INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE SDU-1 STATIC HIGH SPEED CARRIER START DISTANCE RELAY

Caution: It is recommended that the user of this equipment become acquainted with the information in this instruction leaflet before energizing the relay. Failure to observe this precaution may result in damage to the equipment.

APPLICATION

The SDU-1 consists of three single-phase distance units and is used as the phase carrier start relay in the directional comparison blocking system. It may be used in a backup function to drive a timer. Its operating characteristic on an R-X plot includes the origin. The relay therefore is non-directional and is capable of operating on a sustained basis with the potential circuit shorted. It is capable of driving a nominal 20 volt, 10 milliampere maximum load.

CONSTRUCTION

The relay comprises three compensators, nine isolating transformers and three printed circuit boards. A hinged and removable door on the front provides access to all adjustments and output test points. The test points on the printed circuit boards are easily accessible and hence no card extender is necessary. At the rear portion of the relay a 24 terminal jack and a 8 terminal block are provided. The terminal jack provides external voltage connections and output terminals of the relay. The terminal block provides external current connections.

Compensator

The compensators are designated as T_{AB}, T_{BC} and T_{CA}. Each has two primary windings and a tapped secondary winding. Current I_A and I_B are respectively provided to two primary windings of T_{AB}. Similarly I_B, I_C and I_C, I_A are provided to T_{BC} and T_{CA} respectively. Each primary winding has seven taps which determines the impedance reach of the relay. The tap values are marked as follows: 3.36, 5.05, 6.75, 10.1, 14:3, 19.4, and 26.1 ohms.

A voltage is induced in the secondary winding when there is a current in any of the primary winding. The voltage and current establishes a linear relationship depending upon cross sectional area of laminated iron core, length of air gap, length of magnetic path in the core, number of turns of primary and secondary windings, loading of the secondary winding and also tightness of the laminations. The clamps holding the tightness of the laminations should not be disturbed in any case since current and voltage proportionality is precisely set at the factory.

The secondary winding has a single tap which divides the winding into two sections. The operation of the secondary winding is dealt in later sections.

Isolating Transformer

Transformer (T1, T4, T7) has 3 windings each. The primary winding get a voltage signal from one portion of the compensator secondary winding. One of the secondary windings is center tapped having a phase splitter circuit.The other secondary winding develops a voltage proportional to the primary winding which is subtracted from the input voltage and fed to the primary of isolating transformer (T2, T5, T8) the secondary of which contains a phase splitter circuit.

The isolating transformer (T3, T6, T9) has a turn ratio of 1:8 between primary and secondary. It's primary obtains a voltage proportional to the voltage induced in the other half of the compensator secondary winding through a resistor (R1, R6, R11). The secondary winding with center tap helps to provide a rectified dc output explained later on.

Phase Splitter Circuit

Phase splitter circuit is comprised of a capacitor (C2, C3, C5, C6, C8 or C9) and resistor (R4, R5, R9, R10, R14, or R15) device connected to the center tapped secondary windings of isolating transformers (T1, T4, T7) and (T2, T5, T8). Two terminals of resistor and the center tap provides a three phase output which are rectified and contains low ripple. The phase splitter in transformer (T1, T4, T7) provides an "operate" quantity and that in transformer (T2, T5, T8) provides "restrain" quantity.

SUPERSEDES I.L. 41-495.11
*Denotes change from superseded issue.

EFFECTIVE SEPTEMBER 1974

Printed Circuit Board

The relay contains three printed circuit board (PCB) assemblies respectively for AB, BC and CA phase operation. PCB assemblies are shown in Figure 4 and Figure 5. Each contains resistors capacitors diodes, transistors necessary to perform the function of magnitude comparison.

Components on each board are identified by a letter followed by a number so that they exclusively identified where the component is shown on a schematic drawing, Figure 4 which includes more than one PCB, the component designation on the schematic is preceded by board location number. For example, each PCB in Figure 4 has an R10 resistor. R10 in the phase AB board located in position 1 is 1R10 while R10 is the phase BC board located in position 2 is designated 2R10.

Case Construction

The jack plug on the rear has 24 terminals numbered left to right and top to bottom, Thus terminal #1 located at upper left hand corner and terminal #24 located at the lower right hand corner viewed from the rear. Terminal #1 is connected internally to the chassis ground and may be used for grounding the connecting cable shields.

The 8-terminal block used for current terminal which is located at the right hand side of rear when viewed from the back. The terminals are numbered from left to right.

The chassis case, cover and front panel have electrical connections established by the use of shakeproof washers which cut through any point or protective coating to make electrical contact with the base metal. The complete relay is then grounded to the switchboard or cabinet by an external wire connection which must be made by clamping the wire under a shakeproof washer which also serves to help hold the cover in place.

The door is hinged at the bottom and is secured at the top by two captive screws. It may be opened to 90 degrees where it is stopped by a slotted strap attached to the door and also to the frame of the case. To remove the door, release the strap by either unscrewing it or unhooking it from the door and then slide the door to the right to disengage the hinges.

Printed circuit boards are connected into the electrical circuits of the relay through 14-terminal connectors. The boards can be disengaged by a steady pull outward. Sometimes a simultaneous up-and-down motion (if there is clearance) will help free the mating connection. The boards are keyed so that they cannot be pushed into the wrong * connector.

OPERATION

Operating and Restraining Quantity

Figure 6 and Figure 7 shows the condition of BC phase for phase B-C fault and phase A-B-C fault respectively. A trip condition exist when $\frac{1}{2}|(I_B-I_C)\,Zc| > |V_{BC}-\frac{1}{2}(I_B-I_C)\,Zc|$ and a restrain condition follows when $\frac{1}{2}|(I_B-I_C)\,Z_c| < |V_{BC}-\frac{1}{2}(I_B-I_C)\,Zc|$. $\frac{1}{2}|(I_B-I_C)\,Zc|$ is termed as operating quantity and $|V_{BC}-\frac{1}{2}(I_B-I_C)\,Z|$ denotes restrain quantity. Thus it follows that operating quantity must exceed restrain quantity in order to operate the relay. DC voltage across R16 is the rectified output from phase splitter circuit, through diodes D9 to D14 which is the operating quantity V_{OP}. Similarly DC voltage across R18 is the rectified output from phase splitter circuit through diodes D15 to D20 which the restraining quantity V_r.

In order to increase the sensitivity at low energy of fault current a rectified output (V_{OC}) obtained from transformer T3, T6, T9 is added to V_{OP}. This rectified output V_{OC} is clipped by diodes D2, D3, D4 and D5, D6, D7 so that its effect is most at low energy of fault current and is least at high energy of fault current.

Magnitude Comparison Circuit

So it transpires from preceding paragraph that $|V_{OP} + V_{OC}| > Vr$ in order to provide an operating condition. The comparison of $V_O = V_{OP} + Voc$ with Vr is effected in the magnitude comparison circuit. When Vo becomes more positive than Vr, transistor Q1 conducts which turns on transistor Q2. The positive feedback circuitry R22 and D27 helps to turn on Q1 and consequently Q2 very sharply to provide an output at TP5.

Fast Starting Circuitry

At the time of fault, the fault voltage goes down sharply, but the restrain quantity does not follow this change suddenly. So there is enough restrain transient available to delay the operation of the relay. This delayed operation is mitigated by a

fast starting circuitry, C10, R19, D22, and D23
* which suppresses this transient and allows high speed of operation.

CHARACTERISTICS

Distance Characteristics

* This unit will operate on all phase faults. A typical polar characteristic of the relay in R-X plane is shown in Figure 8. Most of the relay characteristics fall in the first quadrant which is desirable. This characteristic is also independent of source impedance.

Sensitivity

A plot of relay reach in percentage of its setting versus relay terminal voltage is shown in Figure 9. The unit will operate at zero relay terminal voltage for all phase faults. For this condition, the product of IZ should not be less than 0.4 volts with rated voltage at the unfaulted phase for phase to phase fault. It is apparent from the figure that the relay overreaches when fault voltage is low.

General Characteristics

Impedance settings in ohms reach can be made in steps between 3.36 to 26.1 ohms at maximum sensitivity angle of 75° ± 3° which is set at the factory. This adjustment should not be disturbed for carrier start application.

TIME CURVES & BURDEN DATA

Operating Time

The speed of the relay is shown by the curve in Figure 10. The speed characteristics is defined as operating time in milliseconds as current times the reach setting at maximum sensitivity angle.

Burden

The d.c. drain of the relay at rated supply voltage is 70 m.a.

Current Circuit Rating

"T" Tap Setting	Continuous	1 Second
3.36	10	240
5.05	10	240
6.75	10	240
10.1	10	240
14:3	10	240
19.4	10	240
26.1	10	240

Output Circuits

Open Circuit-Voltage . . . . .17V to 21V d.c.

Rated Current . . . . 10 milliamperes

CALCULATION AND SELECTION OF SETTING

Tap markings and corresponding relay reach based on maximum sensitivity of 75° is shown below: Tap Markings—3.36; 5.05; 6.75; 10.1; 14:3; 19.4; 26.1.

The reach setting $Z\theta$ can be made if the line impedance Zpri, current transformer ratio RC and potential transformer ratio RV is known.

$$Z\theta = Zpri \frac{RC}{RV}$$

In order to obtain optimum setting of the relay select T-setting (compensator tap) nearest to the desired value of $Z\theta$.

When relay is used for carrier start functions disregard correction in difference between the characteristic angle of the line and the maximum sensitivity angle of the relay.

