INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPES SI AND SI-1 OVERCURRENT RELAYS

CAUTION: Before putting relay into service, operate the relay to check the electrical connections. Close output switches last when placing relay in service. Open output switches first when removing relay from service.

APPLICATION

These overcurrent relays are static devices that produce a d.c. output voltage when the input current in them exceeds a given value. This output voltage is used as the input to other devices that trip a breaker.

The number of inputs and outputs varies with the type of relay. Generally, these are as follows:

Type SI relay-three inputs, one or two outputs.

Type SI-1 relay-one input, one output.

CONSTRUCTION

The type SI-1 relay consists of an input transformer, a setting circuit, a phase splitter circuit, a sensing circuit, an amplifier circuit, a voltage regulator circuit, a feedback circuit and a transistor output. An operational indicator is an optional unit. The type SI relay in addition to these components has two input transformers, two phase splitter circuits, and either a single output or a dual output transistor circuit.

The components are connected as shown in Figs. 1 to 4.

Input Transformer – The input transformer is a two winding type with a non-tapped primary winding and a tapped secondary winding. The secondary is connected to the setting circuit and from a fixed tap to the phase splitter circuit.

Setting Circuit – The setting circuit is connected across the secondary winding of the input transformer and consists of two branches, a resistor and a rheostat connected in parallel with a resistor and Zener diode. This circuit loads the transformer and produces a secondary voltage proportional to the input current. The rheostat has a locking feature to minimize accidental change of current setting.

Phase Splitter Circuit – The phase splitter circuit consists of two capacitors, resistor, potentiometer and a three-phase rectifier bridge. This circuit converts the single phase a.c. voltage from the output of the transformer to a three-phase voltage and rectifies this voltage to d.c.

Sensing Circuit – The sensing circuit consists of three resistors, a transistor and a Zener diode. This circuit is connected between the output of the phase splitter circuit and the amplifier circuit. In this circuit, a reference voltage is established which turns the transistor on. To turn the transistor off, the output voltage from the phase splitter must be greater than the reference voltage.

Amplifier Circuit – The amplifier circuit consists of a normally conducting transistor, Zener diode, three resistors and a diode. This circuit is the final output stage of the relay.

Feedback Circuit – The feedback circuit consists of a resistor, potentiometer, and diode. This circuit controls the dropout current of the relay.

Voltage Regulator Circuit – The voltage regulator circuit consists of a silicon power regulator and a series resistor. The silicon power regulator is a 10 watt Zener diode mounted on an aluminum heat sink. The series resistor is a 3-½ inch resistor and is used to reduce the supply voltage to the Zener voltage.

Operational Indicator – The operational indicator consists of a silicon control rectifier, lamp, microswitch, Zener diode, and three resistors. This circuit is triggered by a signal from the output of the relay.

SUPERSEDES I.L. 41-777B
*Denotes change from superseded issue.

EFFECTIVE MARCH 1968

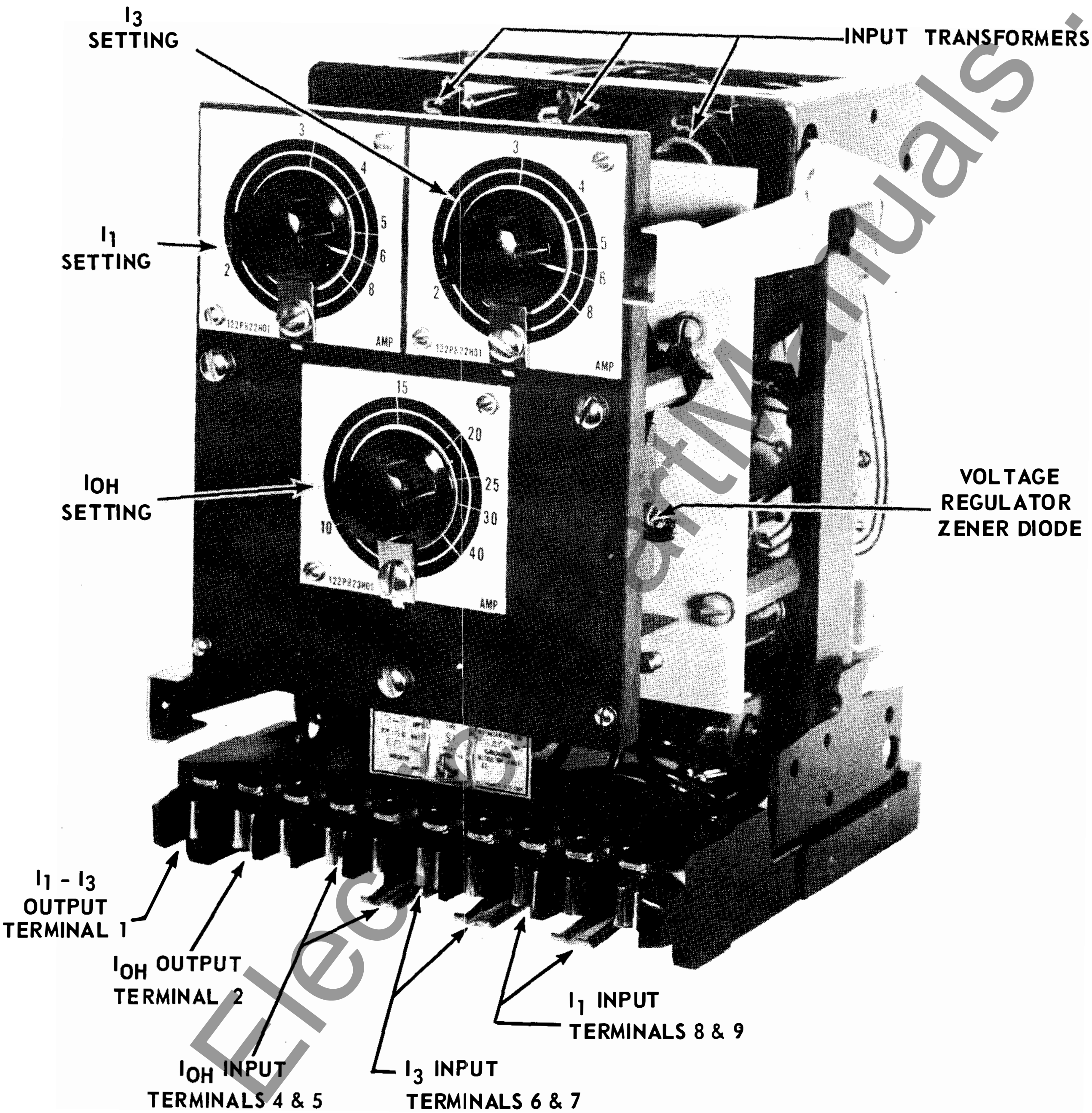


Fig. 1 Type SI Relay in an FT-21 case (front view).

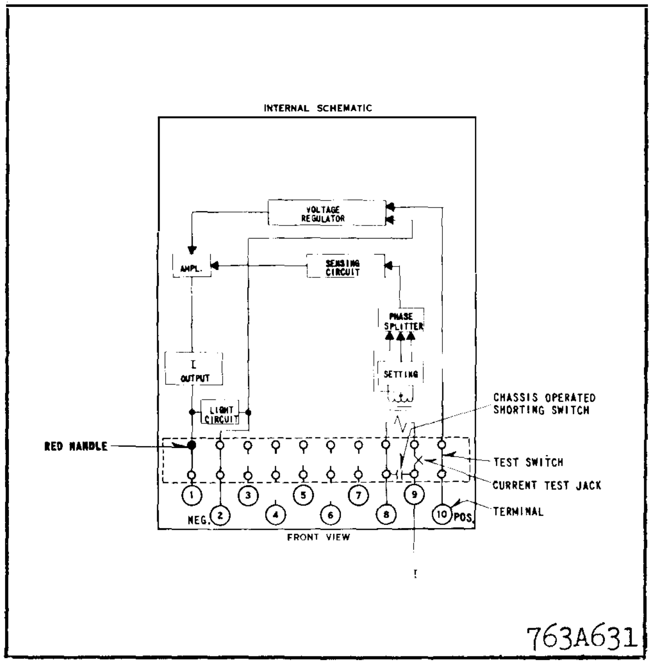


Fig. 2 Block diagram of the Type SI-1 Relay in FT-11 case (diagram of SI-1 without the operation indicator is 763A630).

OPERATION

The components of the SI-1 relay are connected as shown in Fig. 5. With no input to the relay, all transistors (Q_1 and Q_2) are conducting and a very small output is obtained from the relay. Zener diode (Z_2) of the sensing circuit establishes the reference voltage from the emitter of Q_1 to negative and allows a base current to flow in Q_1 through R_5 to negative.

When a.c. current is applied to the primary of the transformer (T), a voltage is produced on the secondary side that is proportional to the amount of resistance in the rheostat (S1). This single phase voltage is applied to the phase splitter circuit where a three phase voltage is produced, rectified, and applied to resistor R_5 of the sensing circuit. If the voltage from the rectifier is greater than the reference voltage across the sensing circuit, Q_1 turns off to allow Q_2 to turn off which produces an output.

When Q_2 turns off, positive voltage is applied to the feedback circuit such that a voltage is applied to the base of Q_1. By varying the magnitude of this voltage, the dropout of the relay can be regulated from approximately 98% to 0% of pickup.

When large currents are applied to the primary of the input transformer, the Zener clipper on the secondary prevents the voltage applied to the electronic components from becoming excessive.

The operation of the type SI relay is similar to the SI-1, except that the SI has three overcurrent inputs. These three inputs are applied through seperate phase splitting and setting circuits to a common sensing circuit which operates on the maximum voltage applied to it.

Figs. 6, 7, and 8 show the connections of the SI-1, SI with single output and the SI with a dual output.

CHARACTERISTICS

The SI-1 relay is available in the current ranges shown in Table I.

TABLE I

Range	Scale Marking					
.25 – 1 ampere	.25	.4	.5	.6	.8	1.0
.5 – 2 amperes	.5	.75	1.0	1.25	1.5	2.0
1 – 4 amperes	1.0	1.5	2.0	2.5	3.0	4.0
2 – 8 amperes	2	3	4	5	6	8
4 – 16 amperes	4	6	8	10	12	16
10 – 40 amperes	10	15	20	25	30	40

The setting of the relay is the minimum current required to produce an output. Settings between the scale markings can be obtained by applying the desired current to the relay and setting the rheostat at the desired point.

The SI relay is available with any combination of three of the above ranges. In the usual application, two inputs are the same range with an output. The third input is of a different range and can be of a different output than the other two.

The operating time of the relay is shown in Fig. 9. As shown in the figure, there is a maximum and minimum operating time of the relay for each multiple of pickup. This difference in time is due to the point on the current wave that the fault current is applied. Figure 10 shows the operate times for different points on the fault wave for fault currents at twice pickup.

TABLE II

ENERGY REQUIREMENTS

Ampere Range	Setting	VA at Setting	P.F. Angle	VA at 5 amps.	P.F. Angle
.25 – 1	.25	0.17	7.5	23	51°
	.4	0.31	15	22.8	50
	.5	0.42	21	22.7	48
	.6	0.54	25	22.6	48
	.8	0.81	30	22.2	48
	1.0	1.20	35	21.8	48
.5 – 2	.5	0.17	7.5	8.80	32
	.75	0.31	15	8.50	32
	1.0	0.42	21	8.10	33
	1.25	0.54	25	7.80	34
	1.5	0.81	30	7.60	36
	2.0	1.20	35	7.10	37
1 – 4	1	0.17	7.5	3.15	16
	1.5	0.31	15	2.95	19
	2	0.42	21	2.65	21
	2.5	0.54	25	2.35	25
	3	0.81	20	2.21	28
	4	1.20	35	2.0	30
2 – 8	2	0.22	7.5	1.4	13
	3	0.39	15	1.1	15
	4	0.60	21	0.95	21
	5	0.85	25	0.85	25
	6	1.17	30	0.80	30
	8	1.94	35	0.73	35
4 – 16	4	0.26	8.5	0.41	8.5
	6	0.49	13	0.34	13
	8	0.80	15	0.3	15
	10	1.15	16.5	0.29	16.5
	12	1.57	17.5	0.28	17.5
	16	2.56	19	0.25	19.0
10 – 40	10	1.0	3	0.25	3
	15	2.1	4	0.23	4
	20	3.6	5	0.21	5
	25	5.9	6	0.21	6
	30	8.1	6	0.20	6
	40	14.4	6	0.20	6

TABLE III

CURRENT RATINGS

Rating of the Overcurrent Units

Range	Continuous Rating (Amperes)	One Second Rating (Amperes)
.25 – 1	6	185
.5 – 2	8	350
1 – 4	10	400
2 – 8	12	400
4 – 16	15	400
10 – 40	20	460

TABLE IV

Battery Drain

	48 Volts D.C.	125 Volts D.C.
SI-1 Relay	32MA	65 MA
SI-1 Relay with Indicator	65MA	100 MA
SI-Relay Single Output	32MA	65 MA
SI Relay Dual Output	65MA	105 MA
Maximum Output	20 MA at 20 Volts D.C.	

SETTING

The pickup of the relay is selected by adjusting the rheostat, S, in the front of the relay. Setting in between the scale marking can be made by applying the desired current and adjusting the rheostat until an output is obtained.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from moisture. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel-panel mounting or to the terminal studs furnished with the relay for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detailed FT case information, refer to I.L. 41-076.

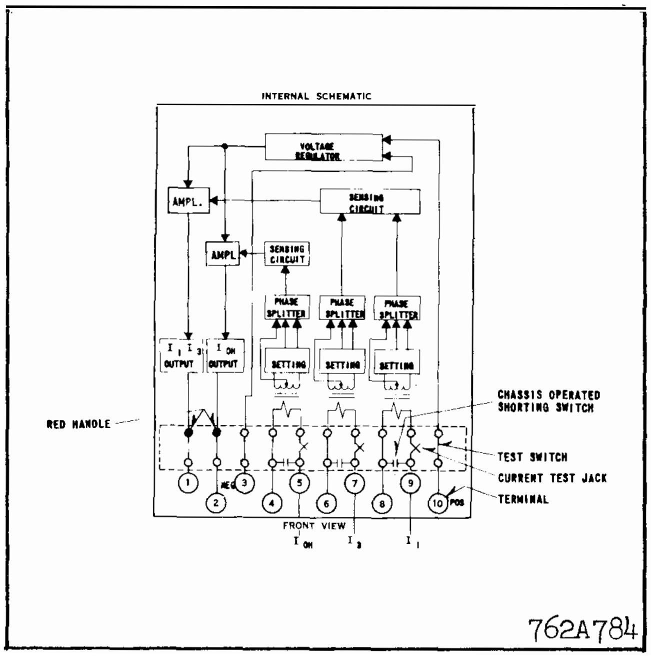


Fig. 3 Block diagram of the Type SI Relay in FT-21 case (for SI with single output omit the circuits connected to terminal 2; dwg. no. 763A629.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer.

Acceptance Tests

The following check is recommended to insure that the relay is in proper working order. All checks can best be performed by connecting the relay per the test circuit of Fig. 11. Refer to fig. 4 and make similar connections for the test of the SI relay.

1. Minimum trip current — Check pickup at the minimum and maximum setting. This is accomplished by applying the specified current and checking that the voltmeter reads approximately 20 volts when the current is within 3% of the setting.

2. Dropout — After checking pickup, the dropout should be checked to be approximately 97% of the pickup when the a.c. current is gradually reduced.

Routine Maintenance

All relays should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.

Calibration

Use the following procedure for calibrating the SI-1 relay if the relay adjustments have been distributed. This procedure should not be used until it is apparent that the relay is not in proper working order. A new scale plate may be necessary when parts are changed. This procedure must be repeated for the other two inputs on the type SI relay.

Splitter Adjustments

1. Turn rheostat (S) on front of relay to extreme counter-clockwise position.

2. Apply minimum S current to the proper relay terminals.

3. With a high resistance voltmeter (a.c.) adjust phase splitter potentiometer such that three voltages approximately equal to each other are obtained across TP 1, printed circuit board terminal 12 and printed circuit board terminal 18 or 14.

Dial Calibration (S)

1. Apply 125 volts d.c. to relay terminals 10 and 2. Terminal 10 is positive.

2. Connect a high resistance d.c. voltmeter across terminals 1 and 2. Terminal 1 is positive.

3. Apply desired S current to terminal 8 and 9.

4. Turn S rheostat until the relay operates as indicated by a sudden reading of approximately 20 volts d.c. on meter.

Dropout (P)

1. Set S on desired point and apply S amperes to relay to make it operate.

2. Lower S amperes to desired droput value and adjust P potentiometer until voltmeter drops to approximately zero.

3. Verify dropout and pickup several times by raising a.c. current until relay operates and then lowering the a.c. current until relay dropouts.

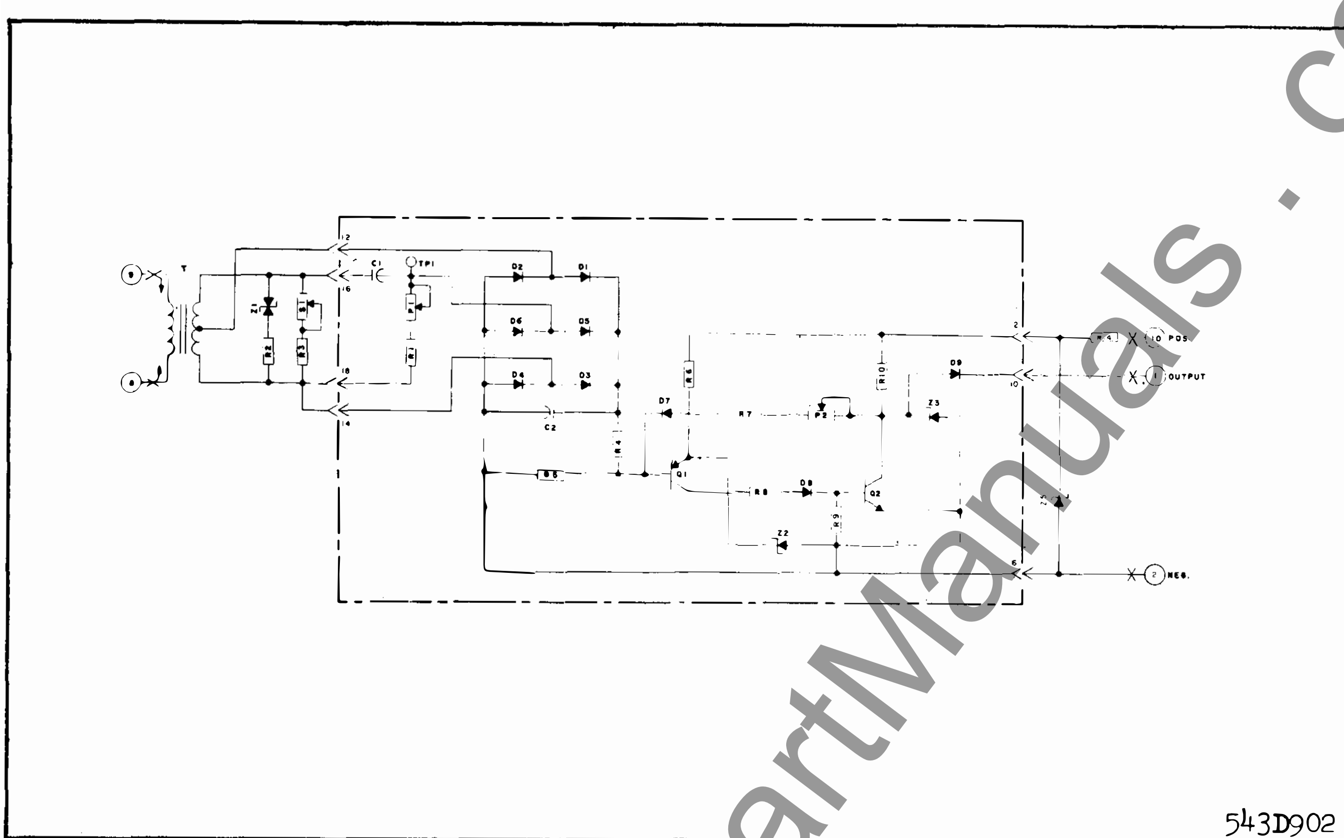
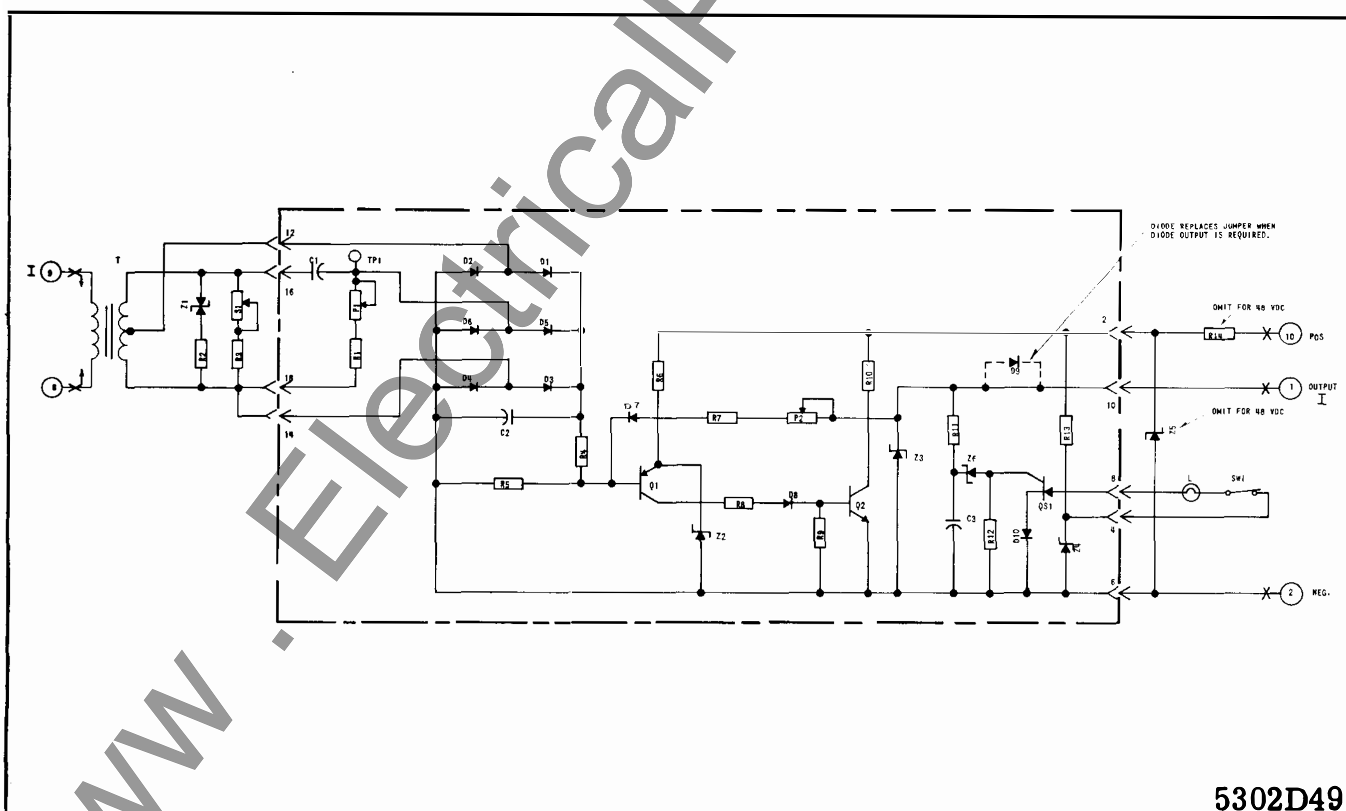


Fig. 4 Internal Schematic for the type SI-1 Relay.



* *Fig. 5 Internal Schematic for the type SI-1 Relay with an operation indicator.*

Trouble Shooting Procedure

Use the following procedure to locate the source of trouble if the SI-1 relay or the SI relay is not operating correctly.

1. Inspect all wires and connections, paying particular attention to printed circuit terminals.
2. Check resistances as listed on the internal schematic of the relays.
3. Check voltages as listed on the electrical checkpoints.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

ELECTRICAL CHECKPOINTS

Connect relay per test circuit of Fig. 11. All voltage readings should be made with a high resistance voltmeter. Refer to Fig. 12, 13 or 14 for printed circuit board points. For some readings it is necessary to scrape varnish from the components to make a connection at the point.

I No. A.C. Current Input 125 volts d.c.

Component	Negative terminal	Approximate d.c. voltage
Z_2	2	7
Z_3	2	less than .6 volts
Z_5	2	45 volts

II Minimum Trip A.C. current applied

Circuit	Terminals	Voltage
Phase Splitter	TP_1 to board 18	7.5 volts a.c.
	TP_1 to board 12	7.5 volts a.c.
	Board 12 to board 18	7.5 volts a.c.
Setting	Board 16 to board 18	15 volts a.c.
Output	Terminal 1(+) and 2	18 to 22 volts D.C.

The above terminals are for the SI-1 relay. For corresponding terminals for the SI relay, refer to the relay.

ELECTRICAL PARTS LIST

TYPE SI

Circuit Symbol	Description
CAPACITORS	
CI-C2-C3	.5 MFD.
C4-C5 ††	.25 MFD.
DIODES	
D18-D20-D22 ††	IN459A
D19-D21 ††	IN457A
POTENTIOMETERS	
P1-P2-P3	2.5K Ω – 1/4W
P4-P5 ††	200K Ω – 1/4W
TRANSISTORS	
Q1-Q3 ††	2N652A
Q2-Q4 ††	2N697
RESISTORS	
R1-R4-R7	2.7 K Ω – 1/2W
R2-R5-R8	50 Ω – 25 W
R3-R6-R9	300 Ω – 25 W
R10-R12 ††	15 K Ω – 1/2 W
R11-R13 ††	39 K Ω – 1/2 W
R14-R19 ††	* 2.7K Ω – 5 W
R15-R21 ††	3.9 K Ω – 2 W
R16-R20 ††	33 K Ω – 1/2 W
R17-R22 ††	1 K Ω – 1/2 W
R18-R23 ††	10 K Ω – 1/2 W
R24	500 Ω – 40 W
RHEOSTAT	
S1-S2-S3	1.5 K Ω – 25 W
TRANSFORMER	
T1-T2	S# 410C268
T3	S#410C268
ZENER DIODES	
Z1-Z2-Z3	INI832C
Z4-Z6 ††	IN957B
Z5-Z7 ††	IN368B
Z8	INI829A

†† Used only in relay with double output.

TYPE SI-1

Circuit Symbol	Description
CAPACITORS	
C1	.5 MFD
C2	.25 MFD
C3†	6.8 MFD
DIODES	
D1 TO D6-D8	IN459A
D7	IN457A
D9 - D10 †	CER - 69
POTENTIOMETERS	
P 1	2.5K Ω – 1/4 W
P 2	200 K Ω – 1/4 W
TRANSISTORS	
Q 1	2N652A
Q 2	2N697
RESISTORS	
R 1	2.7 K Ω – 1/2 W
R 2	50 Ω – 25W
R 3	300 Ω – 25 W
R 4	15 K Ω – 1/2 W
R 5	39K Ω – 1/2 W
R 10	* 2.7K Ω – 5 W
R 6	3.9 K Ω – 2 W
T 7	33 K Ω – 1/2 W
R 8	1 K Ω – 1/2 W
R 9	10 K Ω – 1/2 W
R 14	500 Ω – 40 W
R 12 †	4.7 K Ω – 1/2 W
R 13 †	820 Ω – 1 W
R 11 †	3.9K Ω – 1/2 W
RHEOSTAT	
S 1	1.5 K Ω – 25 W
TRANSFORMER	
T	S # 410C268
ZENER DIODES	
Z 1	INI832C
Z 2 – Z6 †	IN957B
Z 3 – Z4 †	IN3686B
Z 5	INI829A
SWITCHES	
QS 1 †	2N1881
SW 1 †	S # 184A611H01
LAMP	
L †	S # 183A825G05

† Used only in relay with operation indicator

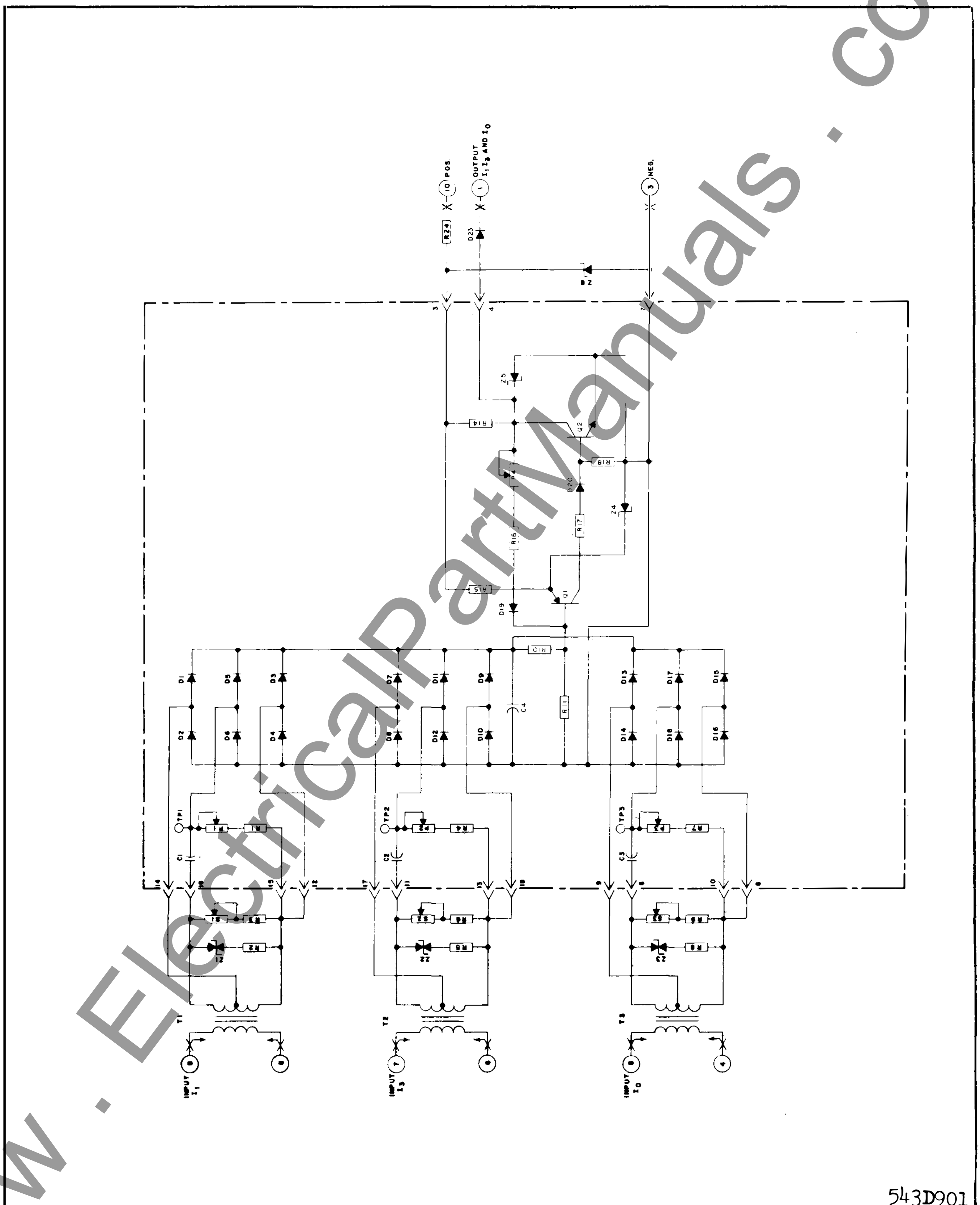


Fig. 6 Internal Schematic for the type SI Relay with a single output.

