Effective: September 1985
Supersedes I.L. 41-579.2B dated July 1977

✪ Denotes Change Since Previous Issue

Type TD-50 Time Delay Relay

CAUTION: Before putting relays into service, operate the relay to check the electrical connections. Close the red handle switch last when placing the relay in service. Open the red handle switch first when removing the relay from service. Printed circuit module should not be removed or inserted while the relay is energized.

APPLICATION

The type TD-50 relay is a dc timing relay for use where operation of the relay is controlled by one or more inputs to a transistor. This permits use of the relay in conjunction with other solid state relays which have a +20VDC output signal such as a type SI overcurrent relay or a contact such as a 52a breaker switch with a 48, 125 or 250 VDC rating.

By switching the TD-50 control voltage input through a 62X, 62Y or BFI contact the relay is well suited for a breaker failure scheme. An internal auxiliary (X) telephone relay permits seal-in of the initiate contact to reduce the effects of contact bounce or momentary closure of the initiate contact due to operation on "memory action" of the primary or backup relaying. This arrangement de-sensitizes the relay to false operation due to significant distributed capacitance (up to 6 MFD) which might couple charging current on to the breaker failure initiate lead. In addition, relays made per internal schematic 3504A92 have a higher threshold starting voltage which is greater than ½ rated DC voltage. This will prevent misoperation of the relay in the event of an accidental ground at the 62X input terminal even in the presence of over 100 MFD connected from the dc bus to ground.

The seal-in feature, if desired, must be wired around the breaker failure initiate contact as shown in external schematic 205C547.

An additional "X" relay contact is brought out to the relay terminals where it may be used to re-trip the primary breaker before the breaker failure relay timer times out.

As indicated on the internal schematic (dwg. 880A708) the user may obtain a second timer output contact by reconnecting a lead at the relay terminal.

Other TD-50 relay styles are available with two and three input with two input starting logic. These are listed in supplementary instruction leaflet L-779641.

CONSTRUCTION

The type TD-50 relay consists of a reference voltage circuit, a rheostat (T) and scale plate, a voltage biasing potentiometer (P), an output telephone relay (TR), and an indicating contactor switch (ICS). In addition, a plug in printed circuit module contains the solid state timing circuit as well as the input starting transistor.

The relay as used here for breaker failure application also contains an auxiliary (X) relay.

In most other respects the TD-50 is similar to the TD-5 relay described in I.L. 41-579.1 and whose description is repeated here.

Reference Voltage Circuits

The reference voltage circuit provides a fixed supply voltage to the R-C time delay circuit and protects the static components from high voltages. It consists of a silicon power regulator and a series resistor (Rs). The silicon power regulator (Z) is a 10 watt Zener diode mounted on an aluminum heat sink. The series resistor (Rs) is a 3½ inch resistor which is tapped for 48/125 volt d-c relays and untapped for the 250 volt relay.

Rheostat and Scale Plate

The rheostat (T) provides a variable resistance

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 this particular installation, operation or maintenance of this equipment, the local ABB representative should be contacted.

for the R-C time delay circuit. It is of wire-wound construction, which minimizes resistance change with temperature. Do not remove the knob from the rheostat shaft, since it is not easy to replace the knob in the calibrated position. The timing scale is non-linear as explained in the section under Printed Circuit.

Potentiometer

The potentiometer (P), provides a baising voltage which keeps the silicon controlled rectifier (SCR) turned off until the capacitor voltage reaches the potentiometer brush voltage. It is of wire-wound construction and has a locking nut which should not be loosened unless the relay is being re-calibrated.

Printed Circuit

The printed circuit contains a diode (D_1) which protects the static components in case the relay is connected with reverse polarity, a limiting timing resistor (R_L), timing capacitor (C) a parallel resistor (R_P) which makes the calibrating scale non-linear and a silicon controlled rectifier (SCR). The printed circuit also contains a diode (D_2) to reverse bias SCR, a resistor (R_C) and diode (D_3) to protect the static components from the inductive voltage kick associated with the telephone relay coil, and series diodes (D_4, D_5, and D_6) which compensate for the forward voltage drop through SCR and D_2 and thereby prevent timing variations caused by reference voltage changes due to self-heating of the Zener diode. The starting transistor (T_2) and switching transistor (T_3) are connected as shown in internal schematic drawing 880A708. Circuit shown in internal schematic 3504A92 require two starting transistors (T_1 & T_2).