SETTING THE RELAY

The relay requires setting for all compensators T_{AB}, T_{BC} and T_{CA}. Each compensator taps terminates in inserts which are grouped on a socket and form approximately three quarters of a circle around a center insert which is the common connection for all of the taps. Electrical connection between * common insert and tap inserts are made with a link that is held in place with two connector screws, one in the common and one in the tap. Two settings for each T_{AB}, T_{BC}, and T_{CA} are to be made since each compensator contains two primaries provided with current from two different phases and hence any phase current goes to two compensators. A compensator tap setting is made by loosening the connector screw in the center and removing the connector screw in the tap. Swing the link until it is in position over the insert for the desired tap setting, replace the connector screw to bind the link to this insert, and retighten the connector screw in the center. Since the link and the connector screw carry operating current, be sure that the screws are turned to bind snugly but not so tightly as to break the tap screw.

Line Angle Adjustment

Maximum sensitivity angle is set for 75°±3° (current lagging voltage) in the factory. This adjustment should not be disturbed for carrier start application.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay by means of four slotted holes on the front of the case. Additional support should be provided toward the rear of the relay in addition to the front panel mounting. This will protect against warping of the front panel due to the extended weight within the relay case.

EXTERNAL CONNECTIONS

Figure 11 shows the external connection for the relay. Current circuit connections are made to an eight point terminal board located at the rear of the relay rack. A.C. and D.C. potential circuits as well as input and output logic signal circuits are connected through a 24 terminal jack. Connections are made by a plug on the wiring harness. The plug is inserted between two latching fingers which hook over the back of the plug to prevent accidental loosening of the plug. The plug can be removed by spreading the two fingers apart enough to disengage the hooks from the back and then withdrawing the plug.

Note that terminal number 1 is connected to the case within the relay and may be used for grounding the shields of connecting cable. The grounding connection is broken when the plug is disconnected.

Permanent grounding is accomplished by connecting a ground wire under a washer of a cover screw. These are self tapping screws and provide excellent low resistance contact with the case.

RECEIVING ACCEPTANCE

Acceptance test consists of an electrical tests to verify whether the relay measures the balance point impedance accurately.

Recommended Instrument for Testing

Westinghouse Type PC-161, Style #291B719A33 or equivalent A.C. Voltmeter.

Westinghouse Type PA-161, Style #291B719A21 or a-c ammeter.

Distance Units - Electrical Tests

The test for distance units is accomplished by use of test connections shown in Figure 12. Tripping is indicated by a d-c voltmeter connected at the output terminal. At the balance point the voltmeter reading may be as low as 1 to 2 volt indicating the system is partially tripping. This is a normal balance point characteristic. However, a 10% more current should produce an output of 15 to 20 volts. A reading of less than 15V indicates a defective tripping output or defective logic.

The procedure for Electrical Tests is as follows:

1. Set T_A, T_B and T_C for maximum tap value.
2. Connect the relay for a 1-2 fault as indicated for test #5 and adjust the voltage between PH1 and 1F and between PH2 and 2F for 40 volts each so that the resultant voltage V_{1F} 2F equals 40 volts (120V - 40V - 40V = 40V).
3. The current required to make the unit trip should be within the limit given in Table II at angle of 75° current lagging.
4. Repeat section 3 while using connection for tests #6 and #7.

TABLE II

Test No	Volts V_{1F} V_{2F}	Ampere to Trip for $\theta = 75°$ I Min.	I Max.
5, 6, 7	10	0.170	0.198
	40	0.74	0.84
	70	1.32	1.48

ROUTINE MAINTENANCE

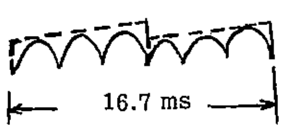
The relay should be inspected periodically at such time intervals as may be dictated by experience to ensure that the relays have retained their calibration and are in proper operating condition.

Calibration

Use the following procedure for calibrating the SDU-1 relay if the relay adjustments have been disturbed. This procedure should not be used until it is apparent that the relay is not in proper working order.

A. Phase Splitter Calibration

1. Unlock locking nuts of potentiometers R3, R4, R5, R8, R9, R10, R13, R14 and R15. Set potentiometers R3, R4, R8, R9, R13, and R14 completely clockwise and R5, R10 and R15 completely counterclockwise. Apply 3 phase 120 VAC to the varicon terminals 7, 8 and 9. Connect an oscilloscope between TP7 and TP2 of printed circuit board PH AB. Adjust R5 until ripple peaks are in a sawtooth arrangement. Tighten locking nut of R5.



Similarly adjust R10 and R15 for printed circuit boards PH BC and PH CA respectively. Tighten locking nuts of R10 and R15.

2. Externally short circuit the varicon terminals 7, 8 and 9. Set compensator taps at maximum. Connect the oscilloscope between TP1 and TP2 of PH AB printed circuit board. Apply 5 amps between terminal blocks 1 and 2. Adjust potentiometer R4 until ripple peaks are in a sawtooth arrangement. Tighten locking nut of R4. Similarly apply 5 amps to terminal blocks 3 and 4 and 5 and 6 respectively and adjust R9 and R14 for printed circuit boards PH BC and PH CA respectively. Tighten locking nuts of R9 and R14.

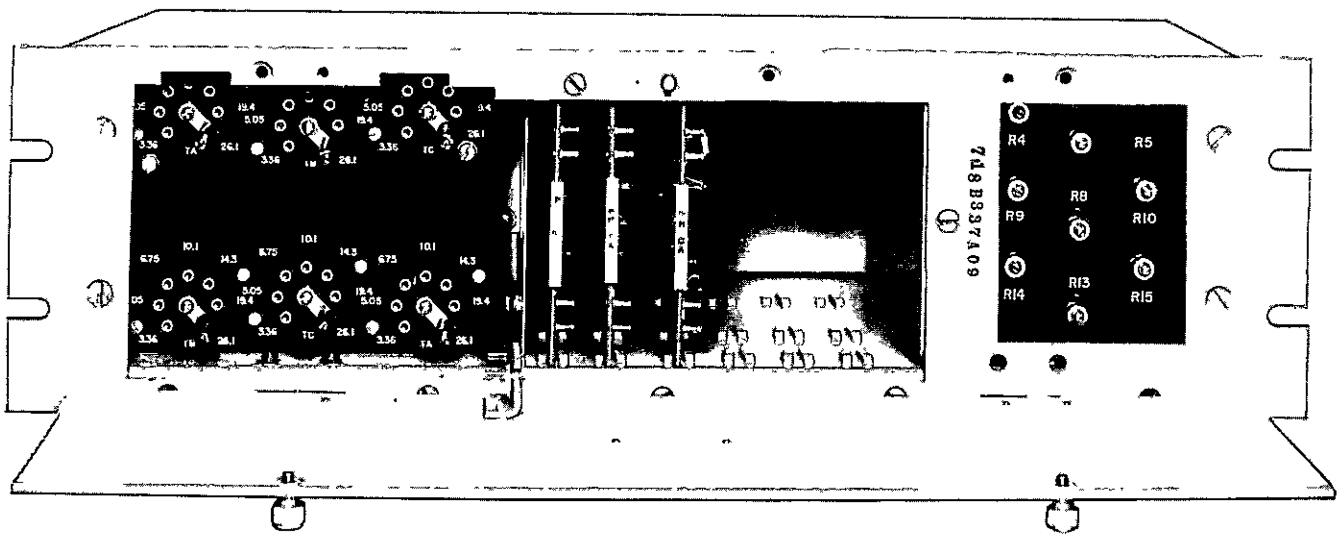
B. Maximum Sensitivity Angle Calibration (Fig. 12)

1. Connect as per Fig. 12.
2. Keep compensator taps setting at maximum.
3. Apply 3 phase 120 VAC to the varicon terminals 7, 8, and 9. Connect the relay for a 1-2 fault as indicated for test #5. Pass the current for test #5 in Table II. Adjust V_{1F2F} and $V_{2F\,3F}$ for 40 volts. Set the phase shifter at 75°. Adjust potentiometer R3 until output appears between TP5 and TP7 on PH AB board. The output should be observed by a rectox type d-c voltmeter or oscilloscope. Similarly adjust potentiometers R8 and R13 for tests #6 and #7 respectively. At the balance point, the output may be initially 5 to 10 volts. 10% increase of current will indicate 20VDC output. Swing the phase shifter to determine two angles $\theta1$ and $\theta2$, $\theta1 \leq 75° \leq \theta2$. Maximum sensitivity angle $= \frac{\theta1 + \theta2}{2}$ which should be 75° ±3°

