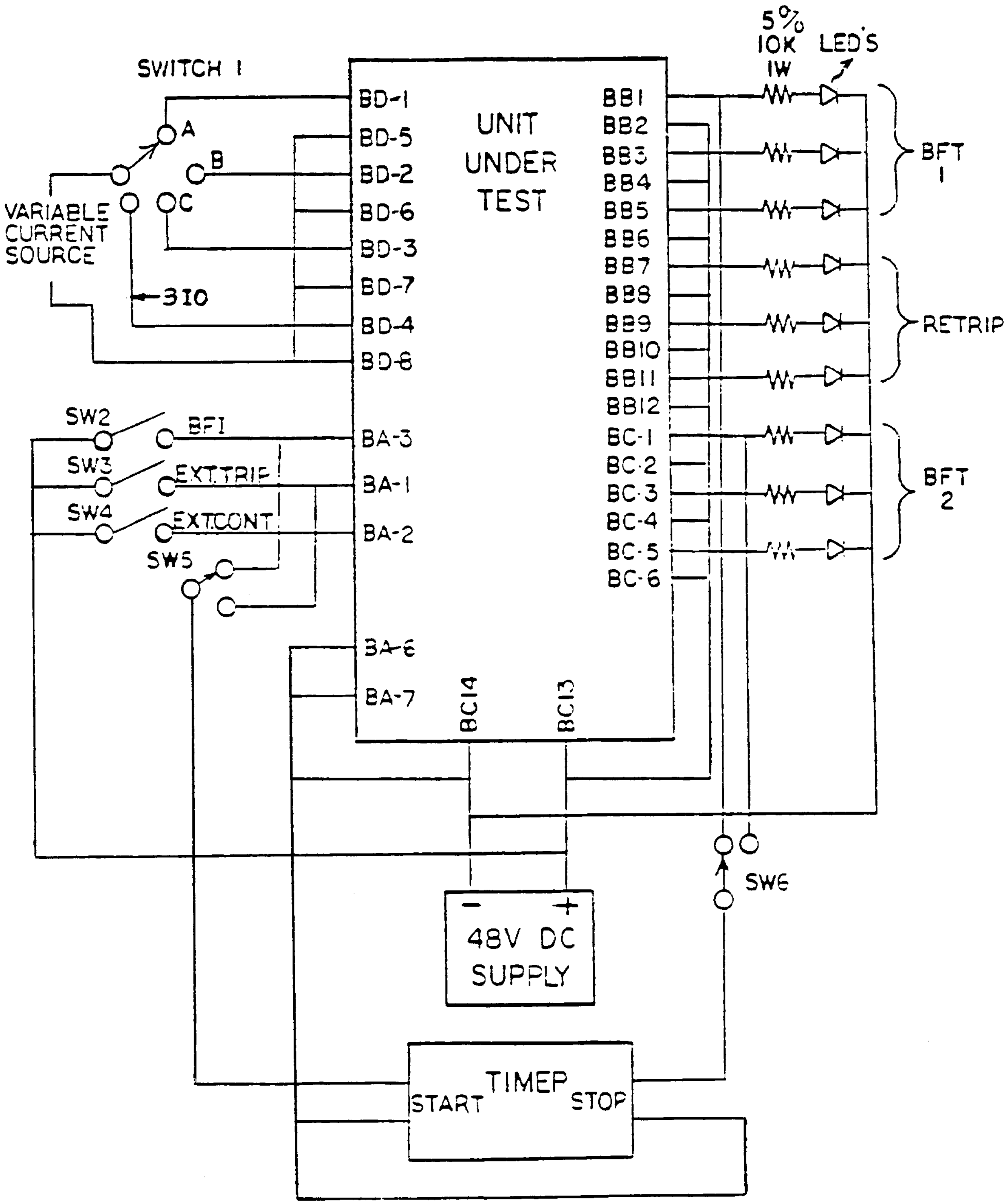


Figure 17 (0285A8154 1) Three-Pole SBC Unit Test Diagram

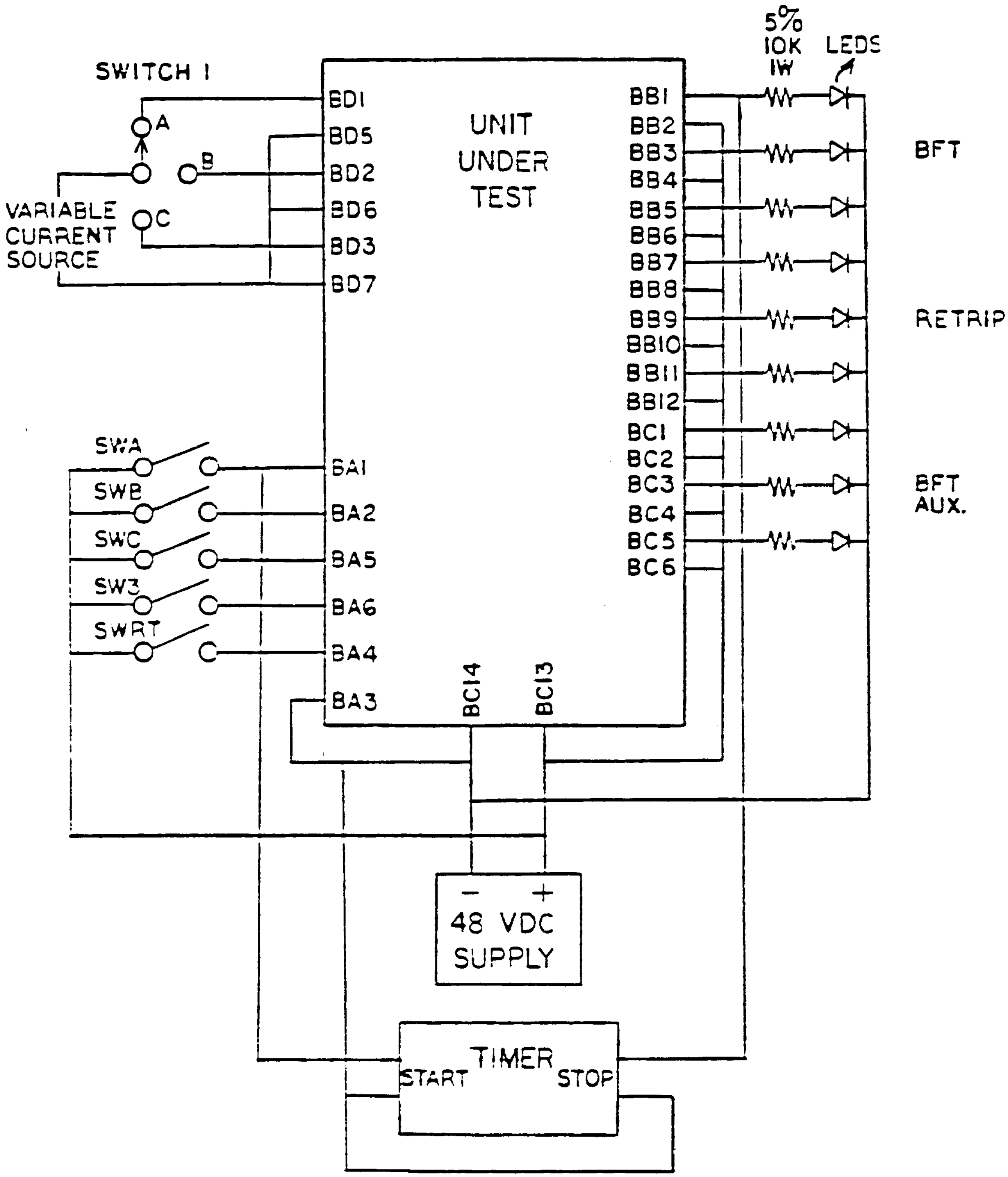


Figure 18 (0285A8155) Single-Pole SBC Unit Test Diagram

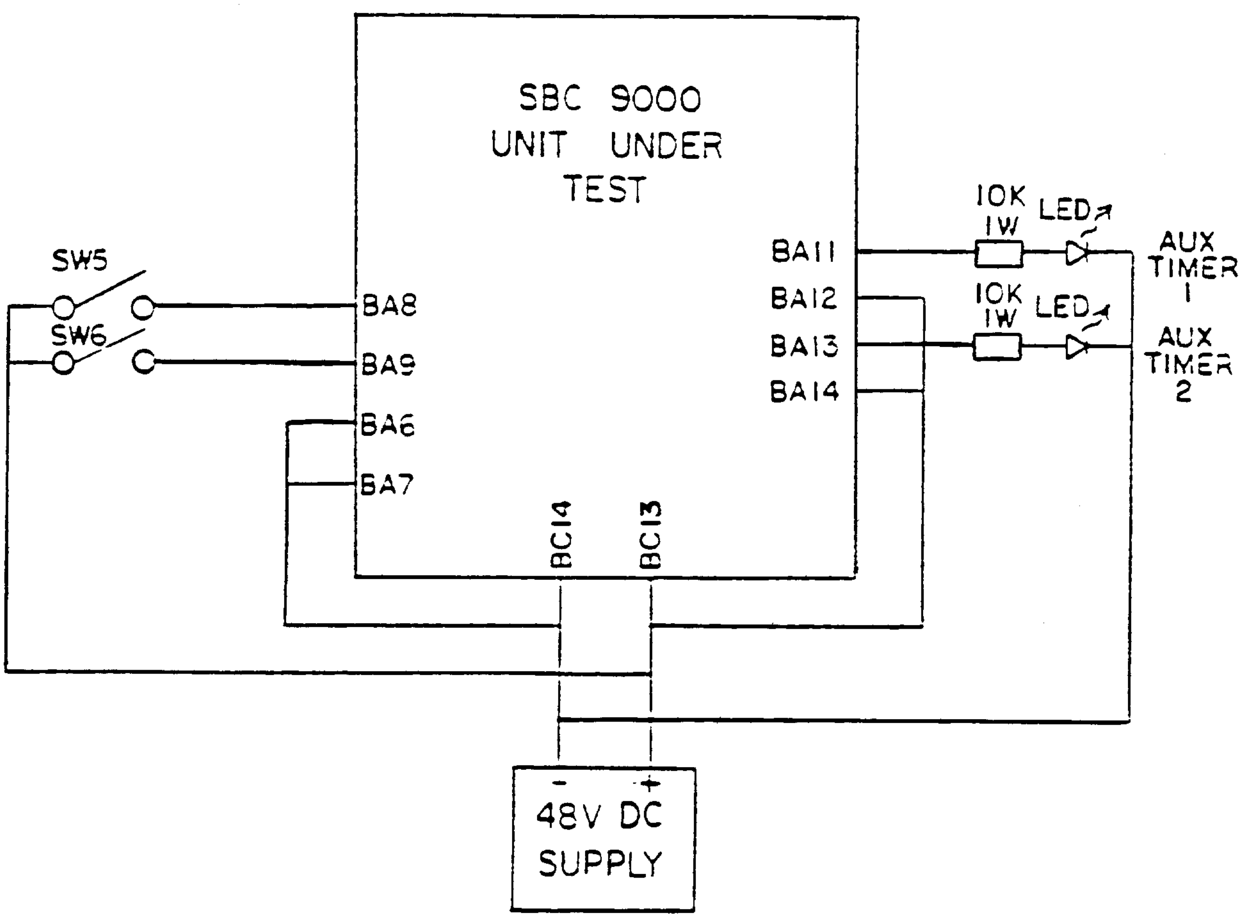
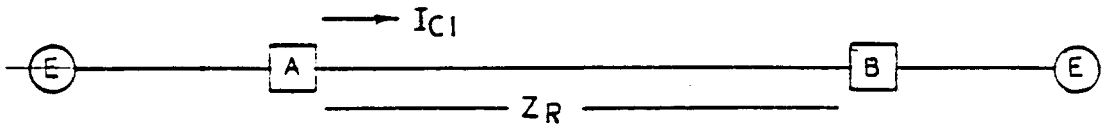


Figure 19 (0285A8156 1) Dual-Auxiliary-Timer Test Diagram

SYSTEM DIAGRAM



BKR A IS CLOSED
BKR B IS OPEN
POSITIVE SEQUENCE OVERVOLTAGE
RELAY AT A
V_{A1} = POSITIVE SEQUENCE VOLTAGE AT THE RELAY
I_{1C} = POSITIVE SEQUENCE CHARGING CURRENT
Z_R = RELAY REACH, SET EQUAL TO THE
LINE IMPEDANCE