Telephone Relay (TR)

The telephone relay (TR) is energized by the SCR at the conclusion of the time delay. The coil is energized by at least three times pick-up wattage to insure positive contact operation. The contacts are made of palladium and are suitable for circuit breaker trip duty, as proven by many years of experience in other relays. Two sets of transfer contacts are provided to give a flexible trip circuit arrangement.

Telephone Relay (X)

The telephone relay (X) is energized through transistor T_3. One contact is wired out to a terminal for use in sealing around the external initiating contact. A second contact is brought out to the relay terminals for use elsewhere.

Indicating Contactor Switch (ICS)

The indicating contactor switch is a small d-c operated clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic 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 operation indicator target to drop. The target is reset from the outside of the case by a push rod located at the bottom of the case.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

OPERATION

Operation of the TD-50 relay begins when an input signal to the starting transistor is present and an external contact connected in series with the relay control voltage closes. The capacitor in the RC timing circuit begins to increase in voltage until it is greater than the voltage setting on the brush of the (P) potentiometer. At this point current will flow into the gate of the silicon controlled rectifier (SCR) which will conduct similar to the closing of a switch. This actuates the telephone relay (TR) in the time set on the front dial.

The output contact (TR) normally energizes a trip circuit, actuating the ICS contact as shown in the external connection diagram.

The rate at which the capacitor charges is determined by the rheostat setting. The charging rate is not a linear function of rheostat setting, since R_P gives a parallel resistive path. This has the effect of expanding the scale for short times and thereby permitting more accurate settings.

CHARACTERISTICS

Time Delay Range and Voltage Rating

Time Delay Range (Seconds)	Voltage Rating (Volts d-c)
.05 – 0.4	48/125
.05 – 0.4	250
.05 – 1.0	48/125
.05 – 1.0	250
0.2 – 4.0	48/125
0.2 – 4.0	250
1.5 – 30	48/125
1.5 – 30	250

Battery Drain

	48 Volts d-c	125 Volts d-c	250 Volts d-c
Stand-By:	0	0	0
Operating:	270 MA	180 MA	80 MA

Voltage Rating Over The Temperature Range

The relay can stand 110% voltage continuously over a temperature range of −40°C to +70°C.

Reverse Polarity

Diode (D_1) limits reverse voltage of the static components to less than one volt d-c, so that no damage is done to the circuit by connecting the relay with reverse polarity. However, the relay will, of course, not operate under this condition, and series resistor (RS) may over-heat if reverse voltage is applied for approximately 15 minutes or more.

Reset Time

TR drop-out time = 0.1 sec. or less.

Discharge of timing capacitor; C is essentially instantaneous, the R-C time constant through P being less than 20 milliseconds, in most cases. However, the discharge path through P is limited by silicon voltage drops through SCR and D2, totalling approximately one volt. Therefore, C discharges rapidly through P down to about one volt and then more slowly through R_P down to zero volts.

Accuracy

The accuracy of the time delay depends upon the repetition rate of consecutive timings, the supply voltage, and the ambient temperature. Self-heating has a negligible effect on the time accuracy.

(1) Nominal Setting

The first time delay, as measured with the test circuit shown in Figure 5, taken at 25°C. and rated voltage, will be within four milliseconds of its setting for settings of 0.2 seconds or less. For settings above 0.2 seconds, this accuracy will be ±2%.

(2) Consecutive Timings

Incomplete capacitor discharge will cause changes in time delay. These changes are a function of discharge rate. Timing accuracy for slow repetitions will be per Table I.

Table I

Relay Rating	Delay Between Readings	Accuracy, as Percent of Setting
.05-0.4 seconds	at least 3 seconds	±2%
.05-1.0 seconds	at least 3 seconds	±2%
0.2 -4.0 seconds	at least 5 seconds	±2%
1.5 -30 seconds	at least 5 seconds	±2%

Timing accuracy for fast repetitions will be per Table II.