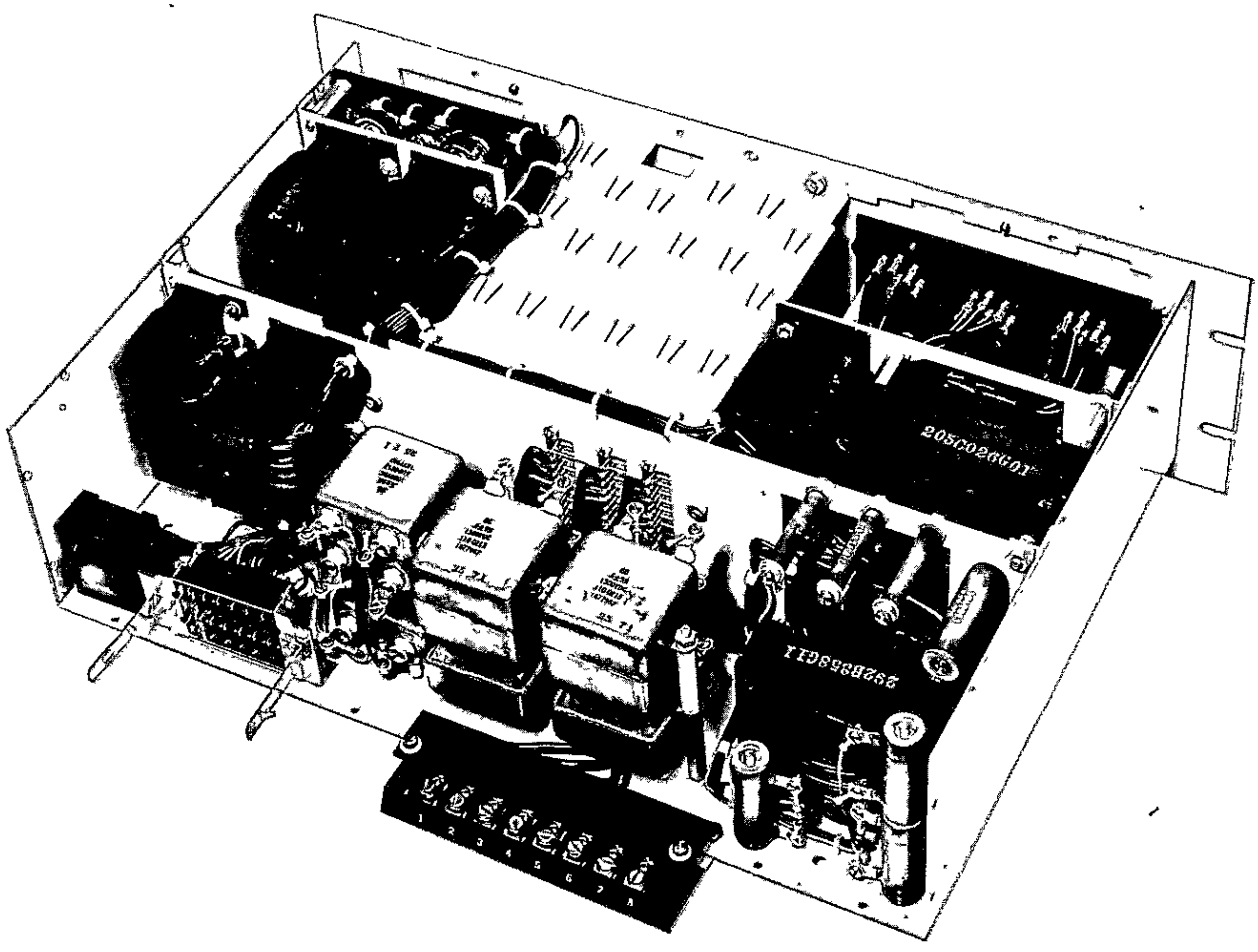
Now tighten the locking nuts of potentiometers R3, R8 and R13.

* ELECTRICAL PARTS LIST – SDU-1

CIRCUIT SYMBOL	STYLE	REQ.	REFERENCE
CAPACITORS			
C1, C4, C7	1877962	3	0.5 MFD
C2, C3, C5, C6, C8, C9	1877966	6	1.0 MFD
1C10, 2C10, 3C10	763A219H05	3	0.0047MFD
1C11, 2C11, 3C11	187A624H11	3	0.5 MFD
3C13	849A437H04	1	.047 MFD
1C10, 2C10, 3C10 (For high speed operation)	187A624H08	3	0.05 MFD
DIODES			
1D1, 1D2, 1D3, 1D6, 1D7, 1D8, 1D21, 1D22, 1D23, 1D27, 1D28 2D2, 2D3, 2D6, 2D7, 2D8, 2D21, 2D22, 2D23, 2D27, 2D28 3D1,3D2,3D3,3D6,3D7,3D8,3D21,3D22,3D23,3D27,3D28,3D29	837A692H03	34	1N645A
1D4, 1D5, 2D4; 2D5, 3D4; 3D5	182A881H07	6	1N100A
1D9 to 1D20, 2D9 to 2D20, 3D9 to 3D20	837A692H04	36	B2B9
1D24; 1D25, 1D26, 2D24; 2D25, 2D26, 3D24, 3D25, 3D26	184A855H14	9	1N4385
ZENER DIODES			
1Z1, 2Z1, 3Z1	584C434H08	3	1N1789
3Z2	862A288H01	1	1N3688A
DZP	762A631H01	1	1N2984B
POTENTIOMETERS			
R3, R4, R5, R8, R9, R10, R13, R14, R15	836A635H04	9	2.5K - 12.5W
RESISTORS			
R1, R6, R11	1267293	3	1.5K - 25W
R2, R7, R12	184A856H17	3	2.7K - 10W
1R16, 2R16, 3R16,	187A643H61	3	27K - 1W
1R18, 2R18, 3R18	763A921H05	3	7.5K - 3W
1R17, 2R17, 3R17	187A641H27	3	1K - ½W
1R19, 2R19, 3R19	629A531H95	3	.47M - ½W
1R20, 2R20, 3R20, 3R25, 3R27, 3R28	629A531H56	6	10K - ½W
1R21, 2R21, 3R21, 3R29	629A531H52	4	6.8K - ½W
1R22, 2R22, 3R22	187A290H28	3	4.7M - ½W
1R23, 2R23, 3R23, 3R30	629A531H78	4	82K - ½W
3R24	629A531H72	1	47K - ½W
3R31	184A859H04	1	150Ω - 3W
RDC (for 48VDC)	1202587	1	400Ω - 25W
RCD (for 125VDC)	1267293	1	1500Ω - 25W
1R34, 2R34, 3R34	629A531H70	3	39K - ½W
TRANSISTORS			
1Q1, 2Q1, 3Q1, 3Q3,	848A851H02	4	2N3417
1Q2, 2Q2, 3Q2, 3Q5	849A441H01	4	1N3645
TRANSFORMERS			
T1, T4, T7	718B271G01	3	
T2	718B272G01	1	
T5, T8	718B272G02	2	
T3, T6, T9	201C480G10	3	
COMPENSATOR ASS'Y.			
T_{AB}, T_{BC}	205C026G01	2	
T_{CA}	292B358G11	1	



a. Front (door open)



b. Top (Cover off)

Fig. 1 Photo of SDU-1 relay

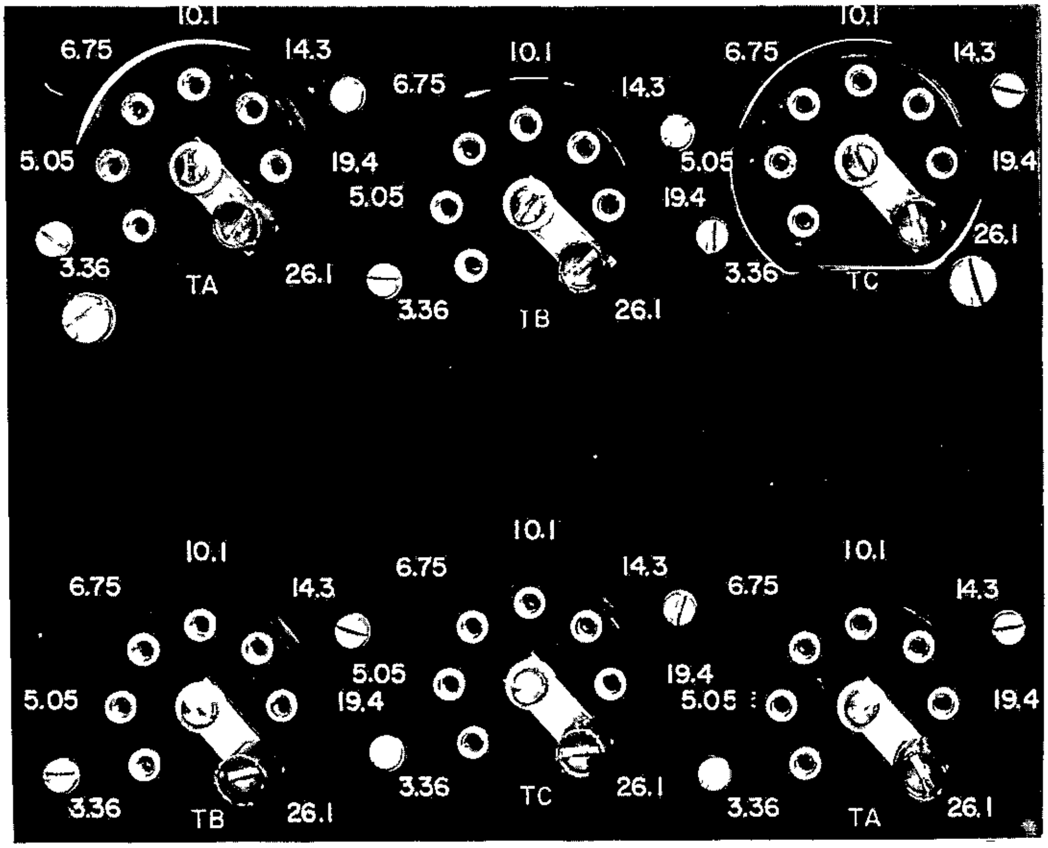
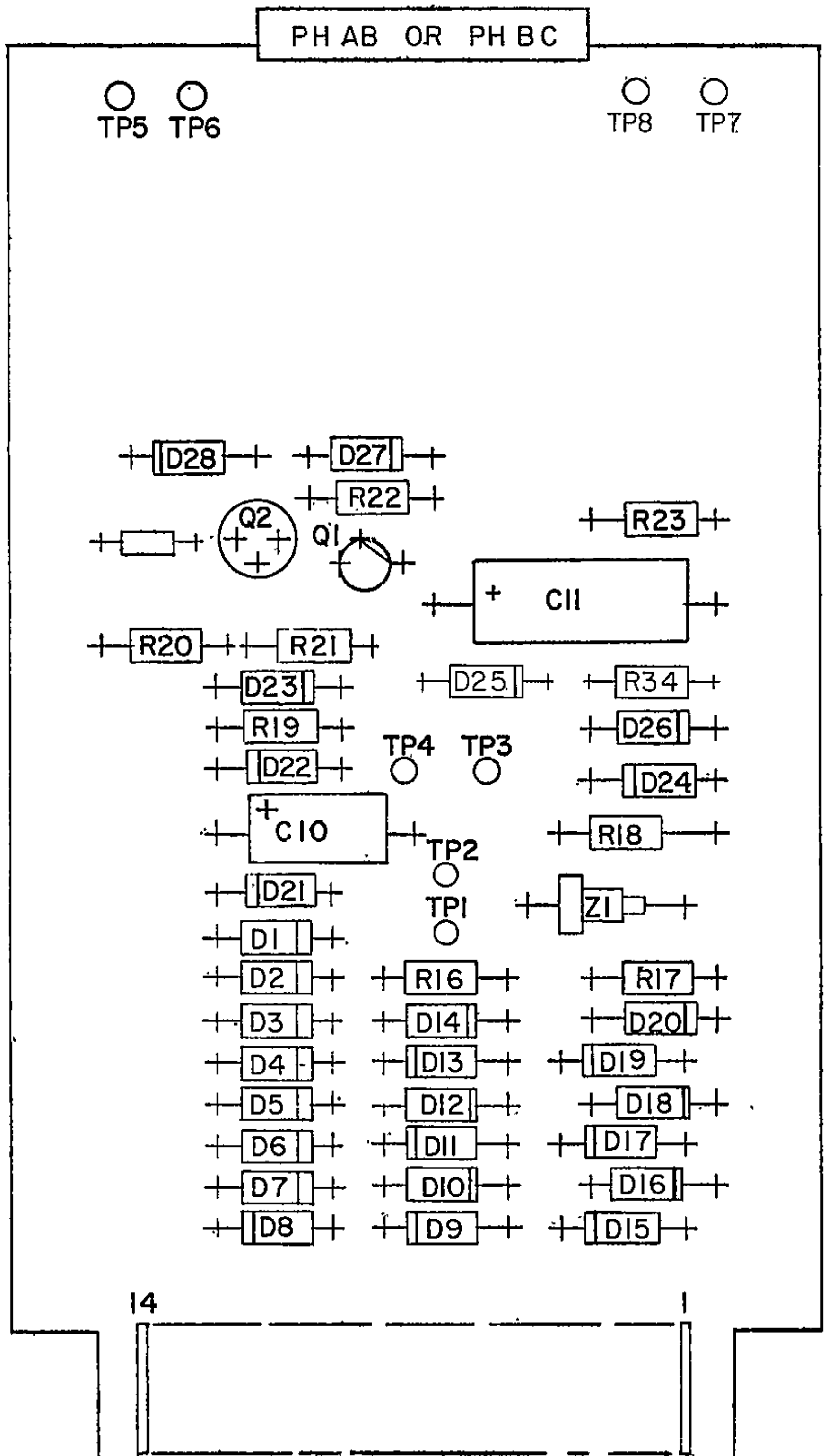


