GEK-86661C

SBC9310

STATIC BREAKER FAILURE RELAY

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INTRODUCTION

The Type SBC9310 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 SBC9310 relay is required for two breakers.

The Type SBC9310 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 17. Both the electronics and magnetics are contained in pluggable modules, which are removable from the front of the unit. The SBC9310 contains two static breaker failure relays which are totally independent of each other.

The logic diagram for the three pole SBC9310 is shown in Figure 7; the elementary is shown in Figures 8 and 9.

BREAKER FAILURE 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 transferred 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 BFT contacts. For example, for protecting 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

These instructions do not purport to cover all details or variations in equipment nor provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.
To the extent required the products described herein meet applicable ANSI, IEEE and NEMA standards; but no such assurance is given with respect to local codes and ordinances because they vary greatly.

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 protected, 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 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 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; and, when the current is increased, a continuous output. Since the breaker failure timer will reset after each pulse, the pickup setting is the current which 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 percent 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 interrupted, 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 & BKR ARRANG.	FIG. #	FAULT LOC.	FAILED BKR	CUR. FROM ASSOC. BKR.	CONT. INIT. FROM	BFT CONT. #1 TRIPS	BFT CONT. #2 TRIPS	BFT CONT. #3 TRIPS
Single bus Single bkr	1	F1	2	2	Line B	Bus lock out Relay	----	----
Double Bus Double Bkr	2	F1 or F2	3	3	Line B or North Bus	North Bus Lockout Relay	Bkr 4	Lockout relay that transfer trips line B and blocks reclosing of Bkr 4
Double Bus Double Bkr	2	F1 or F3	4	4	Line B or South Bus	South Bus Lockout Relay	Bkr 3	Lockout relay that transfer trips line B and blocks reclosing of Bkr 3
Breaker -and-a-half	3	F1 or F3	4	4	Line A or North Bus	North Bus Lockout Relay	Bkr 5	Lockout relay that transfer trips Bkr 10 and blocks reclosing of Bkr 5
Breaker -and-a-half	3	F1 or F2	5	5	Line A or Line B	Bkr 4	Bkr 6	Lockout relay that transfer trips Bkrs. 10, 11 and blocks reclosing of Bkrs 4 and 6
Breaker -and-a-half	3	F1 or F4	6	6	Line B or South Bus	South Bus Lockout Relay	Bkr. 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	Bkr 2	Bkr 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 response to electrical transients. The DC is applied to the output relays and the timers are unblocked only when the BFI or 62X contacts close, indicating that a fault has occurred on a line associated with the breaker being protected. The BFI/62X contact converter input circuit is designed so that the applied DC voltage must exceed 60 percent of nominal rated voltage in order for the relay to operate. This feature prevents false trips due to 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 correctly trip the breaker 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.

SBC9310 - THREE POLE TRIPPING SCHEME

The SBC9310 relay is intended for use in three pole tripping schemes. Each relay in the SBC9310 contains four current inputs, 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 separately adjustable one for the neutral current. The SBC9310 relay includes two timers (TL1 and TL2), three contact converters, three telephone relays (BFT, BFT2, and RT) and switches to select various logic options.

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 S2 and S3. Timer TL1 is energized by an output from the current detector. Timer TL2 is energized by an output from AND1. With switch S2-2 closed, AND1 will produce an output only when both contact converter CC1 and the current detector produce outputs. With switch S2-1 closed, AND1 will produce an output whenever contact converter CC1 is energized.

With link L3 in the 2 position 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 S2-1 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 S2-1 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.

<u>NOTE</u>: Switch S2 and switch S3 are located on the KIM302 module.

RATINGS

Temperature Range:

The SBC relay is designed for use in an environment where the air temperature outside the relay case is between minus 20oC and plus 65oC.

Hipot:

Per ANSI/IEEE C37.90-1978.

Current Ratings:

AC - Continuously rated	10 amperes (five amp model) 2 amperes (one amp model)
AC - One Second Ratings:	500 amperes (five amp model) 100 amperes (one amp model)

Burden:

AC - 0.026 ohm at 4.5° (five amp model)
0.063 ohm at 39° (one 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 and KIM302 modules

DC Voltage Rating: (continued)

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

Operating Range: 80-115 percent of nominal

Voltage Required at BFI Input for Pickup:

60 percent of maximum control voltage for selected voltage range

Mag Module: 1A-5A tap. 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

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.

CHARACTERISTICS

Pickup Time: From AC Input

Ten milliseconds, plus or minus five milliseconds, plus time setting ±3 percent typical, measured from the time the AC input crosses the threshold. (Electronic pickup time less than two millisecond time setting)

Dropout Time: 6-12 milliseconds (2.9-3.4 milliseconds electronics only)

Reset Time: 10 milliseconds (electronics)

Dropout Ratio: 90 percent or more

Variation in Operate Level: With temperature - Less than plus or minus three percent, typical

Variation in Operate Time: With temperature - Less than plus or minus three percent typical

Operate Time from BFI Input: 10-20 milliseconds

Dropout Time from BFI Input: 5-20 milliseconds

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 "
250 VDC	0.5 "

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

MODULE SETTINGS

SBC MAGNETIC MODULE SETTINGS

MGM105, MGM108

There are two versions of the SBC magnetic 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 by means of transactor tap changes. See Figure 13 for the location of the terminal board for the tap changes.

KIM302 - Three Pole Breaker Failure Module

This board contains circuitry which senses when any phase current exceeds the phase operate setting. It also contains circuitry to sense when the 3I0 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. See Figure 14 for the following switch locations.

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.
Iθ	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.

Front Panel Switches (Cont'd)

Identity	Type	Function	Description
3Io	4-stage miniature toggle	3Io 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 application. 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.

POWER SUPPLY

This power supply is a high efficiency DC to DC converter. It includes short circuit and overvoltage protection. It is 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, jumper selectable

Outputs: +12 volts, -12 volts, +25 volts, with same common. Any supply can deliver up to one 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

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 power supply operation

Internal Link

Identity	Function	Description
DC Voltage Link	Selects DC Voltage	Multi-pin jumper must be positioned to cover rectangular outline corresponding to desired operating voltage

ACCEPTANCE TESTS - BREAKER FAILURE RELAY

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

SBC9310 HIPOT TEST (RELAY "A")

NOTE: When hipot testing, it is necessary to remove the jumpers between terminals BD13 and BD14 and between AD13 and AD14. 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,
BB1, BB2, BB3, BB4, BB5, BB6, BB7,
BB8, BB9, BB10, BB11, BB12,
BC1, BC2, BC3, BC4, BC5, BC6, BC7, — HIPOT TO CASE
BC8, BC9, BC13, BC14,
BD1, BD2, BD3, BD4, BD5, BD6, BD7, BD8

BA1, BA2, BA3, BA4 BA5, BA6,	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	HIPOT TO ALL OTHER STUDS AND CASE

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

SBC9310 HIPOT TEST (RELAY "B")

NOTE: When hipot testing, it is necessary to remove the jumpers between terminals BD13 and BD14 and between AD13 and AD14. 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	
AA1, AA2, AA3, AA4, AA5, AA6, AB1, AB2, AB3, AB4, AB5, AB6, AB7, AB8, AB9, AB10, AB11, AB12, AC1, AC2, AC3, AC4, AC5, AC6, AC7, AC8, AC9, AC13, AC14, AD1, AD2, AD3, AD4, AD5, AD6, AD7, AD8	HIPOT TO CASE

AA1, AA2, AA3, AA4 AA5, AA6,	HIPOT TO ALL OTHER STUDS AND CASE
AC13,AC14	"
AA11, AA12	"
AA13, AA14	"
AC7, AC8, AC9	"
AB1, AB2	"
AB3, AB4	"
AB5, AB6	"
AB7, AB8	"
AB9, AB10	"
AB11, AB12	"
AC1, AC2	"
AC3, AC4	"
AC5, AC6	"
AD1, AD5	"
AD2, AD6	"
AD3, AD7	"
AD4, AD8	HIPOT TO ALL OTHER STUDS AND CASE

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

THREE POLE UNIT TEST FOR SBC9310

Refer to Figures 15 and 16. Perform the following tests for relay "A" first, then relay "B."

Set the SBC portion as follows:

Set the PSM module voltage plug to the desired DC voltage
Set the magnetics module to the 1 amp taps (see Figure 13)

NOTE: When 5 amps taps are set, use the current values shown in ( ) parenthesis.

KIM302 - Front Panel Settings:

Time 1 (TM 1/s) - 0.50
Time 2 (TM 2/s) - 0.20
Iϕ - 1.0
3Io - 0.5

KIM302 - On-board Settings:

Voltage jumper to DC voltage desired
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

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 repeat with SW1 set to C.

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

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

Turn off SW3, and turn on SW2 and SW4. The three BFT1 LEDs and three BFT2 LEDs should come on. Turn off SW2 and SW4.

Set SW1 to A. Set input current to 1.5 amps (7.5 amps). Set SW5 to BFI. Set SW6 to BFT1. Turn on SW2. Measure operate time to BFT1 output. Time should be 0.515 - 0.525 seconds (0.5 seconds + BFT1 Pickup Time of 0.015 - 0.025 seconds). Turn off input current.

Set SW5 to EXT TRIP position. Turn on SW4. Set SW6 to BFT2. Turn on SW3. Measure operate time to BFT2 output. Time should be 0.215 - 0.225 seconds (0.2 seconds + BFT2 Pickup Time of 0.015 - 0.025).

If the operate times are off, it may be necessary to adjust trimmer R76 on the KIM302 board to correct the timing oscillator frequency.

CONSTRUCTION

STEEL CASE ASSEMBLY

The case is fabricated from sheet steel. A heavier gage steel is used on the rear cover plate and side mounting brackets for added strength in these critical areas. Overall case dimensions are given in the **SPECIFICATIONS** section.

The front cover consists of plate glass with a steel frame. It is hinged on the bottom and opened from the top by way of two spring-loaded plastic latches. Sliding steel strips are included on the edges to restrain the cover from swinging open more than 96 degrees. This prevents the cover from blocking access to adjoining equipment while still allowing sufficient clearance for the removal of modules and the insertion of the test device.

The cases are painted with a textured finished baked enamel. Gasketing is inserted around the edges of the rear cover plate and along the top and bottom edges of the front cover in order to minimize dust infiltration.

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 consist 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 protect 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) is made by means of two connector sockets; an eight contact current block and a 104-pin signal block. The current block contacts are rated to handle 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 SBC9310. 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 which 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 edge 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 designated 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 the corresponding system side and relay side test plug terminals. Appropriate precautions should be taken when working with station battery DC.

Connections should be made to the test plugs prior to insertion into the SBC9310. 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 SBC9310 for those signals which 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 SBC9310 insofar as the test signals are concerned.

WARNING

IT IS CRITICAL THAT JUMPERS BE INSERTED ON THE SYSTEM SIDE TEST PLUG TERMINALS WHICH 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 (PSM201) may be disconnected by removing the left connection plug for relay "A" (TP1-14), or the right connection plug for relay "B" (TP15-28). It may also be disconnected by removing the corresponding 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 device (test receptacle) on the other hand, is mounted only four centimeters (1.6 inches) from the front of the cases.