Table II

Relay Rating	Delay Between Readings	Accuracy, as Percent of Setting
.05-0.4 seconds	instantaneous	±4%
.05 - 1.0 seconds	instantaneous	±4%
0.2 - 4.0 seconds	instantaneous	±4%
1.5 -30 seconds	approx. ½ sec.	±4%

(3) Supply Voltage

Changes in supply voltage, between 80% and 110% of nominal, cause time delay variations of no more than ±3 milliseconds for settings of 0.3 seconds or less, and no more than ±1% for settings above 0.3 seconds.

(4) Ambient Temperature

Changes in ambient temperature cause changes in time delay. This variation in time delay is a direct function of capacitance change with temperature. Typical variation of time delay with temperature is shown in Figure 4.

SETTINGS

The time delay is selected by adjusting rheostat, T.

The correct tap on series resistor, R_S, should be selected for the supply voltage being used.

Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except 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 dirt, moisture, excessive vibration, and heat. 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 nuts with a wrench.

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

ADJUSTMENT 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, except for the time dial setting.

Acceptance Test

A timing check at minimum and maximum settings is recommended to insure that the relay is in proper working order. For relays built per internal schematic 3504A92 reduce the rated voltage to 50% and see that relay does not pick up when energized as above.

A recommended test circuit is shown in Fig. 5. Close switch S_2 or S_3 before closing S_1 when timing the relay.

Next check for seal-in feature by closing switch S_4, now close switch S_3 and S_1. After relay has timed out and TR has picked up, open switch S_1 and note that TR contact remains picked up. Now open S_3 and see that TR drops out. Repeat the above except to use switch S_2 in place of S_3.

Routine Maintenance

All contacts should be cleaned periodically. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

Trouble Shooting Procedure

Use the following procedure to locate the source of trouble if the TD-50 is not operating correctly.

1. Inspect all wires and connections, paying particular attention to telephone relay and printed circuit terminals.

2. Check the reference voltage circuit. This is done by measuring the d-c voltage across the silicon power regulator, Z. Connect the d-c voltmeter positive terminal to the rear terminal of R_S and the negative terminal to relay terminal 8. Apply rated voltage per the test circuit diagram, Figure 4. The Zener voltage should be between 21.5 and 24.5 volts for 48/125 volt relays, and between 50 and 58 volts for 250 volt relays.

3. Check the timing capacitor voltage and the potentiometer brush voltage (between printed circuit terminal 3 and relay terminal 8) with a cathode ray oscilloscope or a high resistance d-c voltmeter. It is necessary to scrape varnish from the capacitor positive terminal in order to make a connection at this point. The brush voltage, which is constant until the telephone relay trips, should be approximately one half the reference voltage. The capacitor should gradually charge to the potentiometer brush voltage, plus approximately one volt for silicon junction forward voltage drops through SCR and D_2.

4. If reference voltage, capacitor voltage, and potentiometer voltage all appear to behave correctly, the SCR may be the cause of trouble. The anode to cathode voltage, as measured between printed circuit terminals 4 and 3, should be approximately one-half the reference voltage until the capacitor voltage reaches the brush voltage, at which time the anode to cathode voltage should drop to approximately one volt.

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.

1. Rheostat Knob Adjustment, Same Scale Plate

If it is necessary to replace the rheostat (T) or the silicon power regulator (Z), the relay may be recalibrated with the same scale plate, in most cases. This is done by rotating the rheostat shaft, without knob, until a time delay equal to the minimum scale marking is obtained. Then, align the knob for this delay and tighten the knob set-screw securely. Pause several seconds between readings for all delays above .05 seconds. See section under Accuracy for discussion of this.