Fig. 2 Photo of tap plate


PH AB OR PH BC
TP5
TP6
TP8
TP7
D28
D27
R22
Q2
Q1
R23
C11
R20
R21
D23
D25
R34
R19
D26
D22
TP4
TP3
D24
C10
R18
TP2
D21
TP1
Z1
D1
D2
R16
R17
D3
D14
D20
D4
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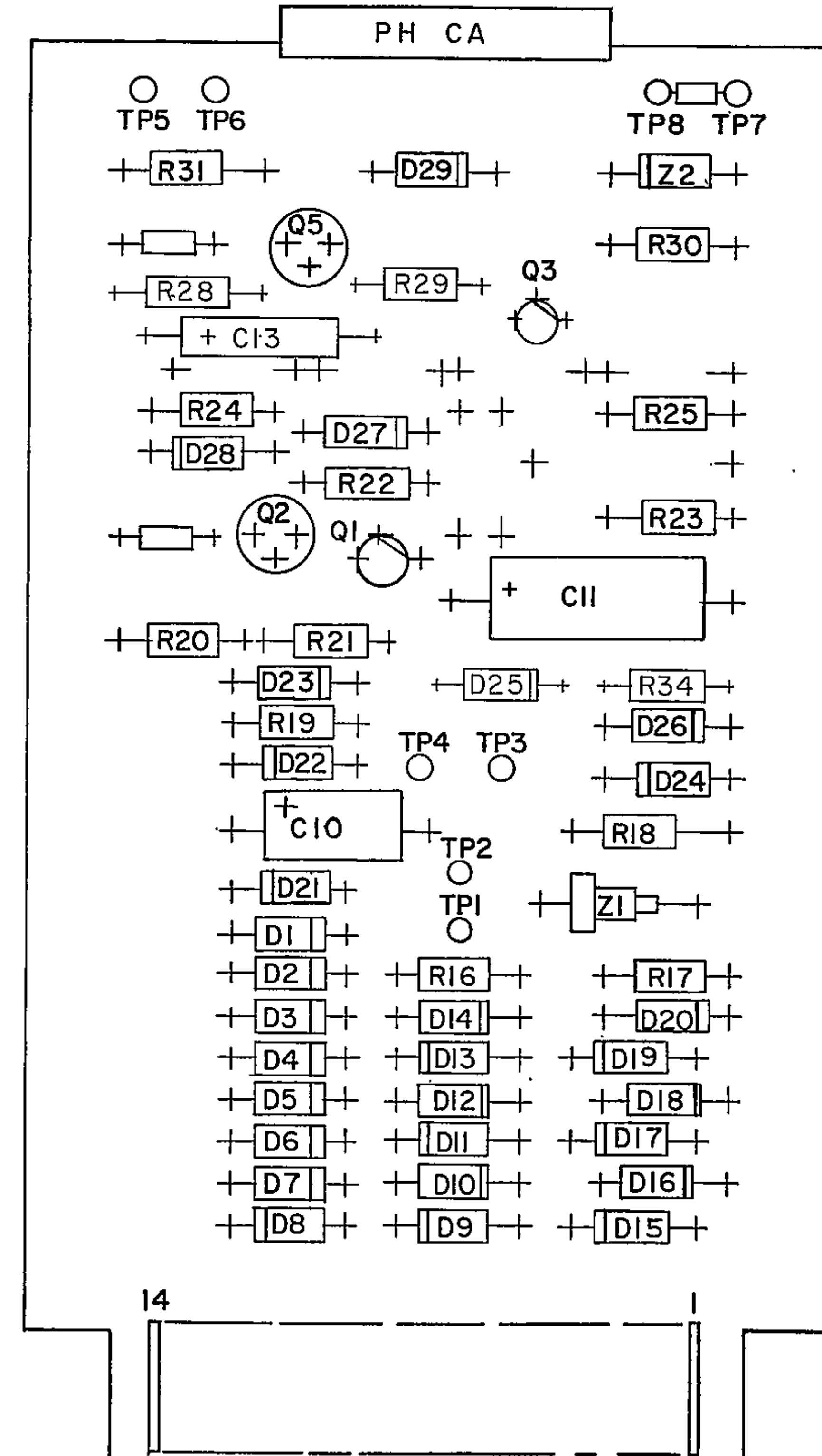
D8
D9
D15
14
1