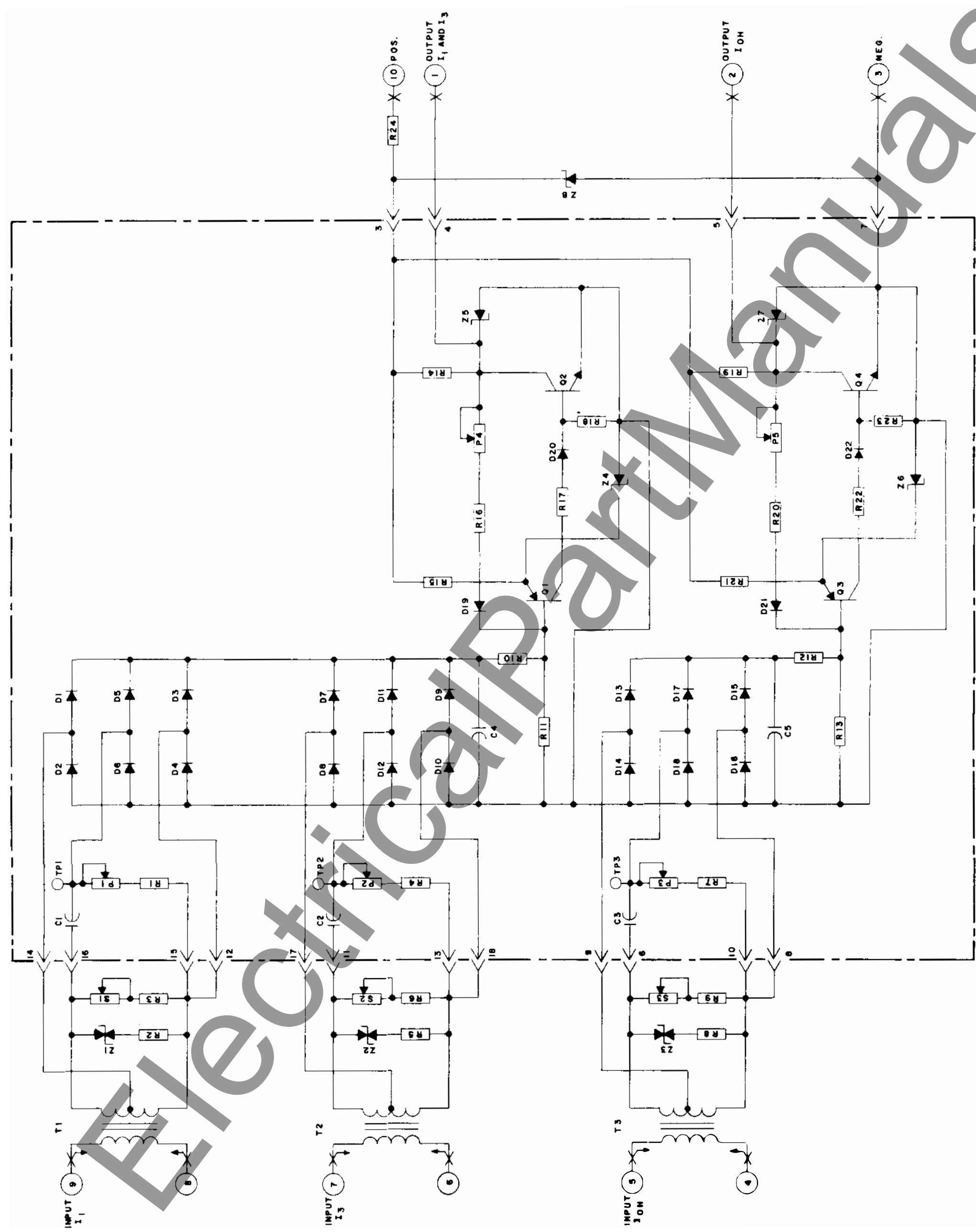


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Fig. 7 Internal Schematic of the type SI Relay with a double output.

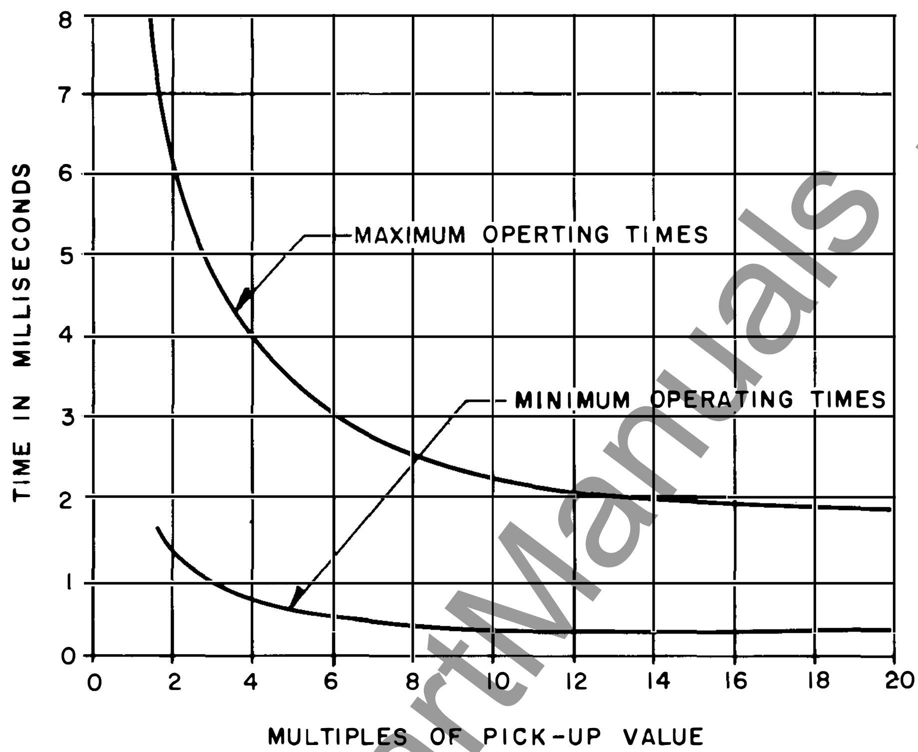


Fig. 8 Operating time for the type SI and SI-1 Relays.

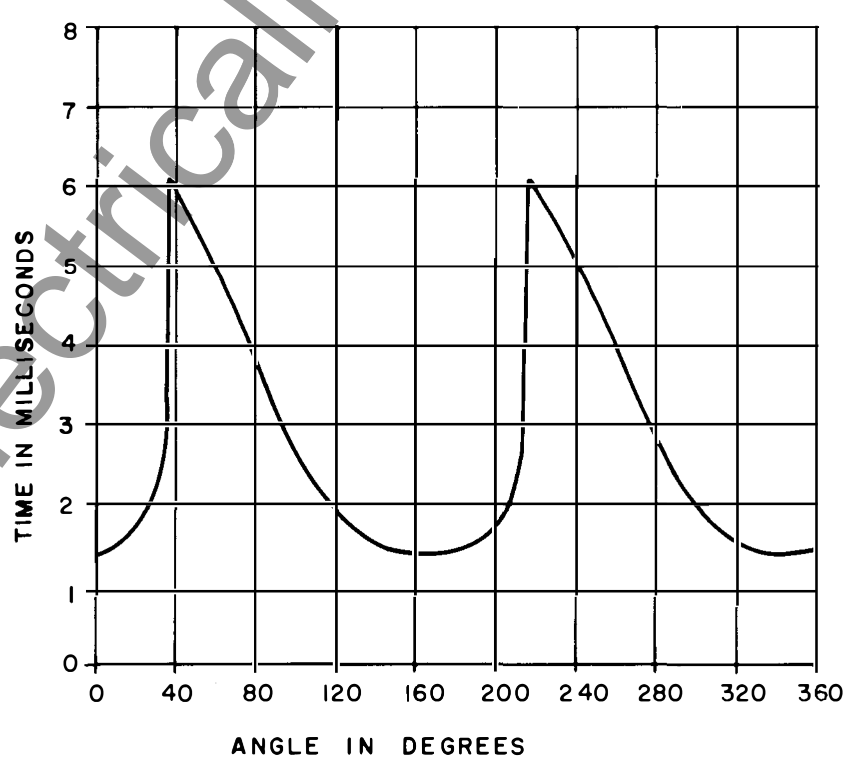


Fig. 9 Operating time for the type SI and SI-1 Relays as a function of fault incidence angle at twice minimum trip.

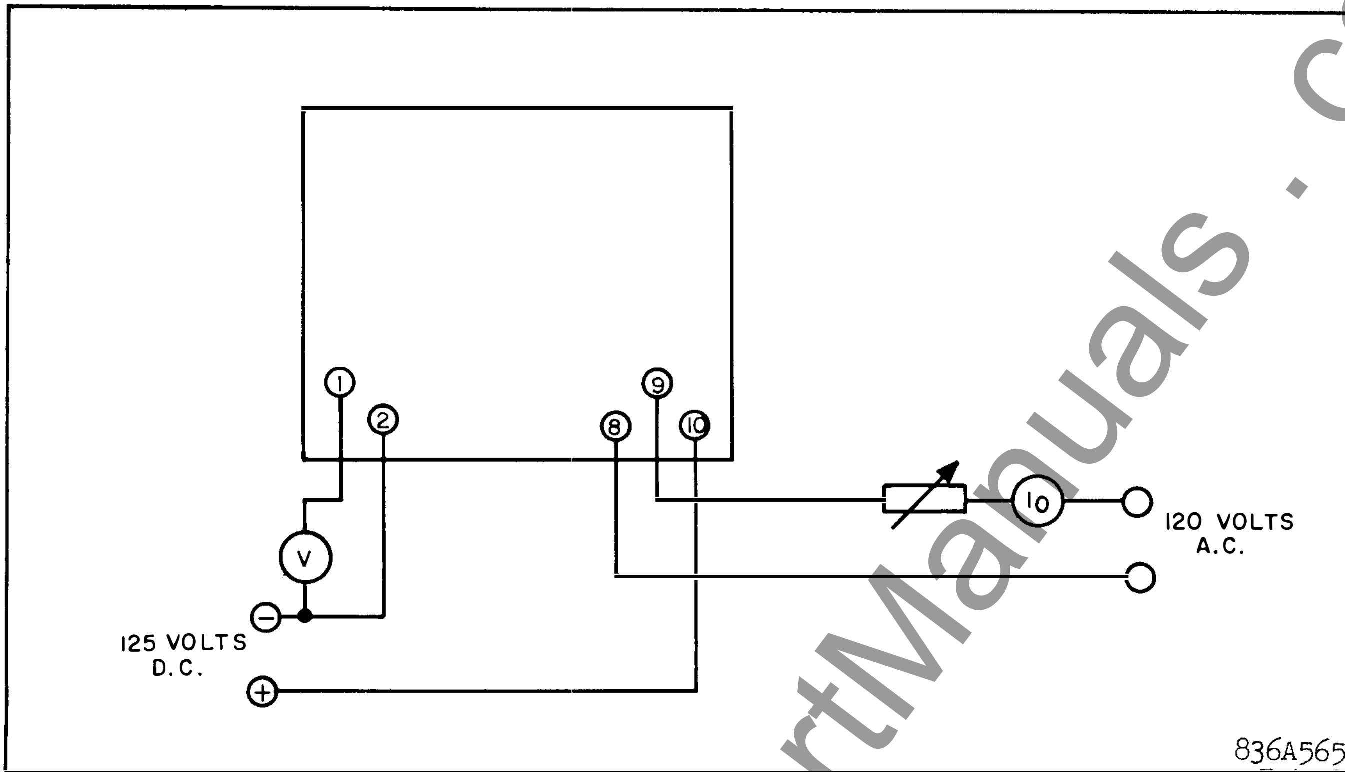


Fig. 10 Test circuit for the type SI-1 Relay.

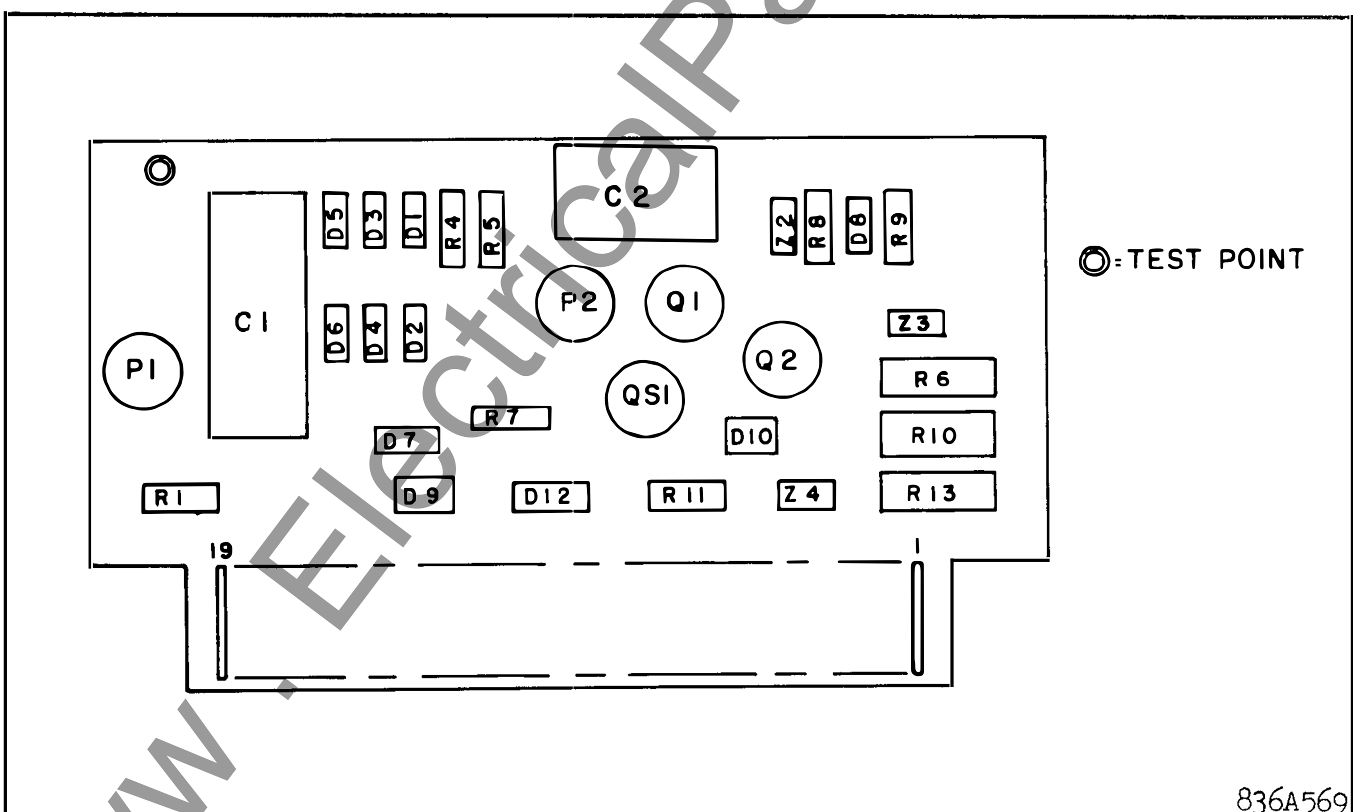
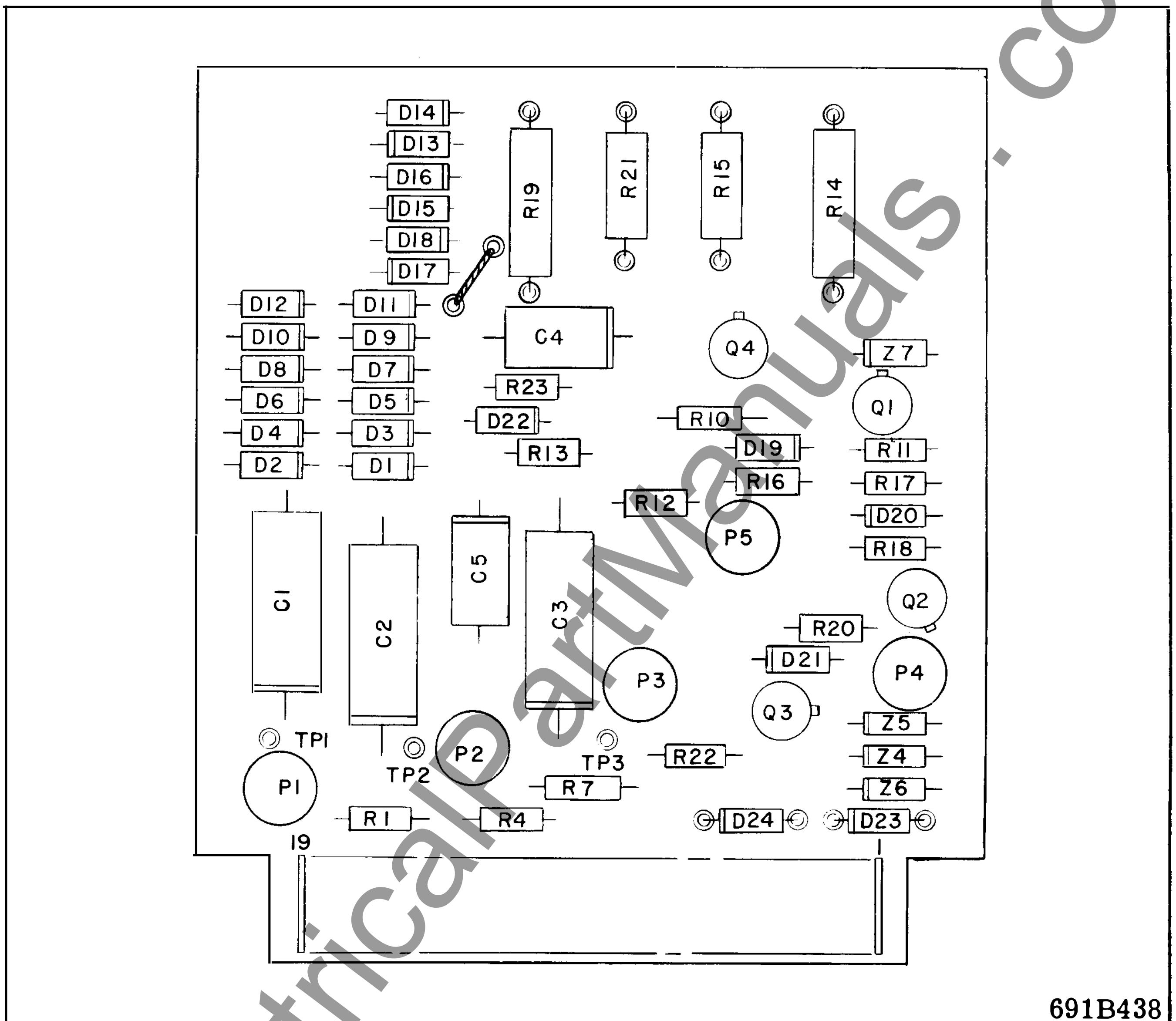


Fig. 11 Component location on printed circuit board for the type SI-1 Relay.



* *Fig. 12 Component location on printed circuit board for the type SI Relay.*

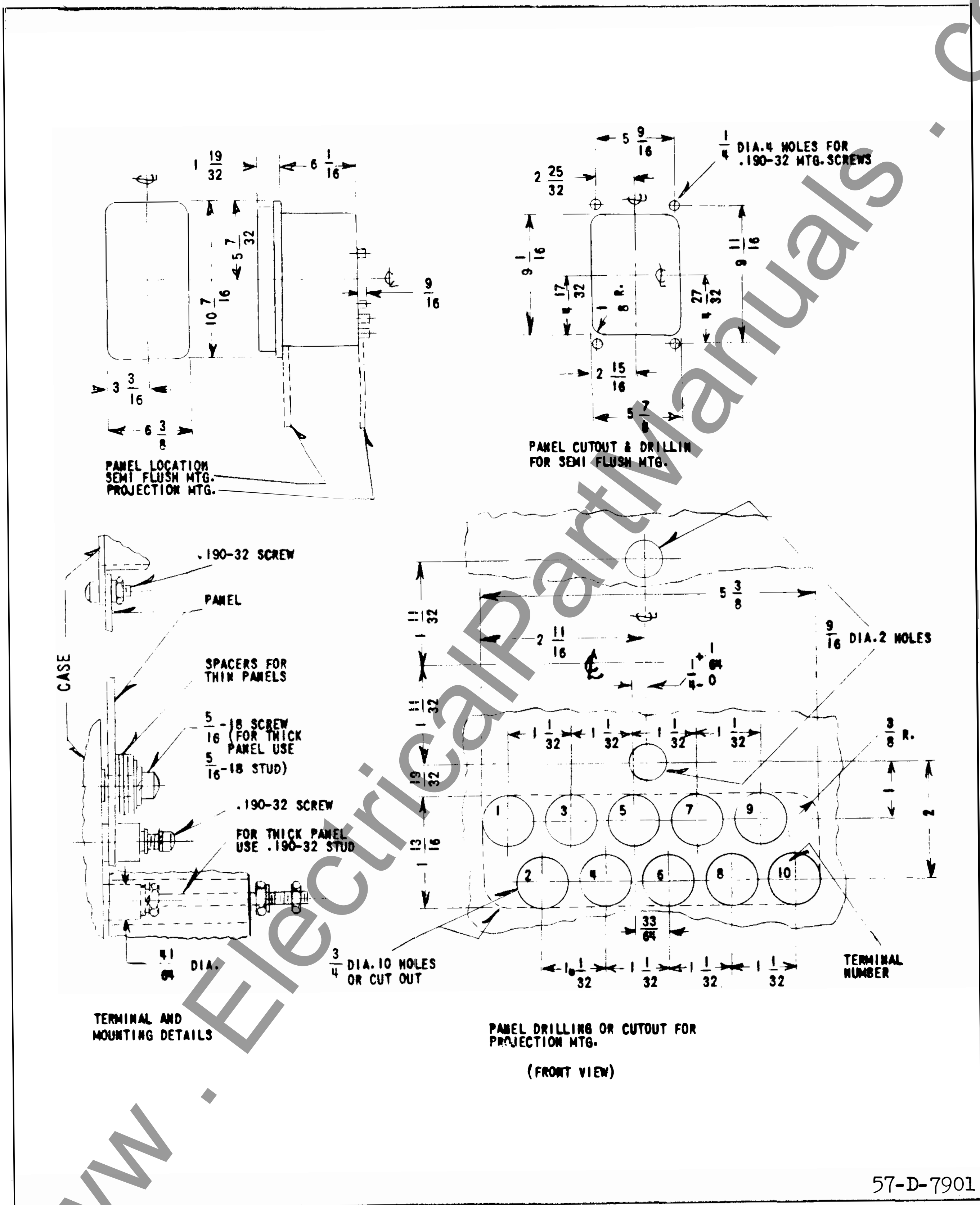


Fig. 13 Outline and drilling plan for the type SI Relay in the FT-21 case.

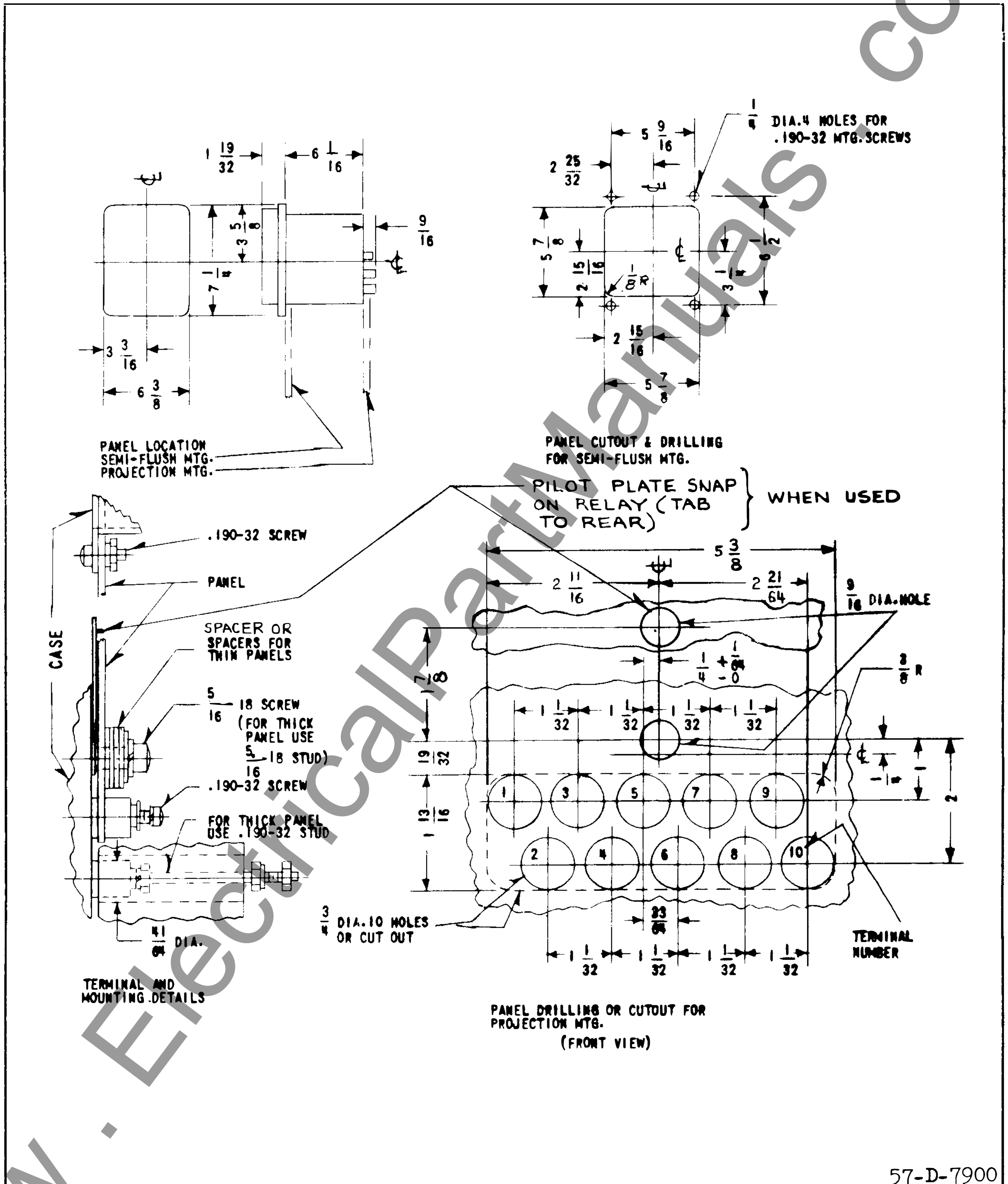


Fig. 14 Outline and drilling plan for the type SI-1 Relay in the FT-11 case.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPES SI AND SI-1 OVERCURRENT RELAYS

CAUTION: Before putting relay into service, operate the relay to check the electrical connections. Close output switches last when placing relay in service. Open output switches first when removing relay from service.

APPLICATION

These overcurrent relays are static devices that produce a d.c. output voltage when the input current in them exceeds a given value. This output voltage is used as the input to other devices that trip a breaker.

The number of inputs and outputs varies with the type of relay. Generally, these are as follows:

Type SI relay-three inputs, one or two outputs.

Type SI-1 relay-one input, one output.

CONSTRUCTION

The type SI-1 relay consists of an input transformer, a setting circuit, a phase splitter circuit, a sensing circuit, an amplifier circuit, a voltage regulator circuit, a feedback circuit and a transistor output. An operational indicator is an optional unit. The type SI relay in addition to these components has two input transformers, two phase splitter circuits, and either a single output or a dual output transistor circuit.

The components are connected as shown in Fig. 4 to 7.

Input Transformer – The input transformer is a two winding type with a non-tapped primary winding and a tapped secondary winding. The secondary is connected to the setting circuit and from a fixed tap to the phase splitter circuit.

Setting Circuit – The setting circuit is connected across the secondary winding of the input transformer and consists of two branches, a resistor and a rheostat connected in parallel with a resistor and Zener diode. This circuit loads the transformer and produces a secondary voltage proportional to the input current. The rheostat has a locking feature to minimize accidental change of current setting.

Phase Splitter Circuit – The phase splitter circuit consists of two capacitors, resistor, potentiometer and a three-phase rectifier bridge. This circuit converts the single phase a.c. voltage from the output of the transformer to a three-phase voltage and rectifies this voltage to d.c.

Sensing Circuit – The sensing circuit consists of three resistors, a transistor and a Zener diode. This circuit is connected between the output of the phase splitter circuit and the amplifier circuit. In this circuit, a reference voltage is established which turns the transistor on. To turn the transistor off, the output voltage from the phase splitter must be greater than the reference voltage.

Amplifier Circuit – The amplifier circuit consists of a normally conducting transistor, Zener diode, three resistors and a diode. This circuit is the final output stage of the relay.

Feedback Circuit – The feedback circuit consists of a resistor, potentiometer, and diode. This circuit controls the dropout current of the relay.

Voltage Regulator Circuit – The voltage regulator circuit consists of a silicon power regulator and a

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

SUPERSEDES I.L. 41-777E, dated September 1971
✪ Denotes change from superseded issue.

EFFECTIVE JUNE 1977

series resistor. The silicon power regulator is a 10 watt Zener diode mounted on an aluminum heat sink. The series resistor is a 3-½ inch resistor and is used to reduce the supply voltage to the Zener voltage.

Operational Indicator – The operational indicator consists of a silicon control rectifier, lamp, micro-switch, Zener diode, and three resistors. This circuit is triggered by a signal from the output of the relay.

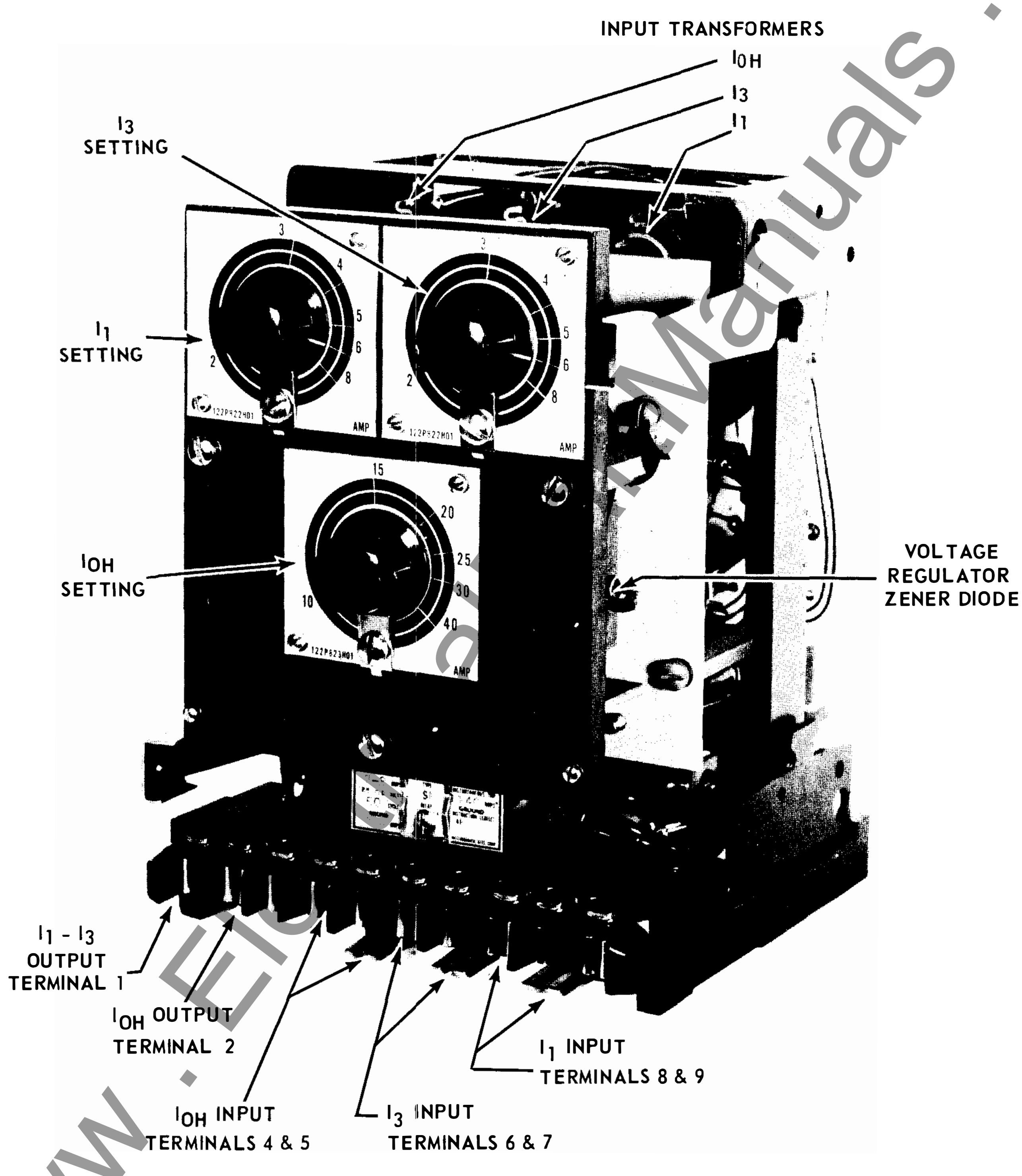


Fig. 1 Type SI Relay in an FT-21 case (front view).