2. Scale Plate Calibration, New Scale Plate

If it is necessary to replace the potentiometer (P) or the printed circuit, the relay should be recalibrated with a new scale plate. Use the following procedure:

a) With the knob off the shaft, set the rheostat (T) at maximum.

b) Adjust P so that the times are 5% to 10% longer than the maximum scale marking.

c) Set the rheostat (T) at minimum and check that times are less than or equal to the minimum scale marking. If not, adjust P slightly to reduce times. Tighten lock nut on P.

d) Place the knob on the rheostat shaft in such a position that the times are symmetrical with respect to the scale plate marking. Tighten the knob set-screw and mark calibration lines on the scale plate. When striking calibration lines for delays above 0.5 second, pause at least 3 seconds between readings. See section under Accuracy for discussion of this.

3. Indicating Contractor 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.

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.

TABLE OF REPLACEABLE PARTS

CIRCUIT SYMBOL	RELAY CHARACTERISTIC		DESCRIPTION	STYLE NO.
	DC VOLTS	TIME RANGES		
T2, T1	48/125		Transistor 2N697	184A638H18
	250		Transistor 2N699	184A638H19
T3	48/125		Transistor 2N1131 or 2N1132	184A638H20
	250		Transistor 2N4356	894A441H02
R1	48/125		Resistor, 4,990 ohms ± 1%, ½ watt	836A503H42
	250		Resistor, 10,000 ohms ± 2%, ½ watt	629A531H56
R2	48/125		Resistor 1,500 ohms ± 1%, ½ watt	836A503H30
	250		Resistor 5,600 ohms ± 5%, 1 watt	184A643H45
R5	All		Resistor 22K ± 2%, ½ watt	629A531H45
R7, R4	All		Resistor 2,210 ohms ± 1%, ½ watt	836A503H34
R9, R8	All		Resistor 49,900 ohms ± 1%, ½ watt	836A503H65
R10	48/125		Resistor 20,000 ohms ± 2%, ½ watt	629A531H63
RX	250		Resistor 2,000 ohms 1 watt 5%	187A643H34
RA	250		Resistor 100,000 ohms 1 watt 5%	187A643H75
R_C	48/125	All	Resistor ½ watt, 270 ± 5% ohms	184A763H13
	250	All	Resistor, ½ watt, 1200 ± 5% ohms	184A763H29
R_P	All	0.05-1 & .05-4	Resistor, ½ watt, 62K ± 1%	862A377H77
	All	0.2-4	Resistor, ½ watt, 267K ± 1%	862A378H42
	All	1.5-30	Resistor, ½ watt, 267K ± 1%	862A378H42
R_L	48/125	0.05-1 & .05-.4	Resistor, ½ watt, 1K ± 1%	862A376H01
	250	0.05-1 & .05-.4	Resistor, 3 watts, 1K ± 5%	184A636H08
	All	0.2-4	Resistor, ½ watt, 5.6K ± 1%	862A376H73
	All	1.5-30	Resistor, ½ watt, 5.6K ± 1%	862A376H73
R_S	48/125	All	Resistor, 40 watts, 550 ± 5% ohms, tap at 95 ohms	187A321H01
	250	All	Resistor, 40 watts, 2500 ± 5% ohms	1955653
Z4	48/125	All	Zener Diode, IN3688A ¾ watt 24 V	862A288H01
Z	48/125	All	Zener Diode, IN2986B, 10 watts, 24 Volts	629A698H03
	250	All	Zener Diode, IN2999B, 10 watts, 56 Volts	629A798H04
Z3	48/125	All	Zener Diode, UZ8870, 1 watt 70 V	837A693H14
Z3	250	All	Zener Diode, IN988B 400 MW 130 V	862A606H03
D	All	All	Silicon Diode, IN645, 225 Volts 150 MA	184A855H13
T	All	0.05-1	Rheostat, 3 Watt, 40K	184A756H01
	All	0.2-4	Rheostat, 4 Watt, 100K	184A756H02
	All	1.5-30	Rheostat, 4 Watt, 100K	184A756H02
	All	.05-.4	Rheostat, 4 Watt, 20K	184A756H04
C	48/125	0.05-1 & .05-.4	Tantalum Capacitor, 22uf, 35 volts	184A661H16
	250	0.05-1 & .05-.4	Tantalum Capacitor, 22uf, 50 volts	184A661H17
	48/125	0.2-4	Tantalum Capacitor, 22uf, 35 volts	184A661H16
	250	0.2-.4	Tantalum Capacitor, 22uf, 50 volts	184A661H17
	48/125	1.5-30	Tantalum Capacitor, 22uf, (7 in parallel) 35 V	184A661H16
	250	1.5-30	Tantalum Capacitor, 22uf, (7 in parallel) 50 V	184A661H17
T_R	48/125	All	Telephone Relay, 125 ohms coil	407C614H06
	250	0.05-1 & .05-.4	Telephone Relay, 125 ohm coil	407C614H06
	250	0.2-4	Telephone Relay, 650 ohm coil	407C614H07
	250	1.5-30	Telephone Relay, 650 ohm coil	407C614H07
X	All	All	Telephone Relay, 1500 ohm coil	541D514H24
SCR	48/125	All	Silicon Controlled Rectifier, 2N885	185A517H02
	250	All	Silicon Controlled Rectifier, 2N886	185A517H03
P	48/125	All	Potentiometer, 4 Watts, 250 ± 10% ohms	185A067H05
	250	All	Potentiometer, 4 Watts, 1300 ± 10% ohms	185A067H06