PHASOR DIAGRAM

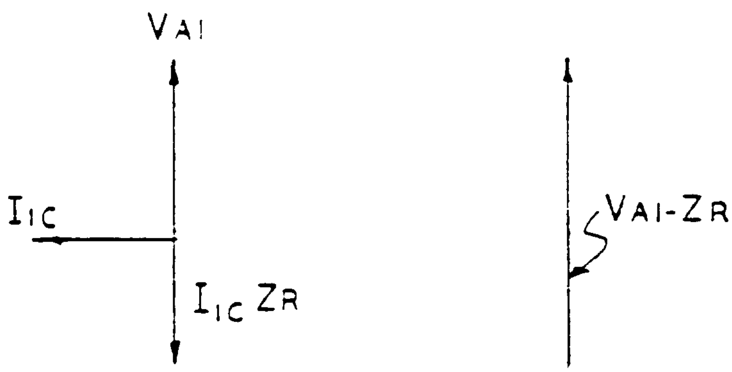


Figure 20 (0285A8120) Positive-Sequence Overvoltage Relay, Description Diagrams

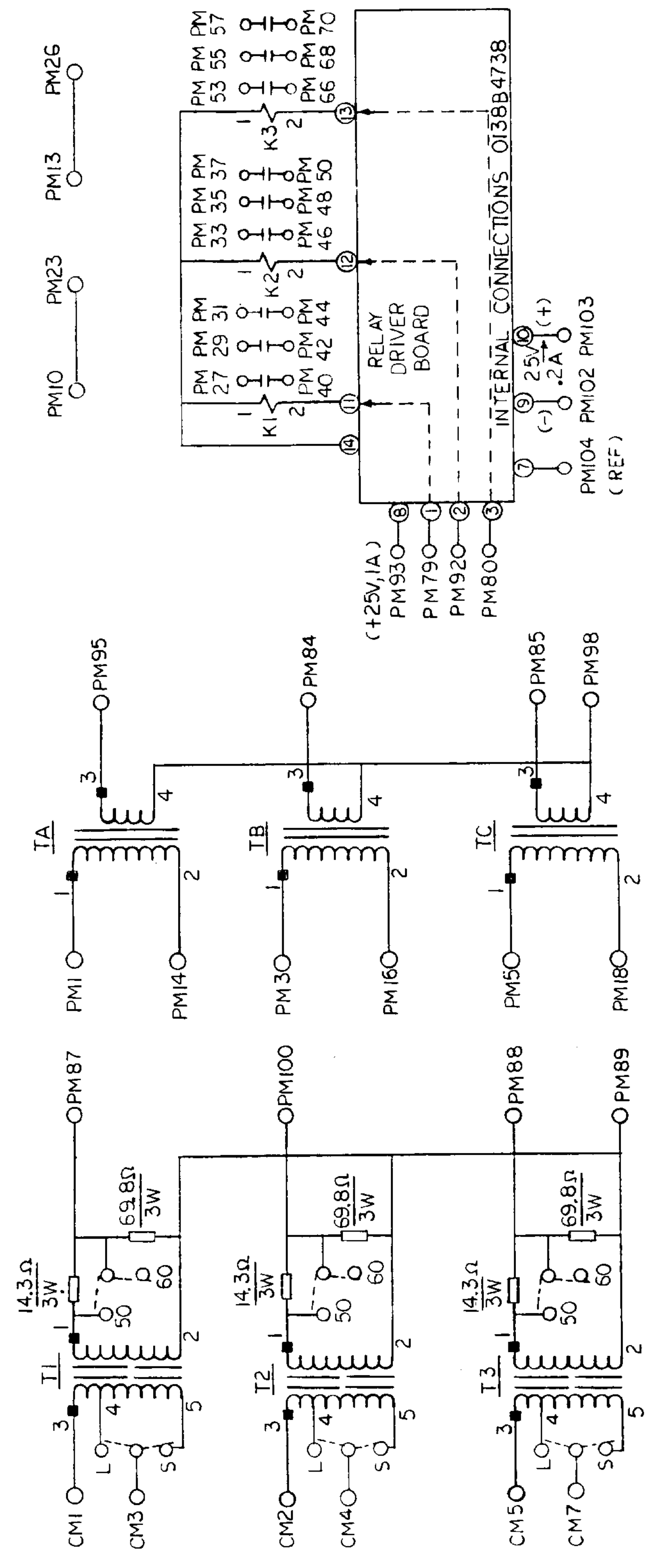


Figure 21 (0183B8096) Internal-Connection Diagram for Magnetics Module MGM106, MGM107