With the exception of the leads which carry the CT secondary currents, internal wiring between 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 electromagnetic 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.

Identification

The SBC9310 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 which 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 each 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 SBC9310 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 nearest 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 SBC9310 case has been designed for standard rack mounting. The case measures four rack units in height. Refer to the outline diagram, Figure 17.

The units may also be flush mounted on a panel with an appropriate cutout. Refer to Figure 17 for the required dimensions.

The relay can be surface panel mounted as well 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 and 9.

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 faulty 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, 0138B7406, is available to facilitate servicing.

CAUTION

Remove all power from the SBC9310 before removing or inserting any of the printed circuit board modules. One method of removing all external power is by removing both of the connections plugs located on the left side of the modular unit.

WARNING

CAUTION MUST BE EXERCISED WHENEVER A CARD EXTENDER IS INSERTED INTO AN IOM OR PSM POSITION SINCE STATION BATTERY POTENTIAL WILL BE PRESENT AT SOME POINTS. FAILURE TO OBSERVE THIS WARNING MAY RESULT IN PERSONAL INJURY OR DAMAGE TO EQUIPMENT.

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.

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 ILLUSTRATIONS

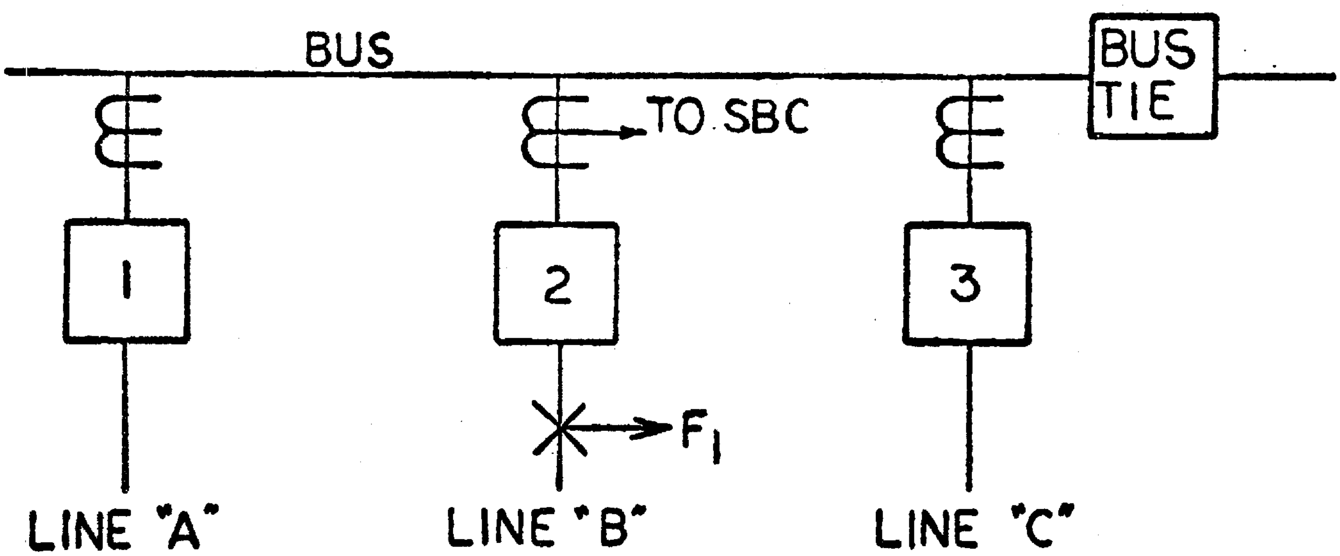


Figure 1 (0246A2279-1) Bus Arrangement: Single Bus/Single Breaker

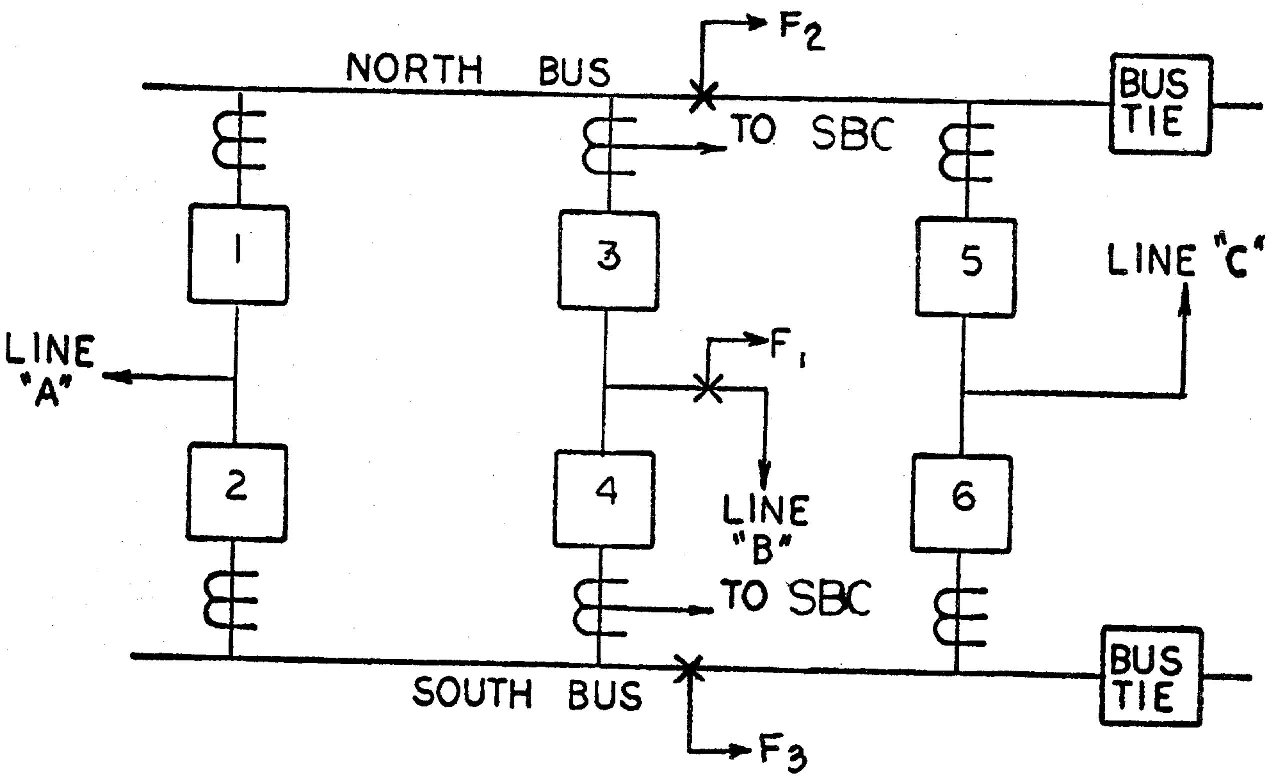


Figure 2 (0246A2277-2) Bus Arrangement: Double Bus/Double Breaker

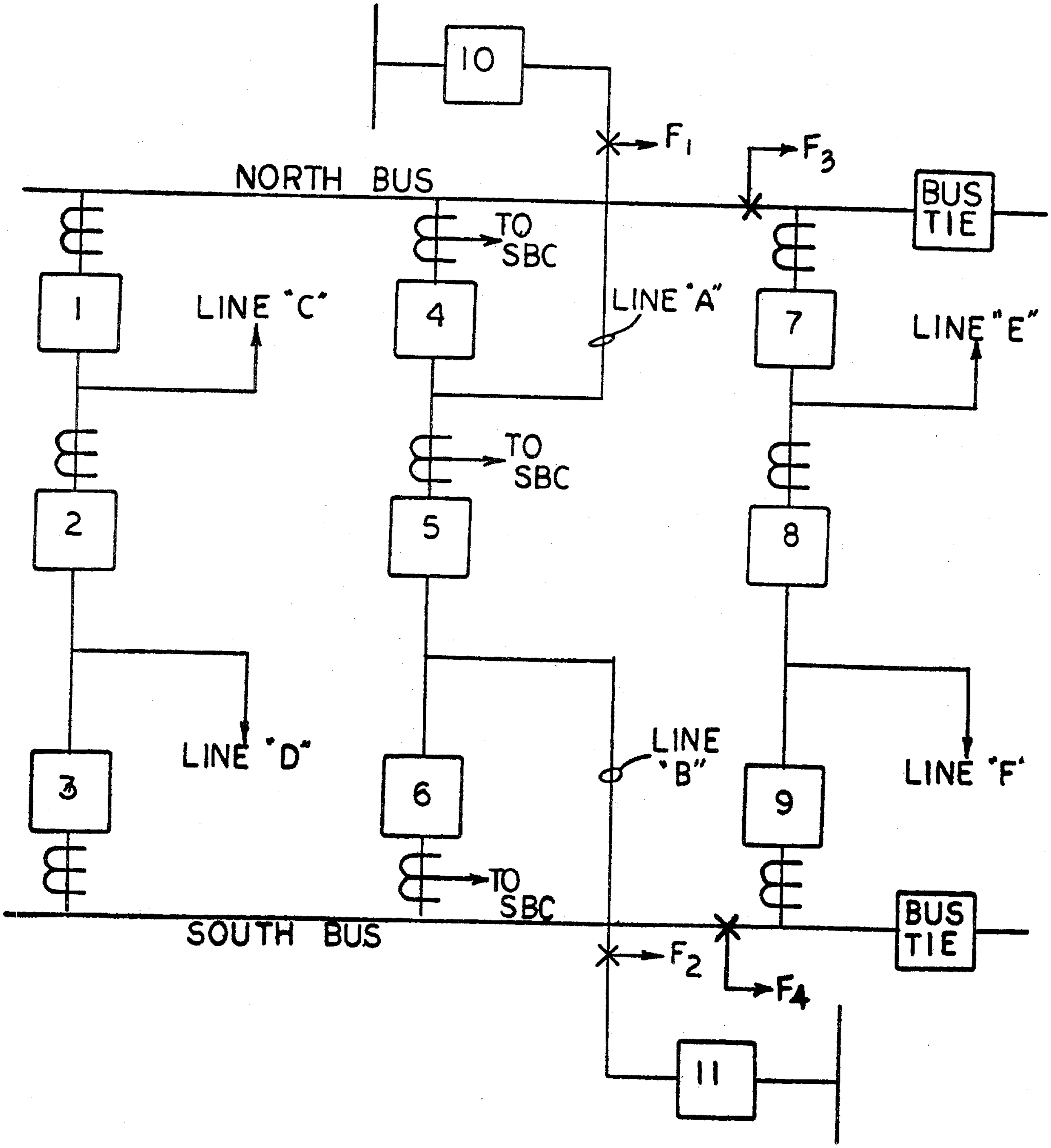


Figure 3 (0246A2280-2) Bus Arrangement: Breaker and a Half

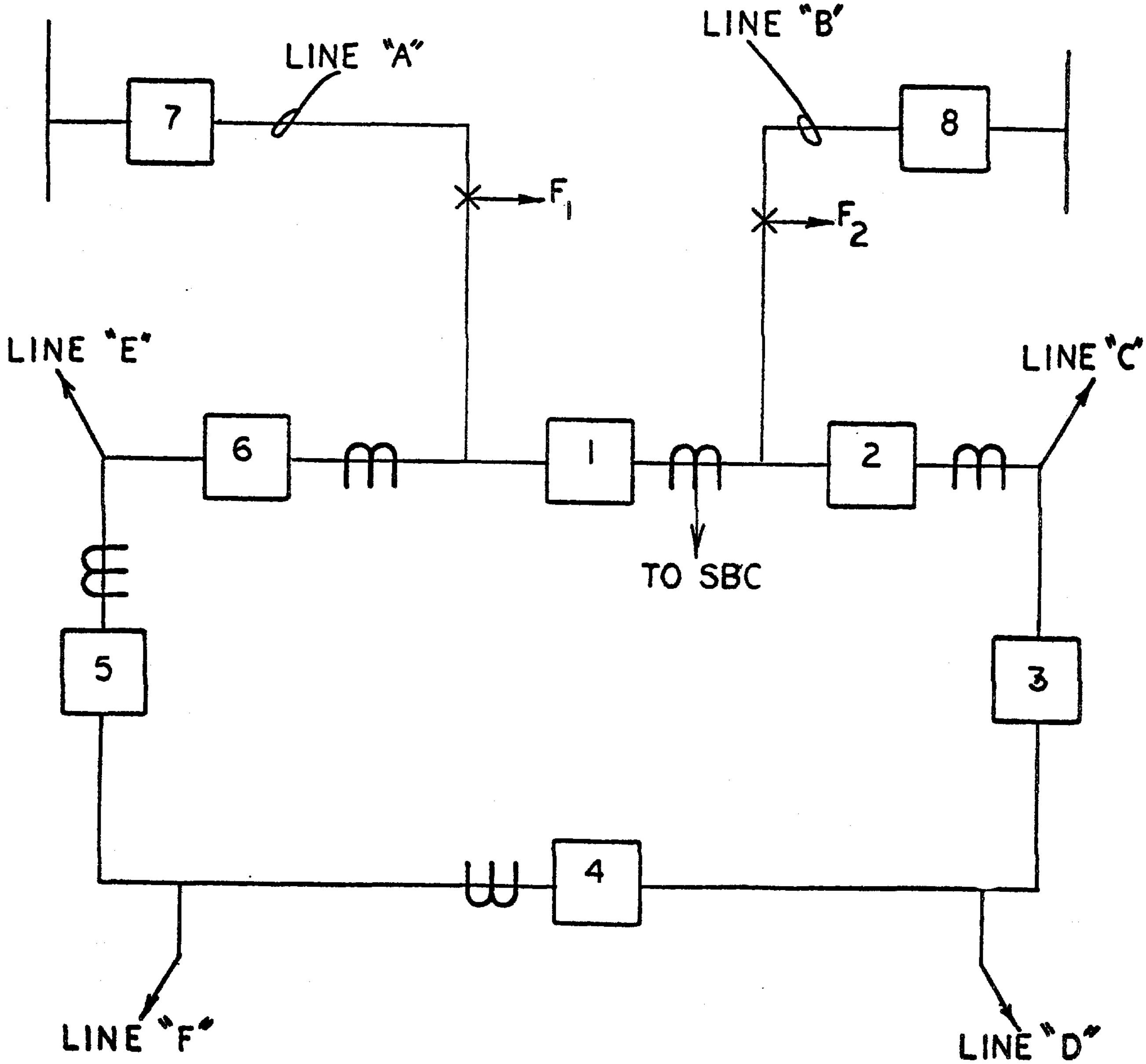


Figure 4 (0246A2278-1) Ring Bus Arrangement

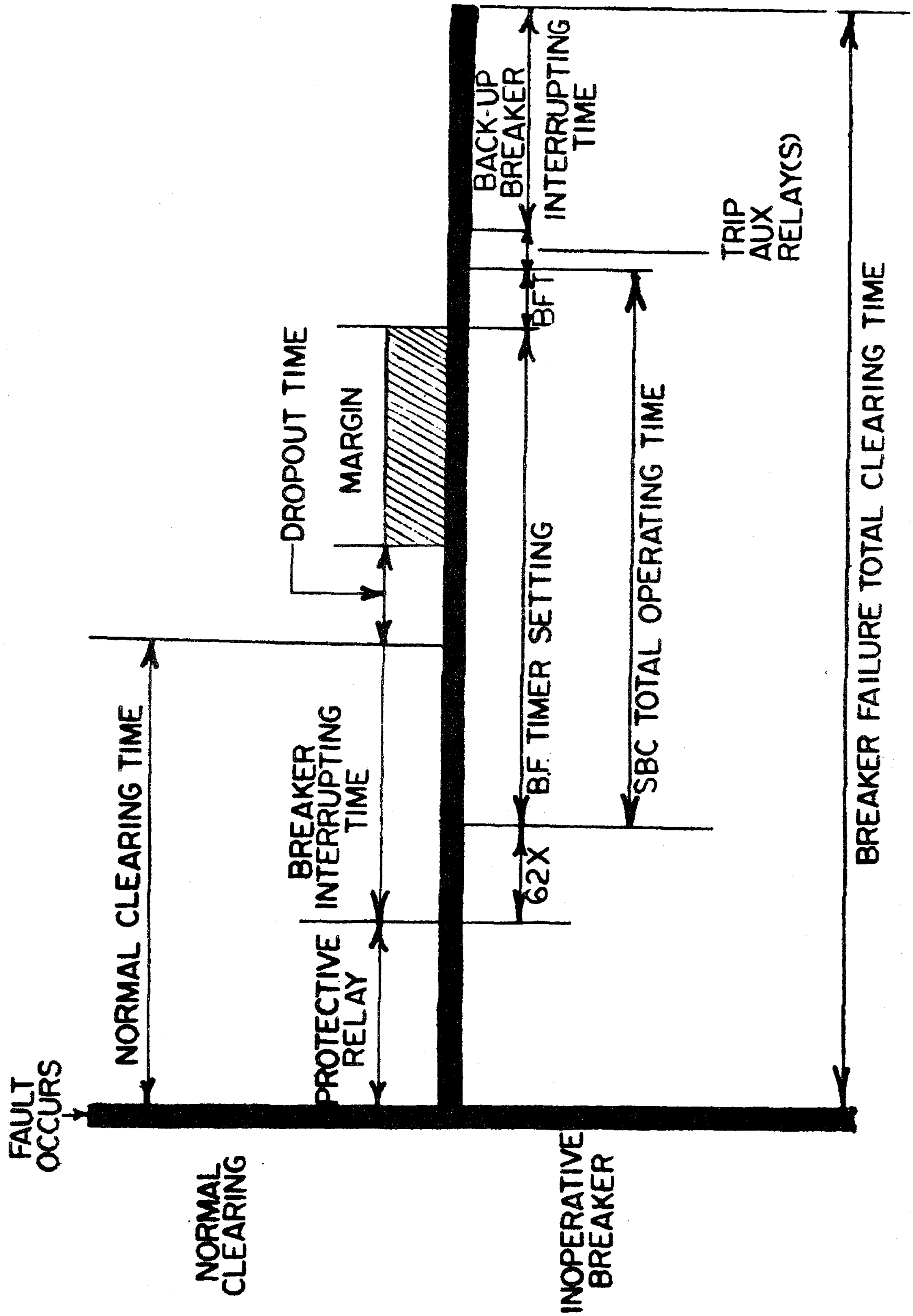


Figure 5 (0285A8160-0) Breaker Failure Timer Settings

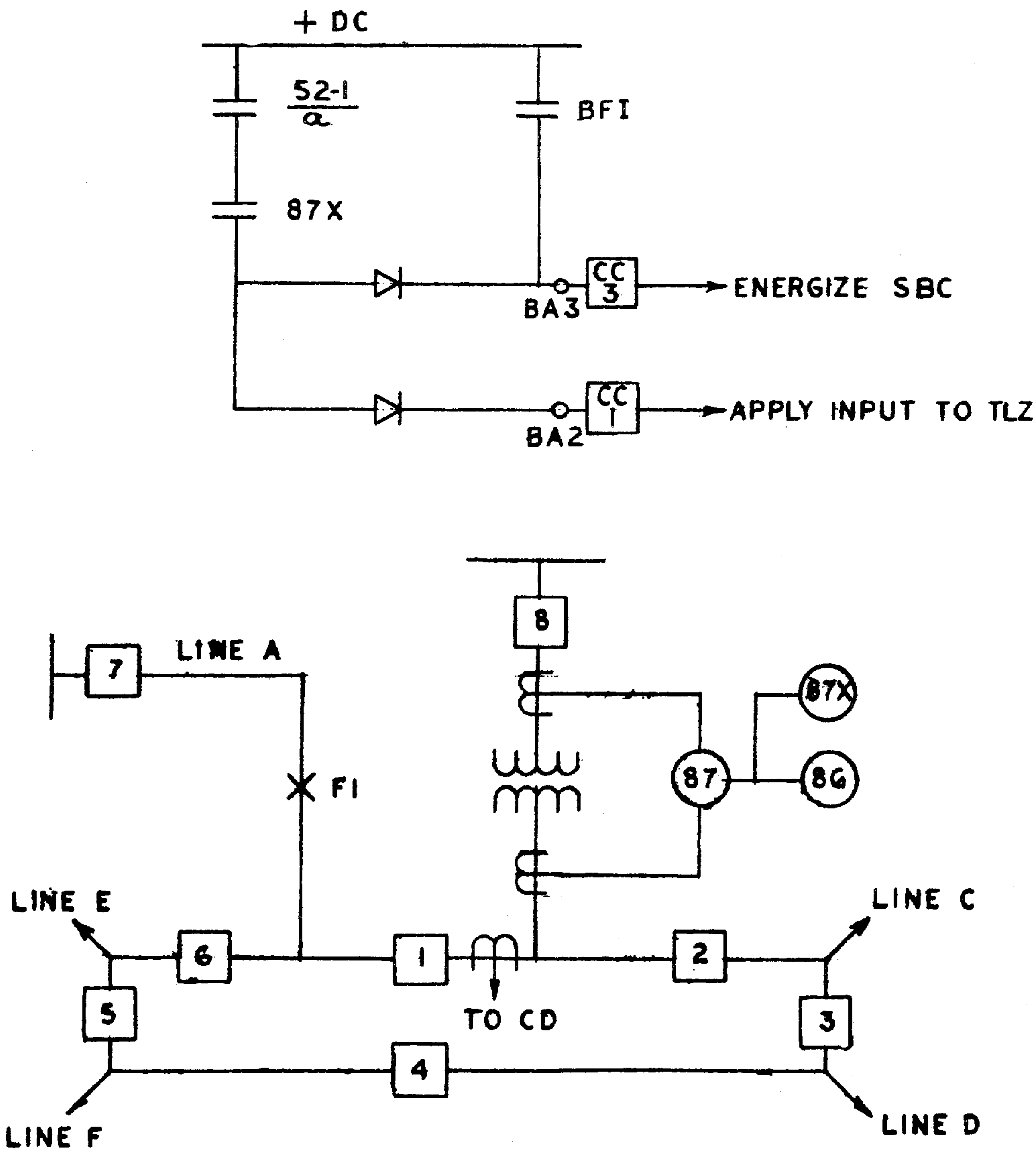


Figure 6 (0285A8123-0) Protection Scheme for a Breaker
Shared by Line and System Transformer