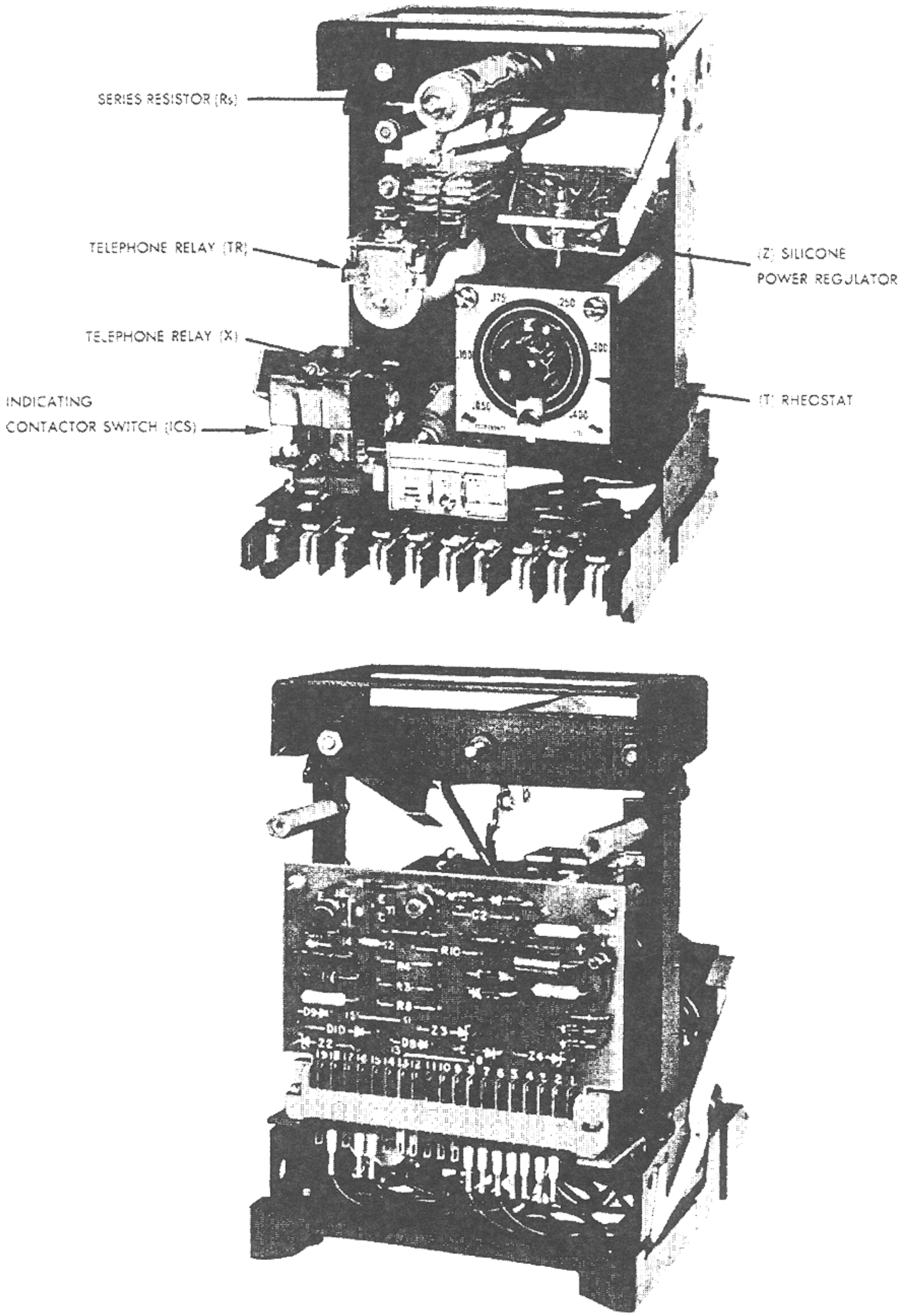

Fig. 1. Front and Rear photo for TD-50 with X telephone relay.