PH CA
TP5
TP6
TP8
TP7
R31
D29
Z2
Q5
R30
R28
R29
Q3
C13
R24
R25
D27
D28
R22
Q2
Q1
R23
C11
R20
R21
D23
D25
R34
R19
D26
D22
TP4
TP3
D24
C10
R18
TP2
D21
TP1
Z1
D1
D2
R16
R17
D3
D14
D20
D4
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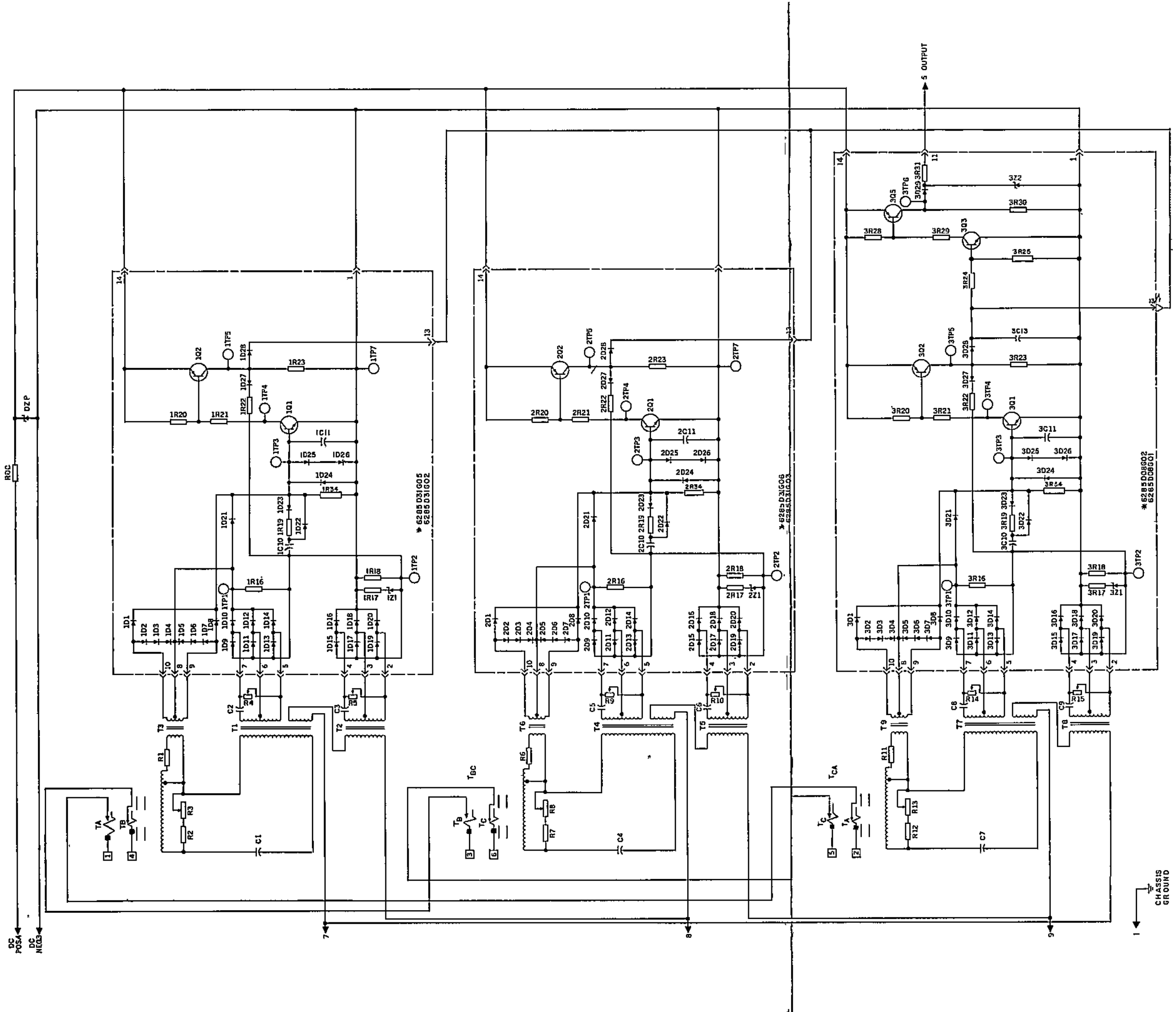
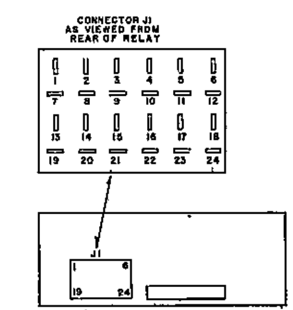
D9
D15
14
1



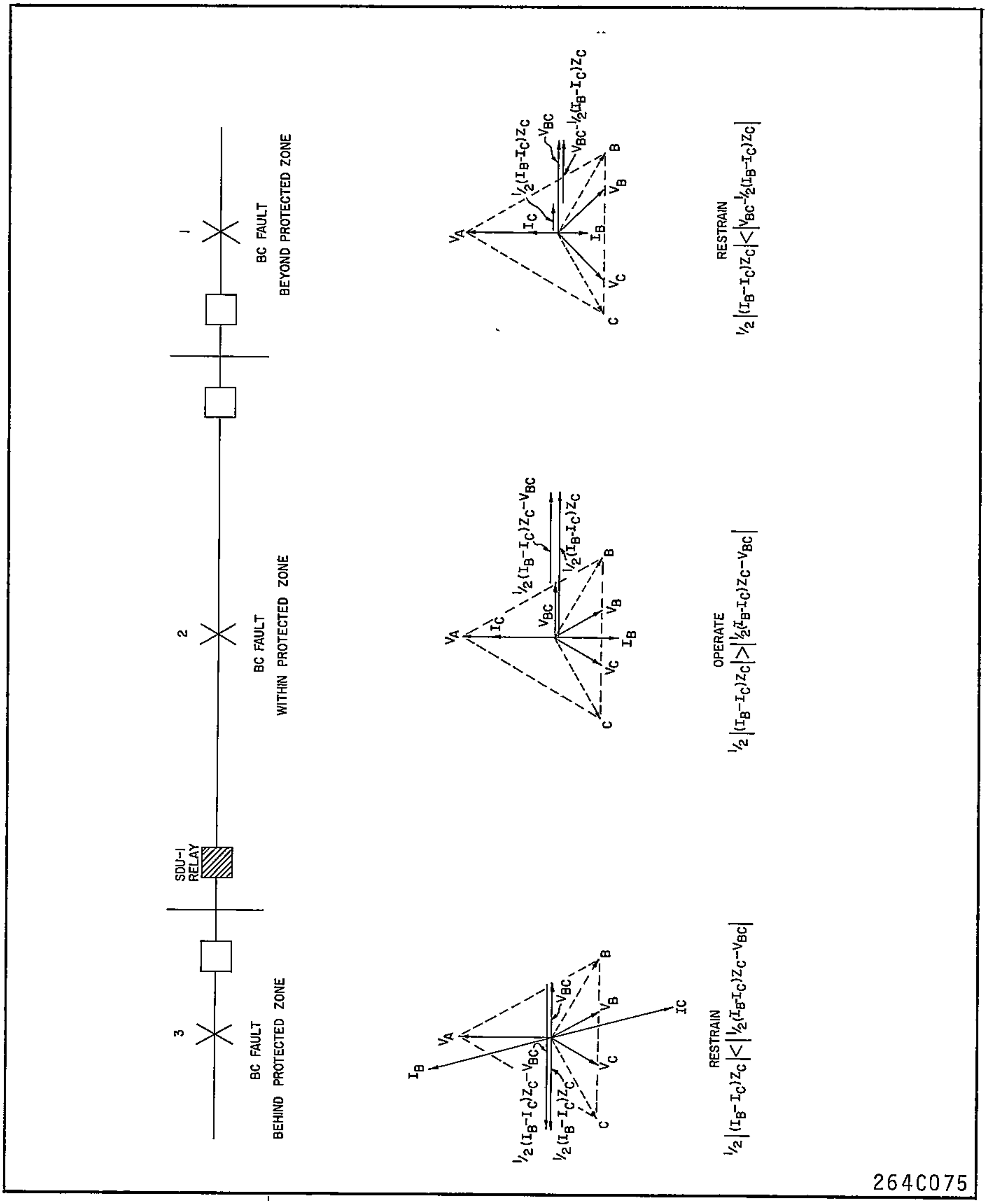


□ = TERMINAL BLOCK

→ = VARICON CONNECTOR

CAPACITOR	STYLE	REQ.	REF.
C1 - C4 - C7	1877962	3	0.5 MFD.
C2-C3-C5-C6-C8-C9	1877946	6	1.0 MFD.
1C10 - 2C10 - 3C10	763A219H05	3	.0047 MFD.
1C11 - 2C11 - 3C11	187A824H10	3	0.5 MFD.
~~3C13~~	~~849A437H04~~	~~1~~	~~.047 MFD.~~
DIODE			
1D1-1D2-1D3-1D6			
1D7-1D8-1D21-1D22			
1D23-1D27-1D28-2D1			
2D2-2D3-2D6-2D7			
2D8-2D21-2D22-2D23			
2D27-2D28-3D1-3D2			
3D3-3D6-3D7-3D8			
3D21-3D22-3D23-3D27			
3D28-3D29	837A692H03	34	1N645A
1D4-1D5-2D4-2D5			
3D4-3D5	182A881H07	6	1N100A
1D9 TO 1D20			
2D9 TO 2D20			
3D9 TO 3D20	837A692H04	36	[illegible]
POTENTIOMETER			
R3-R4-R5-R8-R9			
R10-R13-R14-R15	836A815H04	9	2.5K-12 1/2W
RESISTOR			
R1-R6-R11	1267293	3	1.5K-25W
R2-R7-R12	184A856H17	3	2.7K-10W
1R16-2R16-3R16	187A643H61	3	27K-1W
1R18-2R18-3R18	763A921H05	3	7.5K 3W
1R17-2R17-3R17	187A641H27	3	1K-1/2W
1R19-2R19-3R19	629A531H15	3	.47M-1/2W
1R20-2R20-3R20			
3R26-~~3R27~~-3R28	629A531H66	5	10K-1/2W
1R21-2R21-3R21			
3R29	629A531H52	4	6.8K-1/2W
1R22-2R22-3R22	187A290H25	3	4.7M-1/2W
1R23-2R23-3R23			
3R30 ~~3R32~~	629A531H78	4	82K-1/2W
3R24	629A531H72	1	47K-1/2W
3R31	184A859H04	1	150Ω-3W
RDC 48VDC	1202587	1	400Ω-25W
RDC 125VDC	126,293	1	1500Ω-25W
~~3R25 - 3R33~~	~~184A763H43~~	~~2~~	~~4.7K 1/2W~~
1R34-2R34-3R34	629A531H70	3	39K - 1/2W
TRANSISTORS			
1Q1-2Q1-3Q1			
3Q3-3Q4	848A851H02	4	2N3417
1Q2-2Q2-3Q2			
3Q5	849A441H01	1	2N2646
ZENER DIODE			
~~3Z3~~	~~186A797H06~~	~~1~~	~~1N957B~~
1Z1-2Z1-3Z1	584C434H08	3	1N1789
3Z2	862A288H01	1	1N3686A
DZP	762A631H01	1	1N2989B
~~3Z4~~	~~185A212H06~~	~~1~~	~~1N3686B~~
DIODE			
1D24-1D25-1D26-2D24			
2D25-2D26-3D24-3D25			
3D26	184A855H14	9	1N4385
TRANSFORMER			
T1 - T4 - T7	718B271G01	3	
T2	718B272G01	1	
T3 - T6 - T9	201C480G10	3	
T5 - T8	718B272G02	2	
CAPACITOR			
3C13	849A437H04	1	.047 MFD.
* 1C10-2C10 3C10	187A624H08	3	.05 MFD