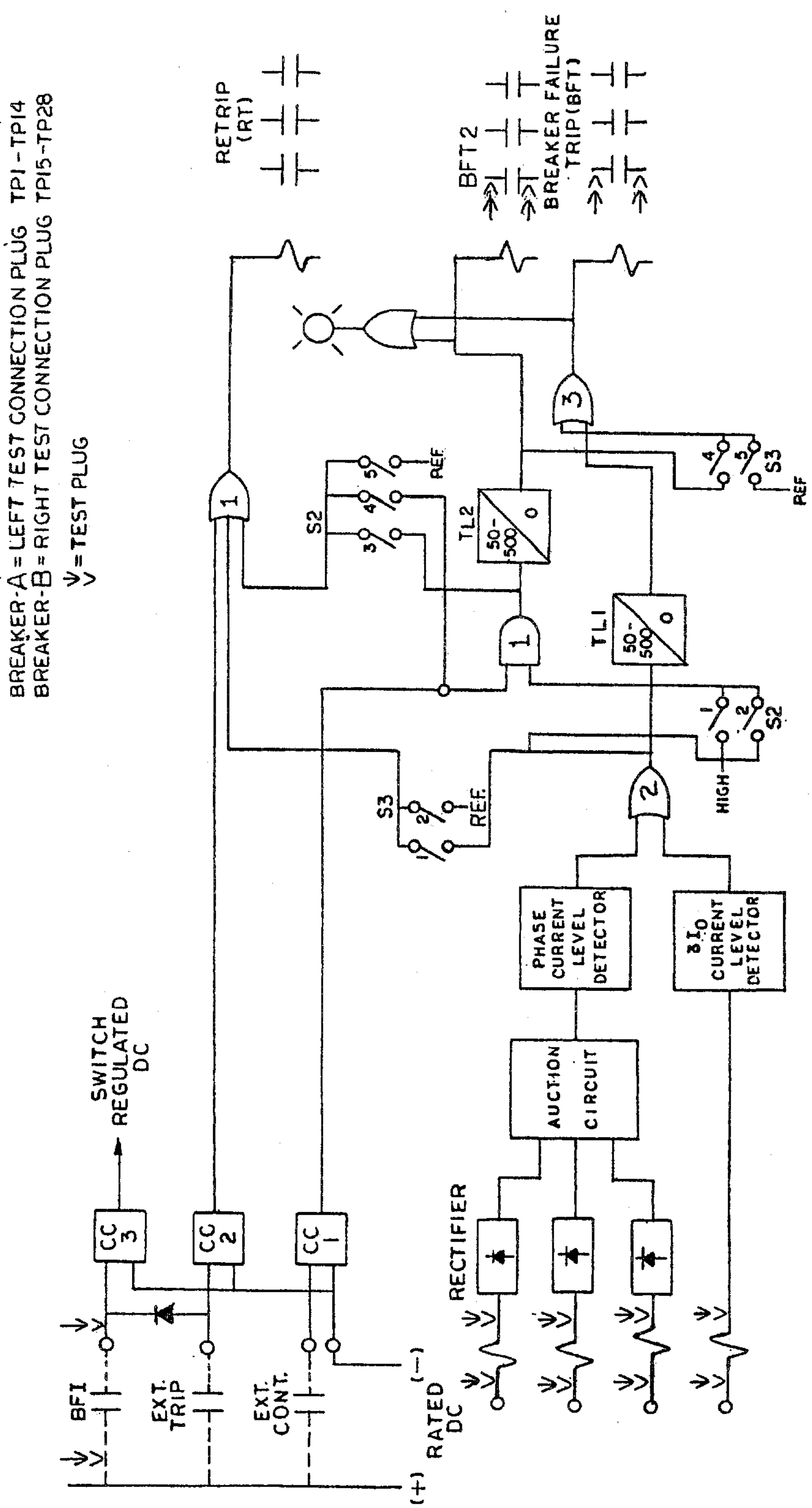


Figure 7 (0138B7786 [3]) Logic Diagram for Type SBC9310 Relay

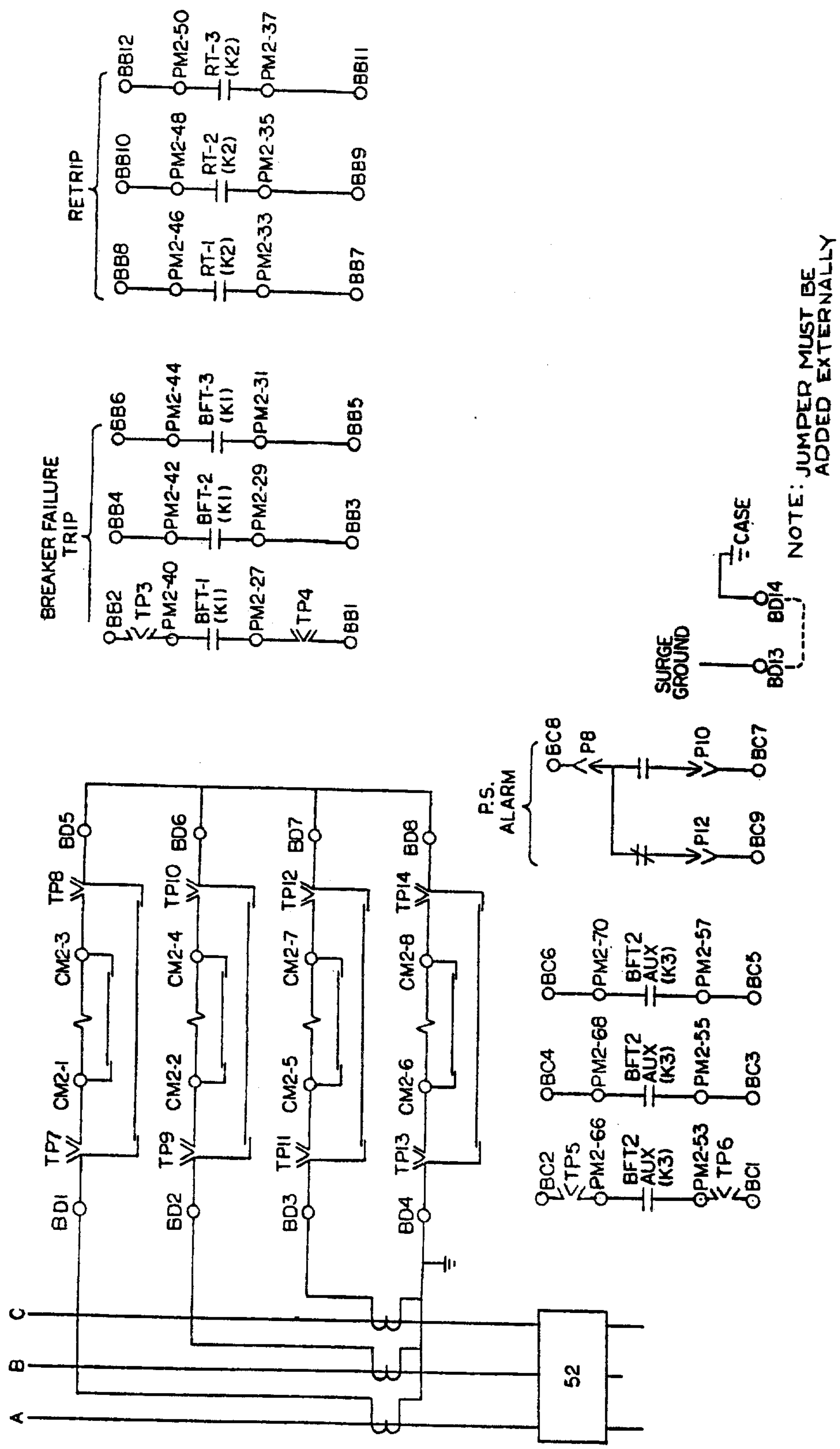


Figure 8A (0138B7785-1, Sh. 3) Elementary Diagram for Type SBC9310 Relay, Breaker "A"

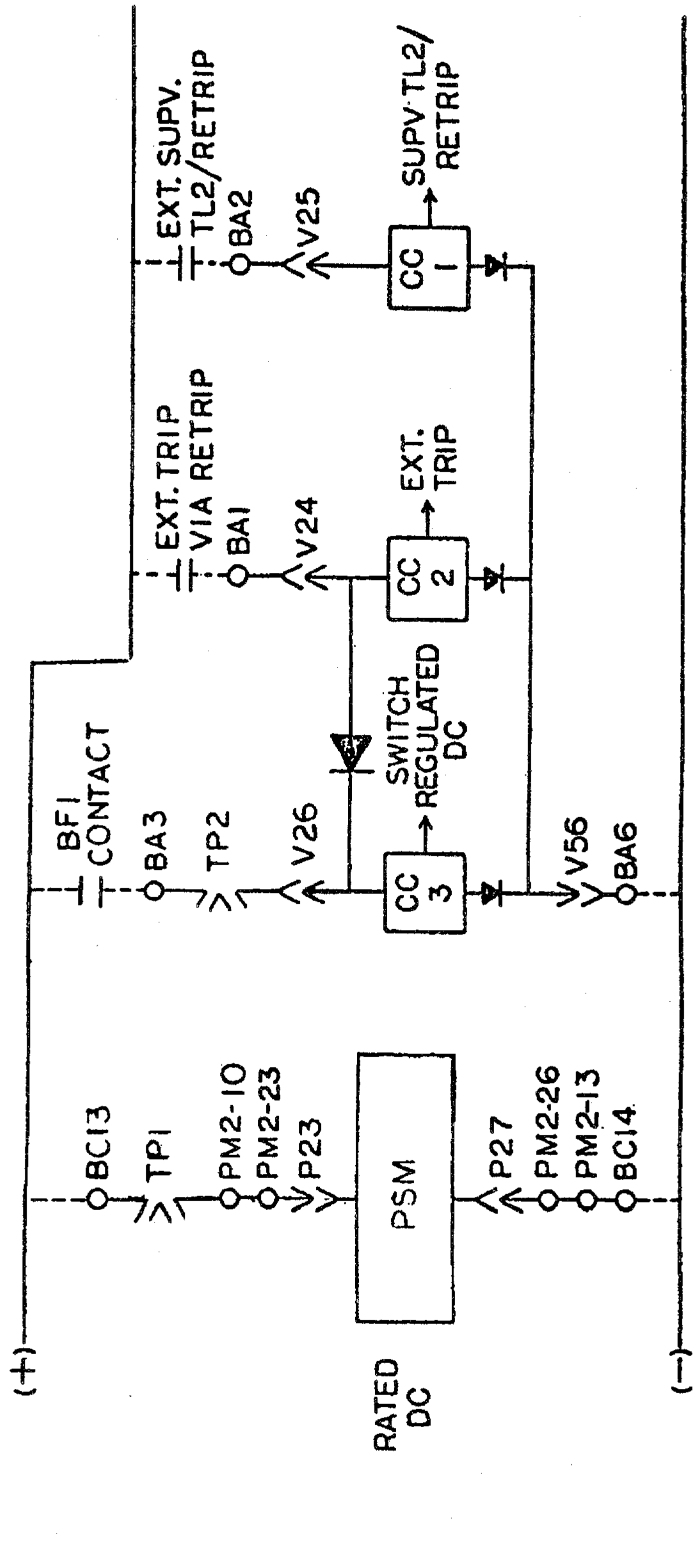


Figure 8B (0138B7785-1, Sh. 1) Elementary Diagram for Type SBC9310 Relay
Breaker "A"