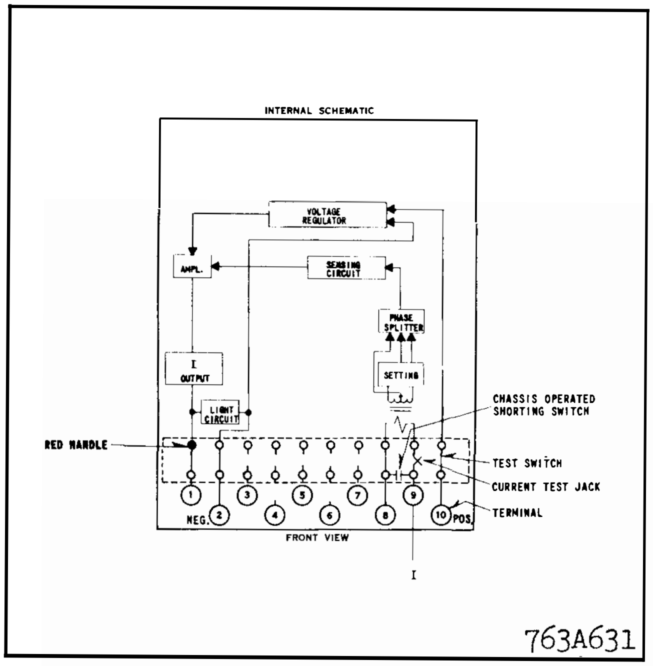


Fig. 2 Block diagram of the Type SI-1 Relay in FT-11 case

OPERATION

The components of the SI-1 relay are connected as shown in Fig. 4 and Fig. 5. With no input to the relay, all transistors (Q_1 and Q_2) are conducting and a very small output is obtained from the relay. Zener diode (Z_2) of the sensing circuit establishes the reference voltage from the emitter of Q_1 to negative and allows a base current to flow in Q_1 through R5 to negative.

When a.c. current is applied to the primary of the transformer (T), a voltage is produced on the secondary side that is proportional to the amount of resistance in the rheostat (S1). This single phase voltage is applied to the phase splitter circuit where a three phase voltage is produced, rectified, and applied to resistor R_5 of the sensing circuit. If the voltage from the rectifier is greater than the reference voltage across the sensing circuit, Q_1 turns off to allow Q_2 to turn off which produces an output.

When Q2 turns off, positive voltage is applied to the feedback circuit such that a voltage is applied to the base of Q1 on relays when feedback resistor "P" is used, the dropout of the relay can be regulated from approximately 98% to 85% of pickup by varying the magnitude of this voltage. On those relays without adj. feedback resistor, the magnitude of feedback voltage is set to give the proper dropout ratio for a snappy pickup.

When large currents are applied to the primary of the input transformer, the Zener clipper on the secondary prevents the voltage applied to the electronic components from becoming excessive.

The operation of the type SI relay is similar to the SI-1 except that the SI has three overcurrent inputs. These three inputs are applied through separate phase splitting and setting circuits to a common sensing circuit which operates on the maximum voltage applied to it.

Figs. 6 and 7 show the connections of the SI with single output and the SI with a dual output.

CHARACTERISTICS

The SI-1 relay is available in the current ranges shown in Table I.

TABLE I

Range	Scale Marking					
.25 – 1 ampere	.25	.4	.5	.6	.8	1.0
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2 – 8 amperes	2	3	4	5	6	8
4 – 16 amperes	4	6	8	10	12	16
10 – 40 amperes	10	15	20	25	30	40

The setting of the relay is the minimum current required to produce an output. Settings between the scale markings can be obtained by applying the desired current to the relay and setting the rheostat at the desired point.

The SI relay is available with any combination of three of the above ranges. In the usual application, two inputs are the same range with an output. The third input is of a different range and can be of a different output than the other two.

The operating time of the relay is shown in Fig. 8. As shown in the figure, there is a maximum and minimum operating time of the relay for each multiple of pickup. This difference in time is due to the point on the current wave that the fault current is applied. Figure 9 shows the operate times for different points on the fault wave for fault currents at twice pickup.

For breaker failure applications, the SI relay is modified to obtain a fast reset characteristic. With reference to Fig. 6, the filtering capacitor, C_4, is removed and the dropout ratio is set at 90% of pickup. This lower dropout ratio allows a snapped pickup without the filtering capacitor. The reset curves of the relay is shown in Fig. 13 and Fig. 14. The external schematic of the relay in a breaker failure application is shown in Fig. 15.

TABLE II
ENERGY REQUIREMENTS

Ampere Range	Setting	VA at Setting	P.F. Angle	VA at 5 amps.	P.F. Angle
.25 – 1	.25	0.17	7.5	23	51°
	.4	0.31	15	22.8	50
	.5	0.42	21	22.7	48
	.6	0.54	25	22.6	48
	.8	0.81	30	22.2	48
	1.0	1.20	35	21.8	48
.5 – 2	.5	0.17	7.5	8.80	32
	.75	0.31	15	8.50	32
	1.0	0.42	21	8.10	33
	1.25	0.54	25	7.80	34
	1.5	0.81	30	7.60	36
	2.0	1.20	35	7.10	37
1 – 4	1	0.17	7.5	3.15	16
	1.5	0.31	15	2.95	19
	2	0.42	21	2.65	21
	2.5	0.54	25	2.35	25
	3	0.81	20	2.21	28
	4	1.20	35	2.0	30
2 – 8	2	0.22	7.5	1.4	13
	3	0.39	15	1.1	15
	4	0.60	21	0.95	21
	5	0.85	25	0.85	25
	6	1.17	30	0.80	30
	8	1.94	35	0.73	35
4 – 16	4	0.26	8.5	0.41	8.5
	6	0.49	13	0.34	13
	8	0.80	15	0.3	15
	10	1.15	16.5	0.29	16.5
	12	1.57	17.5	0.28	17.5
	16	2.56	19	0.25	19.0
10 – 40	10	1.0	3	0.25	3
	15	2.1	4	0.23	4
	20	3.6	5	0.21	5
	25	5.9	6	0.21	6
	30	8.1	6	0.20	6
	40	14.4	6	0.20	6

TABLE III
CURRENT RATINGS
Rating of the Overcurrent Units

Range	Continuous Rating (Amperes)	One Second Rating (Amperes)
.25 – 1	6	185
.5 – 2	8	350
1 – 4	10	400
2 – 8	12	400
4 – 16	15	400
10 – 40	20	460

TABLE IV
Battery Drain

	48 Volts D.C.	125 Volts D.C.
SI-1 Relay	32MA	65 MA
SI-1 Relay with Indicator	65MA	100 MA
SI-Relay Single Output	32MA	65 MA
SI Relay Dual Output	65MA	105 MA
Maximum Output	20 MA at 20 Volts D.C.	

SETTING

The pickup of the relay is selected by adjusting the rheostat, S, in the front of the relay. Setting in between the scale marking can be made by applying the desired current and adjusting the rheostat until an output is obtained.

✪ INSTALLATION

The relay should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the rear mounting stud or studs for the type FT projection case or by means of the four mounting holews on the flange for the semi-flush type FT case. Either the stud or the mounting screws may be utilized for grounding the relay. External toothed washers are provided for use in the locations shown on the outline and drilling plan to facilitate making a good electrical connection between the relay case, its mounting screws or studs, and the relay panel. Ground Wires are affixed to the mounting screws or studs as required for poorly grounded or insulating panels. Other electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the terminal stud furnished with the relay for thick panel mounting. The terminal stud may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detail information on the FT case refer to I.L. 41-076.

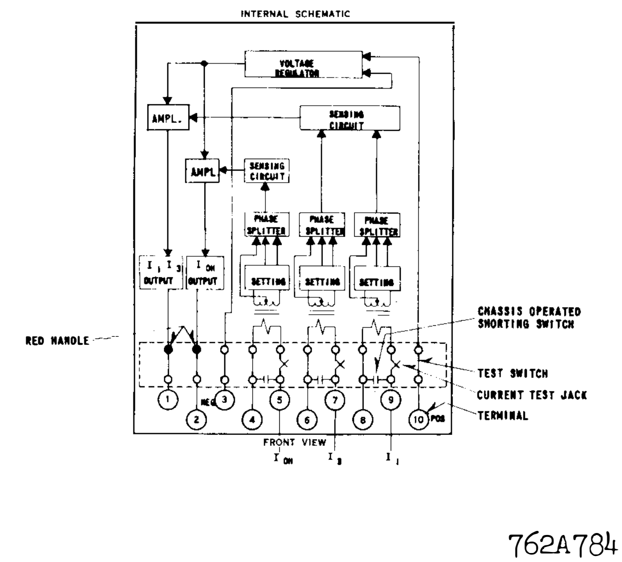


Fig. 3 Block diagram of the Type SI Relay in FT-21 case (for SI with single output omit the circuits connected to terminal 2).

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer.

Acceptance Tests

The following check is recommended to insure that the relay is in proper working order. All checks can best be performed by connecting the relay per the test circuit of Fig. 10. Refer to fig. 6 or fig. 7 and make similar connections for the test of the SI relay.

1. Minimum trip current — Check pickup at the minimum and maximum setting. This is accomplished by applying the specified current and checking that the voltmeter reads approximately 20 volts when the current is within 3% of the setting.
2. Dropout — After checking pickup, the dropout should be checked to be 96 to 98% of the pickup when the a.c. current is gradually reduced. For relay with fast reset characteristics, the dropout ratio should be 90 to 98%.

Routine Maintenance

All relays should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.

Calibration

Use the following procedure for calibrating the SI-1 relay if the relay adjustments have been distributed. This procedure should not be used until it is apparent that the relay is not in proper working order. A new scale plate may be necessary when parts are changed. This procedure must be repeated for the other two inputs on the type SI relay.

Splitter Adjustments

1. Turn rheostat (S) on front of relay to extreme counter-clockwise position.
2. Apply minimum S current to the proper relay terminals.
3. With a high resistance voltmeter (a.c.) adjust phase splitter potentiometer such that three voltages approximately equal to each other are obtained across TP 1, printed circuit board terminal 12 and printed circuit board terminal 18 or 14.

Dial Calibration (S)

1. Apply 125 volts d.c. to relay terminals 10 and 2. Terminal 10 is positive.
2. Connect a high resistance d.c. voltmeter across terminals 1 and 2. Terminal 1 is positive.
3. Apply desired S current to terminal 8 and 9.
4. Turn S rheostat until the relay operates as indicated by a sudden reading of approximately 20 volts d.c. on meter.

Dropout (P) (Where Used)

1. Set S on desired point and apply S amperes to relay to make it operate.
2. Lower S amperes to desired dropout value and adjust P potentiometer until voltmeter drops to approximately zero.
3. Verify dropout and pickup several times by raising a.c. current until relay operates and then lowering the a.c. current until relay dropouts.

On those relays, where dropout adjustment P is not used, the dropout ratio will be 96 to 98% of pickup on the standard relay and 90 to 99% on the fast reset relay.

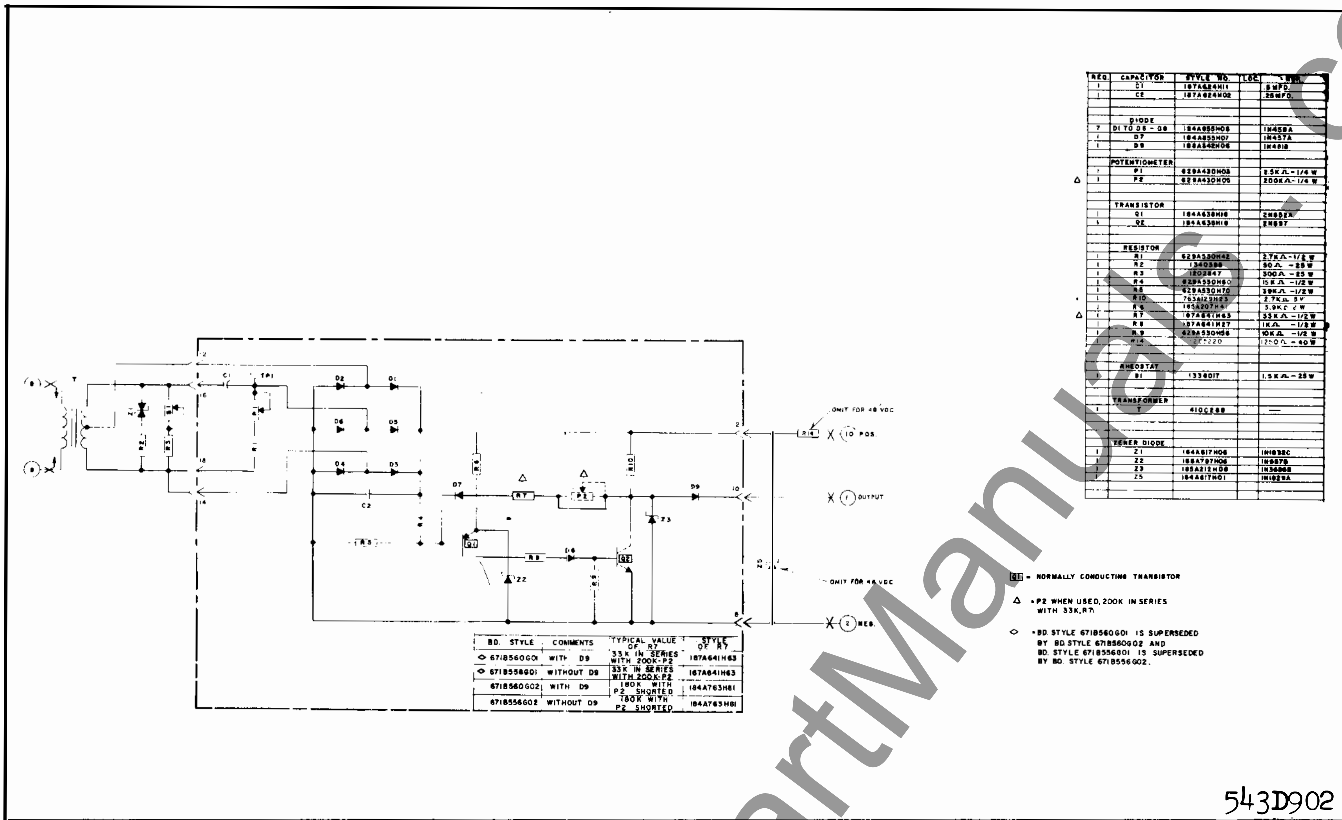


Fig. 4 Internal Schematic for the type SI-1 Relay.

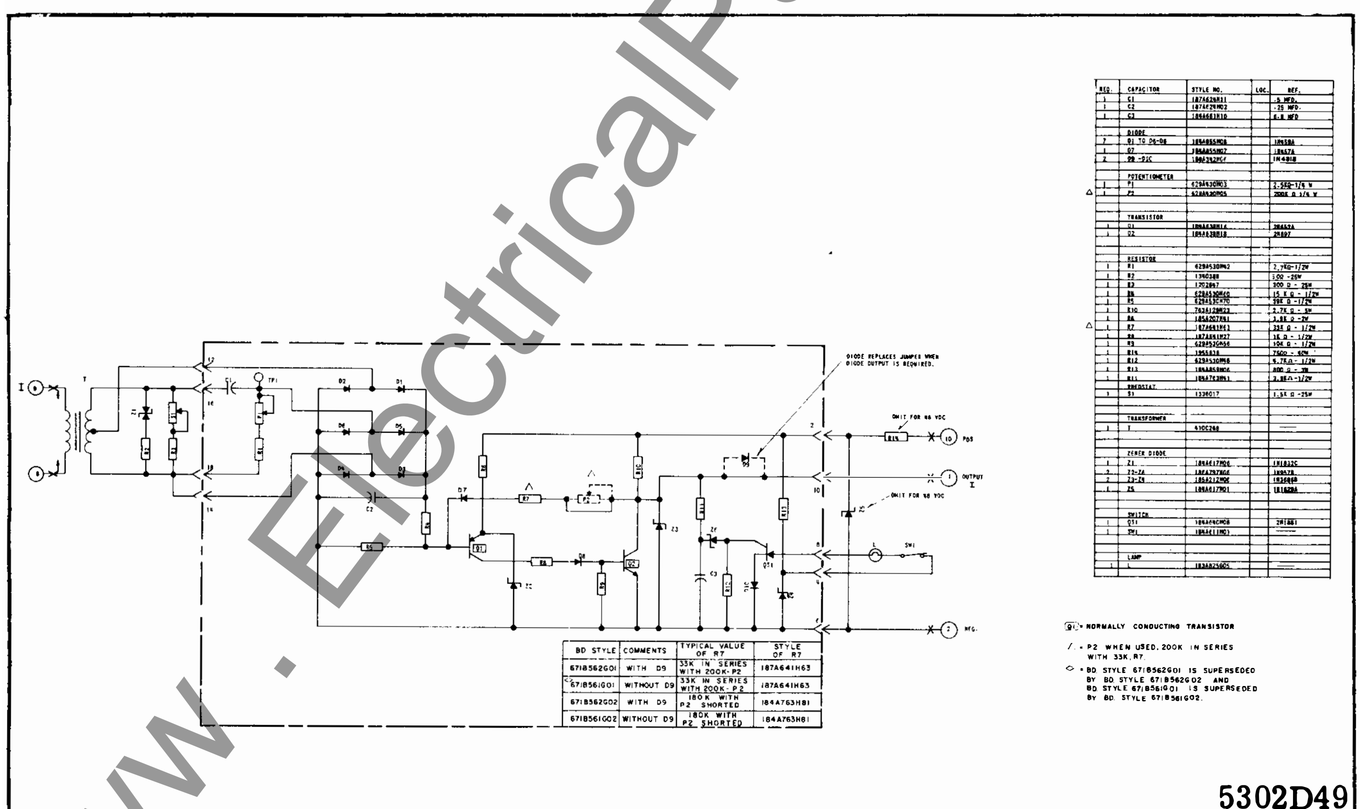


Fig. 5 Internal Schematic for the type SI-1 Relay with an operation indicator.

Trouble Shooting Procedure

Use the following procedure to locate the source of trouble if the SI-1 relay or the SI relay is not operating correctly.

1. Inspect all wires and connections, paying particular attention to printed circuit terminals.
2. Check resistances as listed on the internal schematic of the relays.
3. Check voltages as listed on the electrical checkpoints.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

ELECTRICAL CHECKPOINTS

Connect relay per test circuit of Fig. 10. All voltage readings should be made with a high resistance voltmeter. Refer to Fig. 11 or 12 for printed circuit board points. For some readings it is necessary to scrape varnish from the components to make a connection at the point.

I No. A.C. Current Input 125 volts d.c.

Component	Negative terminal	Approximate d.c. voltage
Z_2	2	7
Z_3	2	less than .6 volts
Z_5	2	45 volts

II Minimum Trip A.C. current applied

Circuit	Terminals	Voltage
Phase Splitter	TP_1 to board 18	7.5 volts a.c.
	TP_1 to board 12	7.5 volts a.c.
	Board 12 to board 18	7.5 volts a.c.
Setting	Board 16 to board 18	15 volts a.c.
Output	Terminal 1(+) and 2	18 to 22 volts D.C.

The above terminals are for the SI-1 relay. For corresponding terminals for the SI relay, refer to the relay.

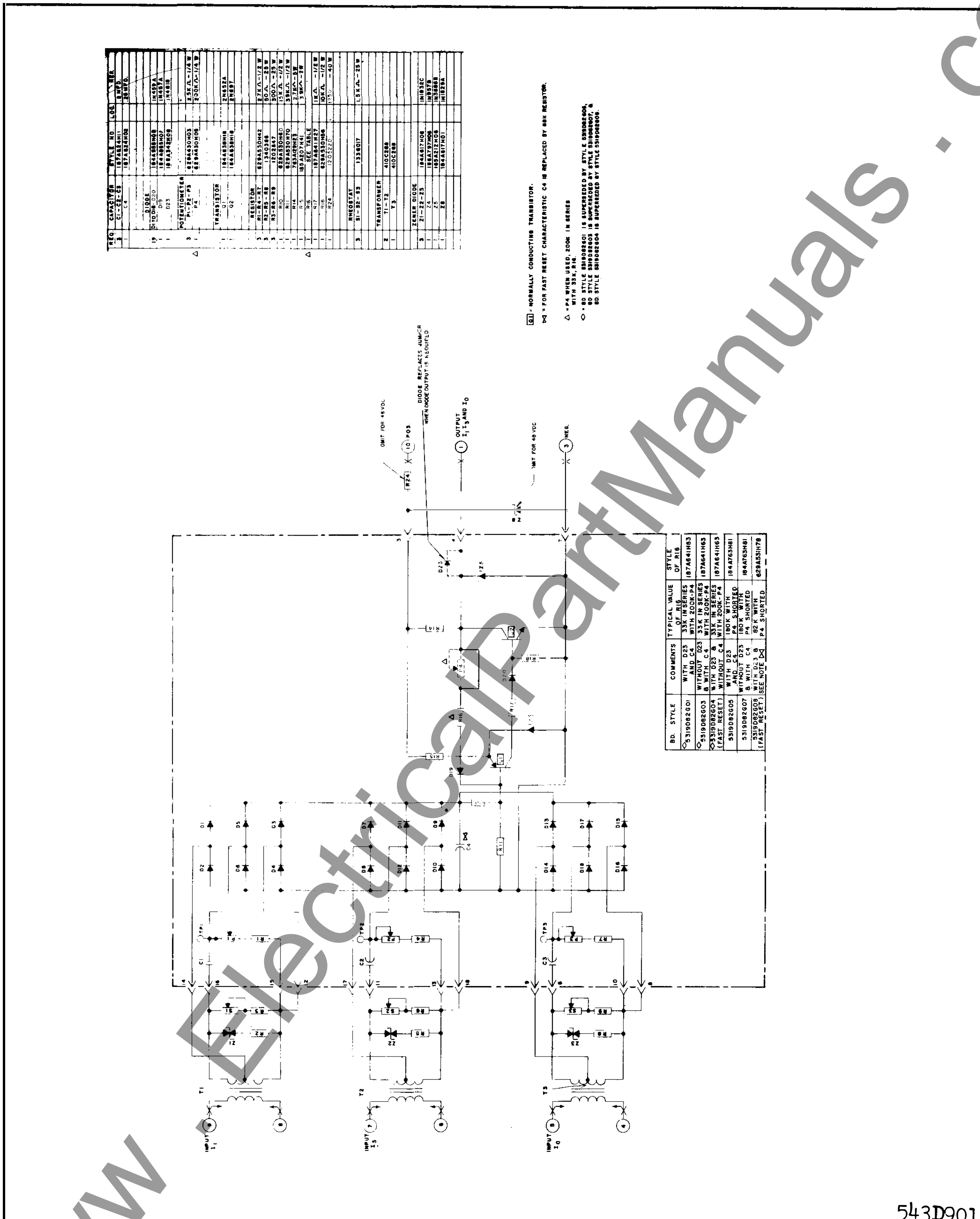


Fig. 6 Internal Schematic for the type SI Relay with a single output.

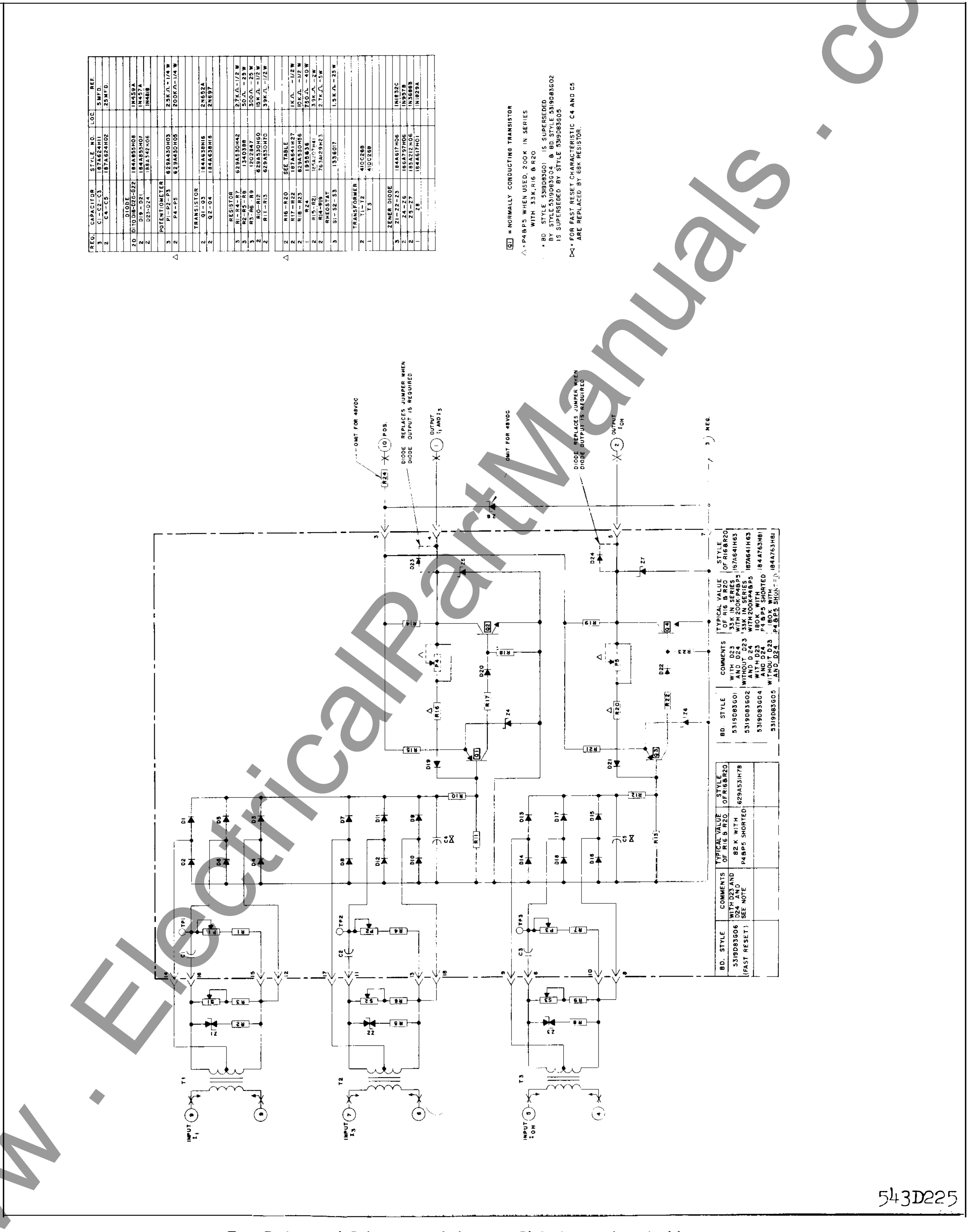


Fig. 7 Internal Schematic of the type SI Relay with a double output.

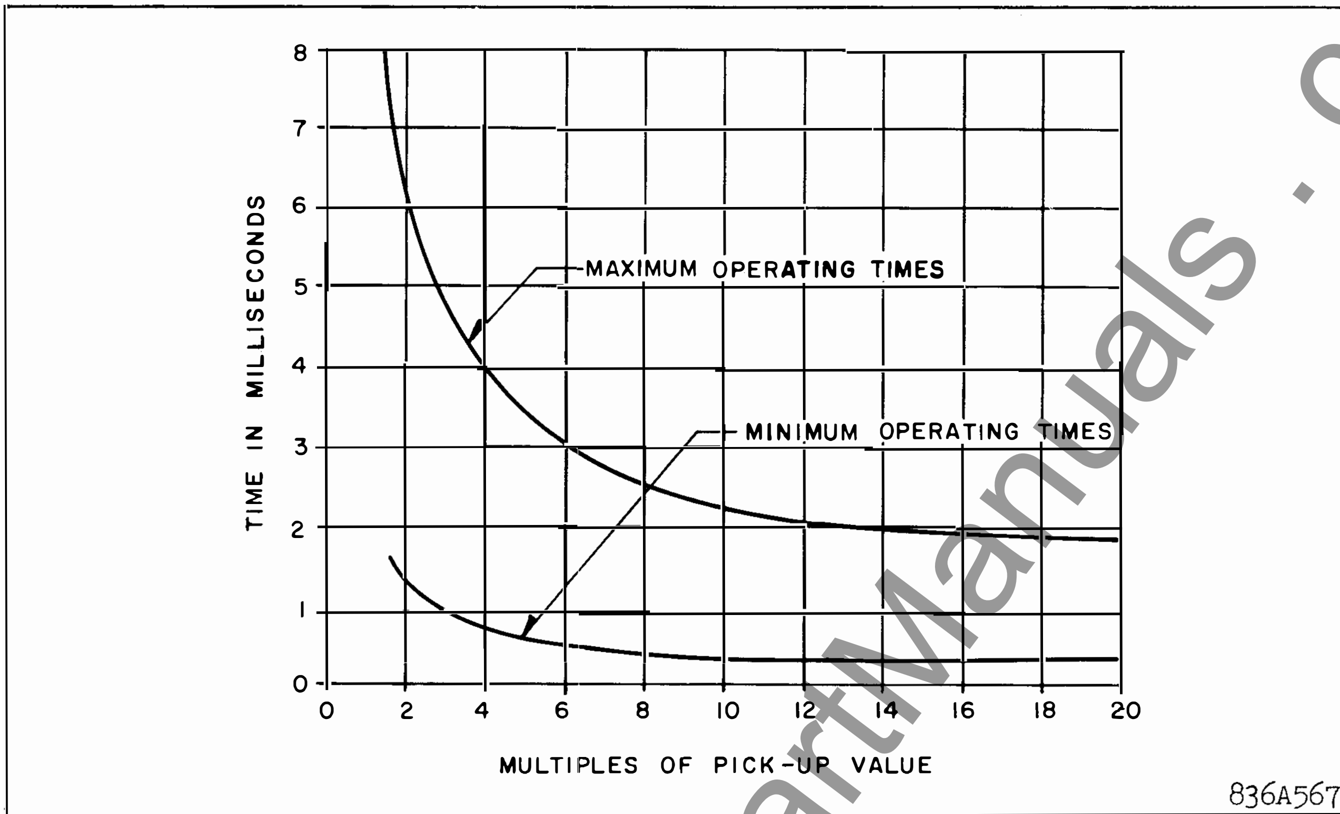


Fig. 8 Operating time for the type SI and SI-1 Relays.