* FOR HIGH SPEED OPERATION



* *Fig. 6 Voltage and current condition for phase to phase fault.*

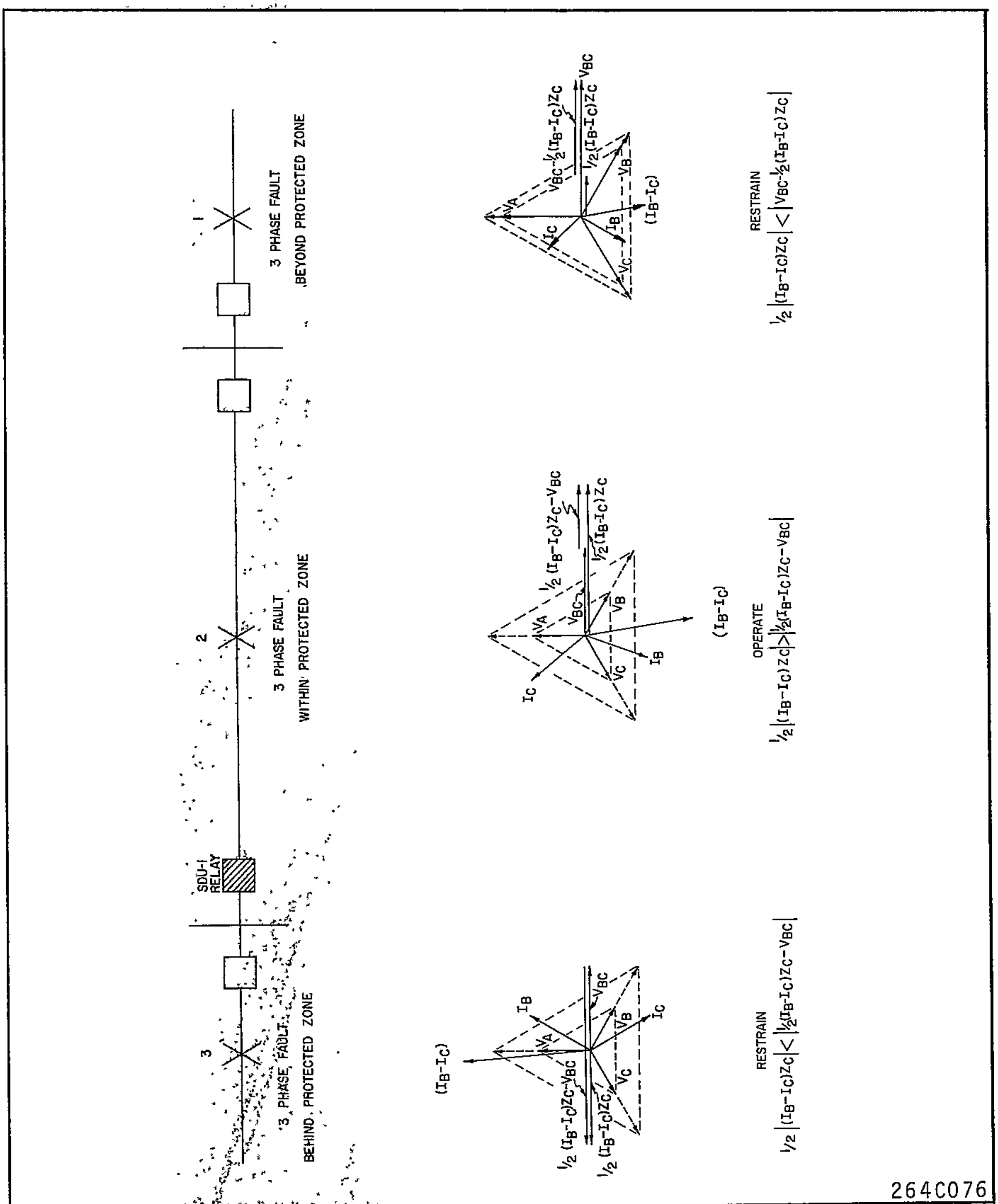


Fig. 7 Voltage and current condition for three phase Fault.

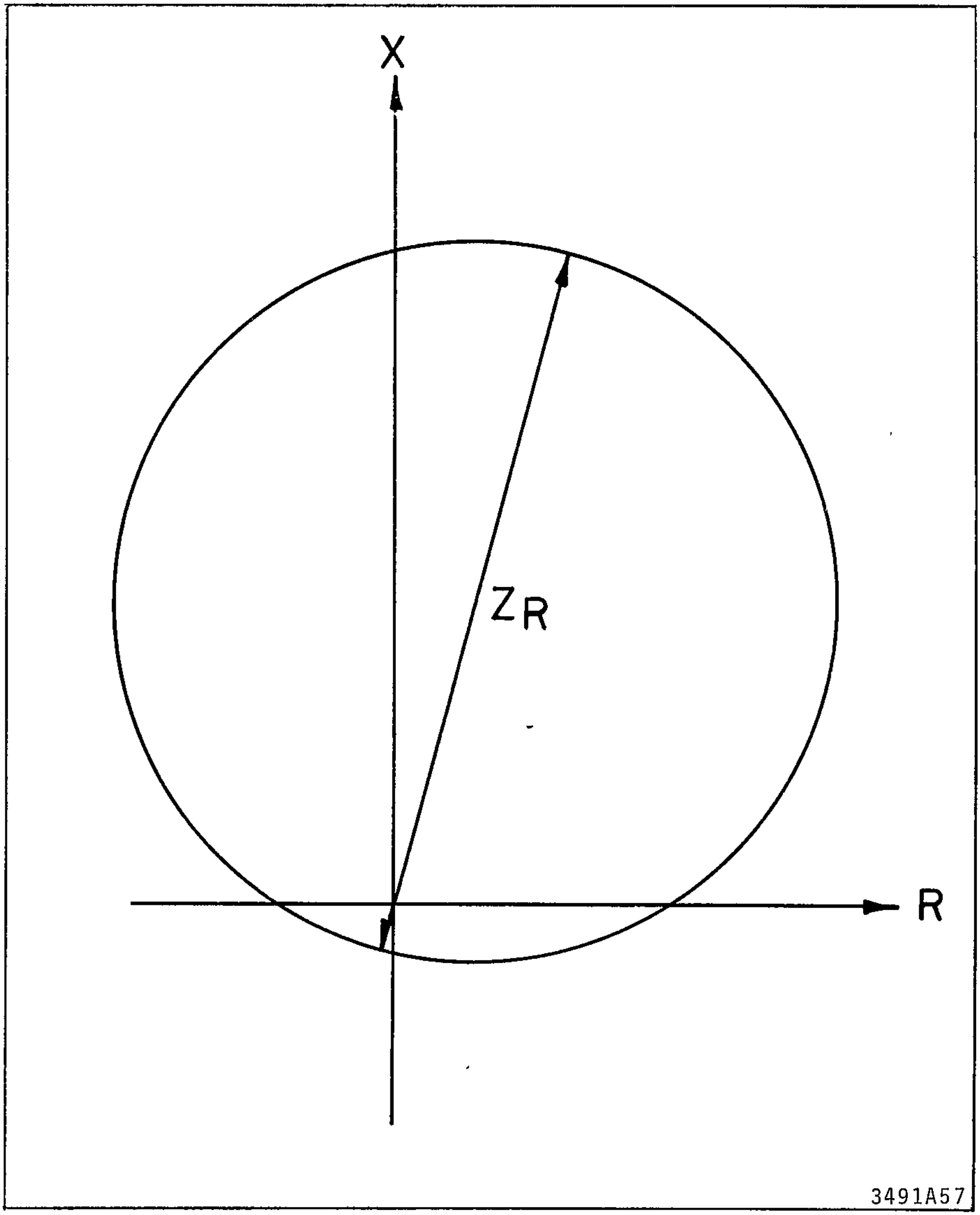


Fig. 8 Characteristics in R-X plane.