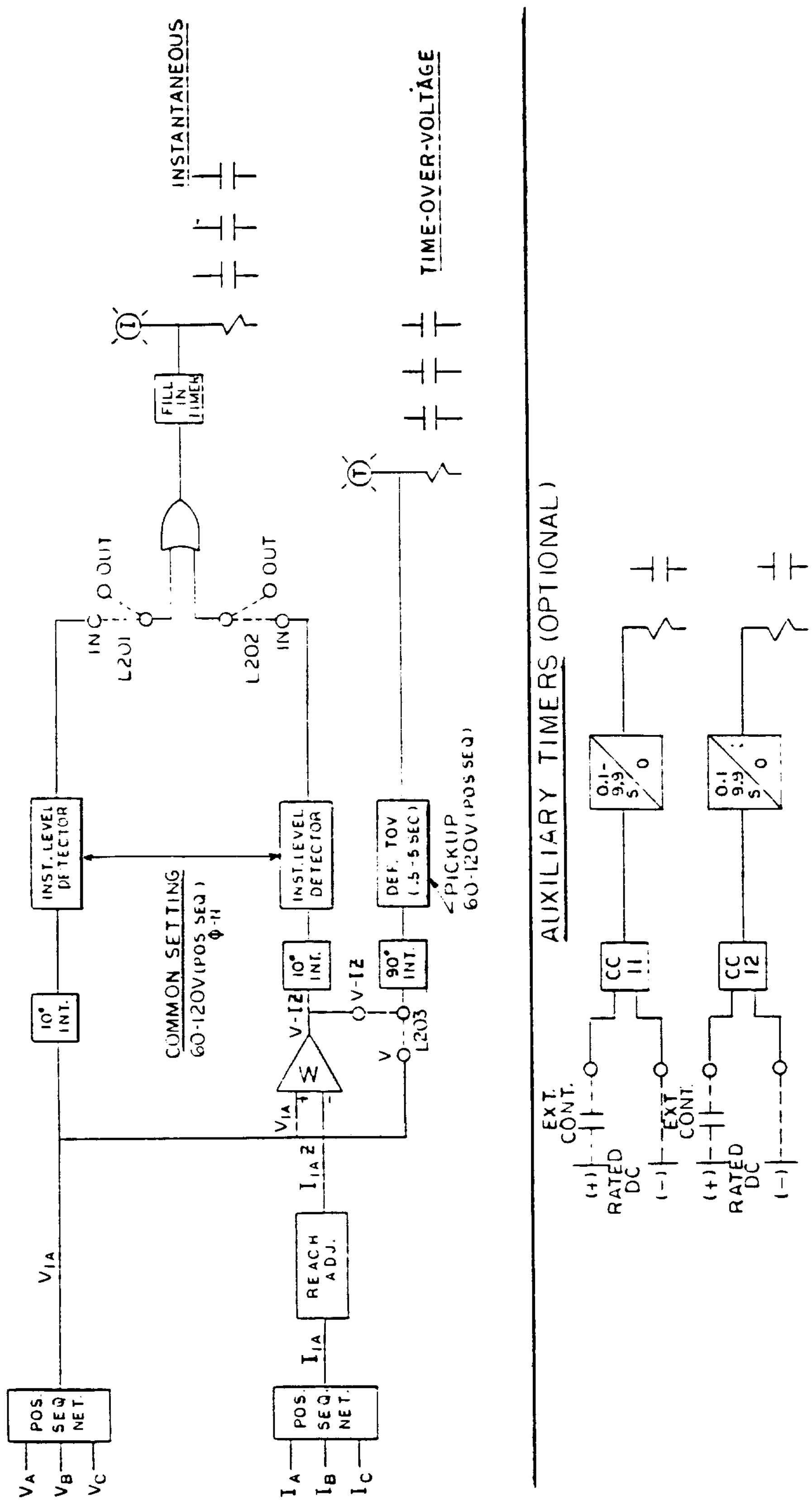


Figure 22 (0138B7781) Logic Diagram for Positive-Sequence Overvoltage Relay

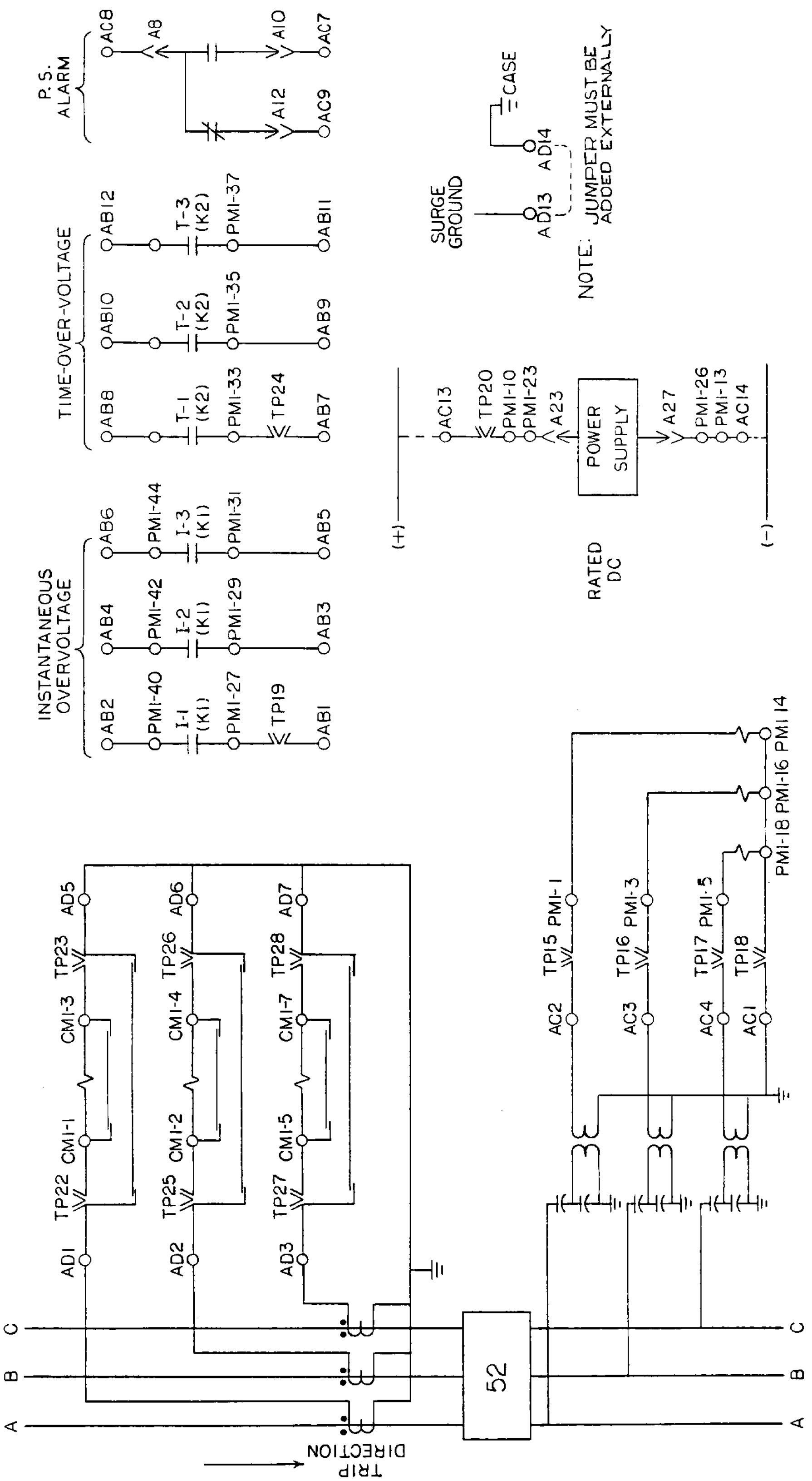
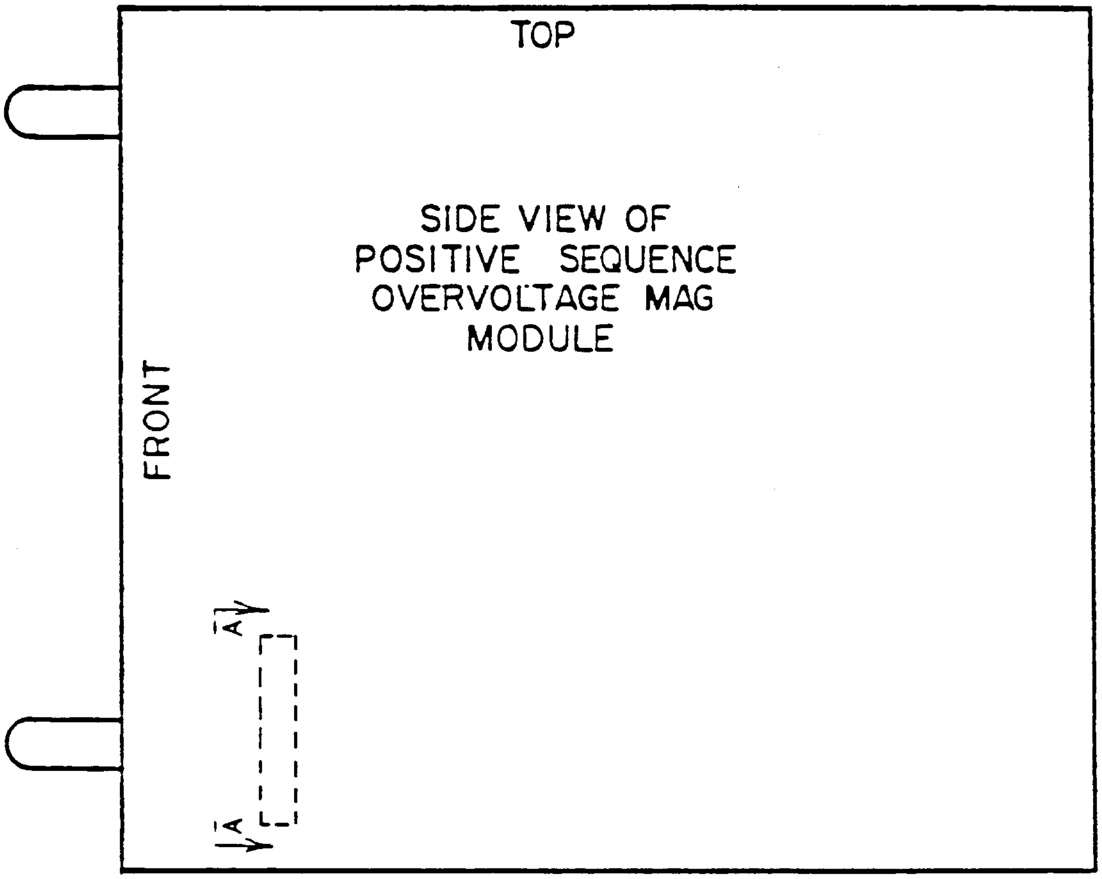
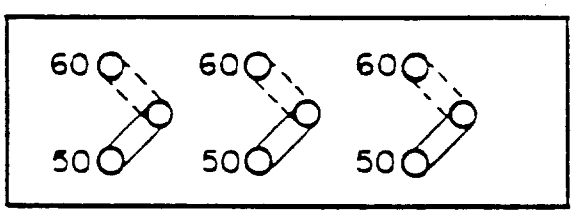