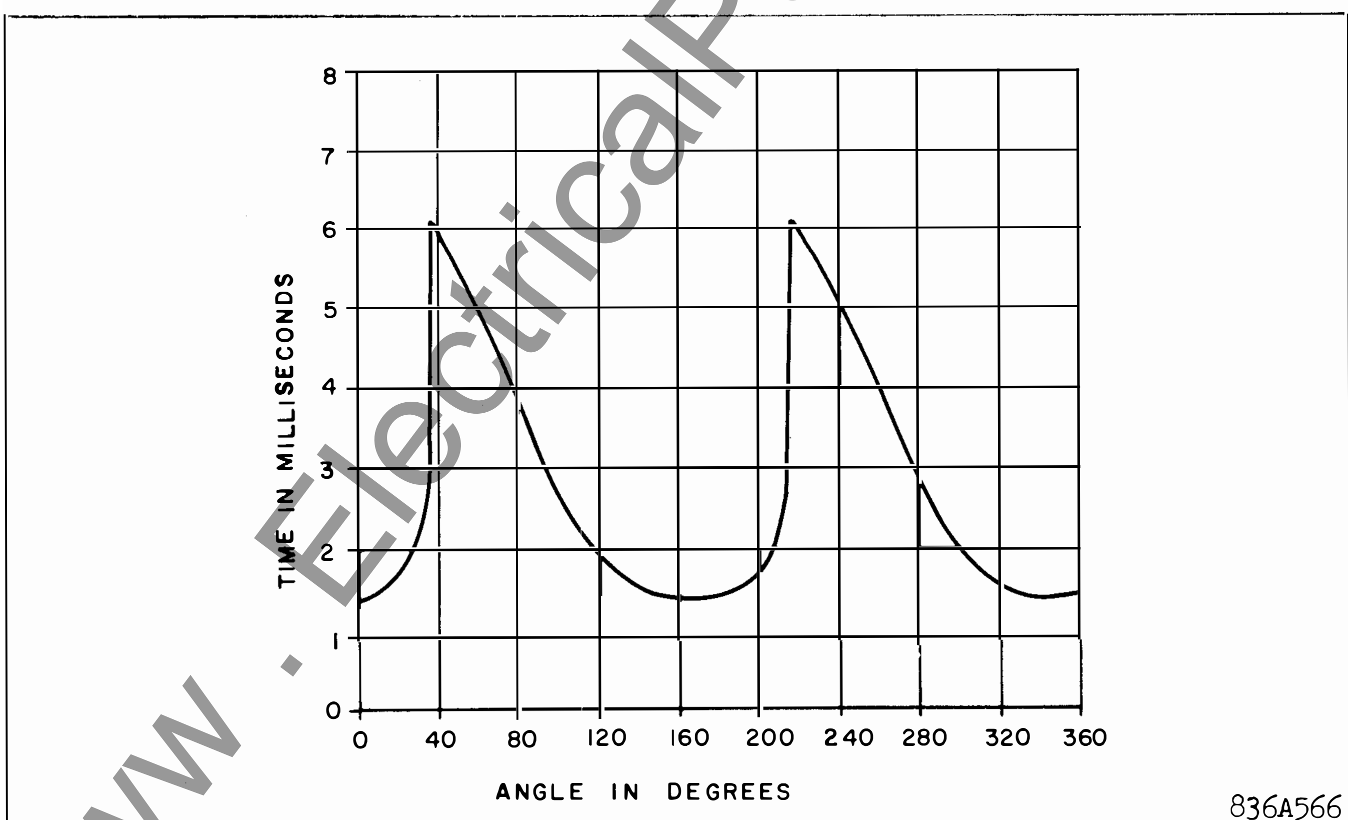


Fig. 9 Operating time for the type SI and SI-1 Relays as a function of fault incidence angle at twice minimum trip.

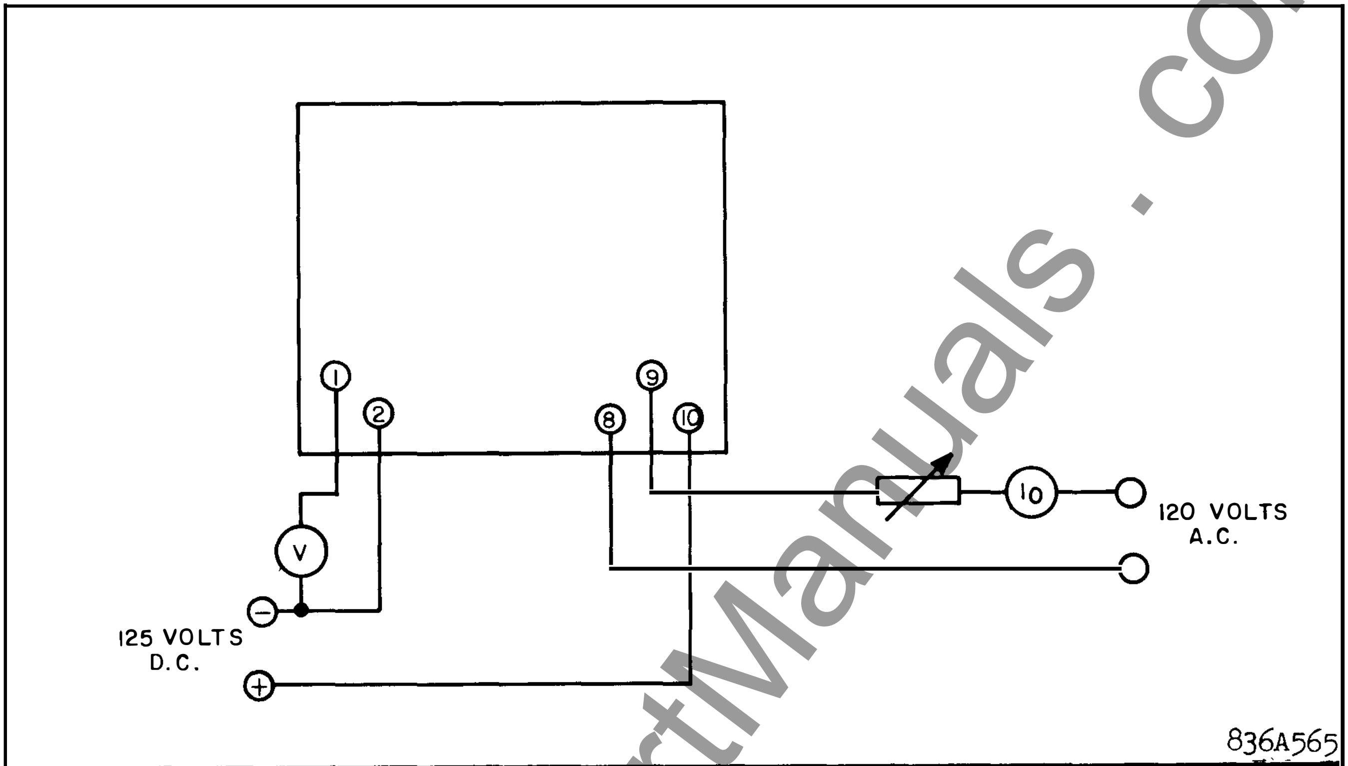


Fig. 10 Test circuit for the type SI-1 Relay.

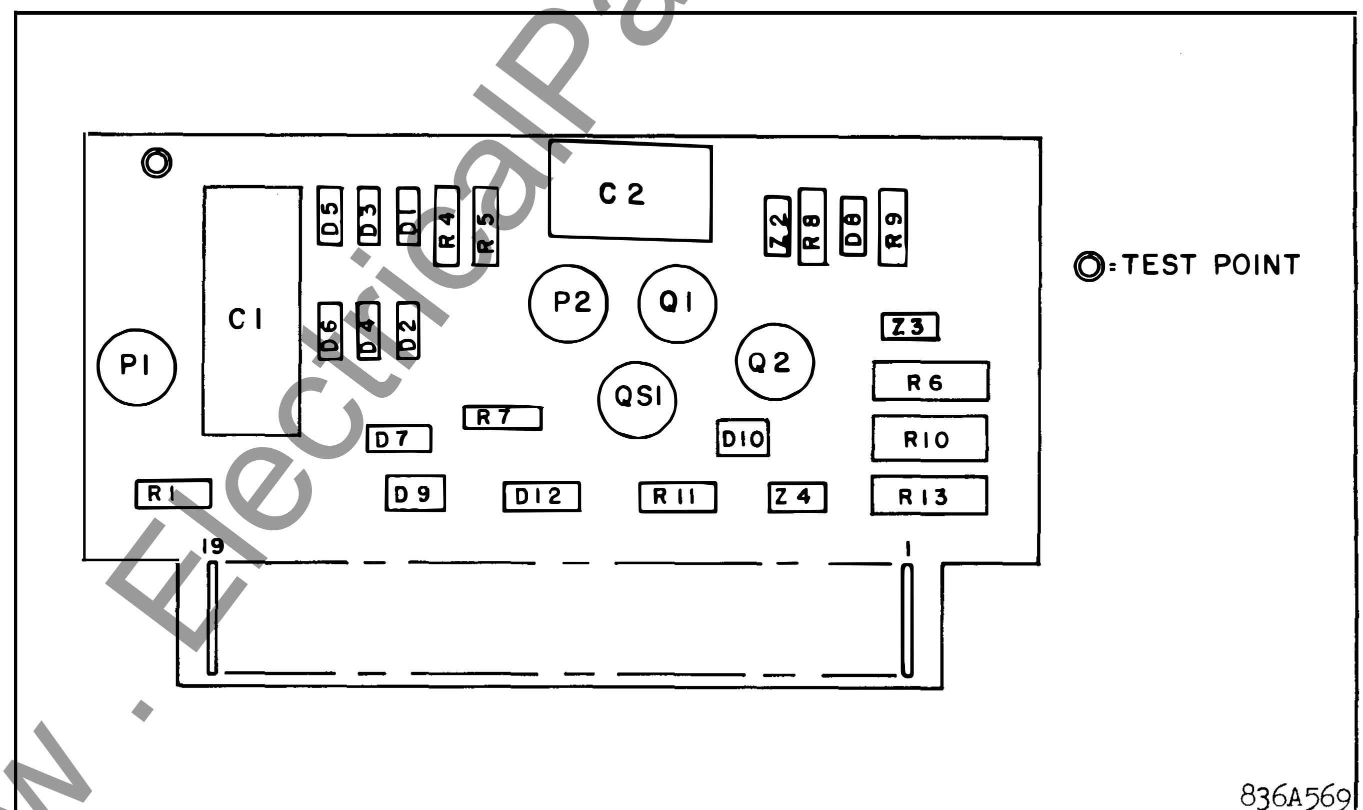


Fig. 11 Component location on printed circuit board for the type SI-1 Relay.

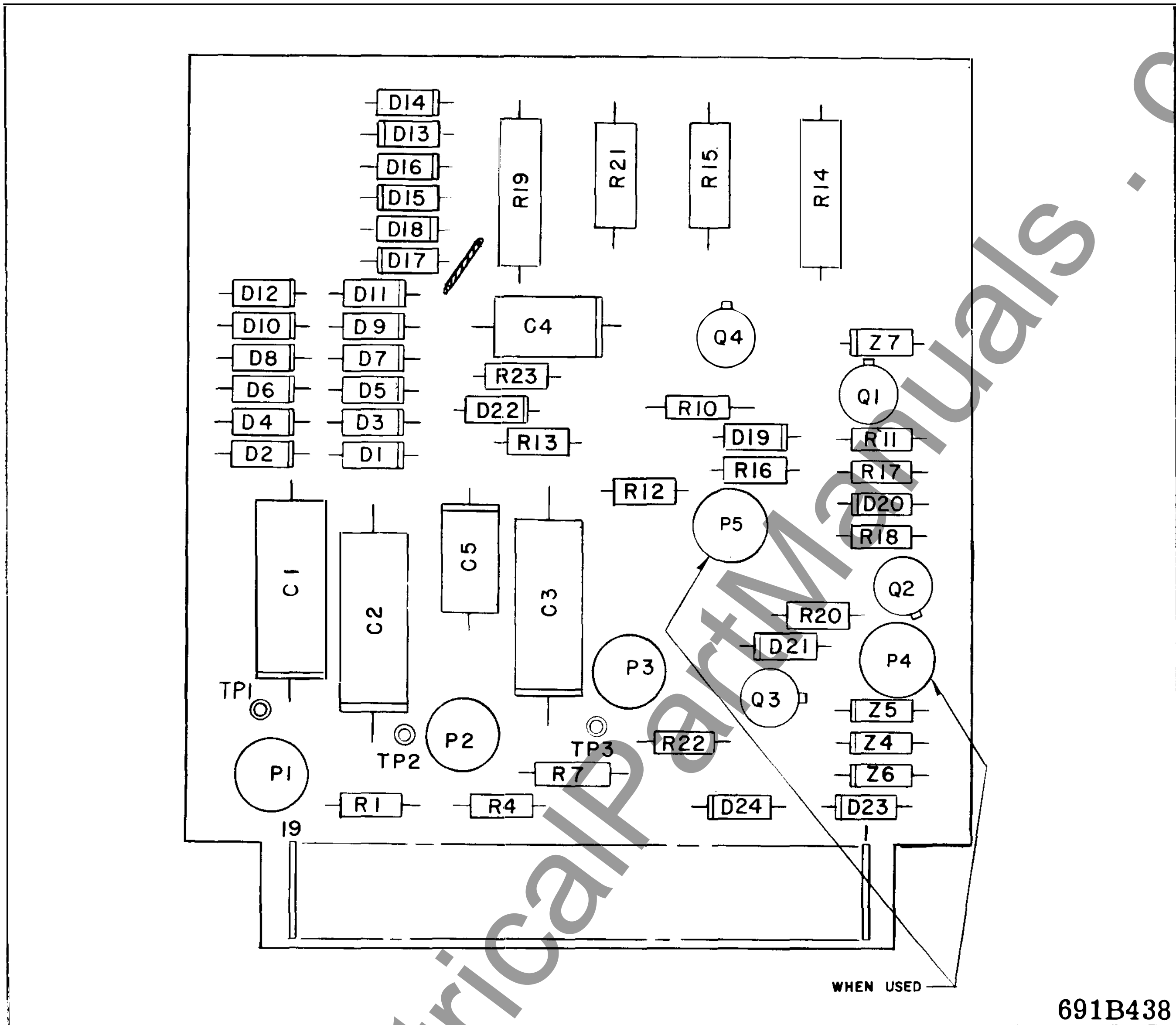


Fig. 12 Component location on printed circuit board for the type SI Relay.

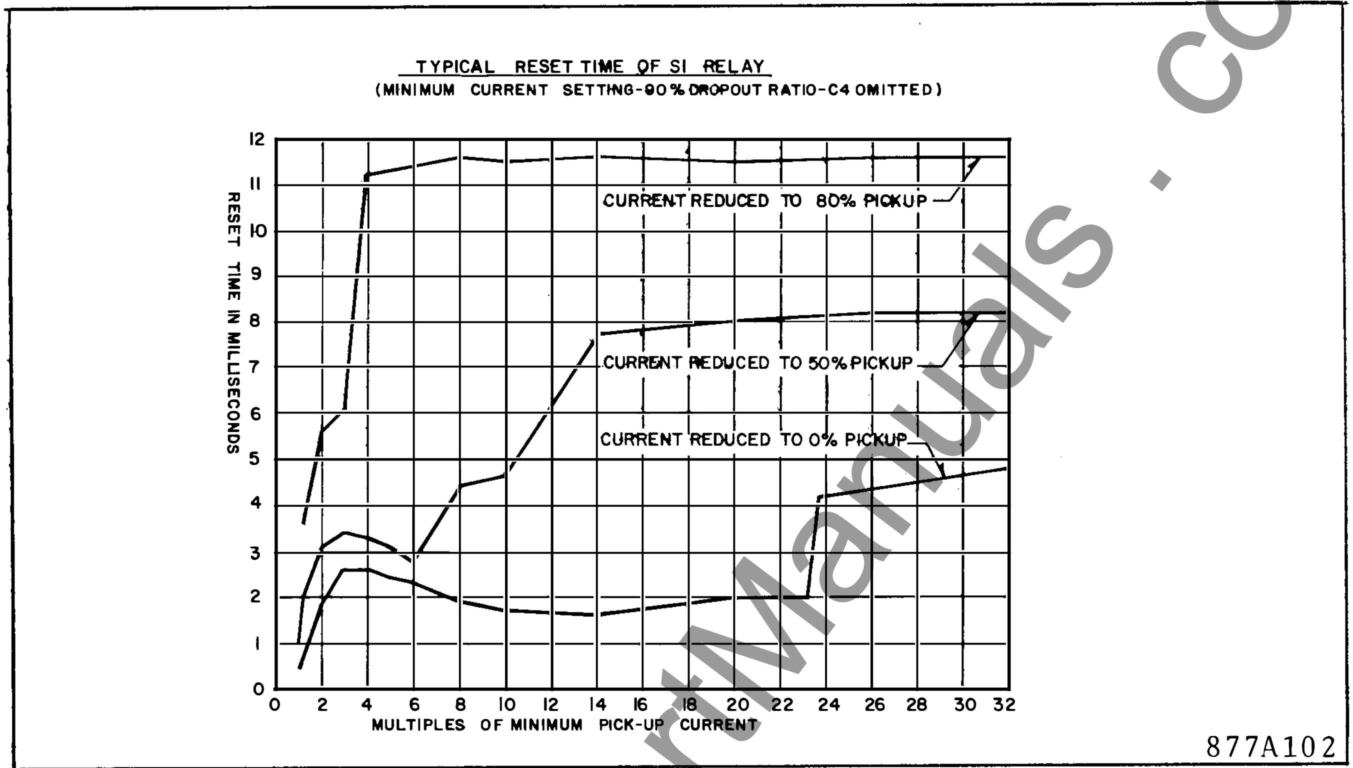


Fig. 13 Reset time of SI Relay with C4 removed at minimum setting

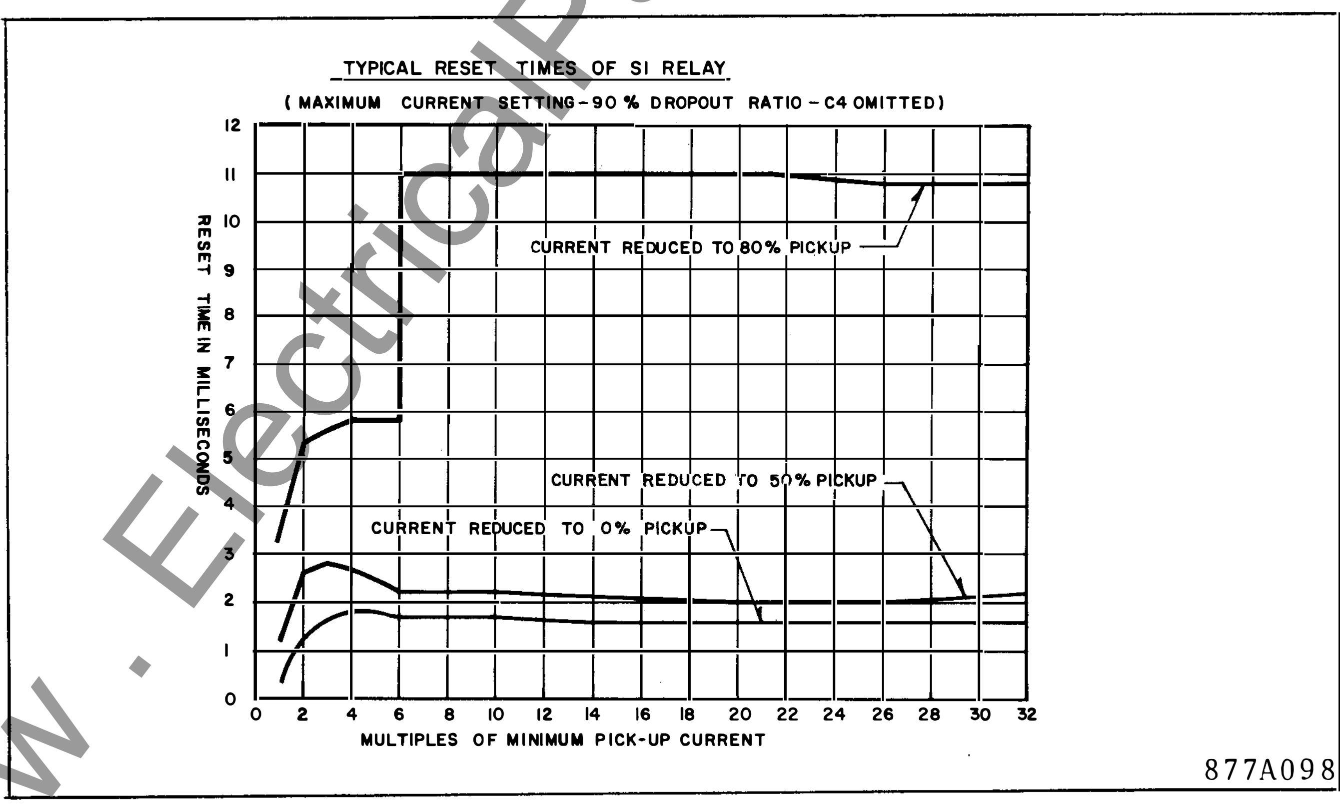
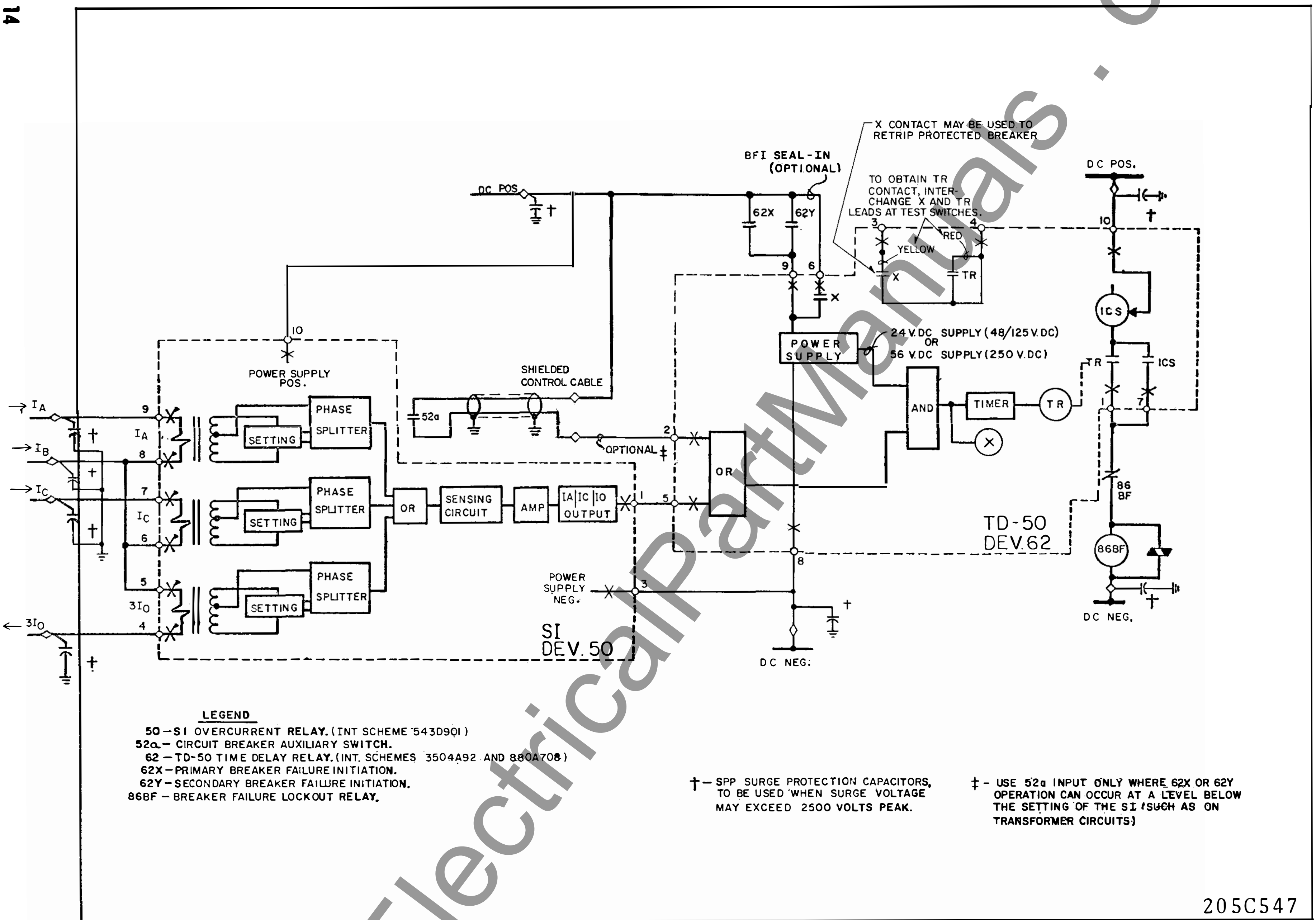


Fig. 14 Reset time of SI Relay with C4 removed at maximum setting.



✪ *Fig. 15 External schematic of SI-TD-50 Breaker Failure System.*

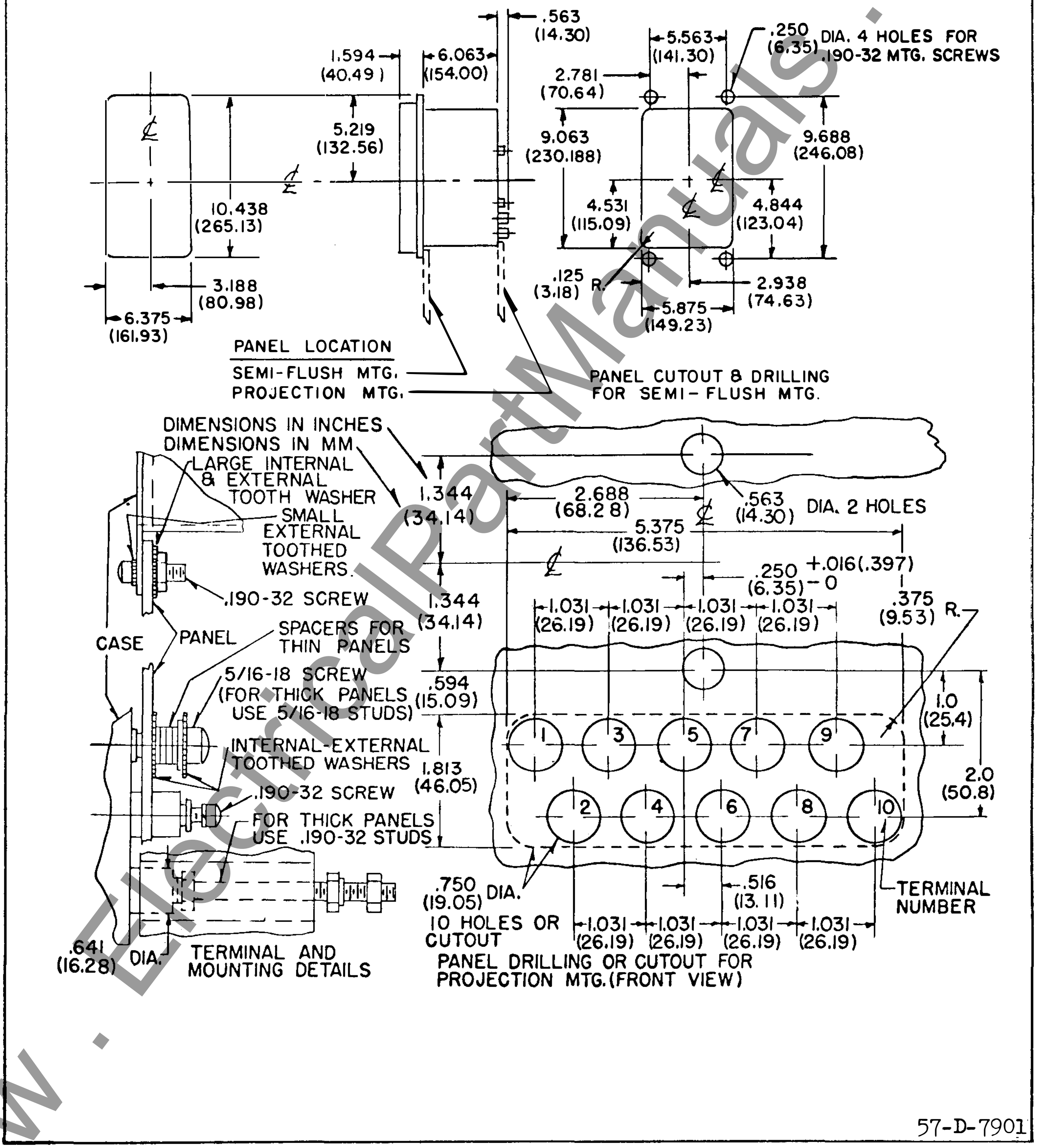
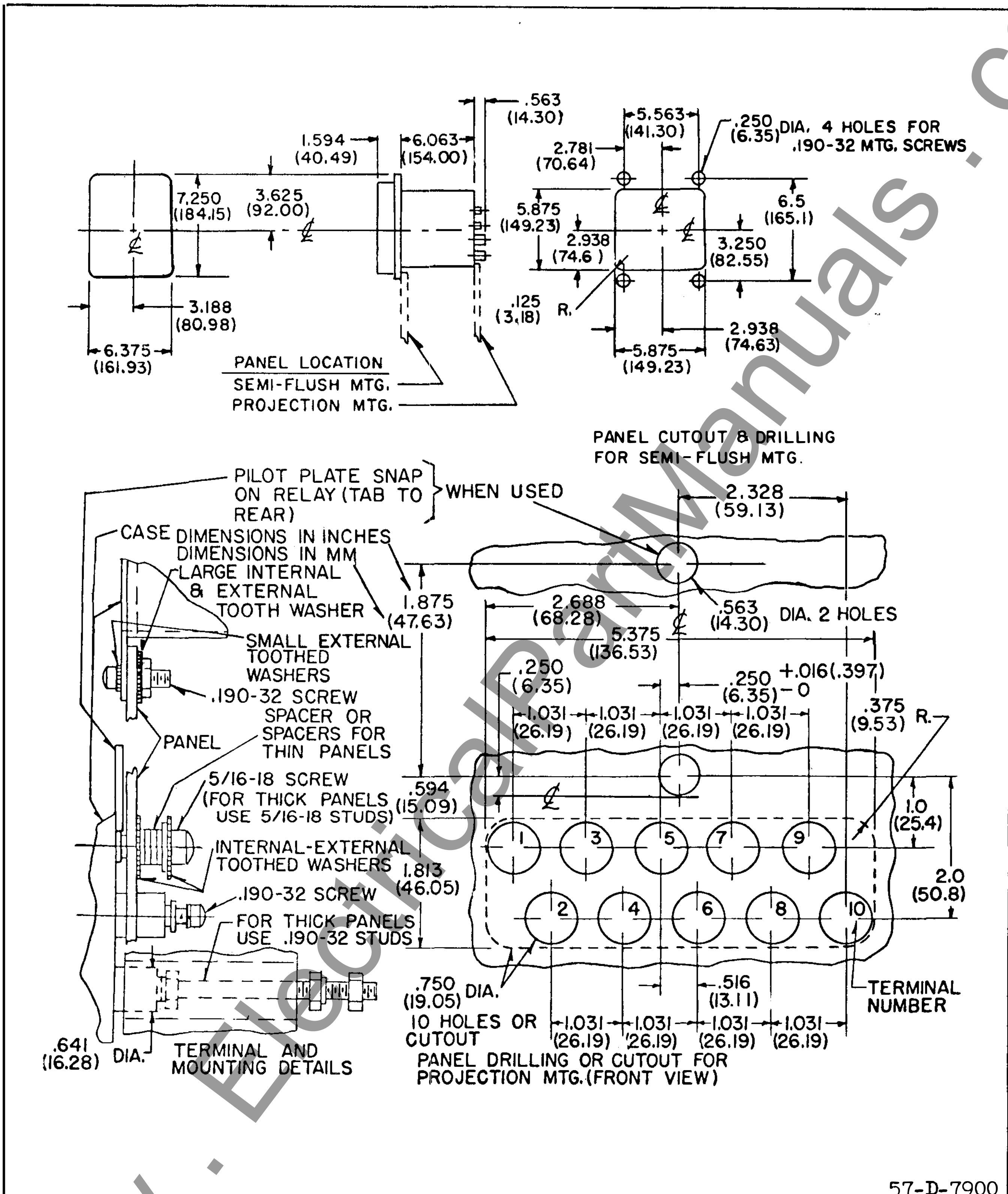


Fig. 16 Outline and drilling plan for the type SI Relay in the FT-21 case.



✪ *Fig. 17 Outline and drilling plan for the type SI-1 Relay in the FT-11 case.*

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE SIU OVERCURRENT RELAY

Caution: It is recommended that the user of this equipment become acquainted with the information in this instruction leaflet and in the system instruction leaflet before energizing the system. Printed circuit modules should not be removed or inserted when the relay is energized. Failure to observe this precaution can result in an undesired tripping output and cause component damage.

APPLICATION

The type SIU relay is an assembly of solid-state overcurrent units that produce a d-c output voltage when the input a-c current exceeds a given value. This output voltage is used as inputs to other devices that perform various functions in a protective relaying system.