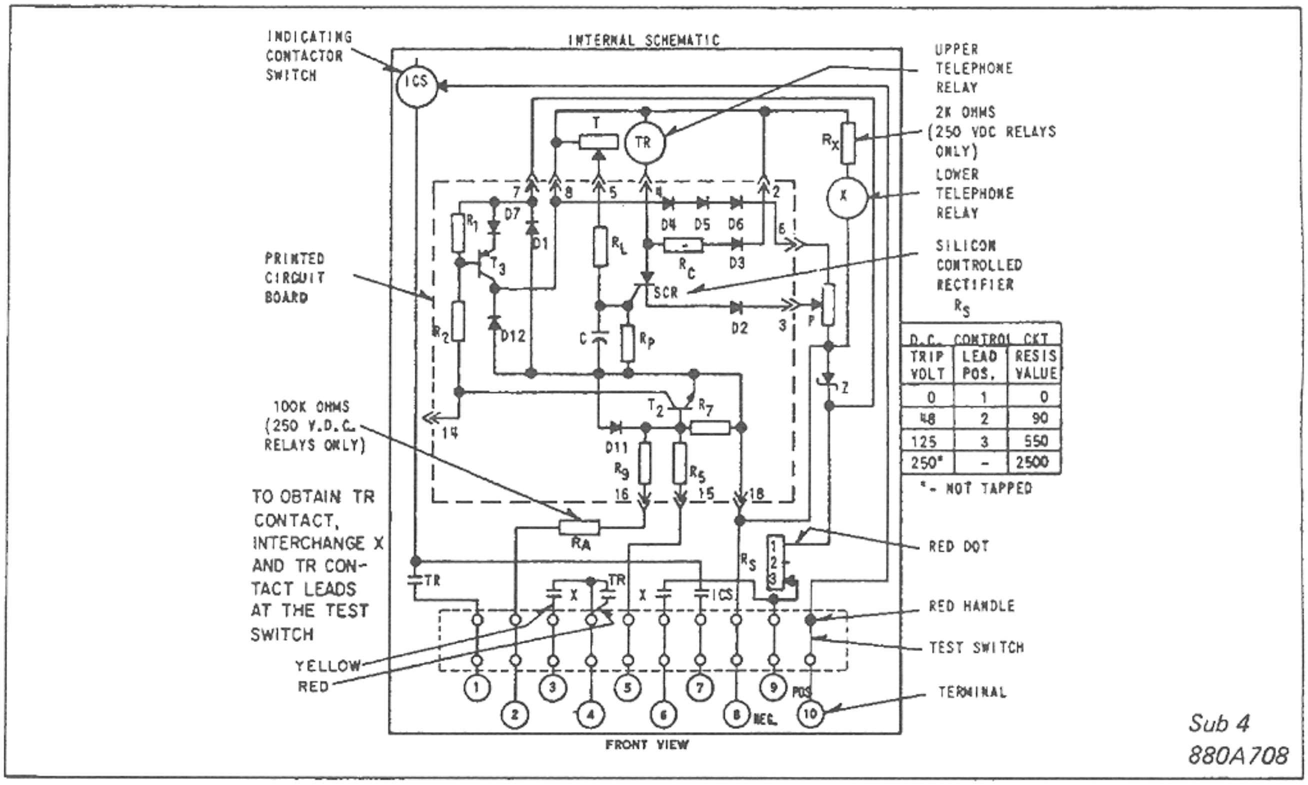

Fig. 2. Internal Schematic of TD-50 with X telephone relay.