Figure 23 (0138B7783 4) Elementary Diagram for Positive-Sequence Overvoltage Relay





(SECTION A-A)
LINK BOARD

Figure 24 (0285A8170) MGM106, MGM107
Magnetics-Module Link Locations

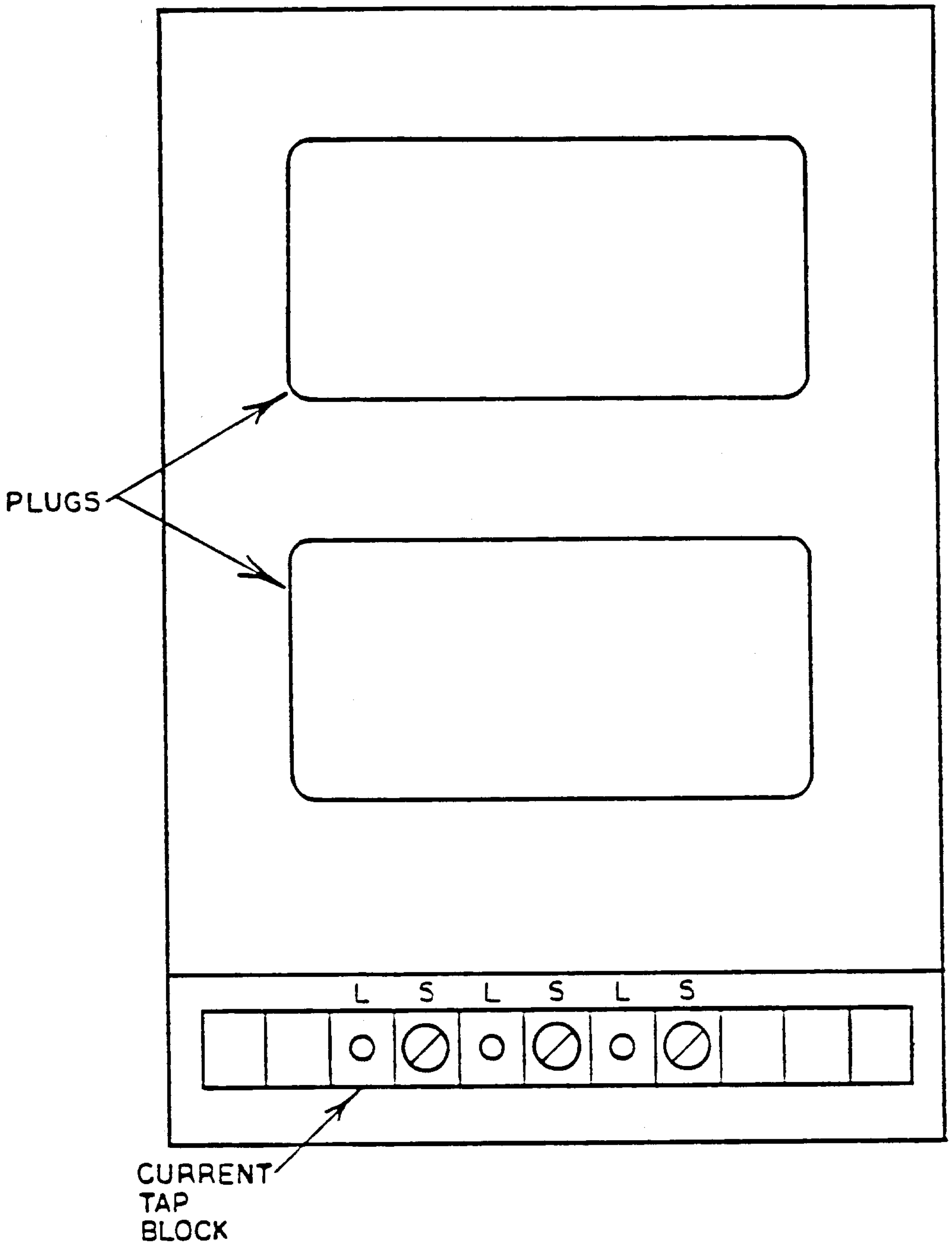