The number of overcurrent functions will vary with the relaying system in which the relay is applied. Some of the typical overcurrent functions that can be supplied in the assembly are as follows:

Symbol	Function	Input Transformer
I_O	SDGU-2 Ground Fault Detector	Non Air Gap
I_N	Zero Sequence Detector for Special Application such as Fault Reclose Block	Non Air Gap
I_{OS}	Carrier Start	Non Air Gap
I_{OH}	Ground Fault Detector for Direct Trip through SRU or SAR Devices	Air Gap
I_{BH}/I_{CH}	Phase Fault Detector for Direct Trip through SRU or SAR Devices	Air Gap
$I_{A\text{-}OS}$	Out-of-Step Supervision	Non Air Gap
I_A/I_C	Optional Fault Detector in Directional Comparison Scheme	Non Air Gap

CONSTRUCTION

The type SIU relay consists of printed circuit boards mounted in a standard 19-inch wide panel, 5 1/4 inches (3 rack units) high. Plug in modules are used to obtain a modular type design. In general, the number of modules will vary with the applications; however, each package will contain a voltage regulator module and one or more overcurrent modules. For some applications, additional logic modules are included in the package.

Each overcurrent function consists of an input transformer, an overcurrent module, and a resistor-Zener diode protective network. The overcurrent module can either be a single input module with one output or a dual input module with a single output.

Input Transformer – The input transformer is a two-winding type with a non-tapped primary winding and a tapped secondary winding. Fig. 18 shows the relative location of these components. The secondary is connected to the overcurrent module and to the resistor-Zener diode protective network. The input transformer may either be an air-gap transformer or a non-air-gap transformer. An air-gap transformer is utilized where minimum transient over-reach is desired and a non-air gap transformer is utilized in applications where over-reach is not a problem.

Overcurrent Module - The overcurrent module consists of a setting circuit, phase splitter circuit, sensing circuit, amplifier circuit, feedback circuit and an output circuit. The location of components on the overcurrent board is shown in Fig. 3 and the schematic is shown in Fig. 4.

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

SUPERSEDES I.L. 41-777.1E, dated July 1974
*Denotes change from superseded issue.

EFFECTIVE SEPTEMBER 1975

a. Setting Circuit - The setting circuit is connected across the secondary winding of the input transformer and consists of two branches, two resistors and a rheostat on the module connected in parallel with a resistor and Zener diode mounted off the board. This circuit loads the transformer and allows a secondary voltage to be produced that is proportional to the input current. The rheostat has a locking feature to minimize accidental change of current setting.

b. Phase Splitter Circuit - The phase splitter circuit consists of a capacitor, two resistors, a potentiometer and a three-phase rectifier bridge. This circuit converts the single-phase a.c. voltage from the output of the transformer to a three-phase voltage and rectifies this voltage to d.c.

c. Amplifier Circuit - The amplifier circuit consists of a transistor and associated resistors and capacitors. The transistor is normally not conducting.

d. Sensing Circuit - The sensing circuit consists of a resistor, Zener diode, and a transistor with associated components. This circuit is connected between the output of the phase splitter circuit and the amplifier circuit. In this circuit, the voltage from the phase splitter network must be high enough to break down the Zener diode to turn on the transistor.

e. Output Circuit - The output circuit consists of two resistors, a diode, and a Zener diode. This output can be measured from the front of the module by means of test points.

f. Feedback Circuit - The feedback circuit consists of a resistor, potentiometer, and diode. This circuit controls the dropout current of the overcurrent unit.

Voltage Regulator Module - The voltage regulator module consists of a transistor, and two Zener diodes. Two resistors mounted off of the module determine the rating of the power supply. The voltage output from the module is 20 volts with reference to negative of the station battery. The schematic of the module is shown in Fig. 5 and the location of components on the module is shown in Fig. 6.

OTHER MODULES - Other modules may be included in the SIU package. Among these are a timer module and two logic modules--a phase module and a ground module. These modules are utilized to perform functions other than an overcurrent function in the overall protective relay system.

1. Timer Module - This module is a transistor, Zener diode, capacitor and resistor type of timer. The module is used in conjunction with a high-set overcurrent unit to slow the tripping time of the overcurrent unit. The schematic of the timer module is shown in Fig. 7 and the location of components on the module is shown in Fig. 8.

2. Logic Modules - The logic modules contain various logic functions and are used to connect phase or ground relays into a protective relay system. The phase module is shown in Fig. 9 and the location of components is shown in Fig. 10. The ground module schematic is shown in Fig. 11 and the location of components is shown in Fig. 12.

OPERATION

The functions of the SIU relay are connected according to the logic diagram that applies to the particular relay. Typical logic diagrams are shown in Figures 13 and 14. With reference to the logic drawings and the schematic of the overcurrent unit of Fig. 4, transistors Q1 and Q2 are normally not conducting and no output is obtained from the overcurrent unit. When a.c. current is applied to the primary of the transformer of the overcurrent unit, a voltage is produced on the secondary side that is proportional to the amount of resistance in the rehostat (S_1). This single-phase voltage is applied to the phase splitter circuit where a three-phase voltage is produced, rectified, and applied to resistor R4 of the sensing circuit. If the voltage from the rectifier is greater than the voltage breakdown of the Zener diode (Z1), the Zener diode breaks down to allow base current to flow in transistor Q1. Q1 turns on to allow base current to flow in transistor Q2. When Q2 turns on, a voltage is obtained across R10 which is the output of the unit.

* When Q2 turns on, positive voltage is applied to the feedback circuit (R9, R12) such that a voltage is applied to Q1. By varying the magnitude of this voltage, the dropout of the relay can be set to values greater than 90% of pickup.

When large currents are applied to the primary of the input transformer, the Zener clipper on the secondary prevents the secondary voltage from becoming excessive.

TABLE I
ENERGY REQUIREMENTS

Ampere Range	Setting	Volt Ampere at Setting	P.F.[1] Angle	Volt Amperes at 5 Amps.	P.F.[1] Angle
AIR-GAP TRANSFORMER DESIGN					
.5 - 2	0.50	0.10	48°	5.8	50
	0.75	0.12	50	5.8	50
	1.00	0.26	51	5.7	50
	1.25	0.38	55	5.7	50
	1.50	0.50	57	5.7	57
	1.75	0.67	58	5.5	57
	2.00	0.86	60	5.3	60
1 - 4	1.0	0.1	46	2.1	42
	1.5	0.2	47	2.0	46
	2.0	0.3	48	1.8	47
	2.5	0.4	48.5	1.7	49
	3.0	0.6	50	1.6	50
	3.5	0.8	52	1.6	54
	4.0	1.0	53	1.5	54
2 - 8	2	0.1	39	0.71	38.5
	3	0.2	38	0.58	37.5
	4	0.35	38	0.53	37.5
	5	0.5	39	0.5	38.5
	6	0.7	40	0.49	40
	7	0.9	41	0.47	40
	8	1.2	42	0.46	40
4 - 16	4	0.16	32	0.26	31
	6	0.32	29	0.26	29
	8	0.57	29	0.21	29
	10	0.80	28	0.21	29
	12	1.10	28	0.20	29
	14	1.87	28	0.20	29
	16	1.50	28	0.20	29
10 - 40	10	0.40	13	0.10	13
	15	0.85	12	0.09	12.8
	20	1.50	11	0.09	12.5
	25	2.25	11	0.09	12
	30	3.25	10	0.09	12
	35	4.60	10	0.09	12
	40	5.75	10	0.09	12

[1] Current lagging voltage.

TABLE I (CONT'D.)
ENERGY REQUIREMENTS

Ampere Range	Setting	Volt Ampere at Setting	P.F.[1] Angle	Volt Amperes at 5 Amps.	P.F.[1] Angle
AIR-GAP TRANSFORMER DESIGN (CONT'D.)					
	20	1.0	7	0.07	9
	30	2.5	6.5	0.07	8.5
	40	4.5	6.0	0.07	8.5
20 - 80	50	7.0	5.0	0.07	7
	60	10.0	5.0	0.07	7
	70	16.8	5.0	0.07	7
	80	19.5	5.0	0.07	7
NON AIR-GAP TRANSFORMER DESIGN					
	0.50	0.06	11.5⁄	2.8	17.5
	0.75	0.09	2	2.7	15.8
	1.00	0.13	4	2.6	14.5
.5 - 2	2.25	0.17	8	2.5	14.5
	1.50	0.21	12	2.3	15.5
	1.75	0.26	14	2.1	16.5
	2.00	0.31	15	2.0	18.0
	1.0	0.06	10.5⁄	1.3	4
	1.5	0.10	0.5	1.1	4
	2.0	0.15	5.5	0.9	5.8
1 - 4	2.5	0.19	9.0	0.8	8
	3.0	0.25	11.0	0.7	11
	3.5	0.32	14.5	0.6	14
	4.0	0.37	16.5	0.6	16
	2	0.07	8⁄	0.44	6⁄
	3	0.12	1.5	0.33	1.5
	4	0.18	5.5	0.28	5.5
2 - 8	5	0.25	8.5	0.25	8.5
	6	0.35	10.5	0.23	10.5
	7	0.45	13	0.22	13
	8	0.50	14	0.2	13.5
	4	0.10	6⁄	0.14	5.4⁄
	6	0.15	3	0.10	3
	8	0.25	5.5	0.10	6
4 - 16	10	0.35	7.5	0.09	8
	12	0.50	9	0.08	9.5
	14	0.65	9.5	0.08	10.5
	16	0.8	10	0.08	11.5

[1] Current lagging voltage ⁄ Current leading voltage

CHARACTERISTICS

The SIU relay is available with the following ranges:

Air-Gap Design	Non Air-Gap Design
.5 - 2	.5 - 2
1 - 4	1 - 4
2 - 4	2 - 8
4 - 16	4 - 16
10 - 40	
20 - 80	

The scale markings of the relay represent the a.c. current required to produce an output. These scale markings are accurate within 10% of the value specified on the scale plate. If a more accurate pickup or setting between the scale markings is desired, the current can be applied to the relay and the setting rheostat set at the specific current.

The operating time of the relay is shown in Fig. 15. As shown in the figure, there is a maximum and minimum operating time for the relay for each multiple of pickup. This difference in time is due to the point on the current wave that the fault current is applied. Fig. 16 shows the operating times for different points on the fault wave for fault currents at twice pickup.

The reset time of the overcurrent unit is shown in Fig. 17. This reset time assumes that the fault current is interrupted at current zero.

TABLE II
CURRENT RATINGS

Ratings of Overcurrent Units
Air-Gap and Non Air-Gap

Range	Continuous Rating (Amperes)	One Second Rating (Amperes)
.5 - 2	8	350
1 - 4	10	400
2 - 8	12	400
4 - 16	15	400
10 - 40	20	400
20 - 80	20	400

TABLE III
BATTERY DRAIN PER BOARD

Power Supply: 15 Milliampere 48 V d.c.
25 Milliampere 125 V d.c.
Max. allowable current: 100 Milliampere

Board	Non-Operate Condition	Operate Condition
Ground	8 Ma.	15 Ma.
Phase	4 Ma.	12 Ma.
Timer	4 Ma.	8 Ma.
I_{OH}	0	3 Ma.
I_{OS}	0	3 Ma.
I_O	0	3 Ma.
I_A/I_C	0	3 Ma.
I_A-OS	0	3 Ma.
I_{BH}/I_{CH}	0	3 Ma.
I_N	0	3 Ma.

* To determine total drain, add power supply drain to drain for operate condition for each function of the application. This drain does not include the d.c. current taken off the output of the modules by external connected devices.

TABLE IV
GENERAL CHARACTERISTICS

Maximum Number of Overcurrent Units Per Relay	8
* Maximum Number of Air-Gap Units Per Relay in Conjunction with Non Air Gap Units	3
Adjustable Range of Timer Module	2 to 8 Milliseconds
Maximum Transient Overreach Air-Gap Design	17 Per Cent
Maximum Transient Overreach Non Air-Gap Design	85 Per Cent

SETTING

The pickup of each overcurrent function is made by adjusting the rheostat in the front of the function's module. Settings in between the scale marking can be made by applying the desired current and adjusting the rheostat until an output is obtained.

INSTALLATION

The SIU relay is supplied on a relay rack as a part of a complete relay system assembly. The location must be free from dust, excessive humidity, vibration, corrosive fumes heat. The maximum ambient temperature around the chassis must not exceed 55°C.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer.

Acceptance Tests

The following check is recommended to insure that the relay is in proper working order. Refer to the logic diagram that applies to the relay and apply current to the proper terminals.

1. Minimum trip current - Check pickup at the minimum and maximum settings. This is accomplished by applying the specified current and checking that a voltage of approximately 20 volts appears across the output test points when the a.c. current is within 10% of the settings.
2. Dropout - After checking pickup, the dropout should be greater than 90% of the pickup as the current is gradually reduced.

Calibration

Use the following procedure for calibrating the overcurrent unit if the module adjustments have been disturbed. This procedure should not be used until it is apparent that the module is not in proper working order. A new scale plate may be necessary when parts are changed. On a dual input overcurrent module, the procedure has to be repeated for the second input.

Phase Splitter Adjustments

1. Turn rheostat on front of module to lowest setting.
2. Apply minimum setting current to the proper relay terminals.
3. Using a high resistance voltmeter (a.c.) adjust phase splitter potentiometer (R13) such that three voltages approximately equal to each other are obtained across TP1, printed circuit board terminal 9, and printed circuit board terminal 10. If a scope is available, adjust R13 such that the following waveform is obtained across TP2 and printed circuit board terminal 1.

Peaks are in a sawtooth arrangement

Dial Calibration (S)

1. Apply the proper d.c. voltage to the relay.
2. Connect a high resistance d.c. voltmeter across the red and black Test Points.
3. Apply the desired S current to proper relay terminals.
4. Turn S rheostat until the relay operates as indicated by a sudden reading of approximately 20 volts d.c. on voltmeter.

Dropout (R12)

1. Set S on desired point and apply S amperes to proper relay terminals to make it operate.
2. Lower S amperes to desired dropout value and adjust R12 until voltmeter drops to approximately zero.
3. Verify dropout and pickup several times by raising a.c. current until unit operates and then lowering a.c. current until unit drops out.

TROUBLE SHOOTING PROCEDURE

Use the following procedure to locate the source of trouble if the SIU overcurrent module is not operating correctly.

1. Check voltages as listed on the electrical checkpoints.
2. Check resistance as listed on the internal schematic of the overcurrent module.
3. Inspect all wires and connections paying particular attention to printed circuit terminal.

ELECTRICAL CHECKPOINTS

The modules can be checked with reference to the following voltages. All voltage readings should be made with a high resistance voltmeter.

I. Overcurrent Module

a. No A.C. Current Input

All test point voltages should read approximately zero volts.

b. Minimum Trip A.C. Current Applied

Circuit	Terminals	Typical Voltage
Phase Splitter	TP1 to Board 10 TP1 to Board 9 Board 9 to Board 10	6.2 volts a.c. 6.2 volts a.c. 6.4 volts a.c.
Setting	Board 8 to Board 10	12.5 volts a.c.
Sensing	TP2 to Board 1 (Neg.)	7.5 volts d.c.
Amplifier	TP3 to Board 1 (Neg.) at twice pickup	0
Output	Red TP (pos.) to Black TP (Neg.)	20 volts d.c.

II. Ground Board

Voltage in D.C. Volts		
Terminal	No Input Condition	Input Condition
TP1 to Board 1 (Neg.)	13.5	0
TP2 to Board 1	16.0	0
TP3 to Board 1	16.0	0
TP4 to Board 1	0	16.0
TP5 to Board 1	20.0	0
TP6 to Board 1	0	20.0
TP7 to Board 1	0	16.0
TP8 to Board 1	20	0
TP9 to Board 1	0	20

III. Phase Board

Voltage in D.C. Volts		
Terminal	No Input Condition	Input Condition
TP1 to Board (Neg.)	16	0
TP2 to Board 1	20	0
TP3 to Board 1	0	20
TP4 to Board 1	16	0
TP5 to Board 1	0	16
Board 9 to Board 1	0	20

IV. Timer Board

Voltage in D.C. Volts		
Terminal	No Input Condition	Input Condition
TP1 to Board 1 (Neg.)	12:5	0
TP2 to Board 1	0	12 (Min. Set)-18 (Max. Set)
TP3 to Board 1	20	0
Red TP (pos.) to Black TP (Neg.)	0	20

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

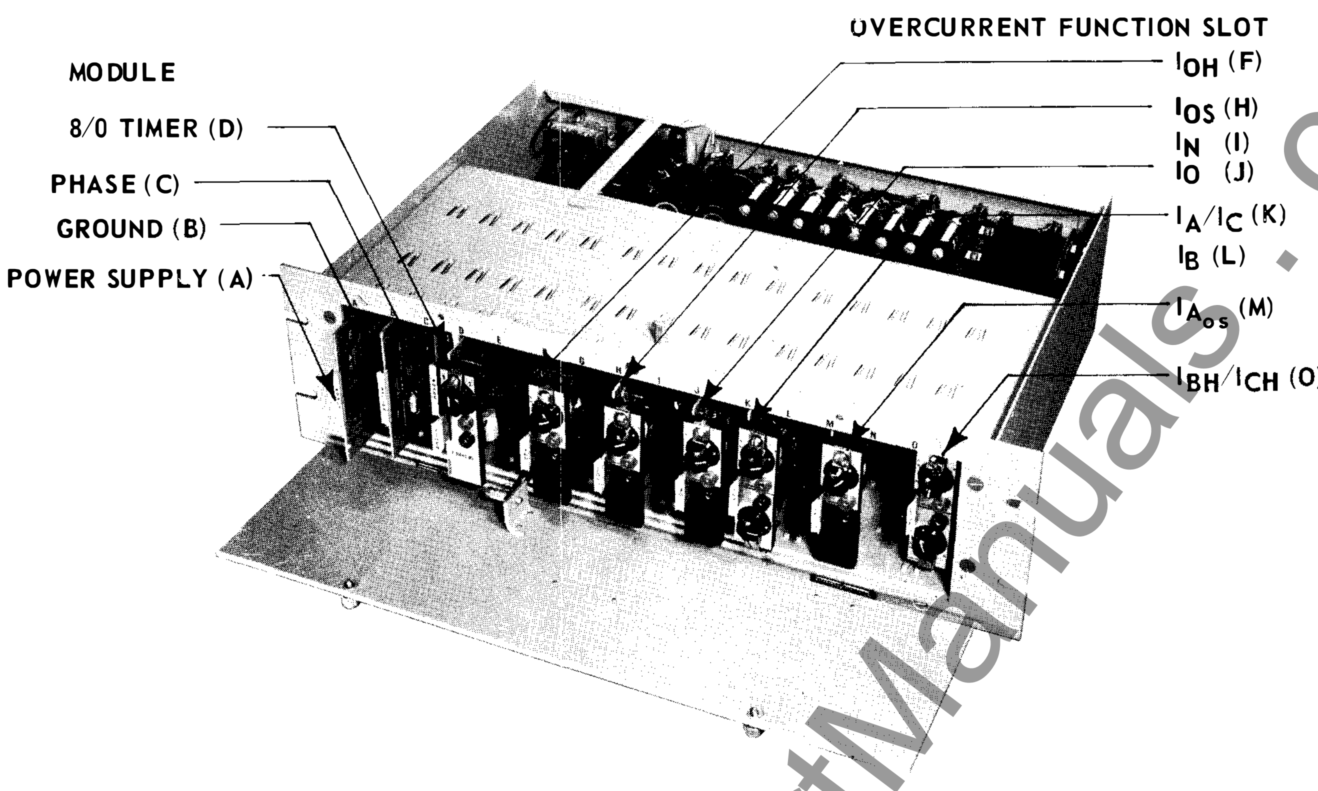


Fig. 1. Photograph (front view)

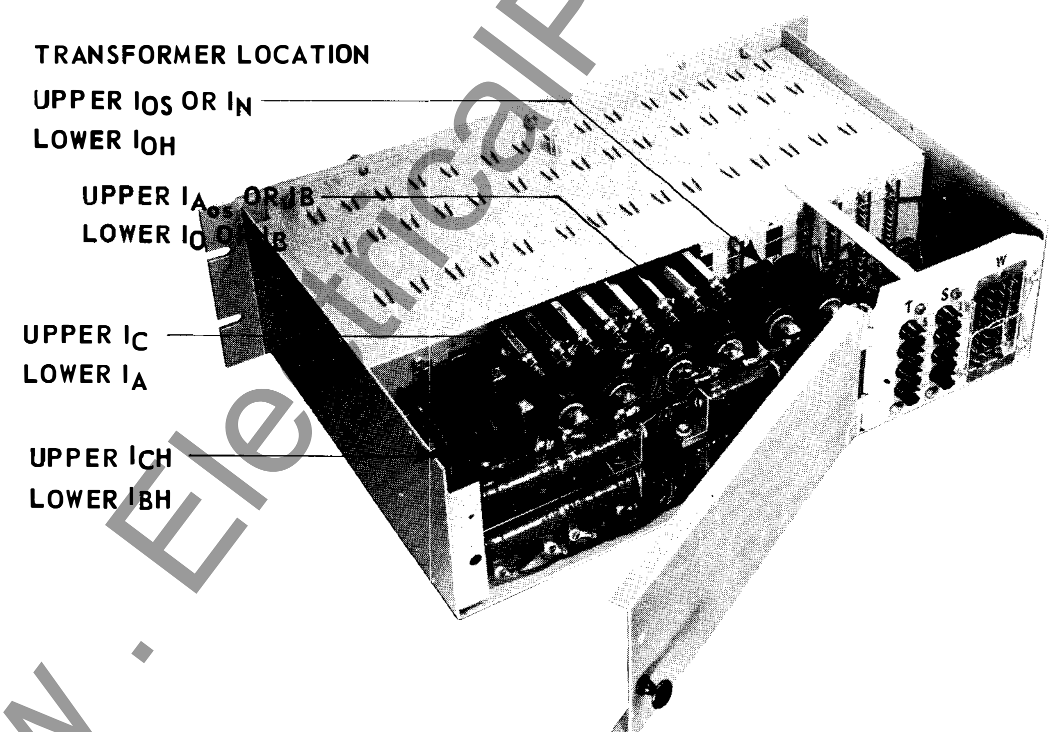


Fig. 2. Photograph (rear view with cover removed)

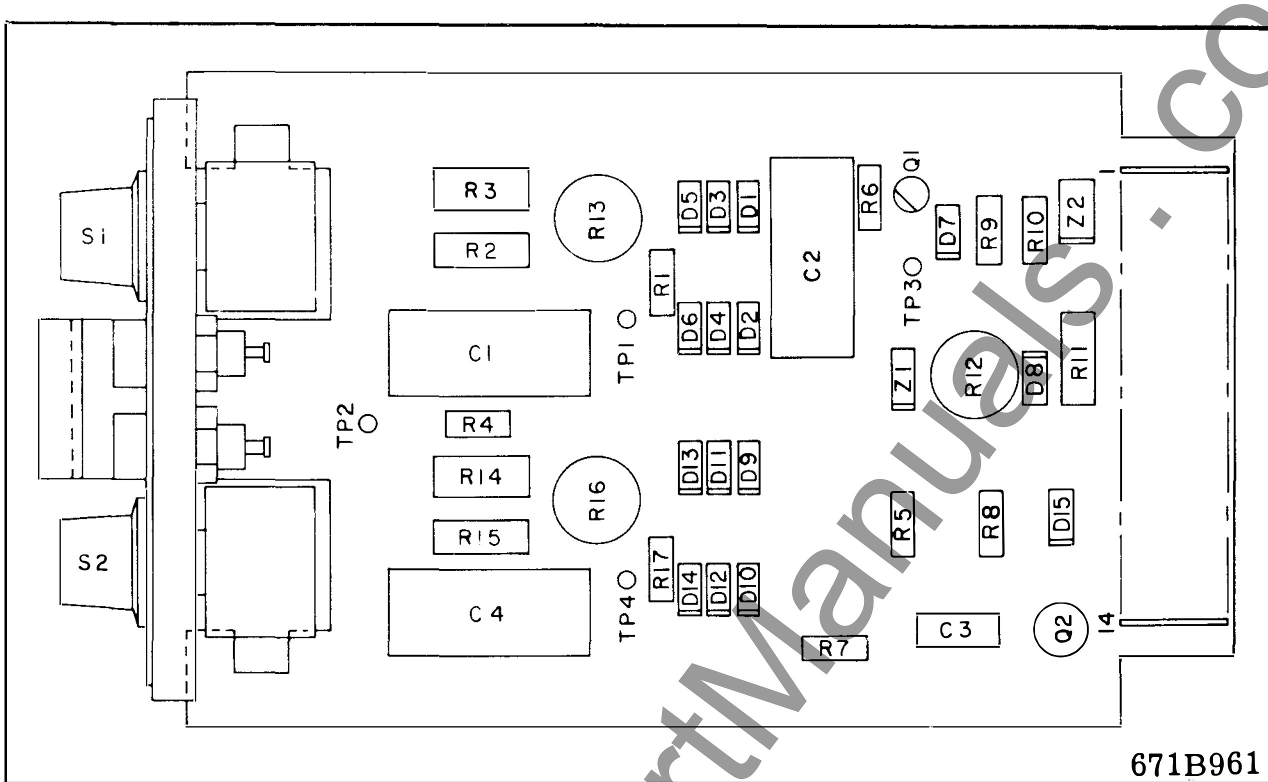
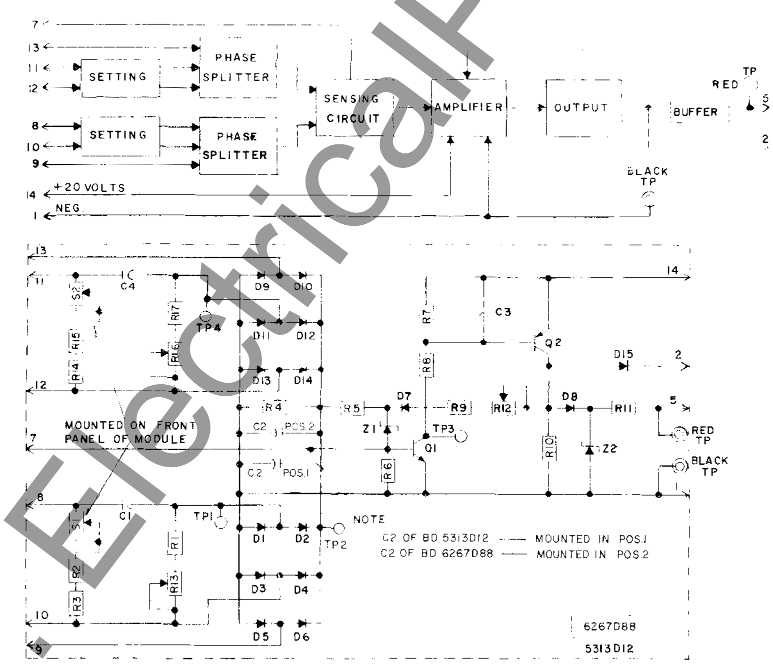


Fig. 3. Location of Components on Overcurrent Module



CAPACITOR	STYLE	REQ	REF.
C1-C2-C4	187A624H11	3	0.5 MFD
C3	187A508H09	1	1.5 MFD
DIODE			
D1 TO D7-D9 TO D14	184A855H07	13	1N457A
D8-D15	837A692H03	2	1N645A
POTENTIOMETER			
S1-S2	836A635H07	2	5K-12-1/2W
R13-R16	629A430H03	2	2.5K-1/4W
R12	629A430H05	1	200K-1/4W
* RESISTOR			
R1-R17	629A531H42	2	2.7K
R2-R3-R14-R15	762A679H02	4	330Ω-3W
R11	762A679H01	1	150Ω-3W
R4	629A531H78	1	82K
R5-R6-R7	629A531H56	[illegible]	10K
R8	629A531H52	1	6.8K
R9	184A763H81	1	180K
R10	629A531H78	1	82K
TRANSISTOR			
Q1	848A851H02	1	2N3417
Q2	849A441H01	1	2N3645
ZENER DIODE			
Z1	186A797H06	1	1N957B
Z2	862A288H01	1	1N3688A

* = RESISTORS TO BE 1/2 WATT ±2% UNLESS OTHERWISE SPECIFIED

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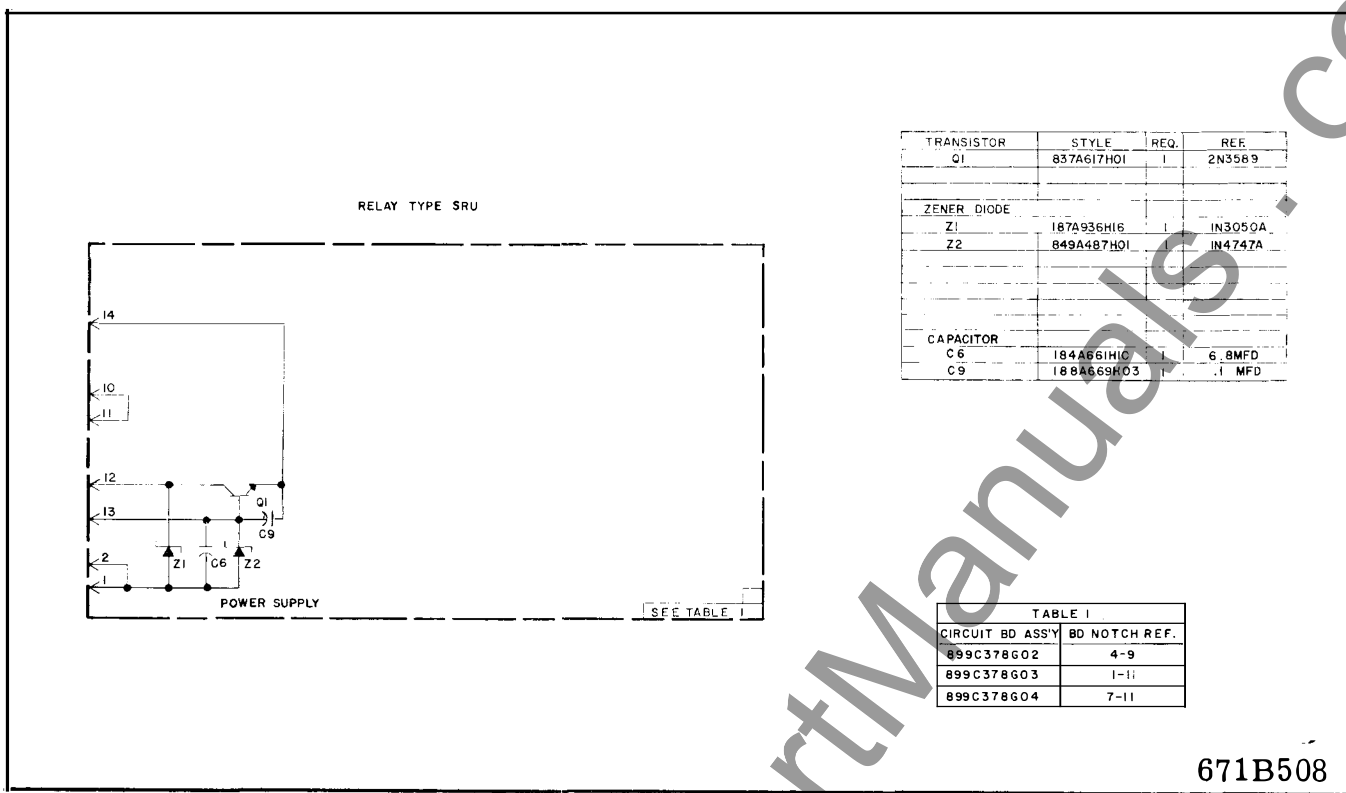
Fig. 4. Schematic of Overcurrent Module



TRANSISTOR	STYLE	REQ.	REF.
Q1	837A617H01	1	2N3589
ZENER DIODE			
Z1	187A936H16	1	IN3050A
Z2	849A487H01	1	IN4747A
CAPACITOR			
C6	184A661H1C	1	6.8MFD
C9	188A669H03	1	.1 MFD