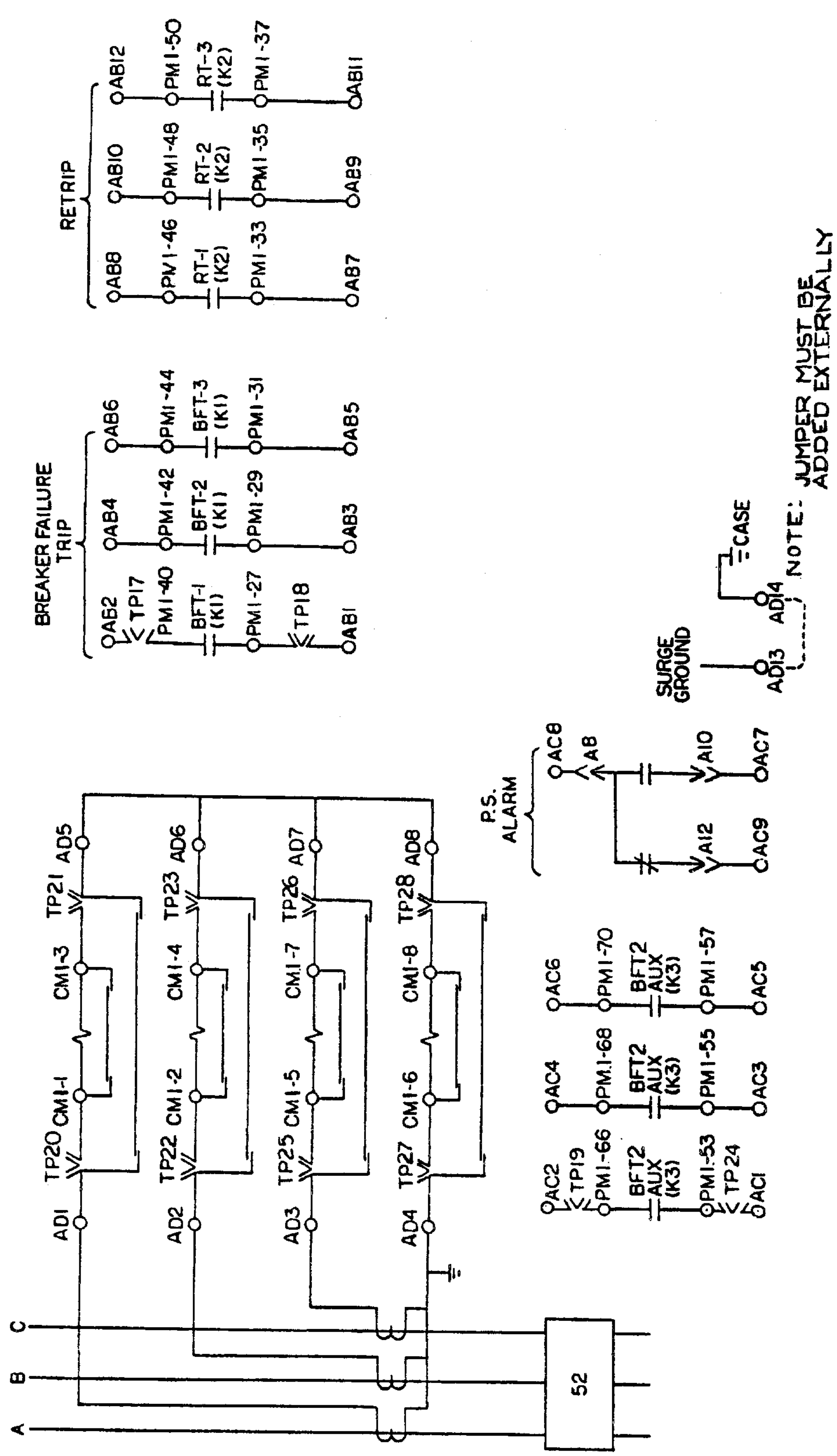


Figure 9A (0138B7785-1, Sh. 4) Elementary Diagram for Type SBC9310 Relay Breaker "B"

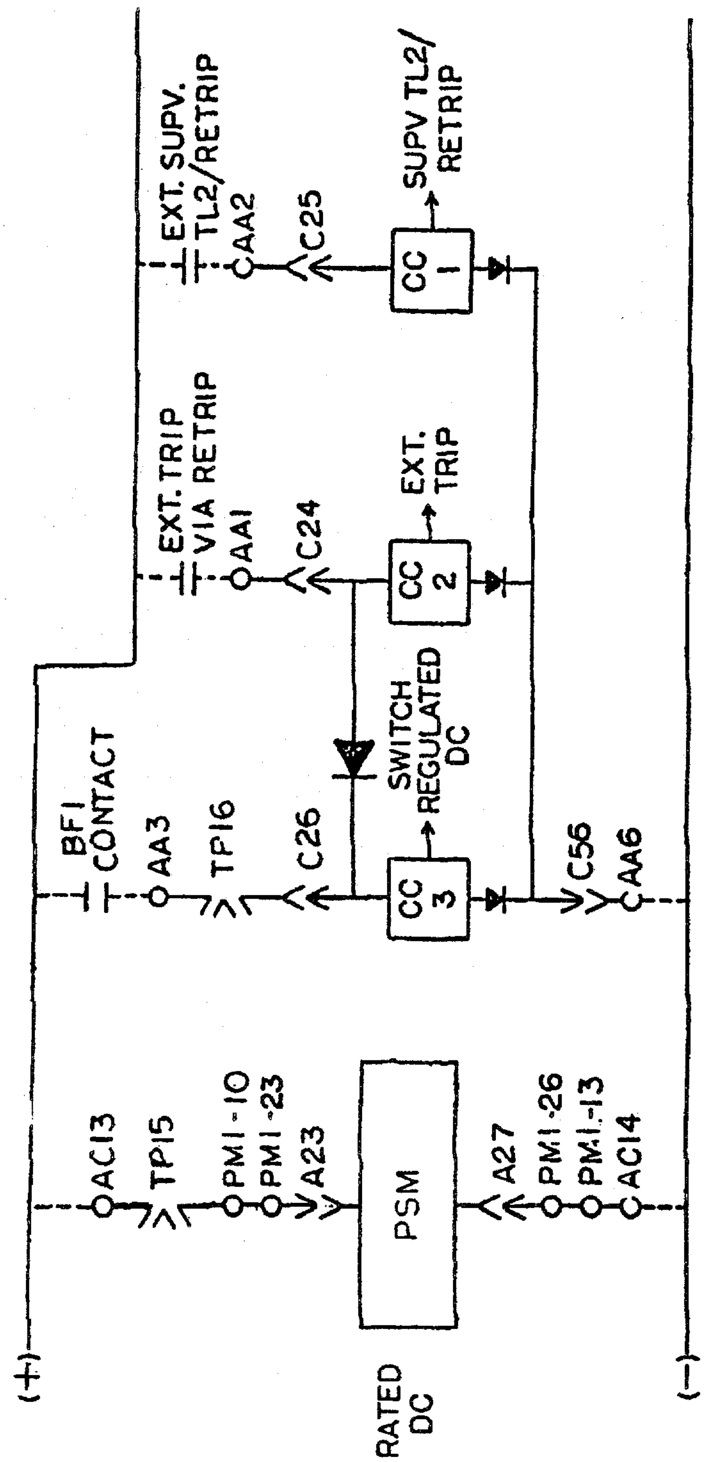


Figure 9B (0138B7785-1, Sh. 2) Elementary Diagram for Type SBC9310 Relay
Breaker "B"

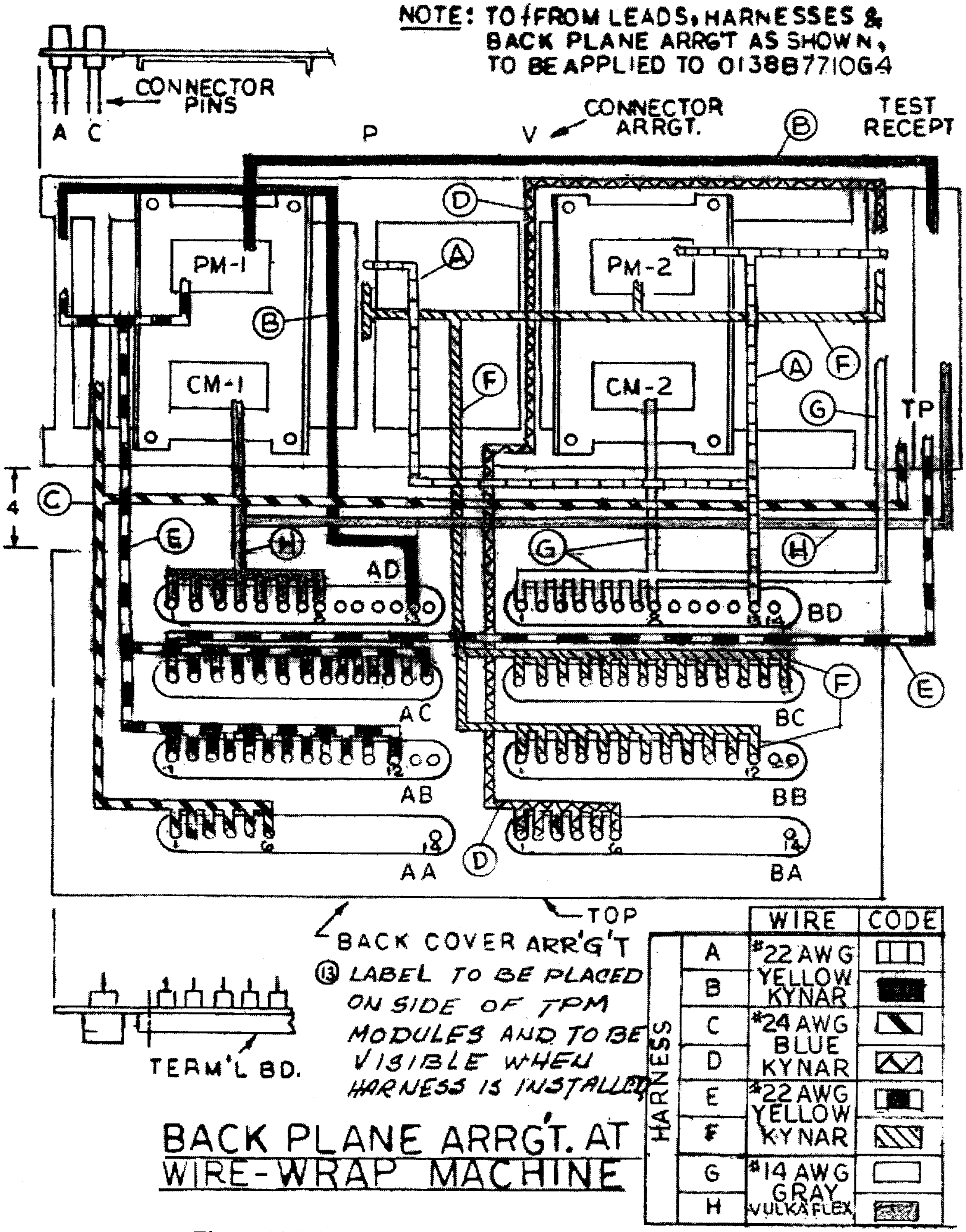


Figure 10A (0285A8867 Sh. 2 [1]) Breaker Failure Relay - Case Wiring, From-To List