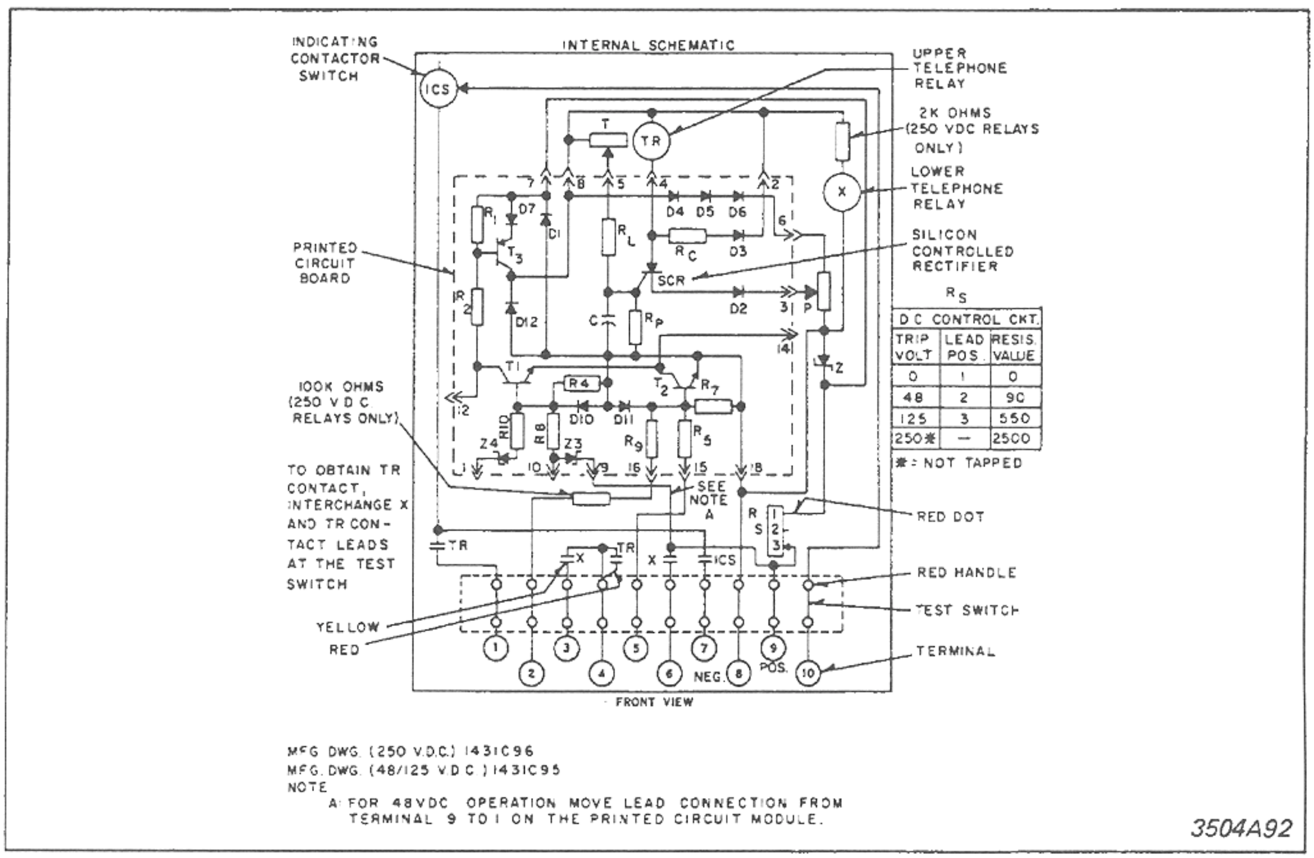

Fig. 3. Internal Schematic of TD-50 with X telephone relay and High Threshold Starting Voltage.