TABLE I

CIRCUIT BD ASS'Y	BD NOTCH REF.
899C378G02	4-9
899C378G03	1-11
899C378G04	7-11

* *Fig. 5. Schematic of Power Supply Module*

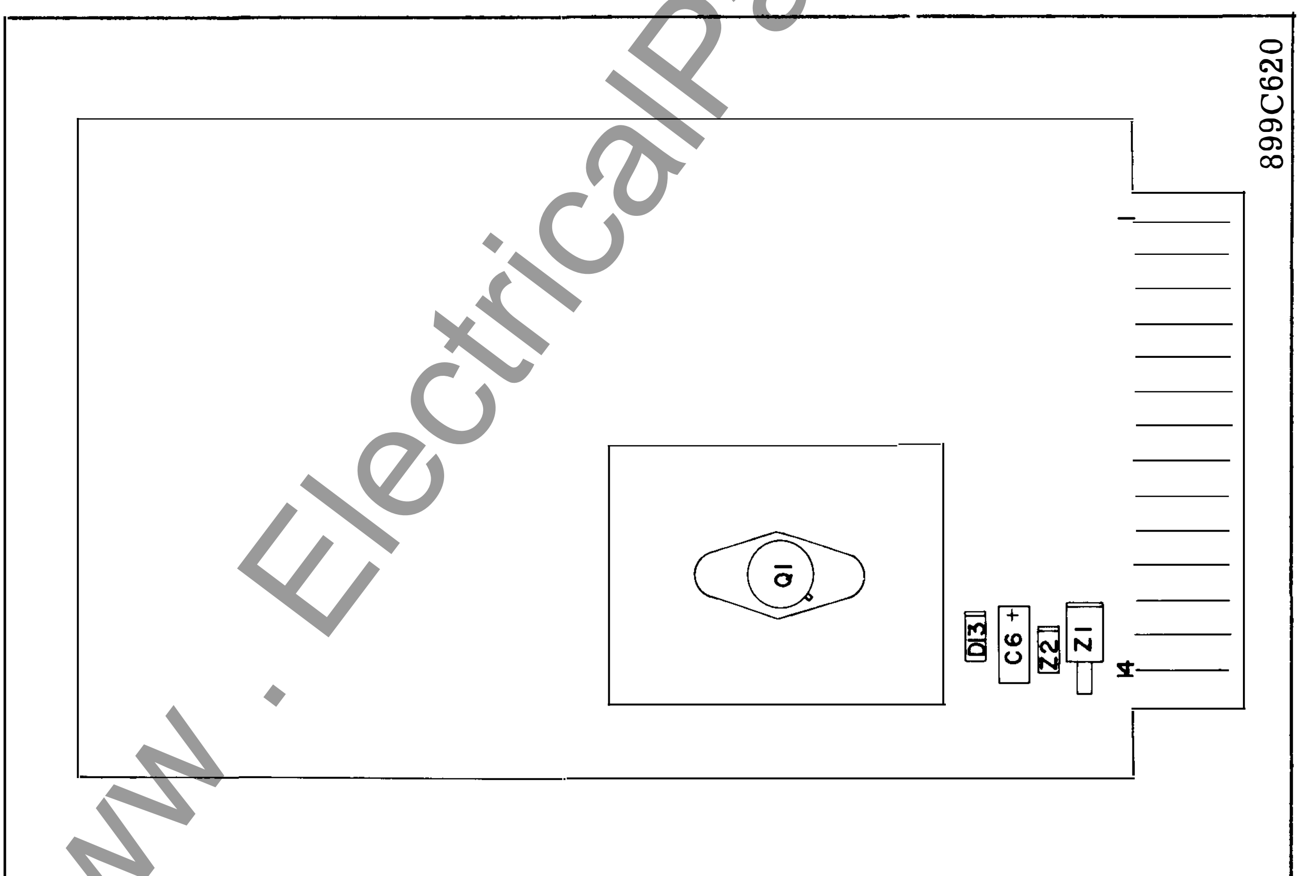
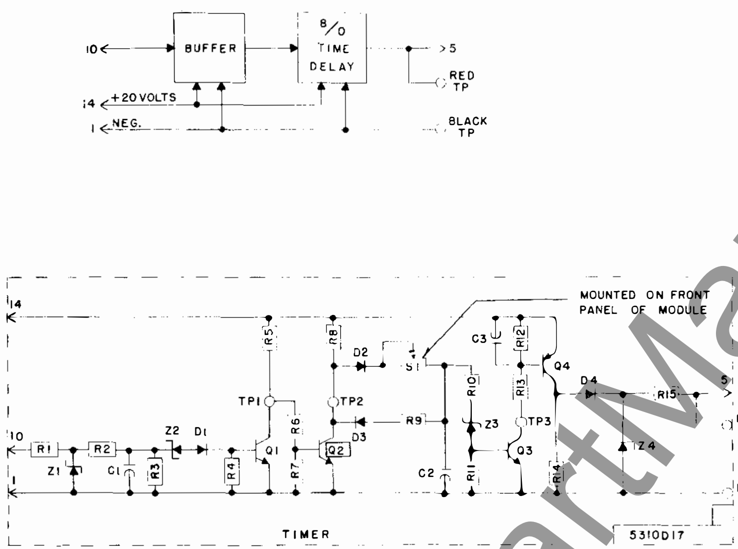


Fig. 6. Location of Components on Power Supply Module



CAPACITOR	STYLE	REQ.	REF.
C1	849A437H04	1	.047 MFD.
C2	188A669H06	1	.33 MFD.
C3	187A508H09	1	1.5 MFD.
DIODE			
D1–D4	837A692H03	2	1N645A
D2–D3	184A855H07	2	1N457A
* RESISTOR			
R1–R2–R10	629A531H48	3	4.7K
R3	629A531H78	1	82K
R4–R6–R7–R11–R12	629A531H56	5	10K
R5–R13	629A531H52	2	6.8K
R9	629A531H24	1	470Ω
R8	629A531H54	1	8.2K
R14	629A531H78	1	82K
R15	762A679HC1	1	150Ω – 3W
TRANSISTOR			
Q1·Q2·Q3	848A851H02	3	2N3417
Q4	849A441H01	1	2N3645
ZENER DIODE			
Z1	185A212H06	1	1N3686B
Z2–Z3	186A797H06	2	1N957B
Z4	862A288H01	1	1N3688A

* = RESISTORS TO BE 1/2 WATT – ±2% UNLESS OTHERWISE SPECIFIED.

|Q2| = TRANSISTOR NORMALLY CONDUCTING

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Fig. 7. Schematic of Timer Module

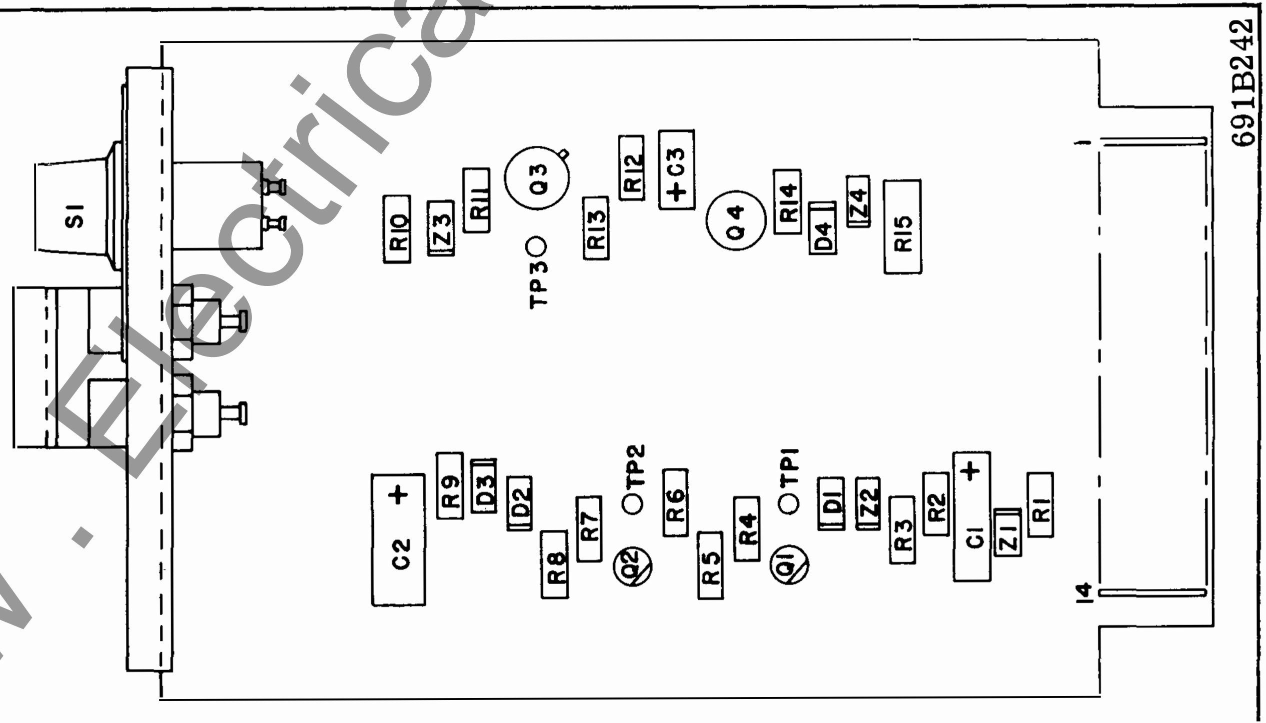
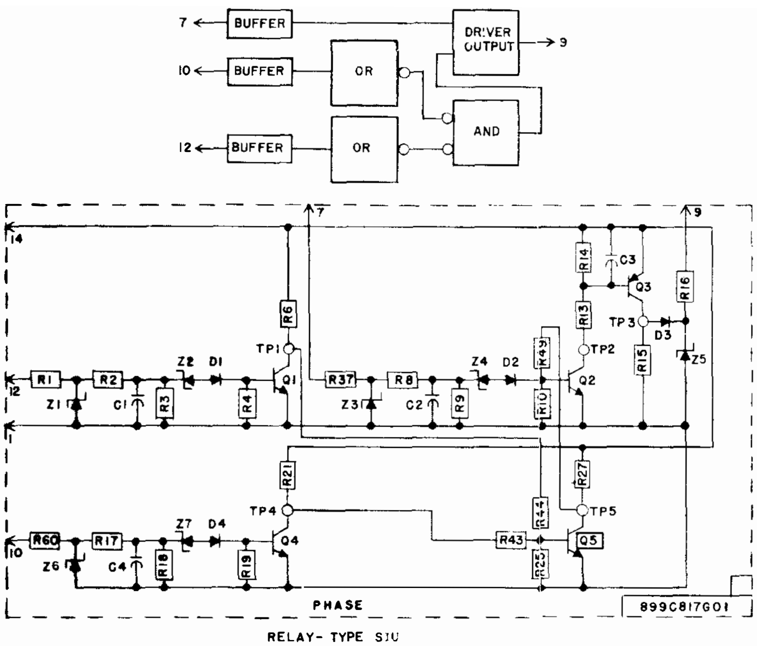


Fig. 8. Location of Components on Timer Module



CAPACITOR	STYLE	REQ.	REF.
C1-C2-C4	849A437H04	3	.047 MFD.
C3	188A669H05	1	27 MFD
DIODE			
D1-D2-D3-D4	837A692H03	4	1N645A
* RESISTOR			
R1·R2·R8·R17·R37·R60	629A531H48	6	4.7K
R4-R10 R14-R19-R25	629A531H56	5	10K
R3·R9·R15·R18	629A531H78	4	82K
R43·R44·R49	629A531H66	3	27K
R13-R6-R21-R27	629A531H52	4	6.8K
R16	762A679H01	1	150Ω - 3W
TRANSISTOR			
Q1-Q2-Q4-Q5	848A851H02	4	2N3417
Q3	849A441H01	1	2N3645
ZENER DIODE			
Z1-Z3-Z6	185A212H06	3	1N3686B
Z2-Z4-Z7	186A797H06	3	1N957B
Z5	862A288H01		1N3688A

* = RESISTORS TO BE 1/2 WATT- ±2% UNLESS OTHERWISE SPECIFIED.

Q5 = TRANSISTOR NORMALLY CONDUCTING

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Fig. 9. Schematic of Phase Module

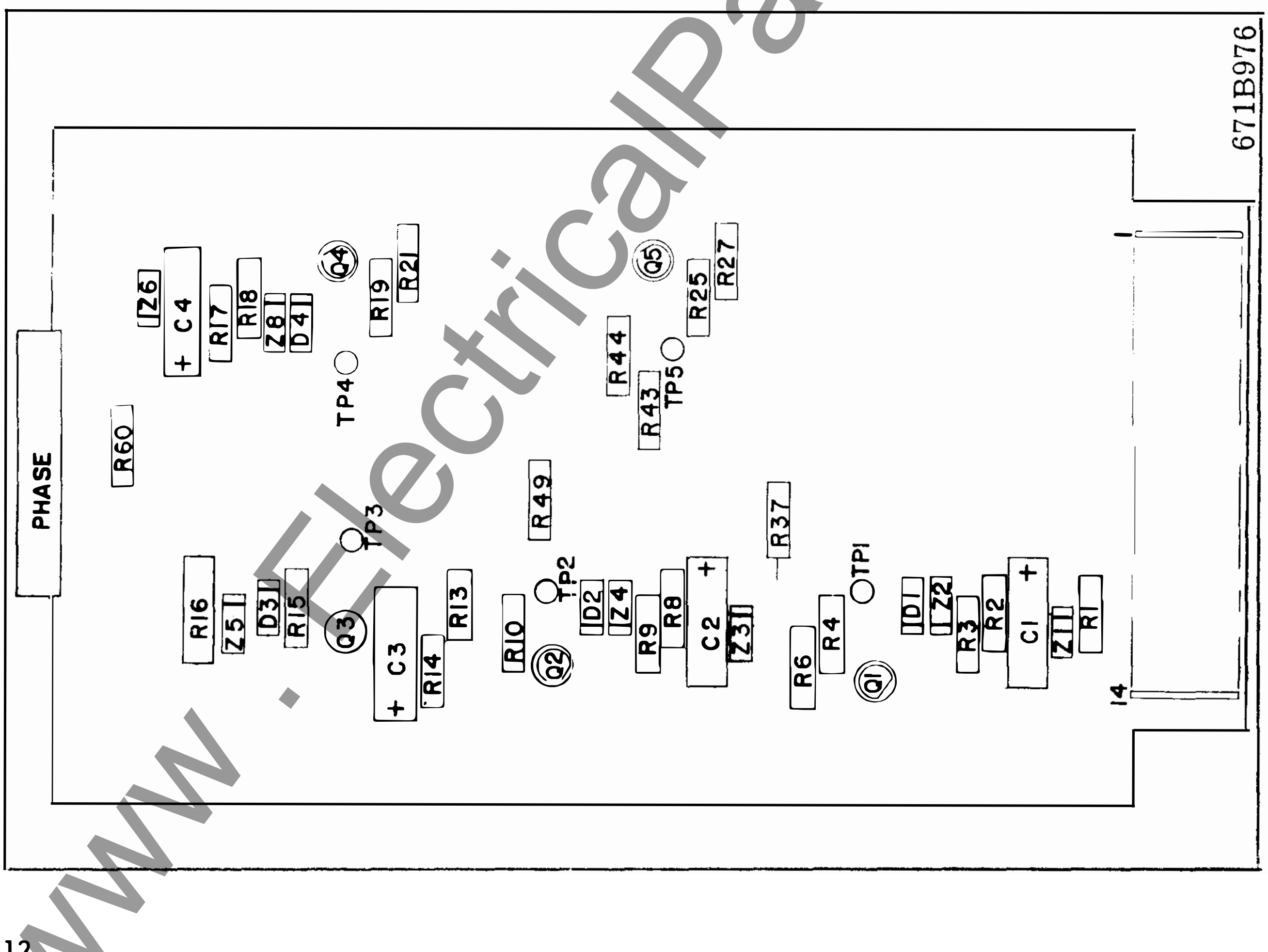
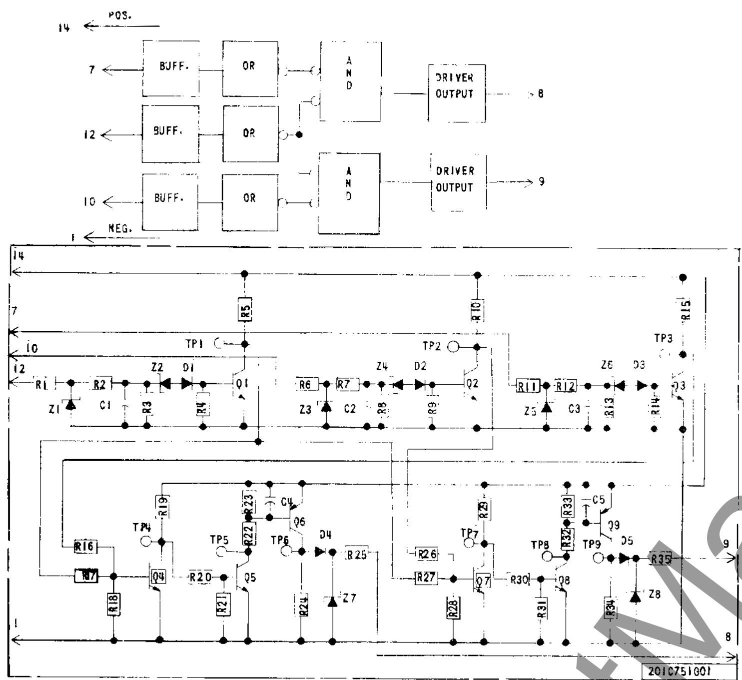


Fig. 10. Location of Components on Phase Module



CAPACITORS	STYLE	REQ.	REF.
C1 - C2 - C3	849A437H04	3	.047 MFD.
C4 - C5	188A669H05	2	.27 MFD.
DIODE			
D1-D2-D3-D4-D5	837A692H03	5	1N645A
RESISTOR *			
R1-R2-R6-R7-R11-R12	629A531H48	6	4.7K
R5-R10-R15-R19-R22-R29-R32	629A531H52	7	6.8K
R4-R9-R14-R18-R21-R23-R28-R31-R33	629A531H56	9	10K
R16-R17-R20-R26-R27-R30	629A531H66	6	27K
R3-R8-R13-R24-R34	629A531H78	5	82K
R25 - R35	762A679H01	2	150 3W
TRANSISTOR			
Q1 TO Q5-Q7-Q8	848A851H02	7	2N3417
Q6 - Q9	849A441HC1	2	2N3645
ZENER DIODES			
Z1 - Z3 - Z5	185A212H06	3	1N3686B
Z2 - Z4 - Z6	186A797H06	3	1N957B
Z7 - Z8	862A288H01	2	1N3688A

* - RESISTORS TO BE 1/2W ± 2% UNLESS OTHERWISE SPECIFIED.

Q4 - TRANSISTOR NORMALLY CONDUCTING

714B359

* *Fig. 11. Schematic of Ground Module*

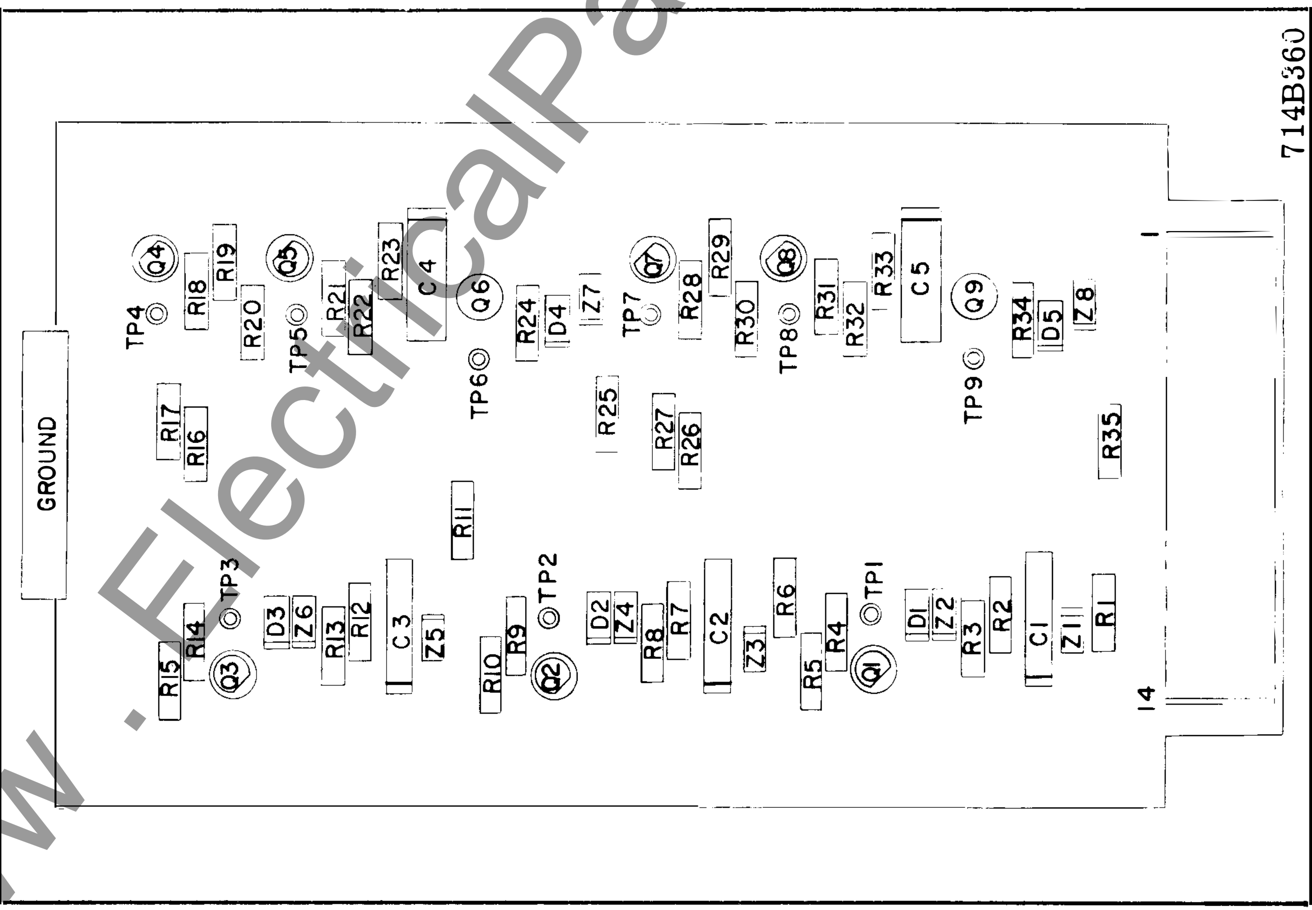
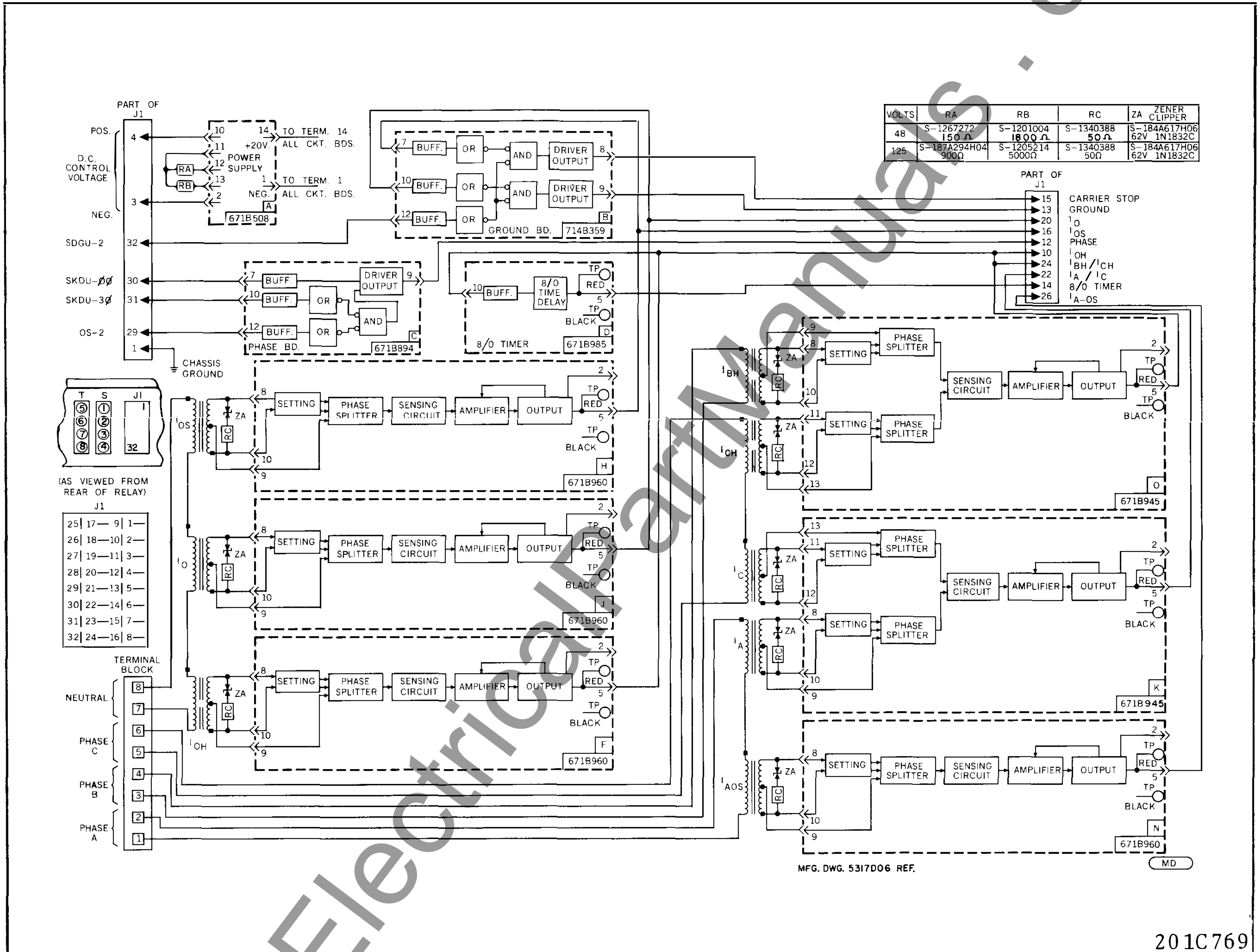


Fig. 12. Location of Components on Ground Module



VOLTS	RA	RB	RC	ZA ZENER CLIPPER
48	S-1267272 150 Ω	S-1201004 1800 Ω	S-1340388 50 Ω	S-184A617H06 62V 1N1832C
125	S-187A294H04 900Ω	S-1205214 5000Ω	S-1340388 50Ω	S-184A617H06 62V 1N1832C

Fig. 13. Typical Logic Diagram of SIU Relay

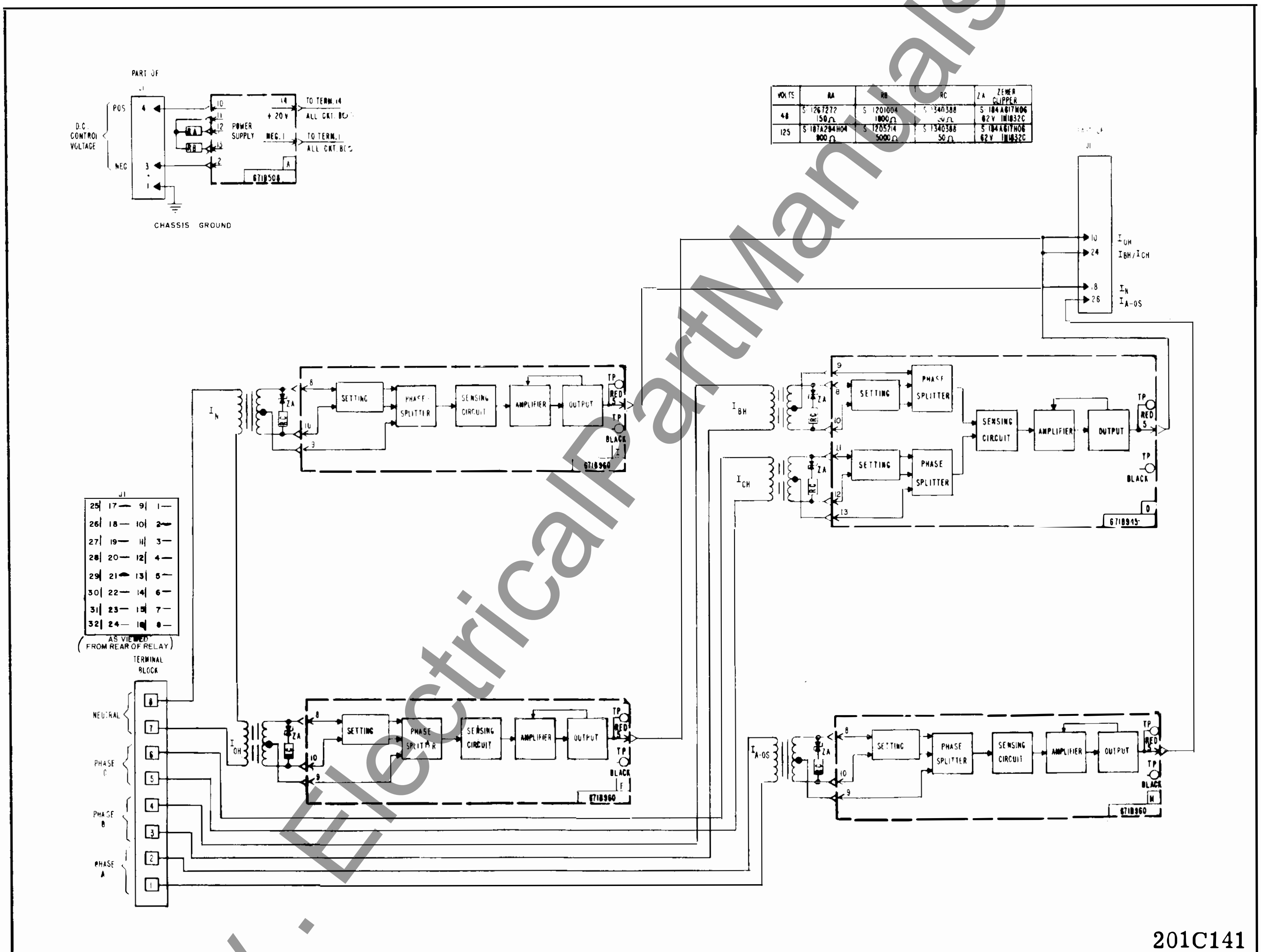


Fig. 14. Typical Logic Diagram of SIU Relay

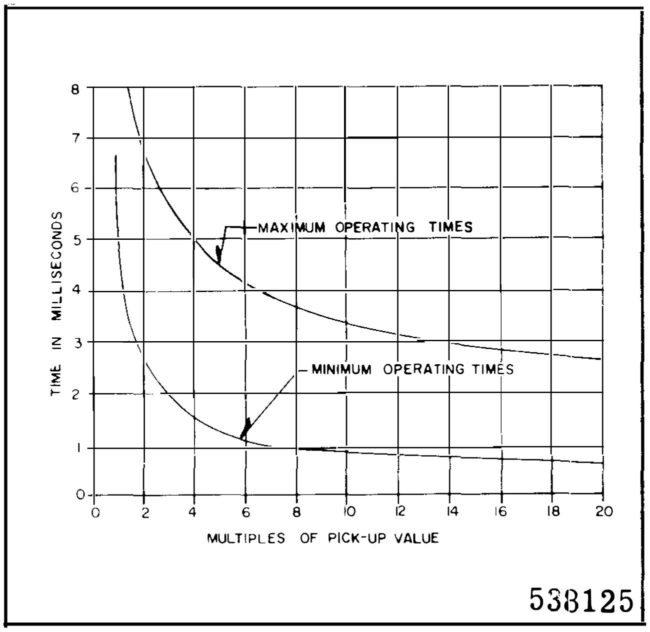


Fig. 15. Operating Time of Overcurrent Module of SIU Relay

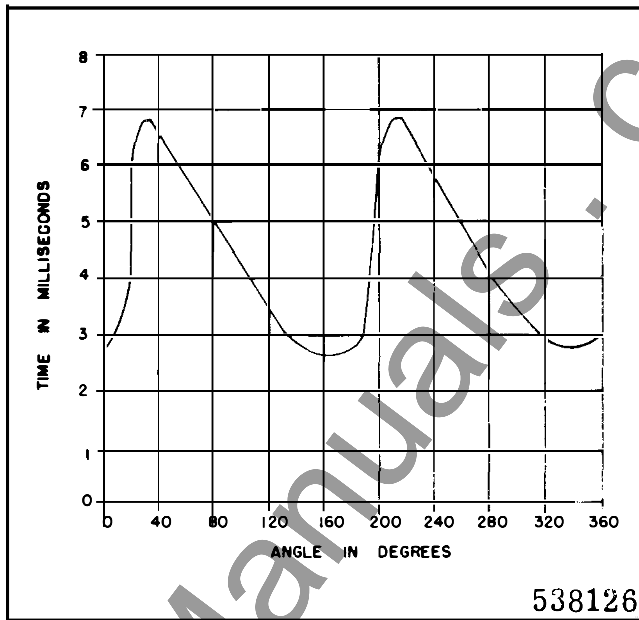


Fig. 16. Operating Time for the Type SIU Relay Overcurrent Module as a Function of Fault Incidence Angle At Twice Minimum Trip