SHORTEST ROUTING

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

FROM	TO		FROM	TO	
A31	A60		P31	P60	
A31	GRD	[D]	P31	GRD	[D]
A4	A34		P4	P34	
A6	A36		P6	P36	
A8	A38		P8	P38	
A10	A40		P10	P40	
A12	A42		P12	P42	
A27	A57		P27	P57	
A23	A53		P23	P53	
C1	PM1-89		V1	PM2-89	
C4	-87		V4	-87	
C10	-100		V10	-100	
C14	-88		V14	-88	
C16	PM1-101		V16	PM2-101	
C28	A34		V28	P34	
C11	PM1-79		V11	PM2-79	
C15	-92		V15	-92	
C12	-80		V12	-80	
C17	-93		V17	-93	
C30	PM1-104		V30	PM2-104	
C31	V60		V31	V60	

Figure 10B (0285A8867, Sh. 3) Breaker Failure Relay - Case Wiring, From-To List

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

HARNESS A — ALL NO. 22 AWG * — COLOR CODE: B ☐ G ☐ Y ■

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

FROM	TO
PM2-27	TP8
-40	TP6
-66	TP10
-53	TP12
PM2-10	TP2
P6(b70)	BD13
PM2-23	PM2-10
PM2-13	PM2-26

(Δ) SPL LEAD 0138B7577G9

HARNESS B — ALL NO. 22 AWG * — COLOR CODE: B ☐ G ☐ Y ■

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

FROM	TO
PM1-27	TP36
-40	TP34
-66	TP38
-53	TP48
PM1-.10	TP30
(Δ) A6 (b71)	AD13
PM1-23	PM1-10
PM1-13	PM1-26

HARNESS —— —— — ALL NO. AWG * — COLOR CODE: B ☐ G ☐ Y ☐

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

FROM	TO

NOTE: HARNESS ROUTING PER THIS DWG SHEET NO. 2.

Figure 10C (0285A8867-0, Sh. 4) Breaker Failure Relay - Case Wiring, From-To List

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

ALL NO. 24 AWG * COLOR CODE B G Y

HARNESS — C —

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

FROM	TO
C24	AA1
C25	AA2
C26	TP32
C54	AA4
C55	AA5
C56	AA6
TP31	AA3

ALL NO. 24 AWG * COLOR CODE B G Y

HARNESS — D —

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

FROM	TO
V24	BA1
V25	BA2
V26	TP4
V54	BA4
V55	BA5
V56	BA6
TP3	BA3

ALL NO. 22 AWG * COLOR CODE B G Y

HARNESS — E —

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

FROM	TO
AB1	TP35
AB2	TP33
AB3	PM1-29
AB4	-42
AB5	-31
AB6	-44
AB7	-33
AB8	-46
AB9	-35
AB10	-48
AB11	-37
AB12	PM1-50
AC1	TP47
AC2	TP37
AC3	PM1-55
AC4	-68
AC5	-57
AC6	PM1-70
AC7	A10
AC8	A8
AC9	A12
AC13	TP29
AC14	PM1-13
A23	PM1-23
A27	PM1-26

NOTE: HARNESS ROUTING PER THIS DWG SHEET NO. 2

Figure 10D (0285A8867-1, Sh. 5) 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 —

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

FROM	TO
BB1	TP7
BB2	TP5
BB3	PM2-29
BB4	-42
BB5	-31
BB6	-44
BB7	-33
BB8	-46
BB9	-35
BB10	-48
BB11	-37
BB12	PM2-50
BC1	TP11
BC2	TP9
BC3	PM2-55
BC4	-68
BC5	-57
BC6	PM2-70
BC7	P10
BC8	P8
BC9	P12
BC13	TP1
BC14	PM2-13
P23	PM2-23
P27	PM2-26

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
BD1	TP13
BD2	TP17
BD3	TP21
BD4	TP25
BD5	TP15
BD6	TP19
BD7	TP23
BD8	TP27
CM2-1	TP14
-3	TP16
-2	TP18
-4	TP20
-5	TP22
-7	TP24
-6	TP26
CM2-8	TP28

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
AD1	TP39
AD2	TP43
AD3	TP49
AD4	TP53
AD5	TP41
AD6	TP45
AD7	TP51
AD8	TP55
CM1-1	TP40
-3	TP42
-2	TP44
-4	TP46
-5	TP50
-7	TP52
-6	TP54
CM1-8	TP56

NOTE: HARNESS ROUTING PER THIS DWG SHEET NO. 2

Figure 10E (0285A8867-0, Sh. 6) Breaker Failure Relay - Case Wiring, From-To List

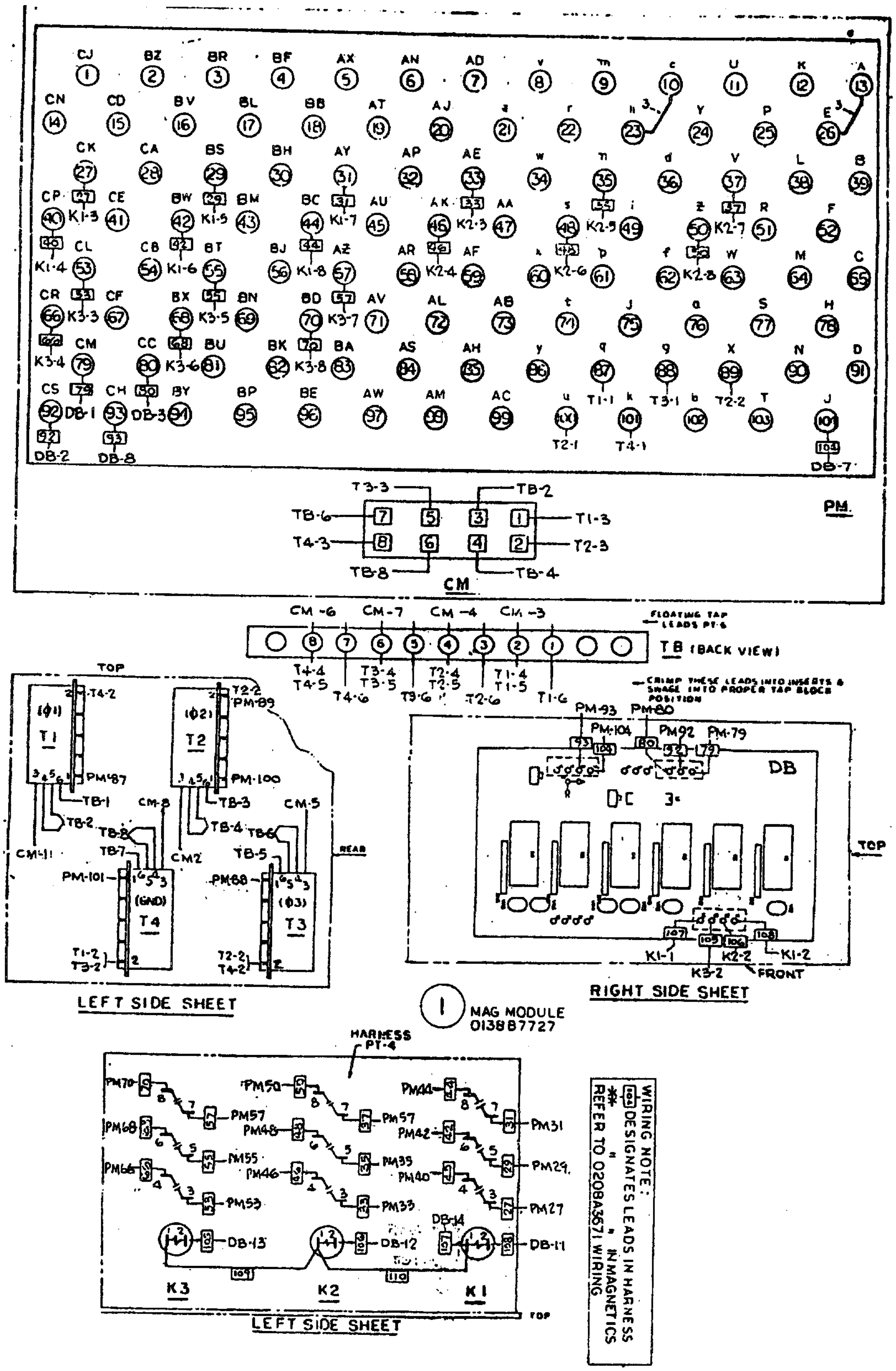


Figure 11 (0138B7700 [3]) Wiring Diagram -
Breaker Failure Magnetic Module, MGM105, MGM108