Figure 25 (0285A8171) MGM106, MGM107
Magnetics-Module Tap Terminals

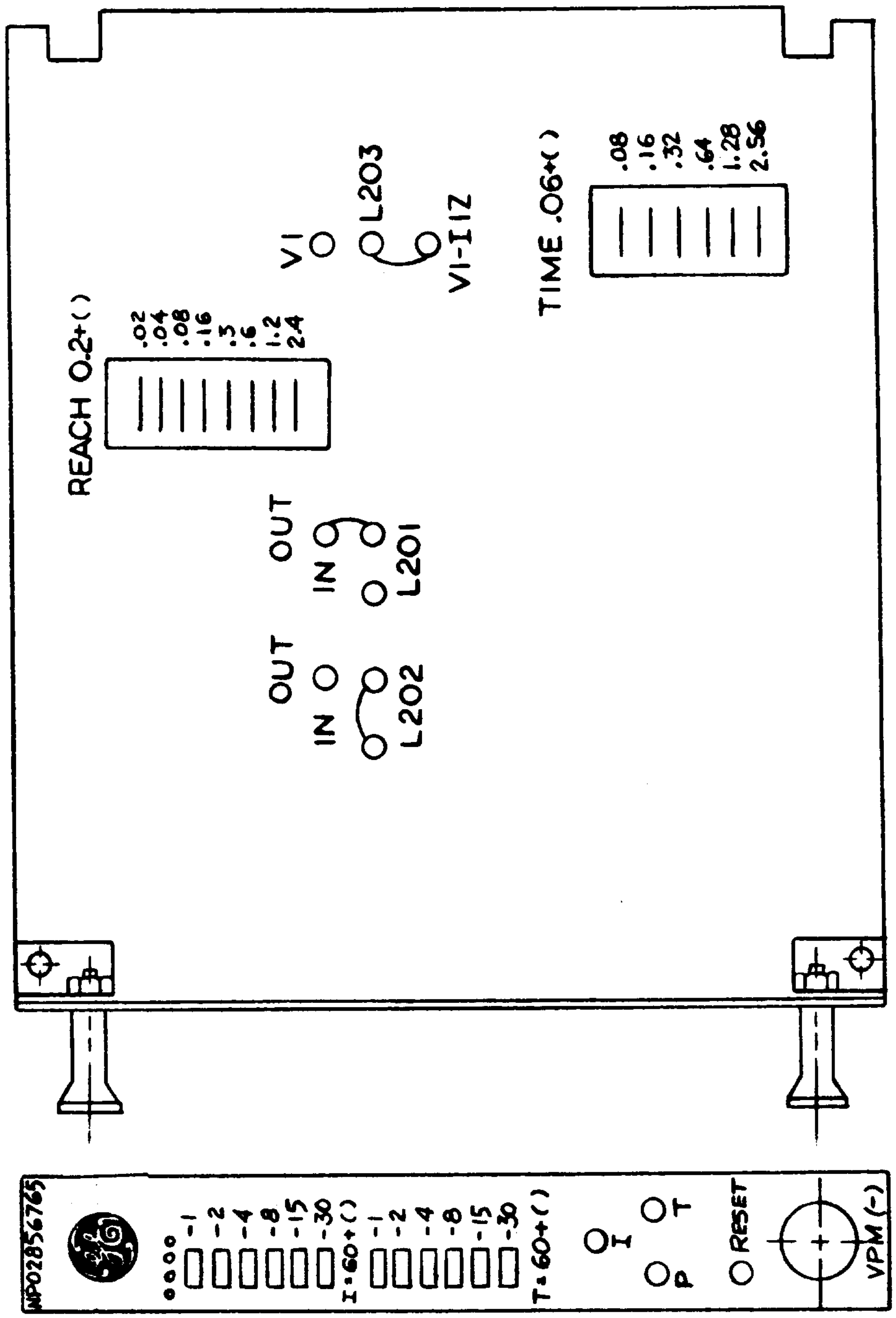


Figure 26 (0285A8981-1) VPM101 and VPM102 Printed-Circuit-Board Switch Locations