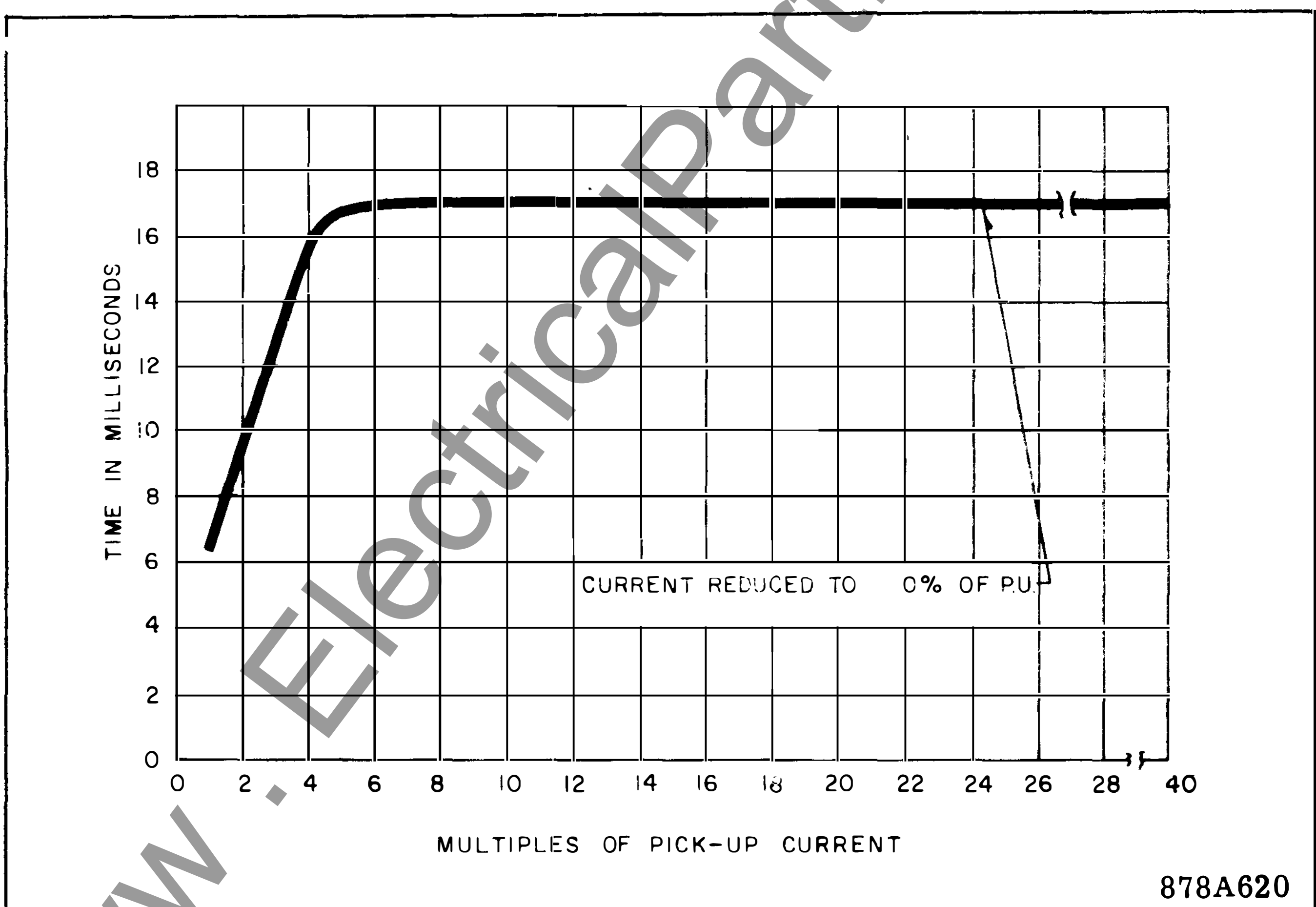
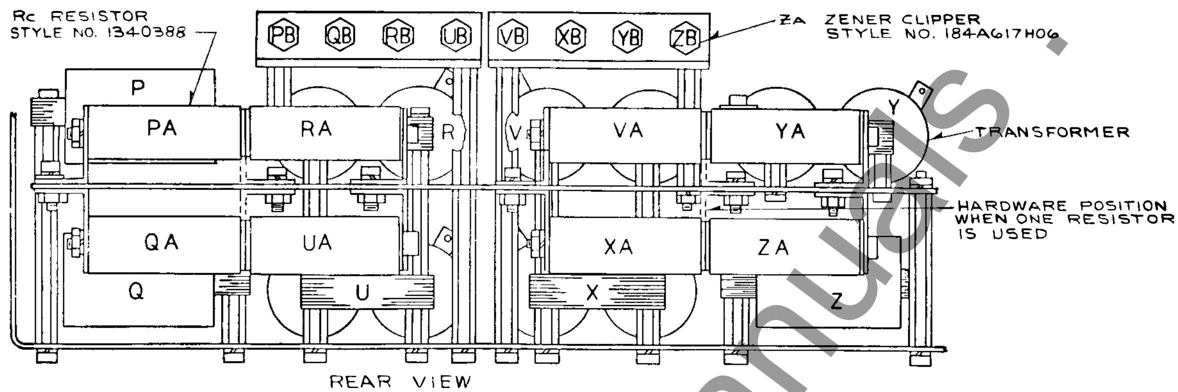


Fig. 17. Reset Time of the Overcurrent Module of the Type SIU Relay. Current interrupted at Current Zero.



OVER CURRENT FUNCTION	RANGE IN AMPERES	TRANSFORMER STYLE
I_{BH}, I_{CH}, I_{OH}	0.5 - 2 1 - 4 2 - 8 4 - 16 10 - 40 20 - 80	691B002G01 691B002G02 691B002G03 691B002G04 691B002G05 691B002G06
I_A, I_B, I_C, I_{AOS}, I_O, I_{OS}, I_N	0.5 - 2 1 - 4 2 - 8 4 - 16	691B017G01 691B017G02 691B017G03 691B017G04

OVER CURRENT FUNCTION	TRANSFORMER, Rc RESISTOR, AND ZA ZENER CLIPPER POSITIONS
I_{CH}	P - PA - PB
I_{BH}	Q - QA - QB
I_C	R - RA - RB
I_A	U - UA - UB
I_{AOS} I_B	V - VA - VB
I_O I_B	X - XA - XB
I_{OS} I_N	Y - YA - YB
I_{OH}	Z - ZA - ZB

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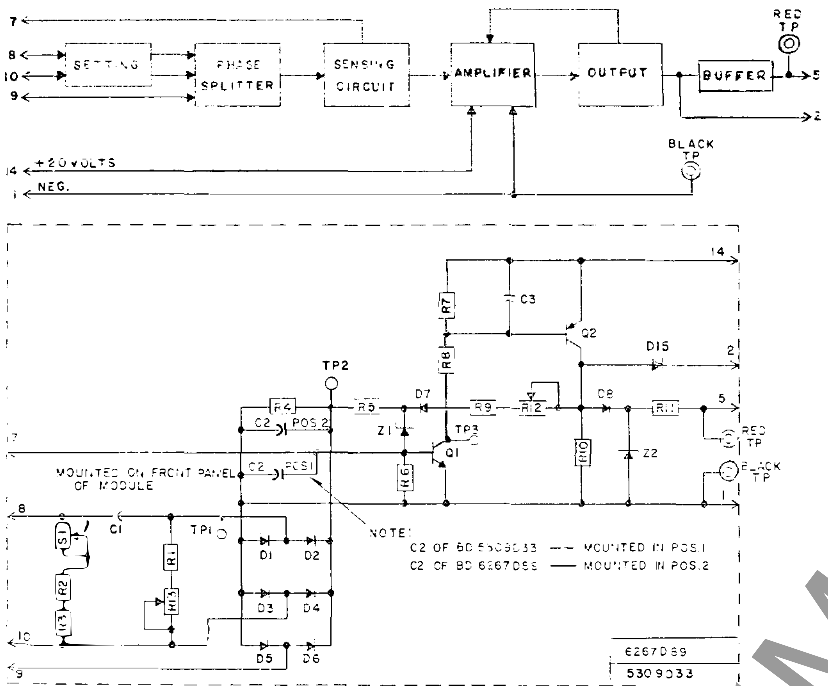
Fig. 18. Location of Transformers, Zener Clipper and RC Resistor in SIU Relay.

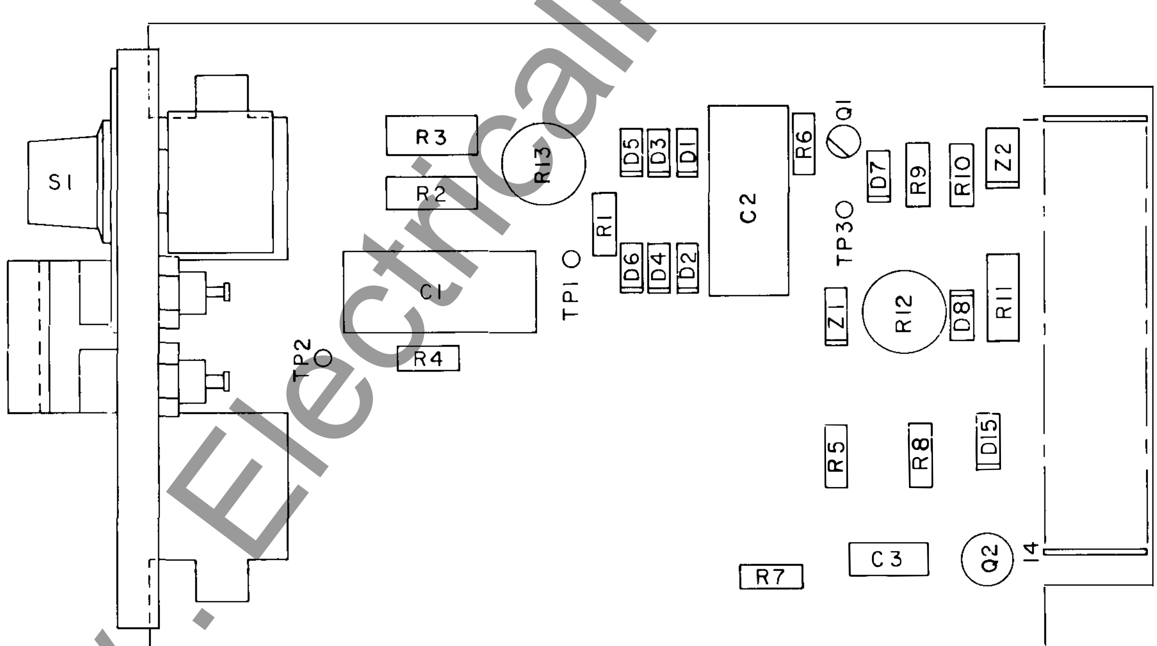


CAPACITOR	STYLE	REQ.	REF.
C1 - C2	187A624H11	2	0.5 MFD
C3	187A508H09	1	1.5 MFD.
DIODE			
D1 TO D7	184A855H07	7	IN457A
D8 - D15	837A692H03	2	IN 645A
POTENTIOMETER			
S1	836A635H07	1	5K-12 1/2 W
R13	629A430H03	1	2.5K-1/4W
R12	629A430H05	1	200K-1/4W
* RESISTOR			
R1	629A531H42	1	2.7K
R2-R3	762A679H02	2	330Ω - 3 W
R11	762A679H01	1	150 Ω -3W
R4	629A531H78	1	82K
R5-R6-R7	629A531H56	2	10K
R8	629A531H52	1	6.8K
R9	184A763H81		120K
R10	629A531H76	1	82 K
TRANSISTOR			
Q1	848A851H02	1	2N3417
Q2	849A441H01	1	2N3645
ZENER DIODE			
Z1	186A797H06	1	IN957B
Z2	862A288H01	1	IN3688A

*= RESISTORS TO BE 1/2 WATT ±2% UNLESS OTHERWISE SPECIFIED

671B960

Fig. 19. Schematic of Single Overcurrent Module



671B962

* *Fig. 20. Component Location of Single Overcurrent Module*

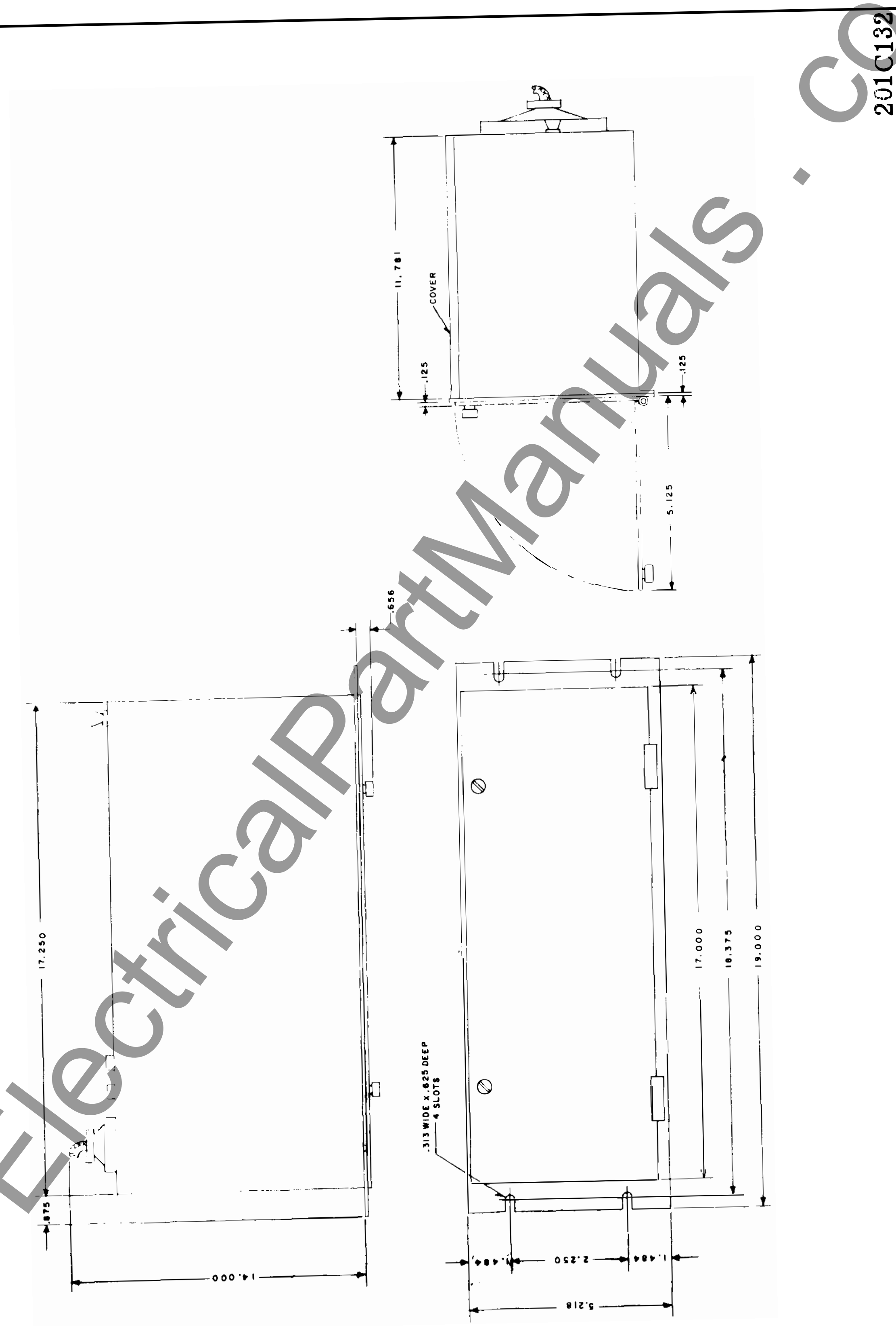


Fig. 21. Outline and Drilling Plan for the Type SIU Relay

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **CORAL SPRINGS, FL.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE SI-T OVERCURRENT RELAY

CAUTION: Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

APPLICATION

The SI-T relay is a high speed overcurrent device intended for use as a fault detector for distance relays, as a direct trip unit, in a breaker failure scheme or any similar application requiring an accurate current level detector. It contains three overcurrent units, each of which may be independently set and each of which may be used for a phase or ground relaying function.

The output unit is a telephone relay equipped with two independent contacts. The direct trip SI-T is further equipped with an ICS (indicating contactor switch) for each of the two trip circuits.

The SI-T can be used in applications requiring continuous energization above pickup level. Also, it has a dropout ratio of 88% or higher and a maximum transient overreach of 20%.

It is frequency compensated to prevent its operating on the high frequency current associated with line energization.

CONSTRUCTION

The type SI-T relay consists of three input current transformers, three resistor-zener diode protective networks, three setting circuits, three phase splitter circuits, an OR circuit, a sensing circuit, an amplifier circuit and a telephone relay. The relay for direct trip application also includes two indicating contactor switches.

The components are connected as shown in Figs. 3 and 4.

Input Transformer – The input transformer is a two-winding type with a tapped primary winding and a non-tapped secondary winding. The secondary is connected to the resistor-zener diode protective network on a small circuit board, to the setting circuit, and to the phase splitter circuit.

Setting Circuit – The setting circuit is connected across the secondary winding of the input transformer and consists of a rheostat on the front panel and a resistor on the main circuit board. It is in parallel with the resistor-zener diode protective network. This circuit loads the transformer and allows a secondary voltage to be produced that is proportional to the input current. The rheostat has a locking feature to minimize accidental change of current setting.

Phase Splitter Circuit – The phase splitter circuit consists of two capacitors, three resistors, and a three-phase rectifier bridge. This circuit converts the single-phase ac voltage from the output of the transformer to three voltages 60° out of phase with each other and rectifies these voltages.

OR Circuit – Combining three three-phase rectifiers, the voltage across the resistor R20 will be the highest output voltage from these rectifiers.

Sensing Circuit – The sensing circuit consists of a resistor, zener diode and a transistor with associated components. This circuit is connected between the output of the OR circuit and the amplifier circuit. In this circuit, the voltage from the OR circuit must be high enough to break down the zener diode to turn on the transistor.

Amplifier Circuit – The amplifier circuit consists of a transistor and associated resistors and capacitor. The transistor is normally not conducting.

Feedback Circuit – The feedback circuit consists of a resistor and a diode. This circuit controls the dropout current of the overcurrent unit.

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

SUPERSEDES I.L. 41-777.3, dated May 1976
✪ Changed since previous issue.

EFFECTIVE MAY 1979

Output Circuit – The output circuit consists of a transistor driver, a telephone relay and several voltage dropping resistors. The transistor is normally not conducting and the two telephone relay contacts are open. For direct trip application there are two Indicating Contactor Switches.

Indicating Contactor Switches (ICS) – The indicating contactor switch is a small dc operated clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magentic core upon energization of the switch. When the switch closes the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation, two fingers on the armature deflect a spring located on the front of the switch which allows the target to drop. The target is reset from the outside of the case by a push rod located at the bottom of the cover.

Power Supply – The power supply circuit consists of a zener diode, a capacitor and two resistors. It is rated for supply voltages of either 48 volts dc or 125 volts dc. The output from the zener diode is 20 volts dc. As an option, there are another zener diode and two voltage dropping resistors for rated supply voltage of 250 volts dc.

OPERATION

The logic diagram of the SI-T relay is shown in Figs. 1 and 2. With reference to the logic diagrams and the internal schematics Fig. 3 and Fig. 4, transistors, Q_1, Q_2 and Q_3 are normally not conducting and the contacts of the telephone relay are open. When ac current is applied to the primary of the transformer (T_1, T_2 or T_3), a voltage is produced on the secondary side that is proportional to the amount of resistance in the rheostat (R_1, R_2 or R_3). The single phase voltage is applied to the phase splitter circuit where three voltages 60° out of phase are produced, rectified, and applied to the resistor R20. If the voltage from rectifier is greater than the voltage breakdown of zener diode (Z4), the zener diode conducts to allow base current to flow in transistor Q_1. In turn, Q_2 and Q_3 are turned on to operate the telephone relay.

When Q_2 turns on, positive voltage is applied to the feedback circuit (R26) such that a voltage is applied to Q_1. The value of R26 controls the dropout ratio which is set above 88% of pickup.

When three ac input currents are applied simultaneously the sensing circuit operates on the voltage across R20, which is dependent on the maximum of the three bridge rectifier outputs.

When large currents are applied to the primary of the input transformer, the zener diode on the secondary prevents the secondary voltage from becoming excessive.

CHARACTERISTICS

The SI-T relay is available with the following ranges of overcurrent functions:

0.25 to 8 amps

0.5 to 16 amps

2 to 64 amps

The range of the overcurrent unit is obatined in two ways:

1. - A 1 to 4 range by means of the rheostat on the front panel.
2. - Transformer taps which multiply the rheostat setting by one of the following: 1, 4, or 8.

The scale markings of the relay represent the ac current required to operate the output telephone relay. These scale markings are accurate within 10% of the value specified on the scale plate. If a more accurate pickup or setting between the scale markings is desired, the current can be applied to the relay and the rheostat set at the desired point.

The operating time of the relay is shown in Fig. 7. There is a maximum and minimum operating time for the relay for each multiple of pickup. This difference in time is due to the point on the current wave that the fault current is applied.

The reset time curve is shown in Fig. 8. It is taken at the condition of the current interrupted at current zero and maintained at zero.

The transient overreach is a maximum of 20%.

The frequency response of the relay is shown in Fig. 9. It shows that the maximum sensitivity is occured at 60 Hz.

Battery Current Drain: 33 milliamperes (max.) for 48, 125 and 250 volts dc.

Energy Requirements: (Table I)

Transformer Current Ratings: (Table II)

TRIP CIRCUIT (FOR RELAYS WITH ICS UNIT)

The main contacts will safely close 30 amperes at 250 volts d-c and the seal-in contacts of the indicating contactor switch will safely carry this current long enough to trip a circuit breaker.

The indicating contactor switch has two taps that provide a pickup setting of 0.2 or 2 amperes. To change taps requires connecting the lead locating in front of the tap block to the desired setting by means of a screw connection.

TRIP CIRCUITS CONSTANTS (FOR RELAYS WITH ICS UNIT)

Contactor Switch –

0.2 ampere tap .... 6.5 ohms d-c resistance

2.0 ampere tap .... 0.15 ohms d-c resistance

SETTINGS

The relay must be set for the desired levels of current and where equipped with an ICS unit, a tap must be selected depending on the device being operated.

1. **Fault Detector** – where the SI-T is used as a fault detector, its principal function is to add to the security of the system for circumstances such as loss of potential on distance relays. This requires a setting above the maximum load current and below the minimum fault current for which it must respond.

2. **Direct Trip** – these applications require that differences in fault current be sufficient to distinguish location. The setting should be 125% of the maximum symmetrical fault current for which operation is not desired. For applications involving direct energization of a breaker trip coil, the ICS 2.0 ampere tap should be used. For energization of lockout relays (such as the WL) that produce high speed coil cutoff by their own contact action, the 0.2 ampere tap of the ICS should be chosen.

3. **Breaker Failure** – Trip coil energization that does not cause the cessation of current flow in the breaker after adequate passage of time is identified as breaker failure and appropriate clearing action is initiated. The SI-T can be used to sense this breaker current flow. A pickup setting below maximum load current is permissable from the relay viewpoint. A setting above maximum load current is more secure, but the settings must be below minimum phase and ground fault. levels. An allowance must be made in the setting of the separate breaker failure timer to accomodate the reset time of the SI-T relay as shown in Figure. 8.

The pickup of the relay is made by adjusting the rheostat and the setting of the multiplier of the tap plate in the front of the relay. Setting in between the scale marking can be made by applying the desired current and adjusting the rheostat until the telephone relay operates.

INDICATING CONTACTOR SWITCH (ICS)

The only setting required on the ICS unit is the selection of the 0.2 or 2.0 ampere tap setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from moisture. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel-panel mounting or to the terminal studs furnished with the relay for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detailed FT case information, refer to I.L. 41-076.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be distrubed after receipt by the customer.

ACCEPTANCE TESTS

The following check is recommended to insure that the relay is in proper working order. Refer to the internal schematics and apply current to the proper terminals.

1. **Minimum Trip Current** – Check pickup at the minimum and maximum settings. This is accomplished by applying the specified current and checking the pickup of the output telephone relay when the ac current is within 10% of the settings.

2. **Dropout** – After checking pickup, the dropout should be greater than 88% of the pickup as the current is gradually reduced.

INDICATING CONTACTOR SWITCH (ICS)

Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

ROUTINE MAINTENANCE

All relays should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.

TABLE I
ENERGY REQUIREMENTS

AMPERE RANGE	RHEOSTAT SETTING	MULTIP.	PCIKUP AMPS	OHMS AT PICKUP	P.F. ANGLE	OHMS AT 5 AMPS.	P.F. ANGLE
	.250	1	.250	1.70	21.0	1.3	15
	.375		.375	1.5	19.0	1.3	15
	.500		.500	1.4	18.0	1.3	15
	.625		.625	1.3	17.5	1.3	15
	.750		.750	1.3	17.0	1.2	15
	.875		.875	1.2	16.0	1.2	15
	1.000		1.000	1.2	15.5	1.2	15
	.250	4	1.0	0.190	9.5	0.190	8.5
	.375		1.5	0.180	8.5	0.180	8.0
	.500		2.0	0.170	7.0	0.170	7.5
.25-8	.625		2.5	0.170	6.5	0.170	7.0
	.750		3.0	0.165	6.0	0.165	6.5
	.875		3.5	0.160	6.0	0.160	6.5
	1.000		4.0	0.160	6.0	0.160	6.0
	.250	8	2.0	0.082	5.5	0.082	5.5
	.375		3.0	0.080	5.0	0.080	5.0
	.500		4.0	0.078	4.0	0.078	4.0
	.625		5.0	0.077	4.0	0.077	4.0
	.750		6.0	0.076	4.0	0.076	4.0
	.875		7.0	0.075	4.0	0.075	4.0
	1.000		8.0	0.075	3.5	0.075	3.5
	.50	1	.50	0.42	20.0	0.35	15.0
	.75		.75	0.37	18.0	0.35	15.0
	1.00		1.00	0.34	16.0	0.34	15.0
	1.25		1.25	0.33	15.0	0.33	15.0
	1.50		1.50	0.32	14.5	0.32	14.5
	1.75		1.75	0.31	14.0	0.31	14.0
	2.00		2.00	0.31	13.5	0.31	13.5
	.50	4	2.0	0.055	6.5	0.055	6.5
	.75		3.0	0.052	6.0	0.052	6.0
	1.00		4.0	0.051	5.5	0.051	5.5
.5-16	1.25		5.0	0.050	5.0	0.050	5.0
	1.50		6.0	0.049	4.5	0.049	4.5
	1.75		7.0	0.048	4.5	0.048	4.5
	2.00		8.0	0.048	4.5	0.048	4.5
	.50	8	4.0	0.029	4.0	0.028	4.0
	.75		6.0	0.028	4.0	0.028	4.0
	1.00		8.0	0.027	3.5	0.027	3.5
	1.25		10.0	0.027	3.5	0.027	3.5
	1.50		12.0	0.027	3.5	0.027	3.5
	1.75		14.0	0.027	3.5	0.027	3.5
	2.00		16.0	0.027	3.5	0.027	3.5
	2.00	1	2.00	0.040	8.0	0.040	8.0
	3.00		3.00	0.037	7.5	0.037	7.5
	4.00		4.00	0.035	7.0	0.035	7.0
	5.00		5.00	0.034	6.5	0.034	6.5
	6.00		6.00	0.033	6.5	0.033	6.5
	7.00		7.00	0.033	6.5	0.033	6.5
	8.00		8.00	0.032	6.5	0.032	6.5
	2.00	4	8.00	0.015	2.5	0.015	2.5
	3.00		12.00	0.015	2.5	0.015	2.5
	4.00		16.00	0.015	2.5	0.015	2.5
2-64	5.00		20.00	0.015	2.5	0.015	2.5
	6.00		24.00	0.015	2.5	0.015	2.5
	7.00		28.00	0.015	2.5	0.015	2.5
	8.00		32.00	0.015	2.5	0.015	2.5

TABLE I
ENERGY REQUIREMENTS (Continued)

AMPERE RANGE	RHEOSTAT SETTING	MULTIP.	PCIKUP AMPS	OHMS AT PICKUP	P.F. ANGLE	OHMS AT 5 AMPS.	P.F. ANGLE
	2.00	8	16.00	0.014	2.5	0.014	1.5
	3.00		24.00	0.014	2.5	0.014	1.5
	4.00		32.00	0.014	2.5	0.014	1.5
	5.00		40.00	0.014	2.5	0.014	1.5
	6.00		48.00	0.014	2.5	0.014	1.5
	7.00		56.00	0.014	2.5	0.014	1.5
	8.00		64.00	0.014	2.5	0.014	1.5

TABLE II
CURRENT RATINGS

RHEOSTAT RANGE	MULTIP.	CONTINUOUS RATING AMPERES	ONE SECOND RATING AMPERES
.25-1	1	3.5	88
	4	9.0	80
	8	12.0	88
.5-2	1	7	185
	4	15	185
	8	24	185
2-8	1	24	400
	4	24	400
	8	24	400

CALIBRATION

Use the following procedure for calibrating the 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 new scale plate may be necessary when parts are changed. This procedure must be repeated for the other two inputs.

PHASE SPLITTER CHECK

1. Turn rheostat on front of relay to lowest setting.
2. Apply minimum setting current to the proper relay terminals.
3. Connect scope across output of phase splitter (TP1). Set scope for ac deflection and the following waveform should be observed.

DIAL CALIBRATION

1. Apply the proper dc voltage between terminals 20 and 5. Terminal 20 is positive.
2. Connect a dc voltmeter across TP2 and terminal 5.
3. Apply the desired current to proper relay terminals.
4. Turn rheostat on front of relay clockwise from extreme counter-clockwise position unitl the relay operates as indicated by a sudden reading of approximately 20 volts dc on meter.

INDICATOR CONTACTOR SWITCH (ICS)

Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

TROUBLE SHOOTING PROCEDURE

Use the following procedures to locate the source of trouble if the relay is not operating correctly.

1. Check voltage as listed on the electrical checkpoints.
2. Check resistance as listed on the internal schematic of the relay.
3. Inspect all wires and connections, paying particular attention to printed circuit terminals.

ELECTRICAL CHECKPOINTS

The relay can be checked with reference to the following voltages: All voltage readings should be made with a high resistance voltmeter.