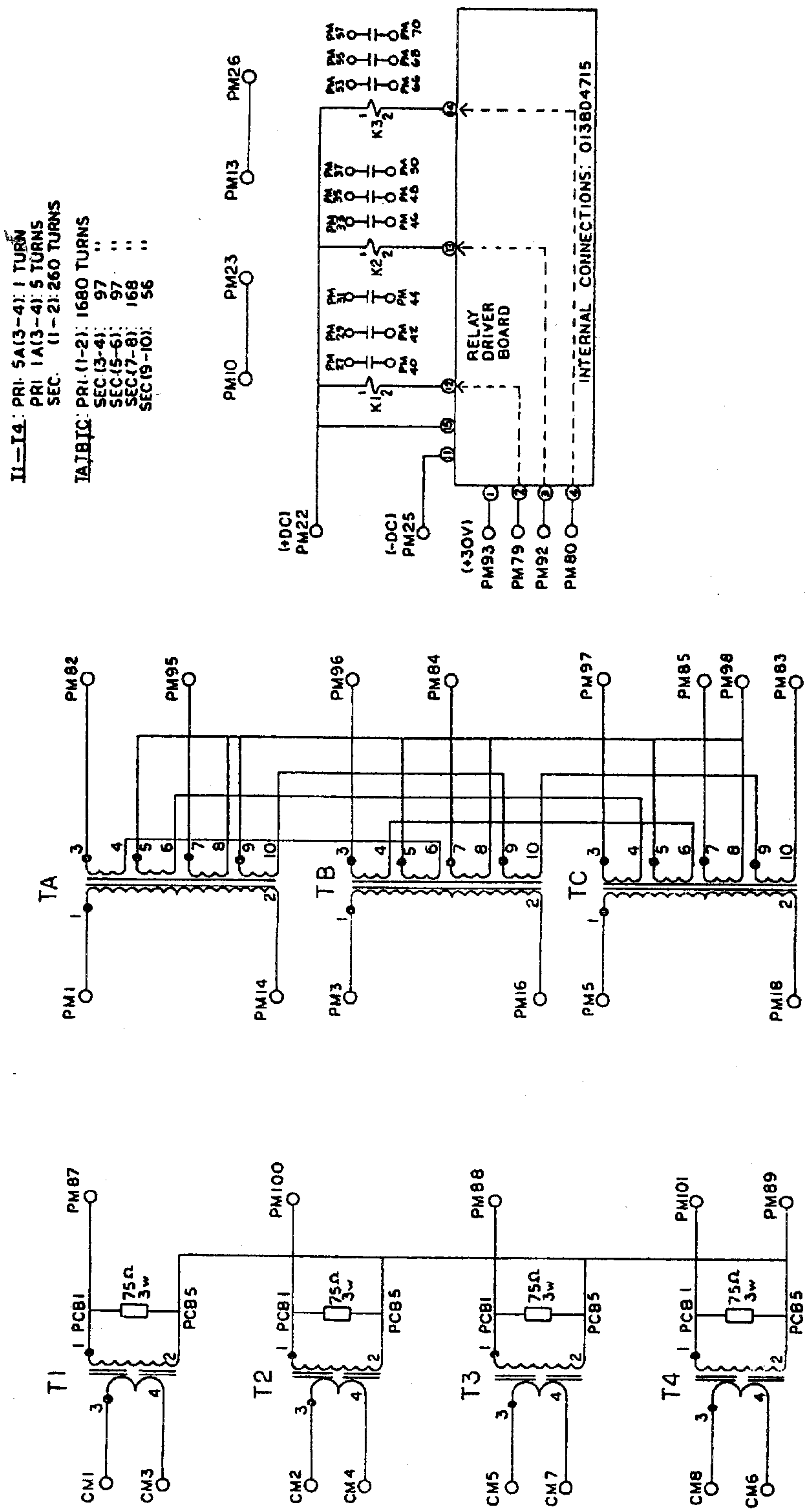


Figure 12 (0138B7654 [1]) Elementary Diagram for MGM105, MGM108 Module

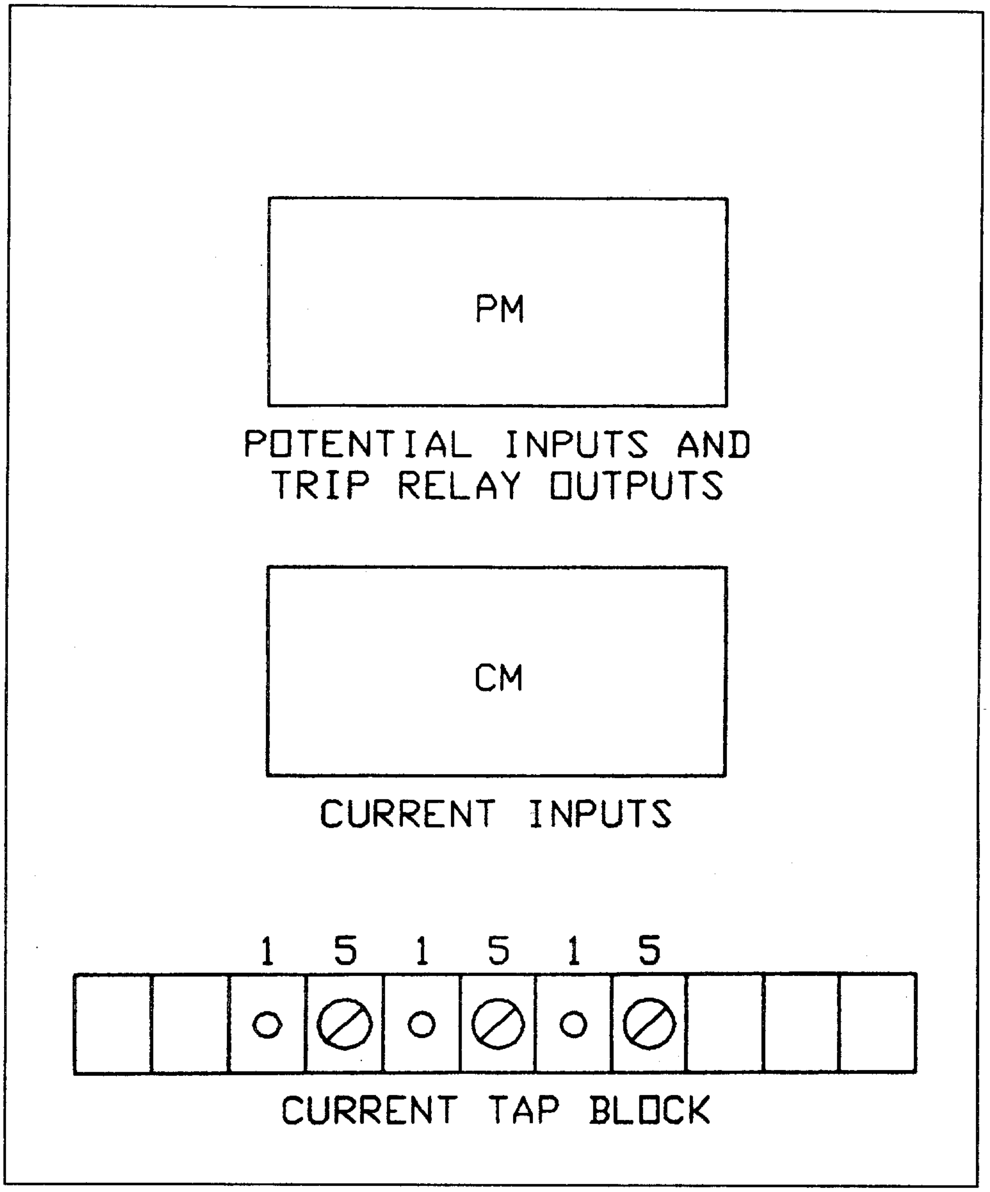
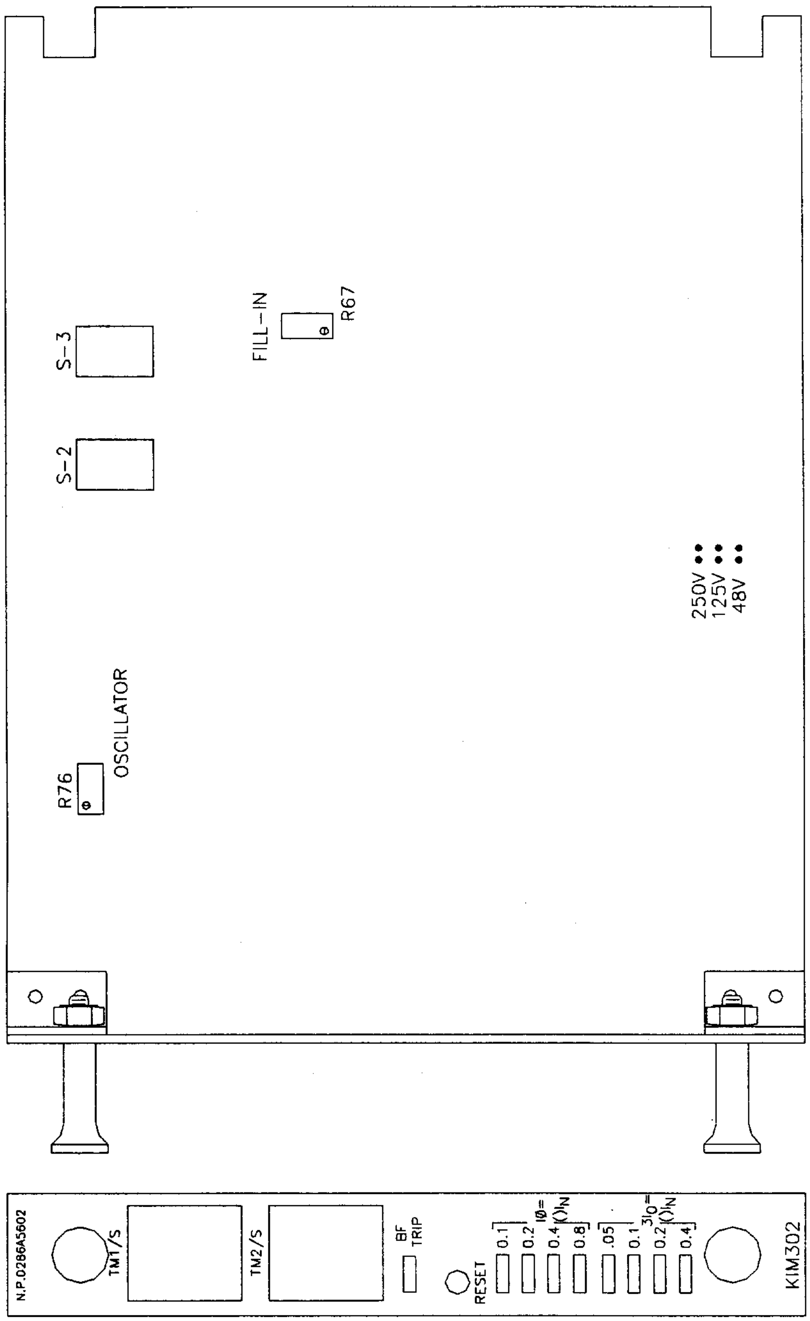