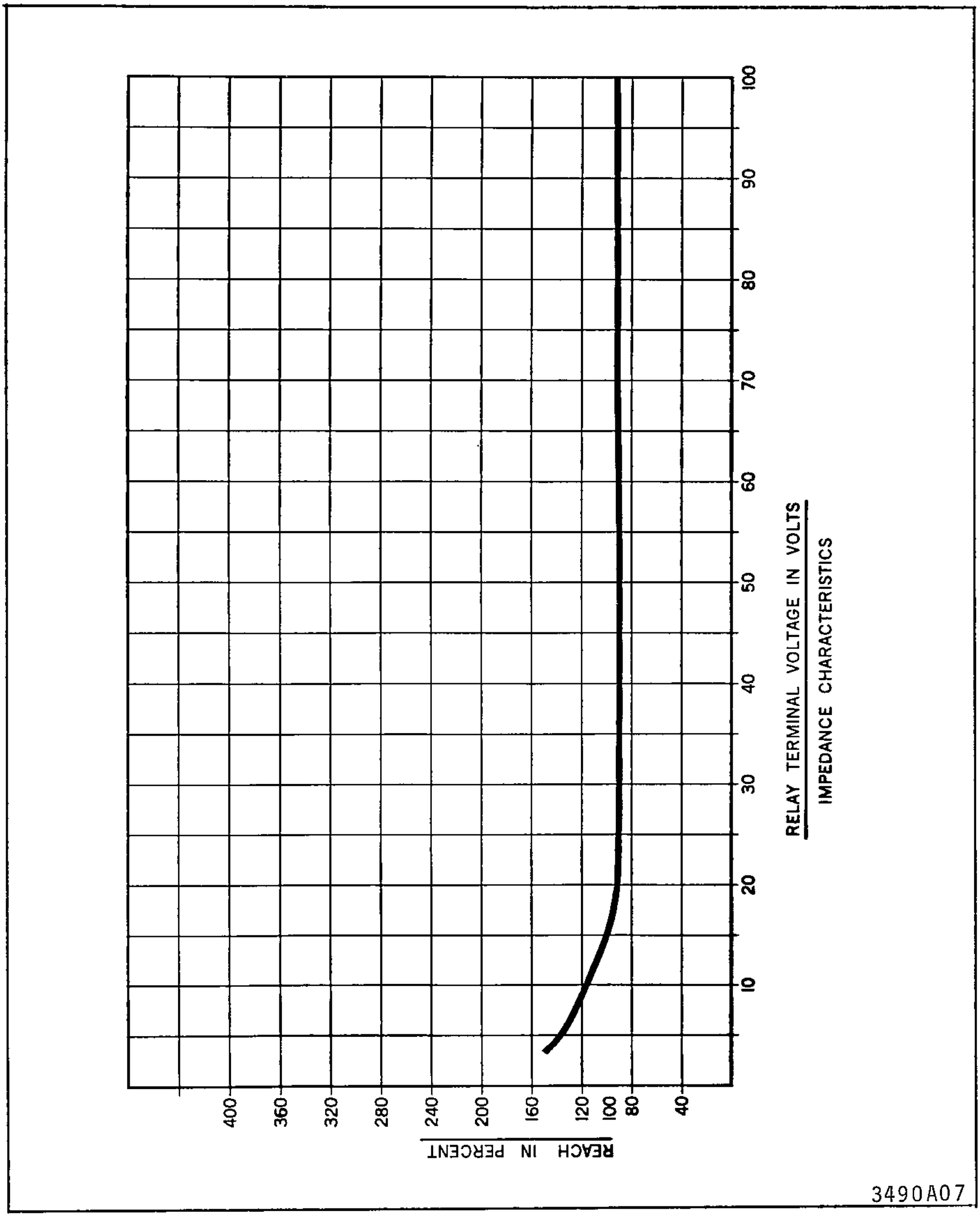
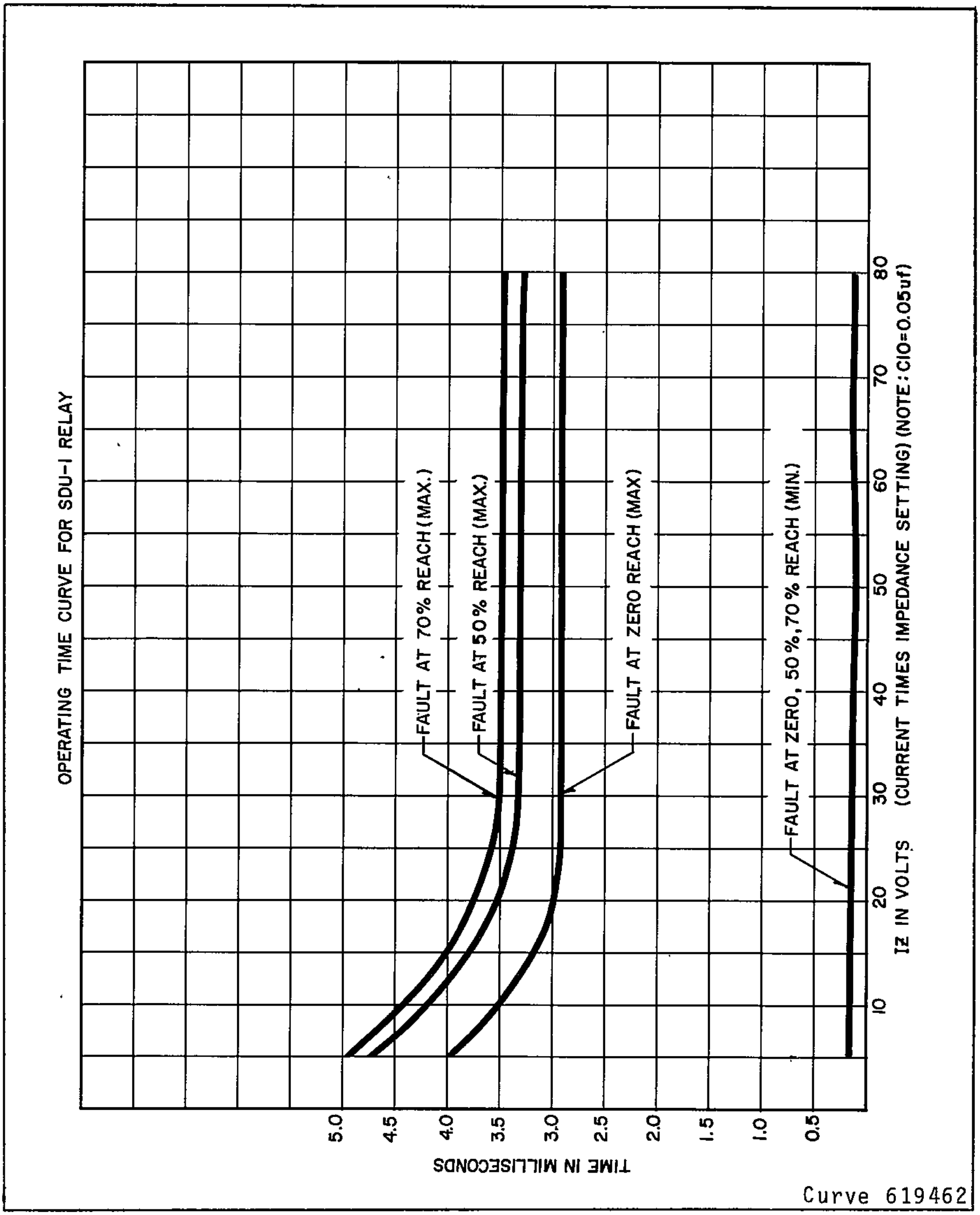
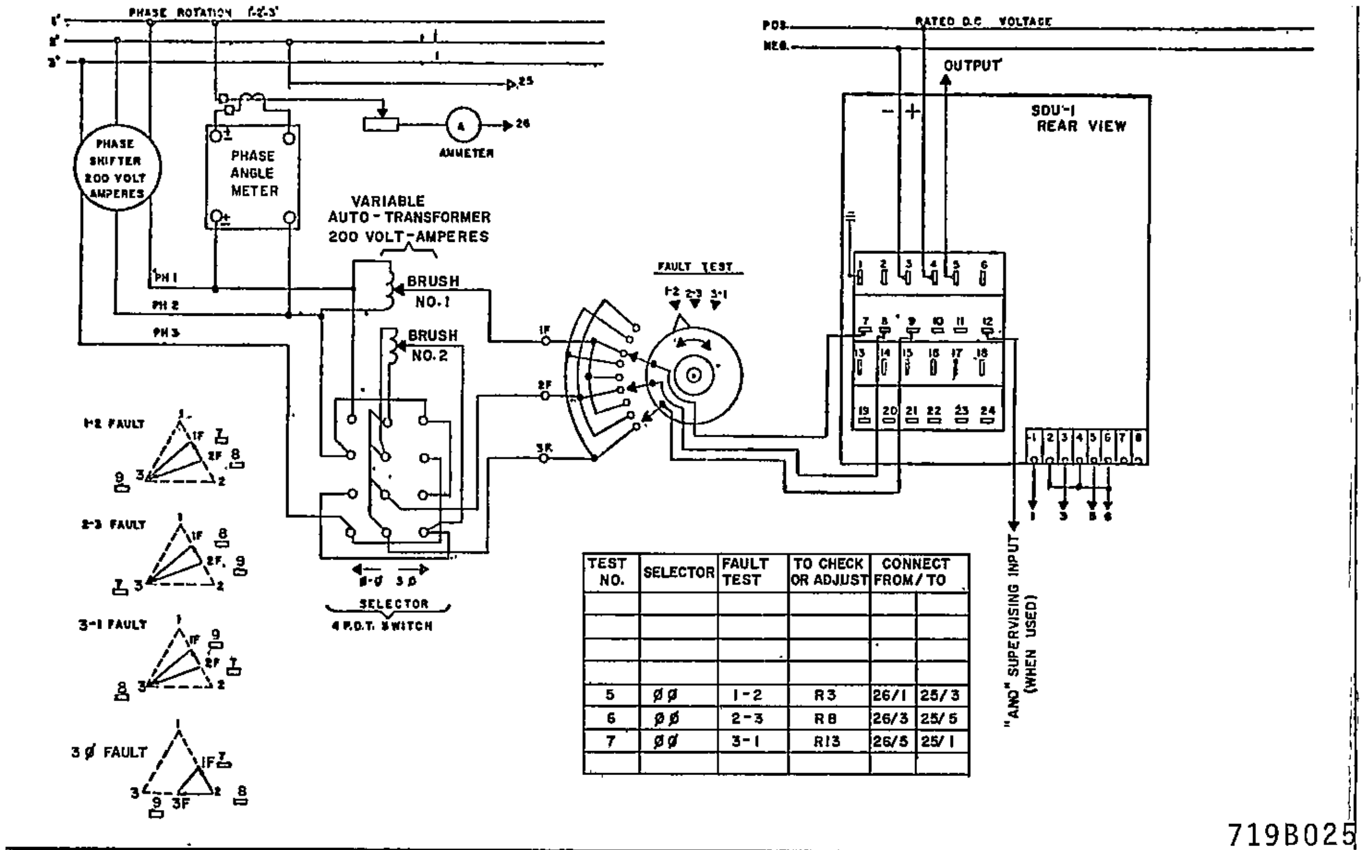


Fig. 9 Maximum impedance reach characteristic at variable fault voltage.