1. No AC Current Input (for 48 volts dc)

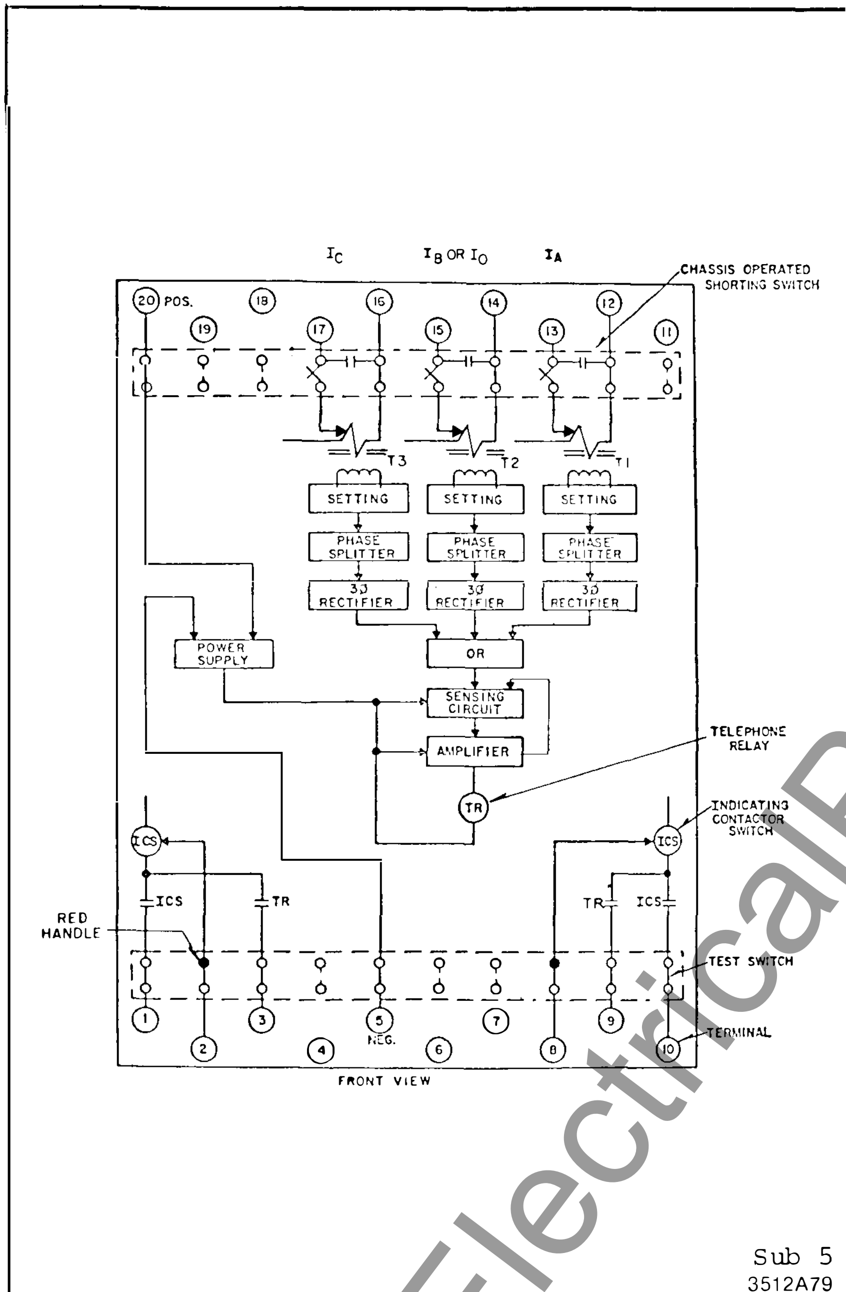
Test Terminal	Typical Voltage
TP1	less than 0.6 volts
TP2	less than 0.6 volts
TP3	48 volts
TP4	20 volts

2. Minimum Trip AC Current Applied

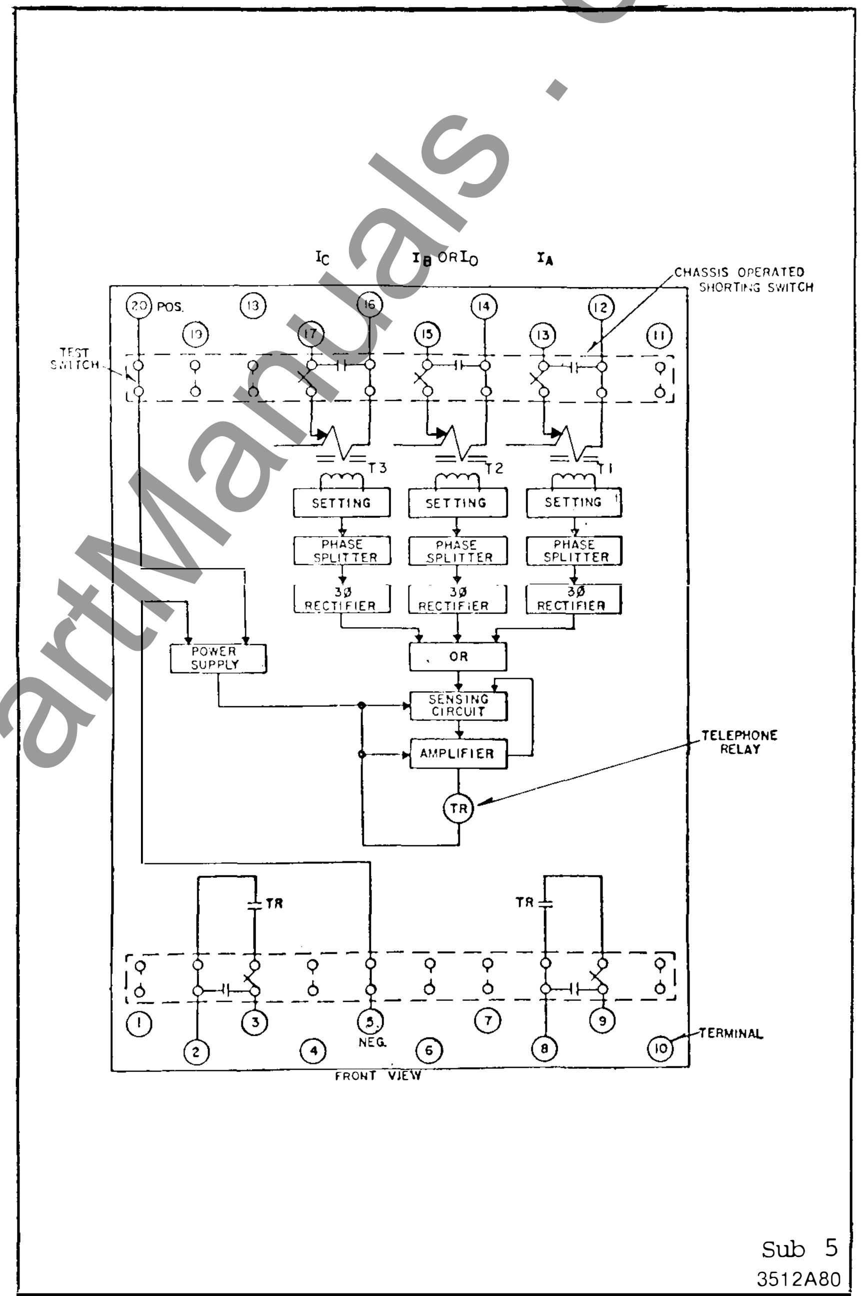
Test Terminal	Typical Voltage
TP1	7.5 volts
TP2	20 volts
TP3	less than 0.6 volts
TP4	20 volts

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.



✪ *Fig. 1. Block Diagram of the Type SI-T Relay in FT-22 Case (with ICS).*



✪ *Fig. 2. Block Diagram of the Type SI-T Relay in FT-22 Case (without ICS).*

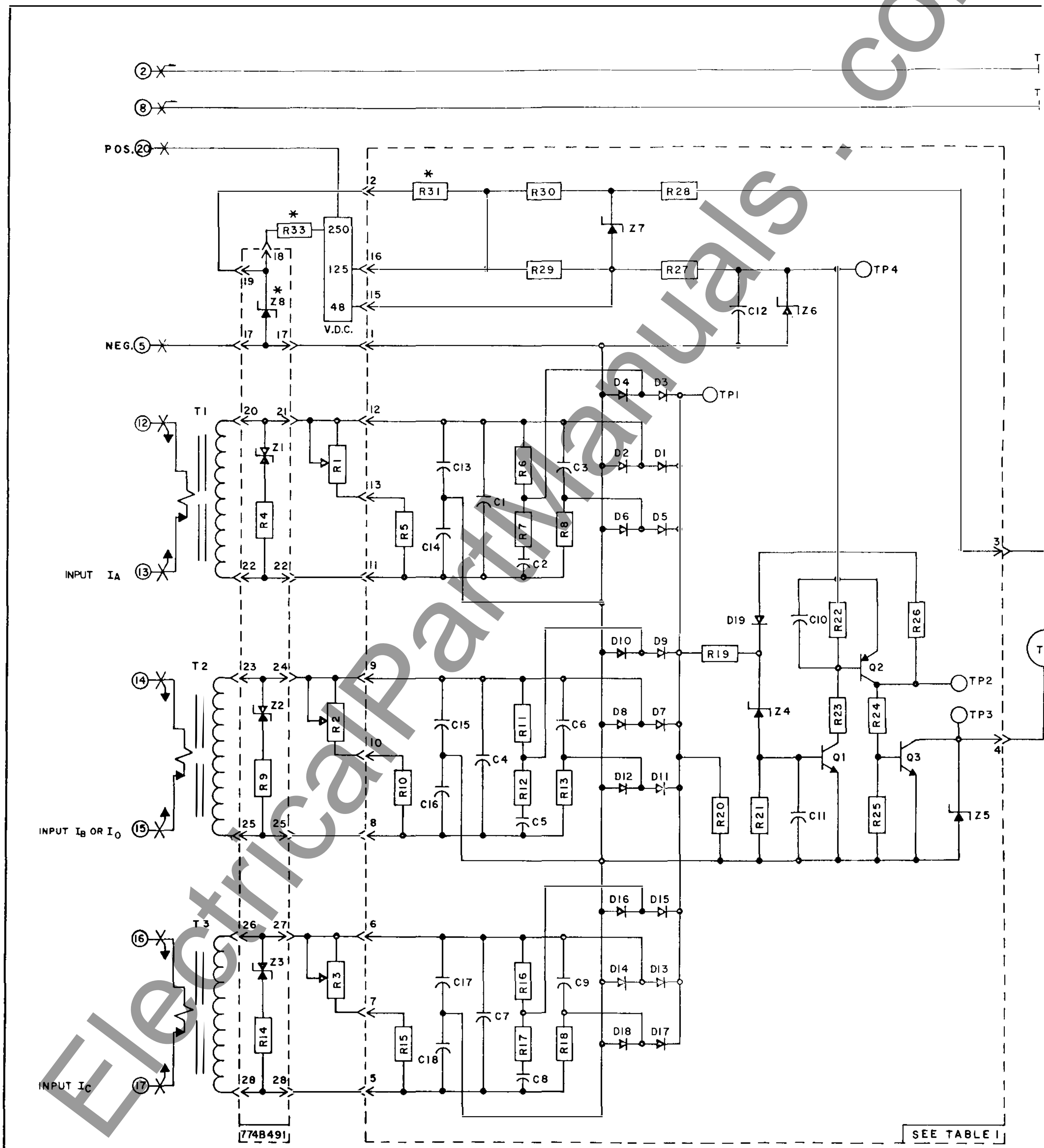


TABLE I

48/125 V	265C862G01 (WITHOUT R31)
250 V	265C862G02 (WITH R31)

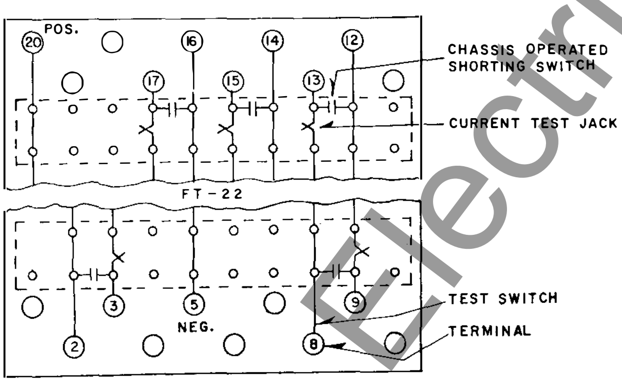
✪ *Fig. 4. Internal Schematic f*

Output.

CAPACITOR	STYLE NO.	REQ.	REF.
C1 - C4 - C7 - C12	188A669H03	4	0.1 MFD.
C2 - C5 - C8	188A669H01	3	0.47 MFD.
C3 - C6 - C9	876A409H15	3	0.22 MFD.
C10	187A508H09	1	1.5 MFD.
C11	187A508H05	1	0.47 MFD.
C13 TO C18	762A680H02	6	0.001 MFD.
DIODE			
D1 TO D19	184A855H07	19	1N457A
POTENTIOMETER			
R1 - R2 - R3	836A635H07	3	5K - 12 1/2 W
-θ- RESISTOR			
R4 - R9 - R14	185A209H06	3	50Ω - 5W
R5 - R10 - R15	763A129H03	3	500Ω - 5W
R6-R8-R11-R13-R16-R18	629A531H58	6	12 K
R7 - R12 - R17	629A531H49	3	5.1 K
R19-R21-R22-R24-R25	629A531H56	5	10 K
R20	629A531H73	1	51 K
R23	629A531H52	1	6.8 K
R26	184A763H79	1	150K-1/2W-±5%
R27	763A127H03	1	2 K - 3W
R28	185A207H31	1	1.5K - 2 W
R29	184A636H10	1	6K - 5 W
R30	763A129H01	1	5 K - 5 W
* R31	762A679H01	1	150Ω - 3 W
* R33	763A098H25	1	4 K - 12 W
TRANSFORMER			
T1 - T2 - T3	774B484G02	3	.5 - 16 A.
TRANSISTOR			
Q1	848A851H02	1	2N3417
Q2	849A441H01	1	2N3645
Q3	837A617H01	1	2N3589
ZENER DIODE			
Z1 - Z2 - Z3	184A617H06	3	1N1832C
Z4	186A797H06	1	1N957B
Z5	187A936H17	1	1N3050B
Z6	849A487H01	1	1N4747 A
Z7	629A369H01	1	1R200
* Z8	762A631H11	1	1N3011B
TELEPHONE RELAY			
TR	541D514H24	1	1,500Ω-24 V.

-θ- = RESISTORS TO BE 1/2 W ± 2% UNLESS OTHERWISE SPECIFIED.

* = FOR 250 V. ONLY.



FRONT VIEW

Sub.6
6682D43

...r the Type SI-T Relay without ICS

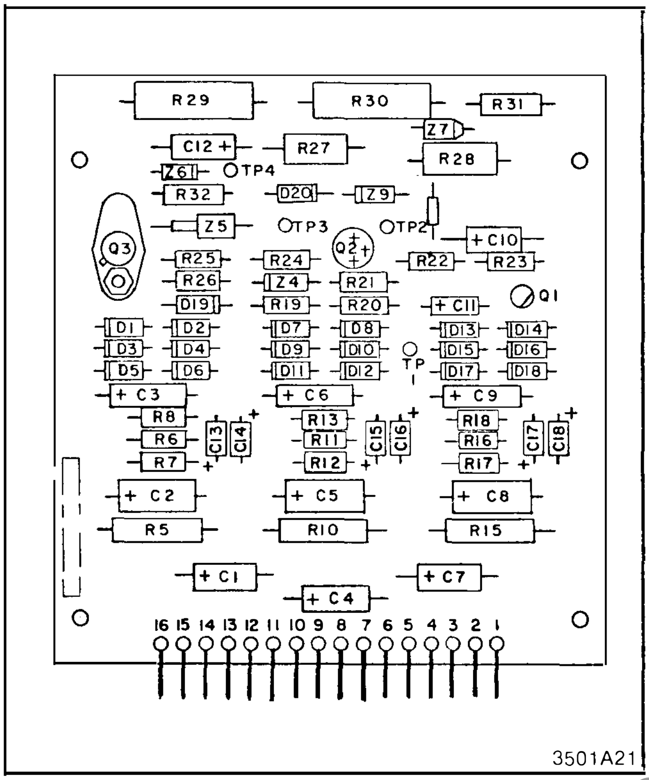


Fig. 5. Component Location on Overcurrent Module.

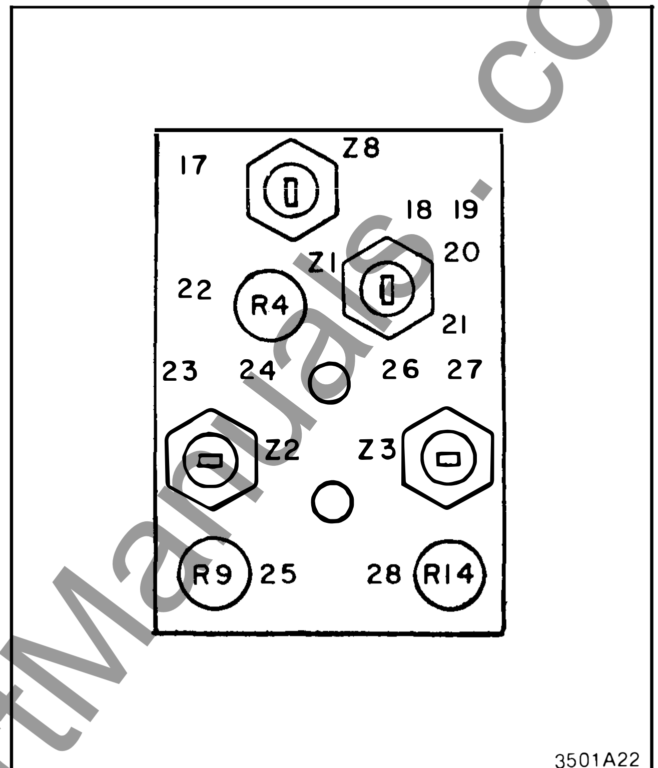


Fig. 6. Component Location on Zener Diode Module

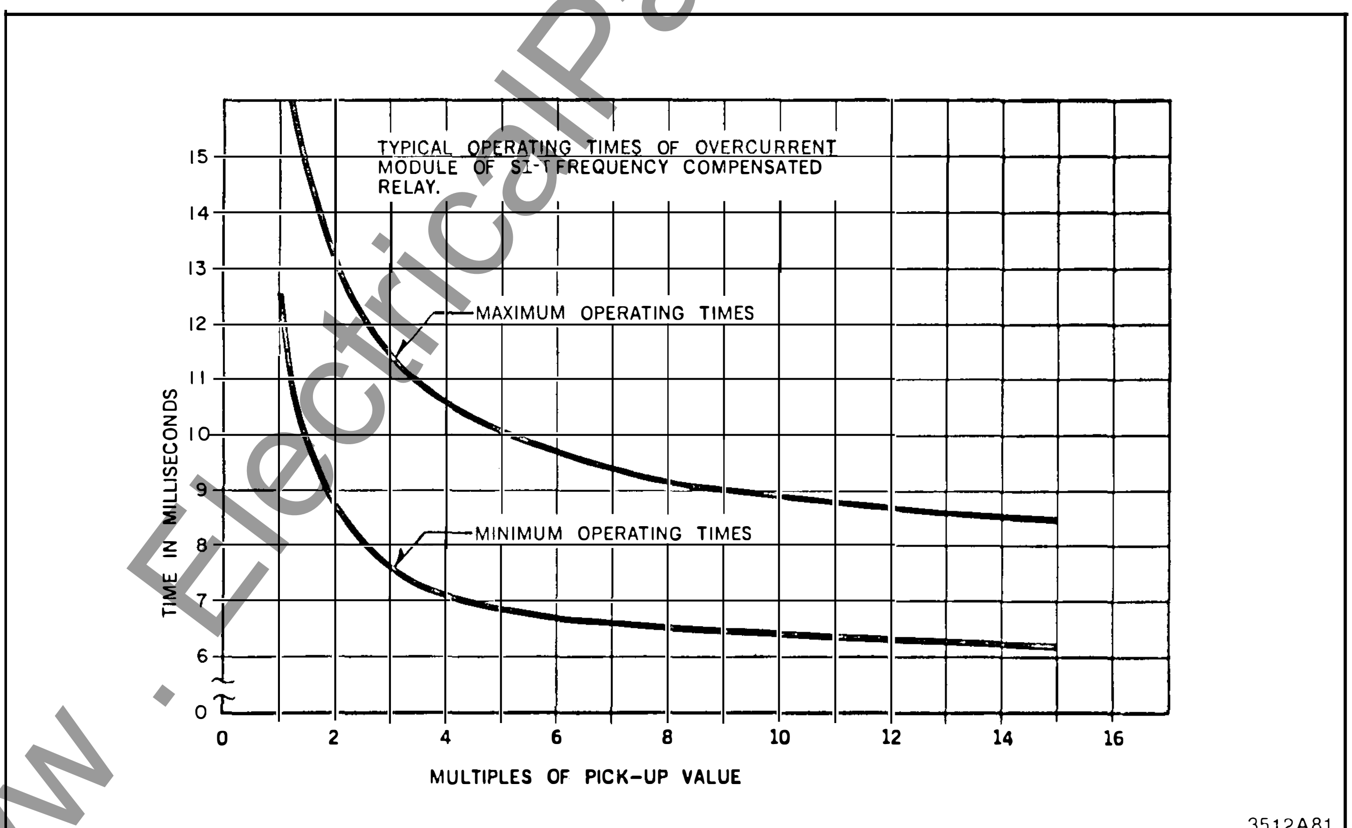


Fig. 7 Typical Operating Time of the Type SI-T Relay.

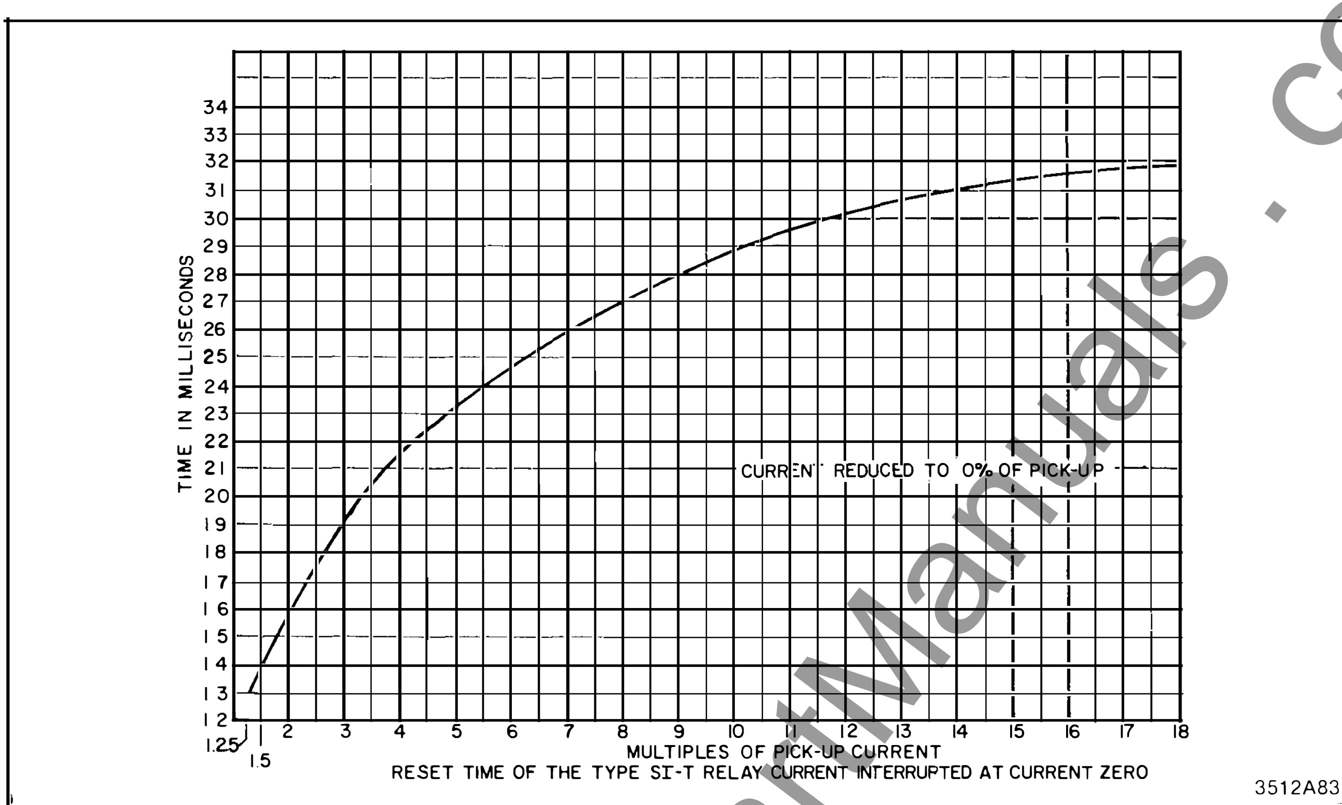


Fig. 8. Typical Reset Time of the Type SI-T Relay.

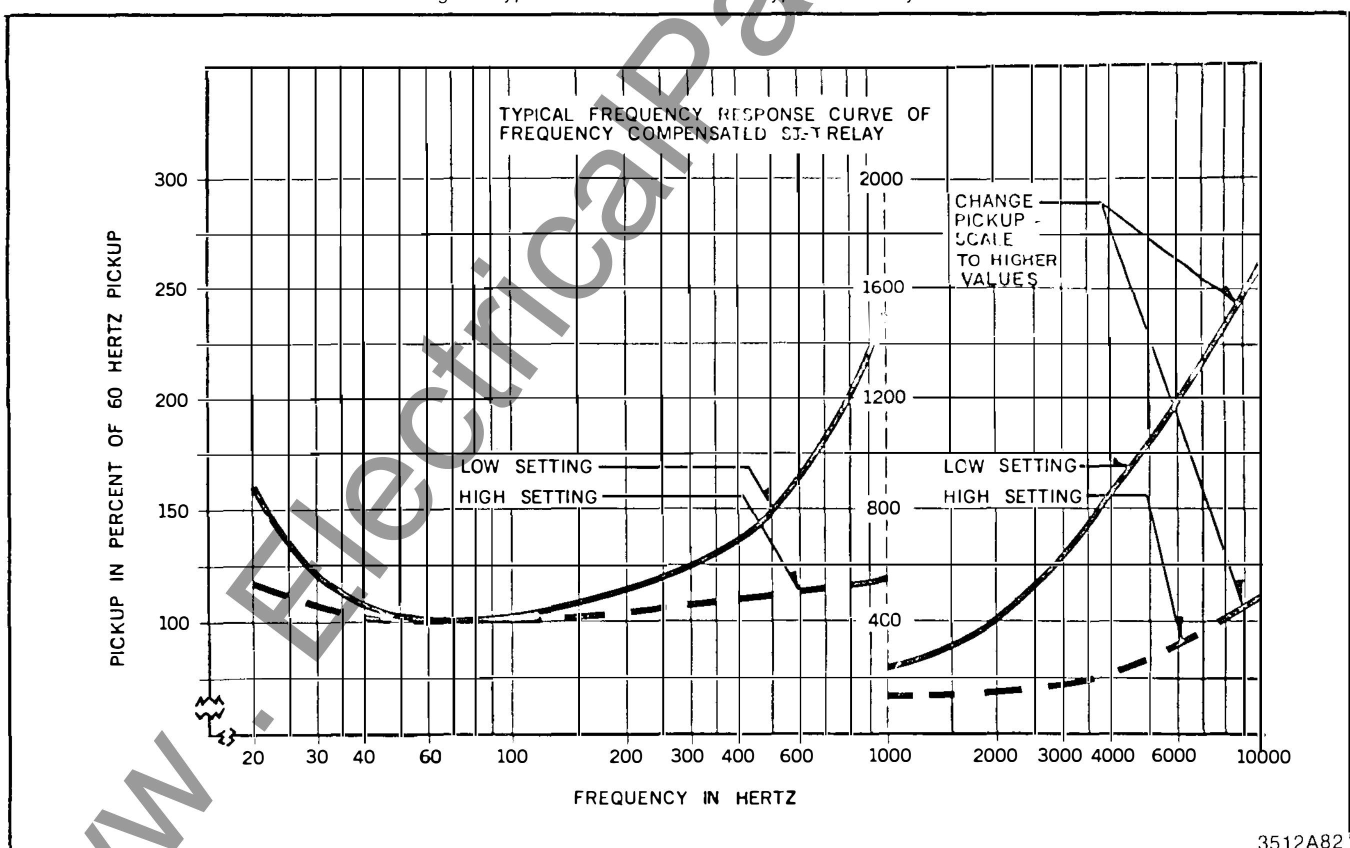
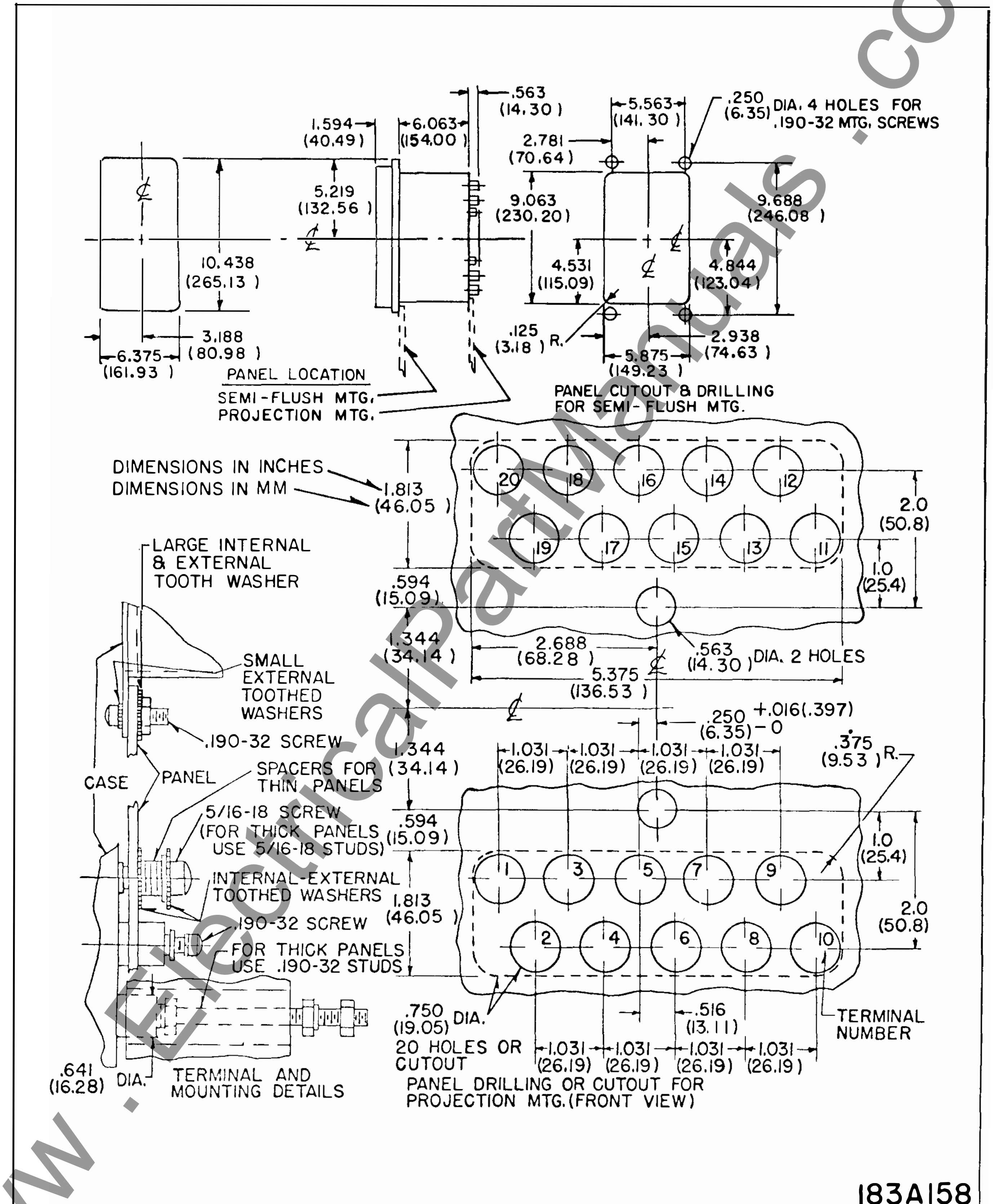


Fig. 9. Typical Frequency Response Curve of the Type SI-T Relay.



✪ *Fig. 10. Outline and Drilling Plan for the Type SI-T Relay in the FT-22 Case.*

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **CORAL SPRINGS, FL.**

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