Figure 13 (0285A8169 [4]) MGM105, MGM108 Magnetics Module Tap Positions



FRONT PANEL SWITCHES AND INTERNAL LINKS FOR THE KIM 302 MODULE

Figure 14 (0361A7554) KIM302 Printed Circuit Board Switch Locations

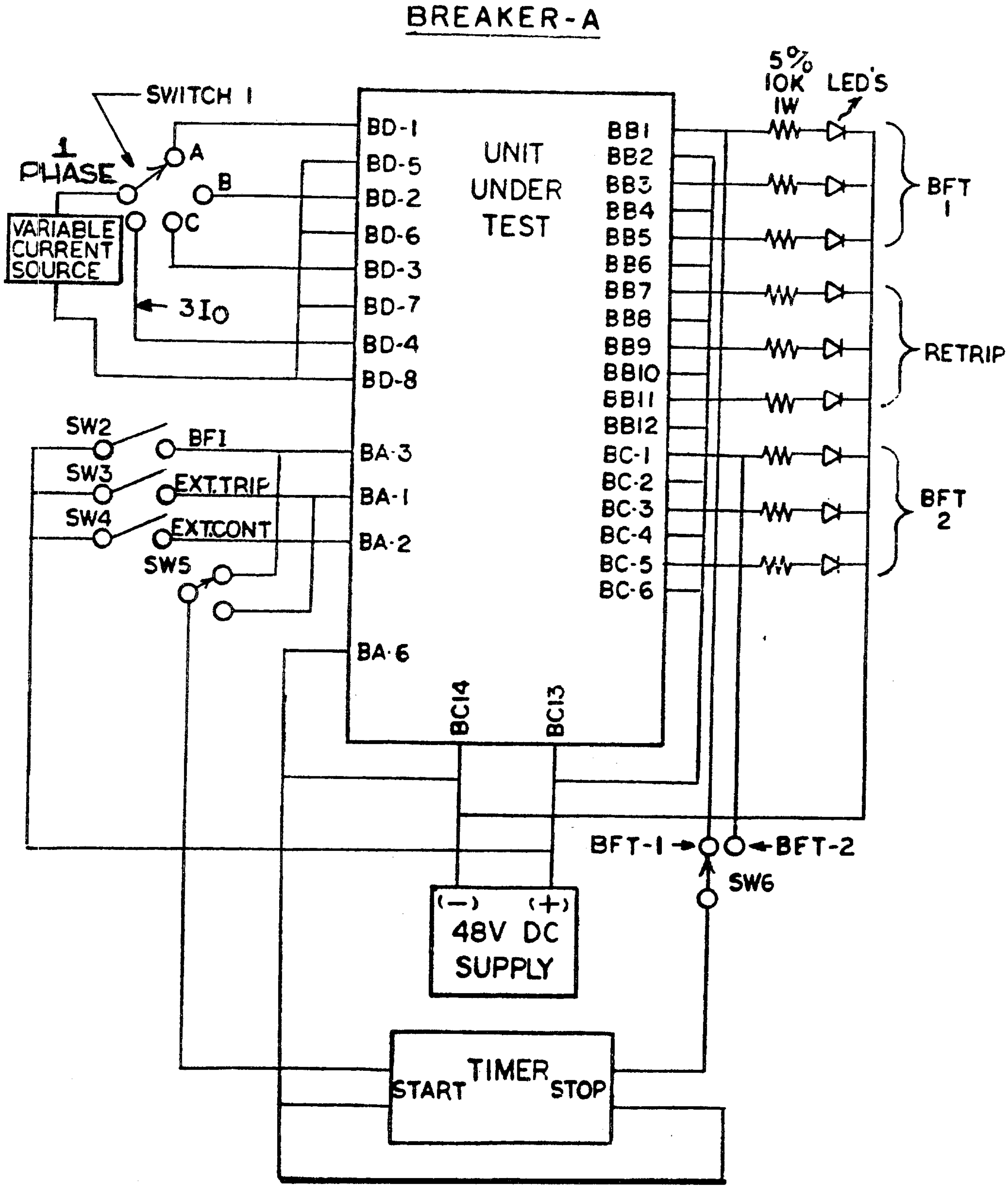


Figure 15 (0285A8876-1, Sh. 1) Three Pole SBC Unit Test Diagram, Breaker "A"

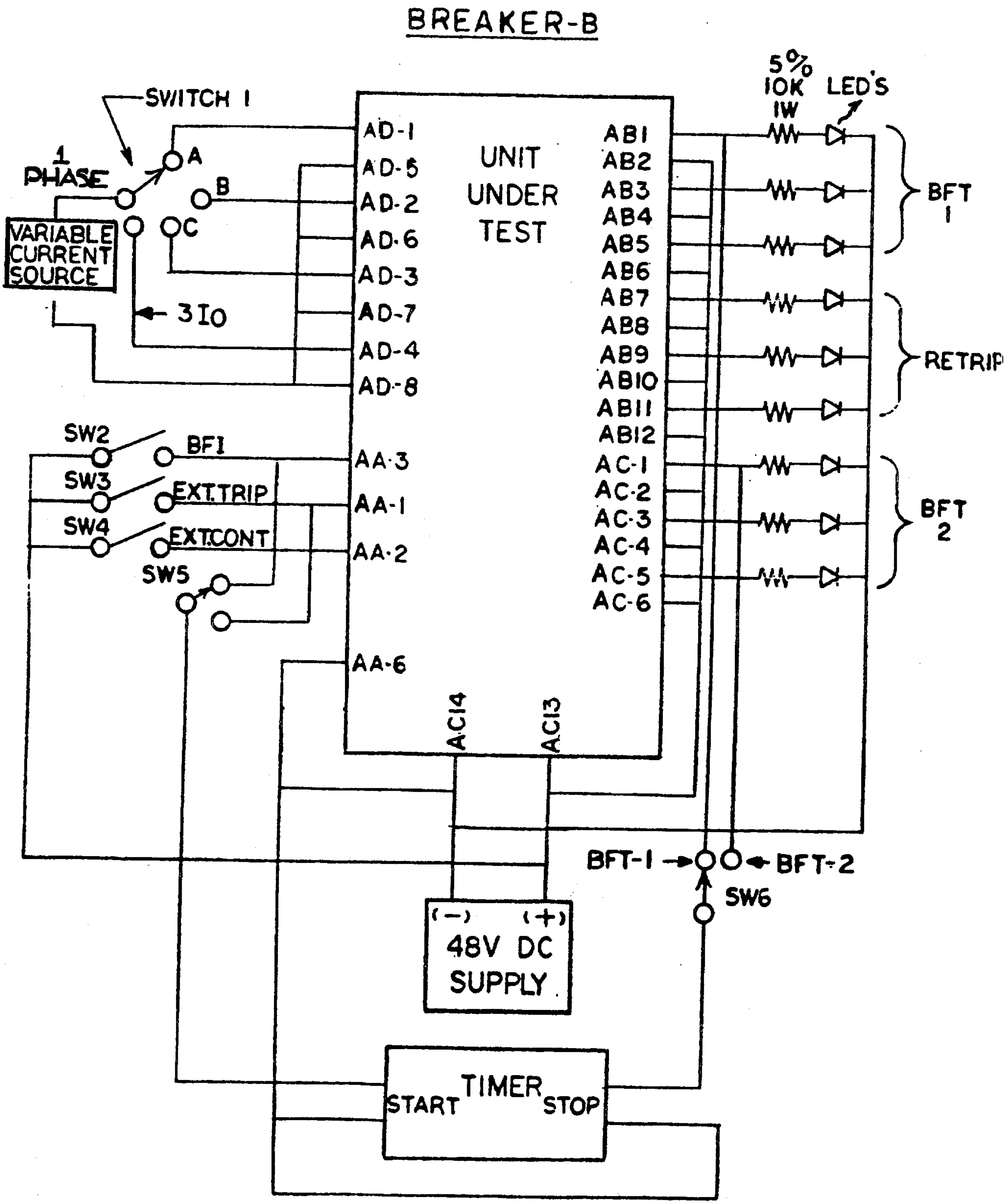


Figure 16 (0285A8876-1, Sh. 2) Three Pole SBC Unit Test Diagram, Breaker "B"

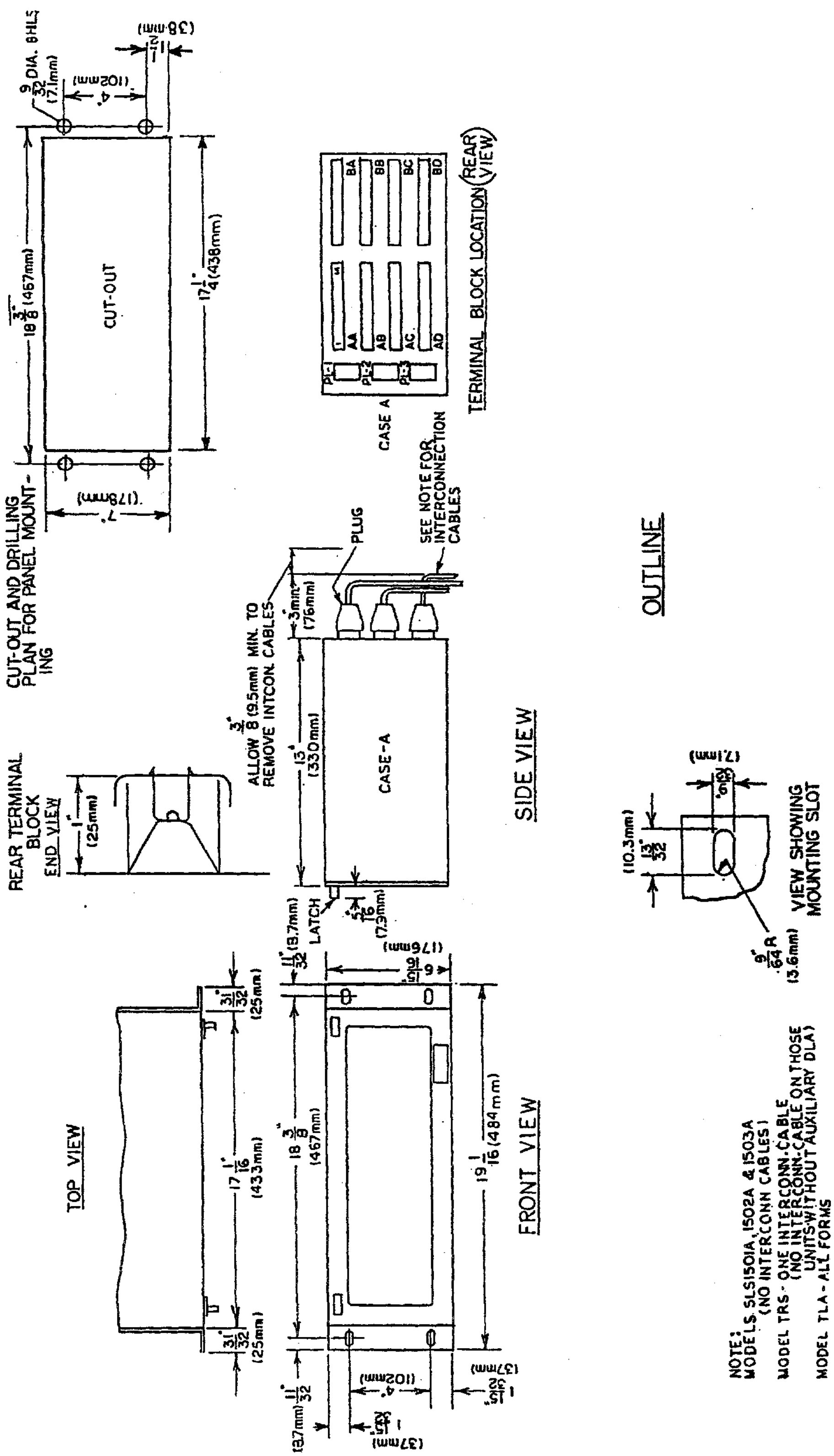


Figure 17 (0138B7600-0, Sh. 1) Type SBC9310 Case Outline

GE Power Management

BC-4/98 (200)

General Electric Company
Protection and Control
205 Great Valley Parkway
Malvern, Pennsylvania 19355-0715
Telephone (610) 251-7000