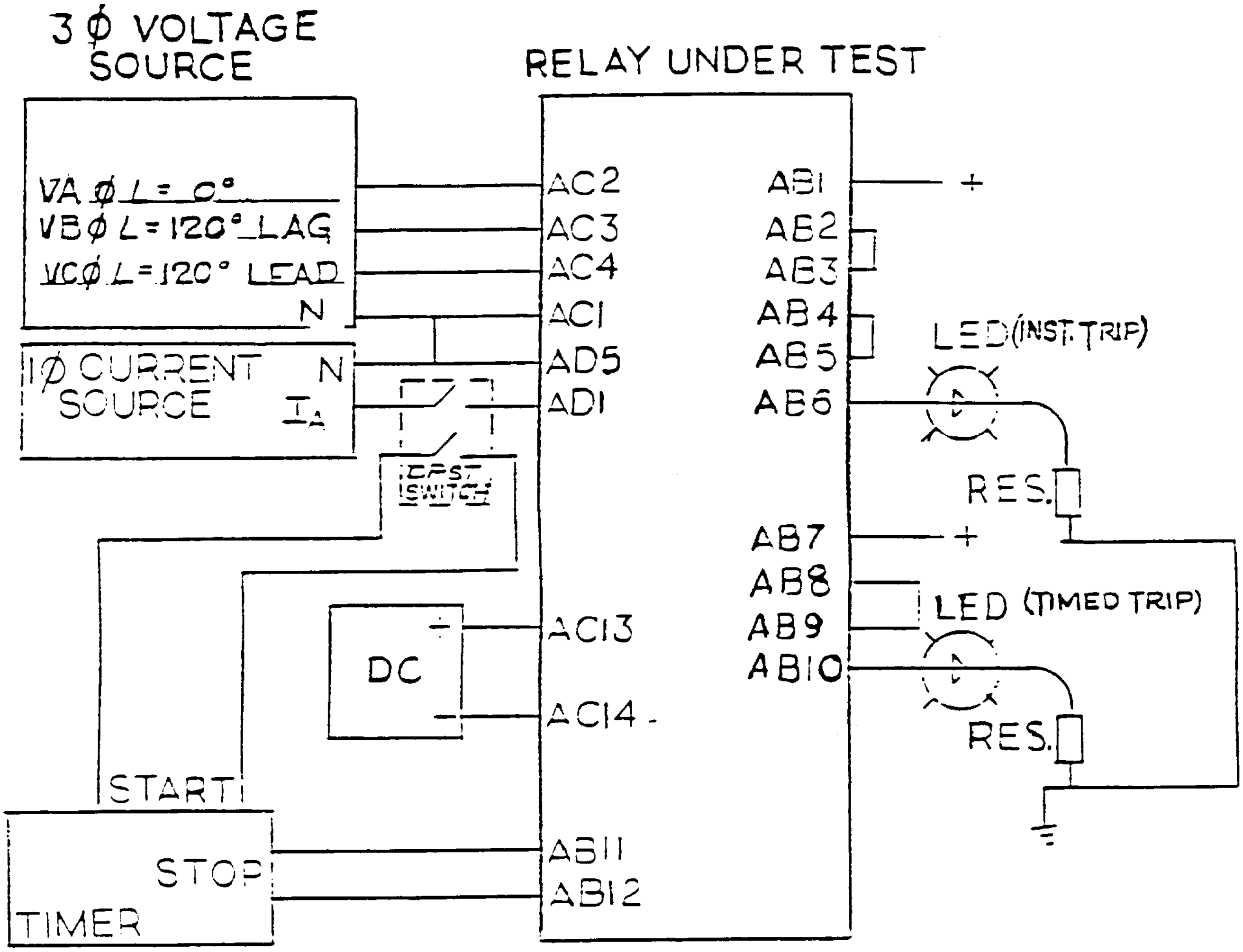


Figure 27 (0285A8157 2) Positive-Sequence Overvoltage Unit Test Diagrams

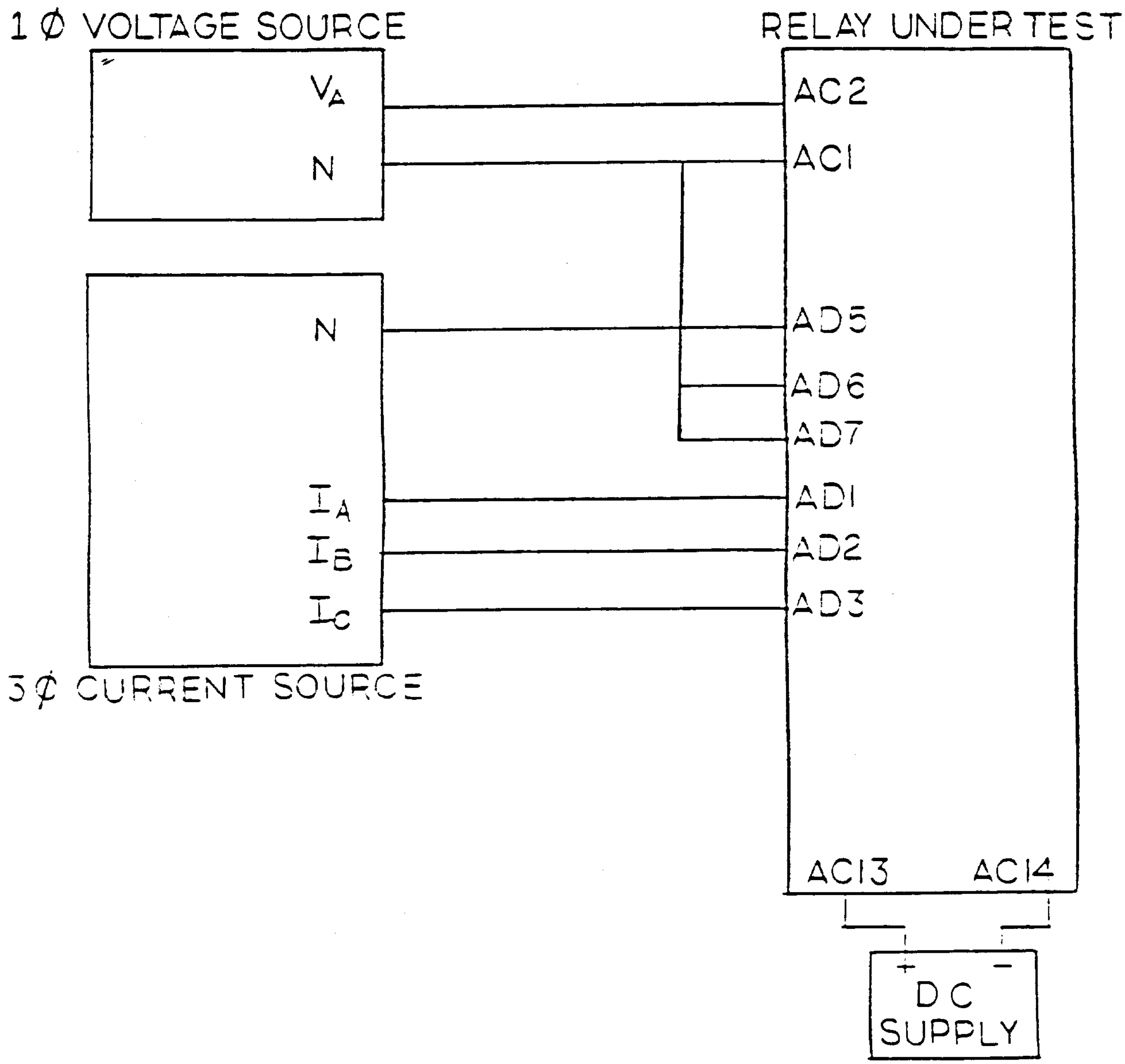
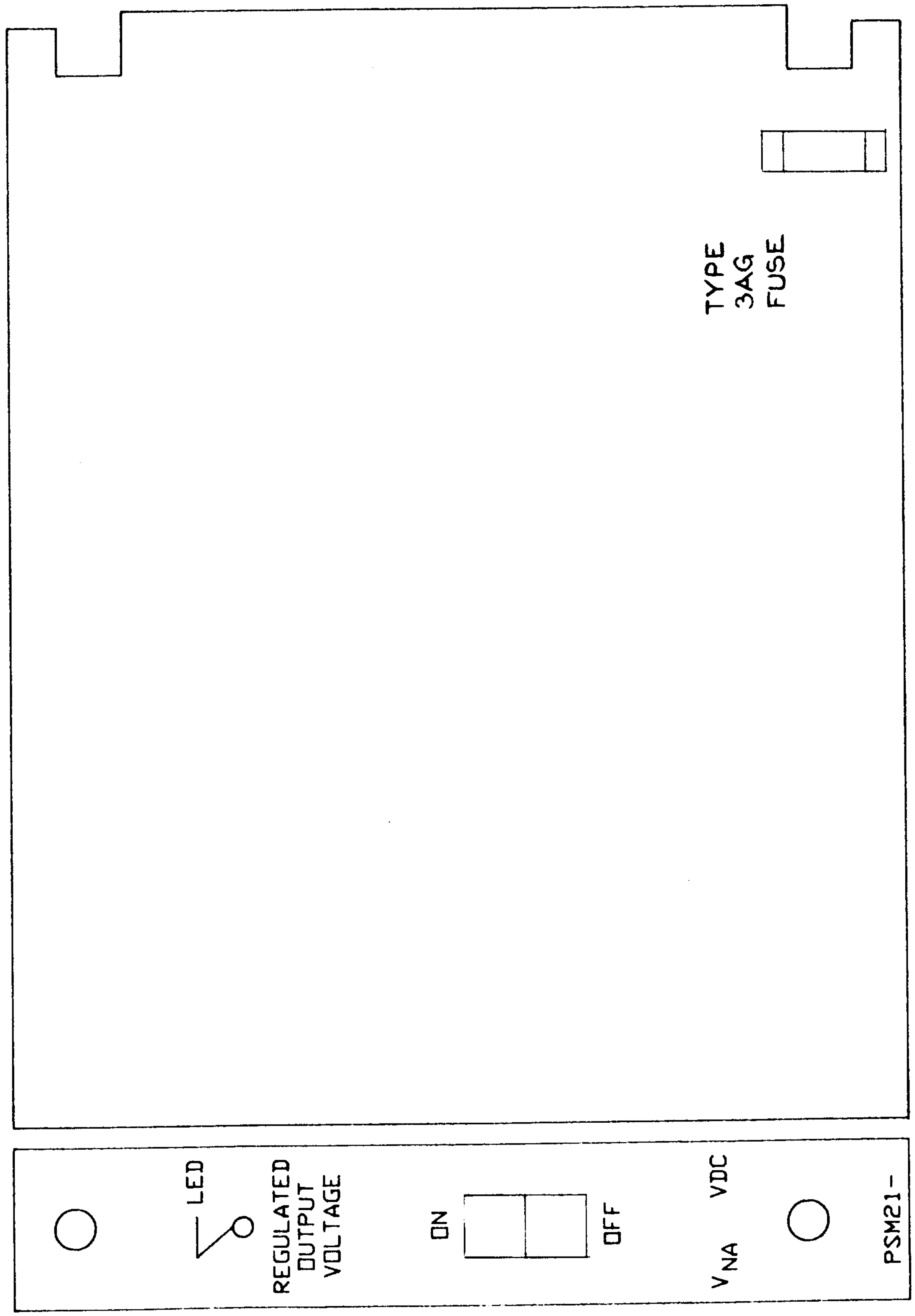