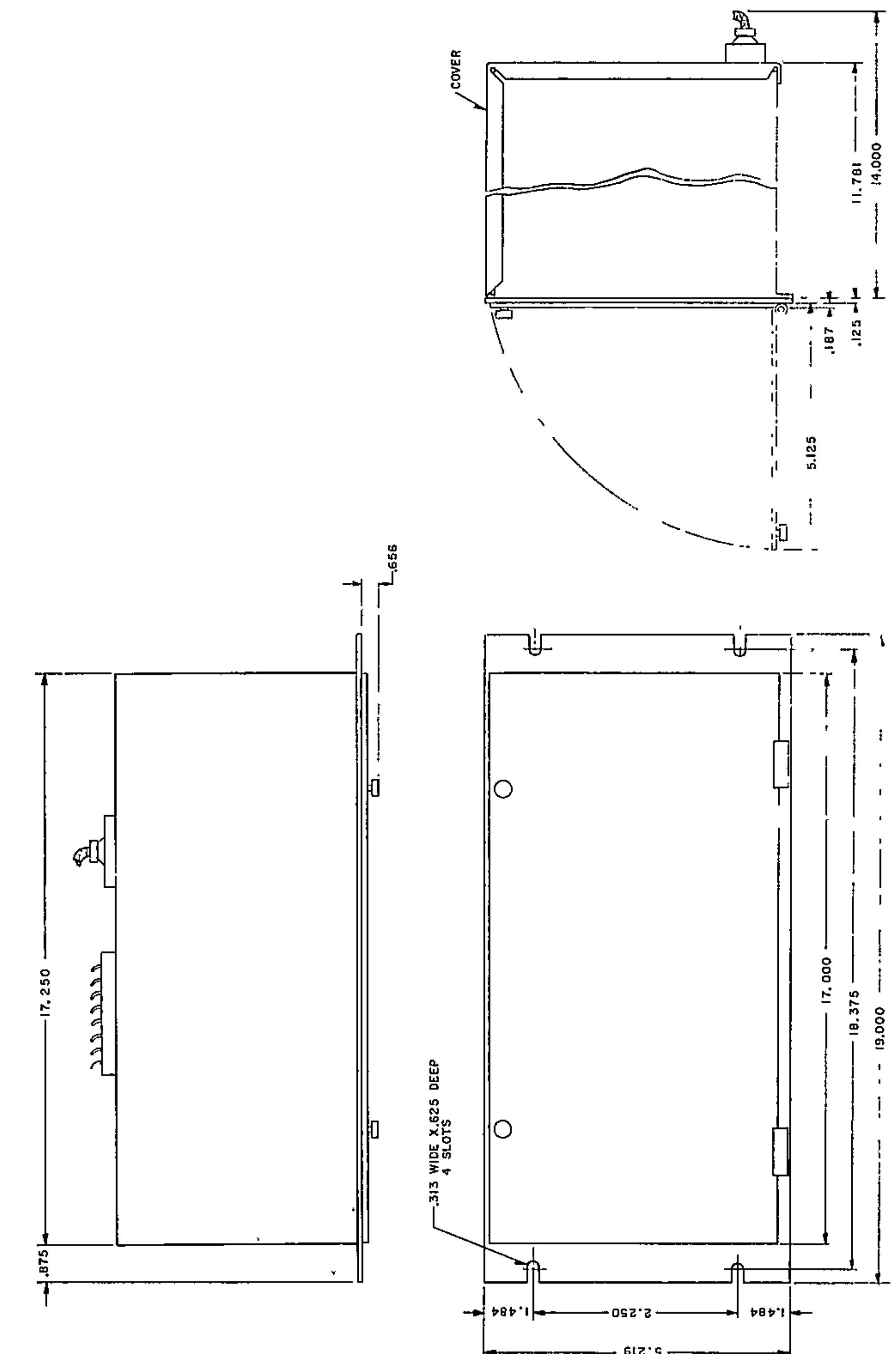
* *Fig. 10 Operating time curve for SDU-1 relay*

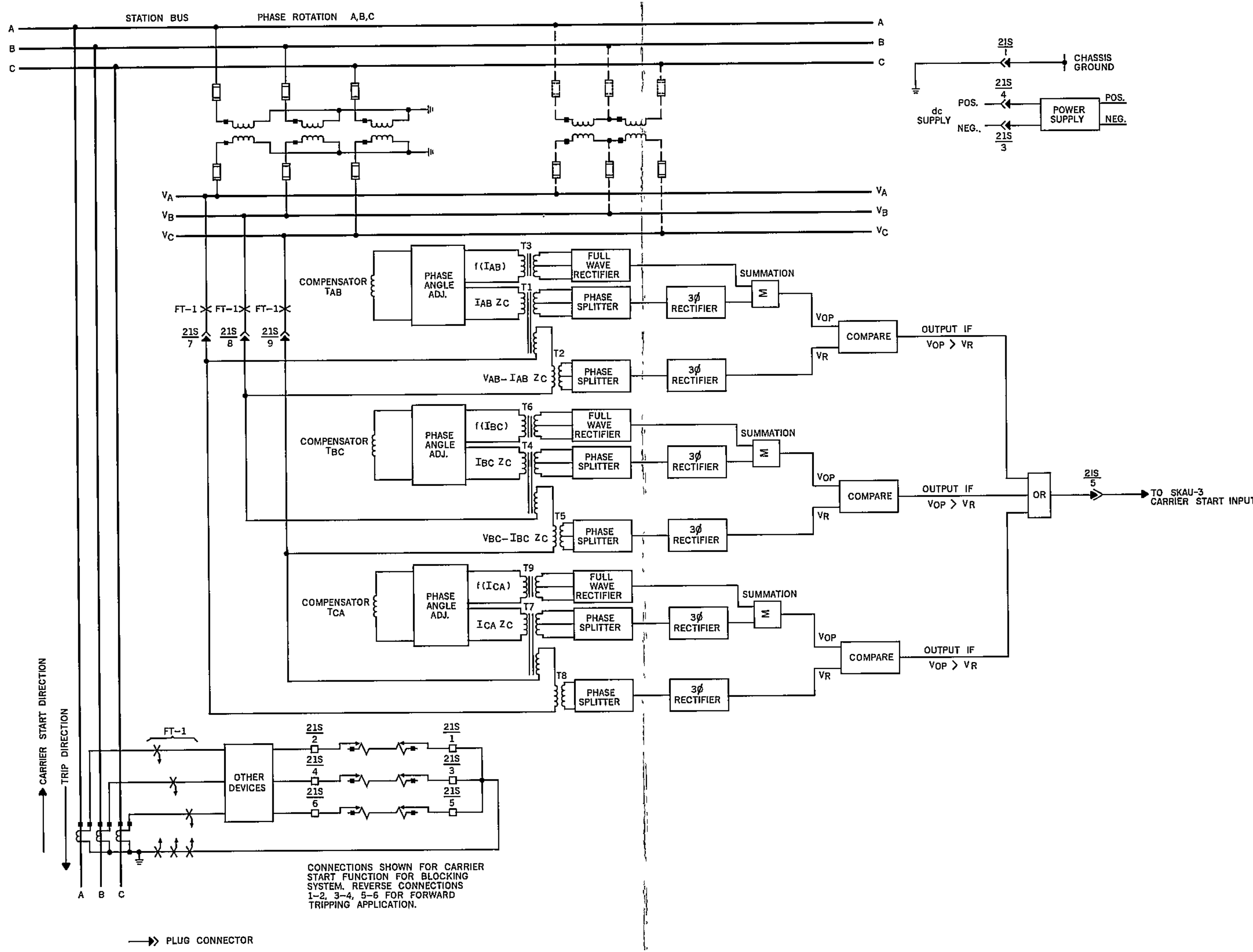


TEST NO.	SELECTOR	FAULT TEST	TO CHECK OR ADJUST	CONNECT FROM/TO	
5	ØØ	1-2	R3	26/1	25/3
6	ØØ	2-3	R8	26/3	25/5
7	ØØ	3-1	R13	26/5	25/1

719B025

* *Fig. 12 Test c anections for SDU-1 relay*





STATION BUS
PHASE ROTATION A,B,C
A
B
C
VA
VB
VC
21S 1
CHASSIS GROUND
dc SUPPLY
POS.
NEG.
21S 4
21S 3
POWER SUPPLY
FT-1
21S 7
21S 8
21S 9
COMPENSATOR TAB
PHASE ANGLE ADJ.
f(IAB)
IAB ZC
T3
T1
T2
VAB-IAB ZC
FULL WAVE RECTIFIER
PHASE SPLITTER
3Ø RECTIFIER
SUMMATION
M
VOP
VR
COMPARE
OUTPUT IF VOP > VR
COMPENSATOR TBC
f(IBC)
IBC ZC
T6
T4
T5
VBC-IBC ZC
COMPENSATOR TCA
f(ICA)
ICA ZC
T9
T7
T8
OR
21S 5
TO SKAU-3 CARRIER START INPUT
CARRIER START DIRECTION
TRIP DIRECTION
OTHER DEVICES
21S 2
21S 6
CONNECTIONS SHOWN FOR CARRIER START FUNCTION FOR BLOCKING SYSTEM. REVERSE CONNECTIONS 1-2, 3-4, 5-6 FOR FORWARD TRIPPING APPLICATION.
PLUG CONNECTOR

WESTINGHOUSE ELECTRIC CORPORATION
RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**
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