Figure 28 (0285A8158 [2]) Positive-Sequence Overvoltage Unit Test Diagrams



Figue 29 (0286A2547 [1]) PSM Power-Supply Switch and Fuse Locations

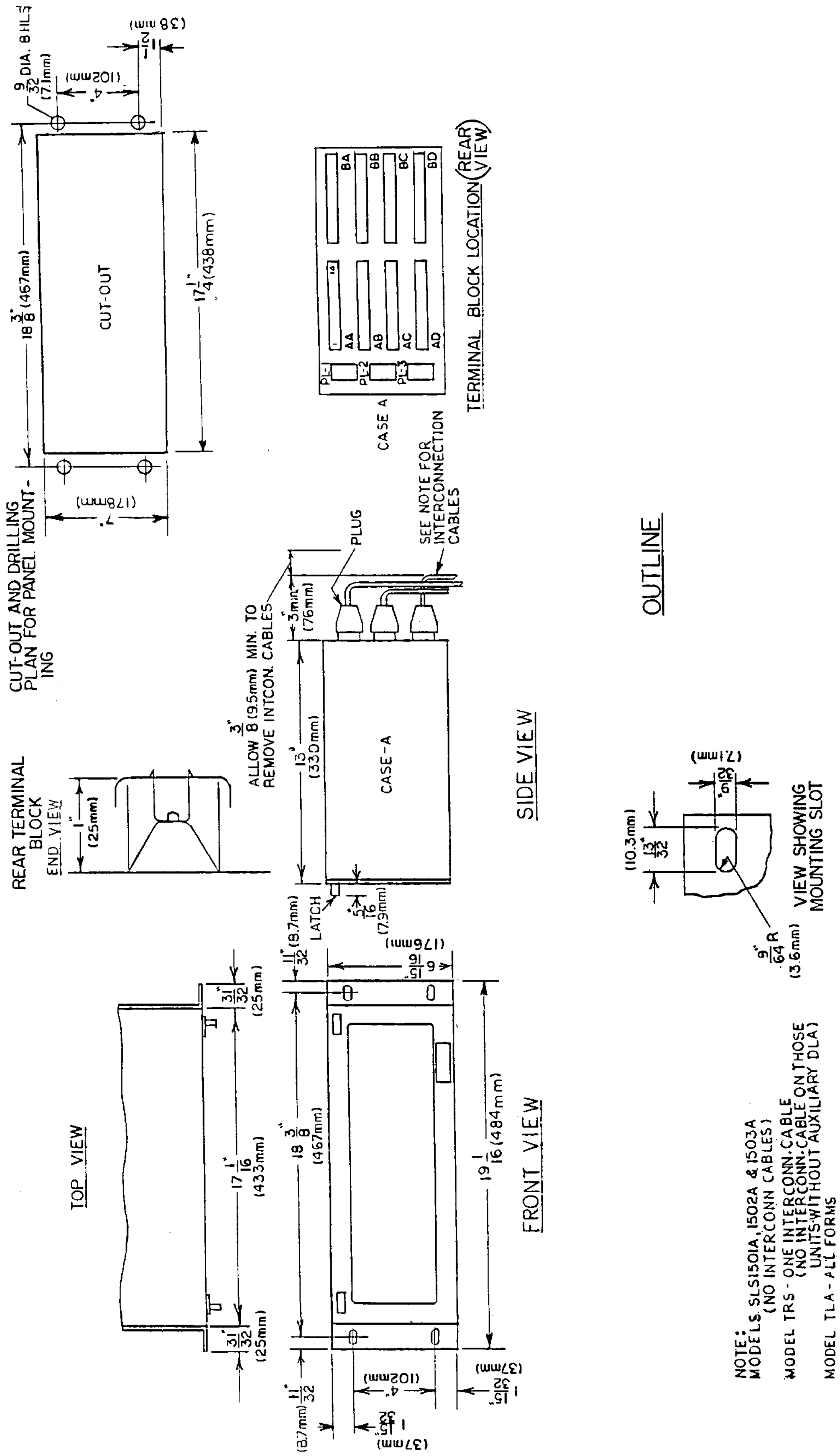


Figure 30 (0138B7600 Sh.1) Type SBC9000 Case Outline and Dimensions Diagram

Protection and Control Business Department

(7/93) (200)

General Electric Company
205 Great Valley Parkway
Malvern, Pennsylvania 19355-1337