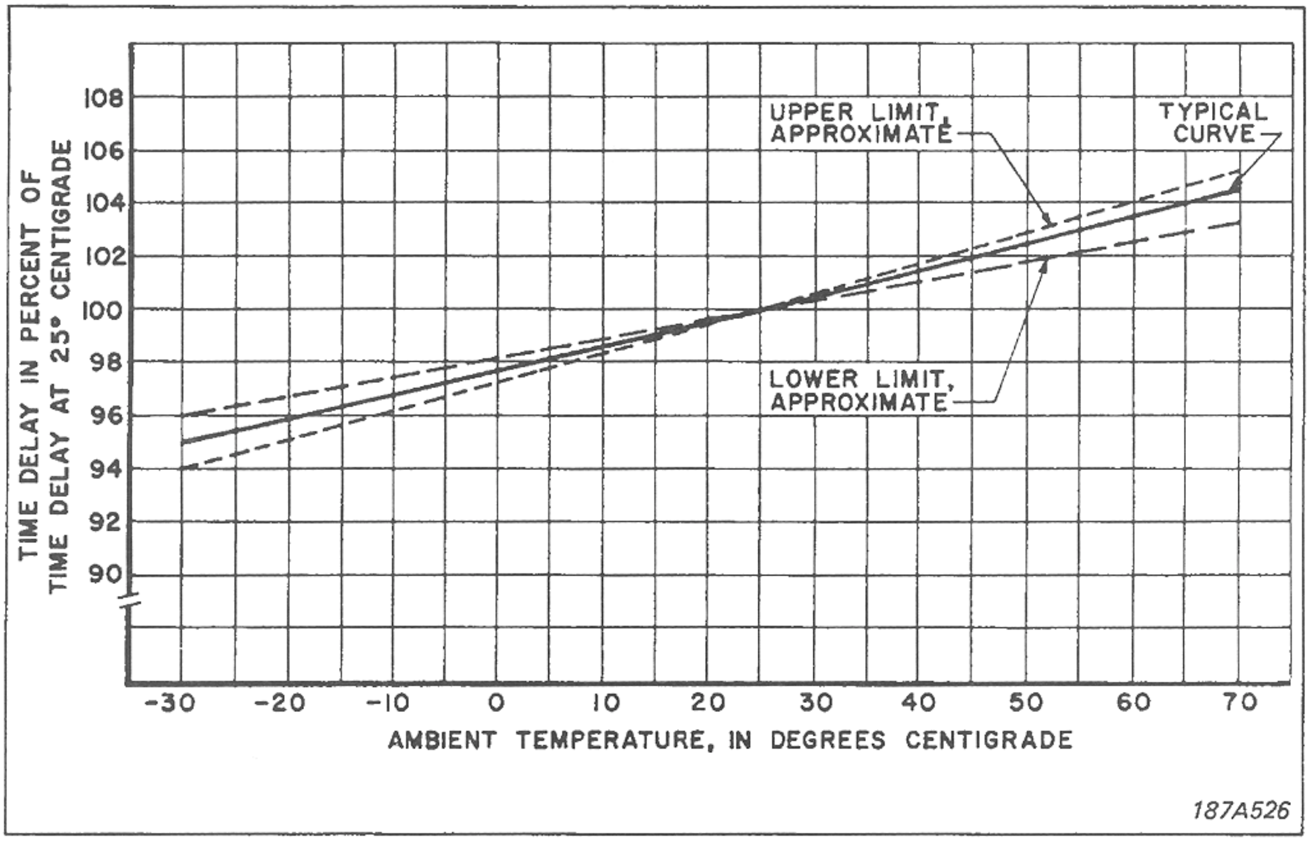

Fig. 4. Timing Variation with temperature changes.

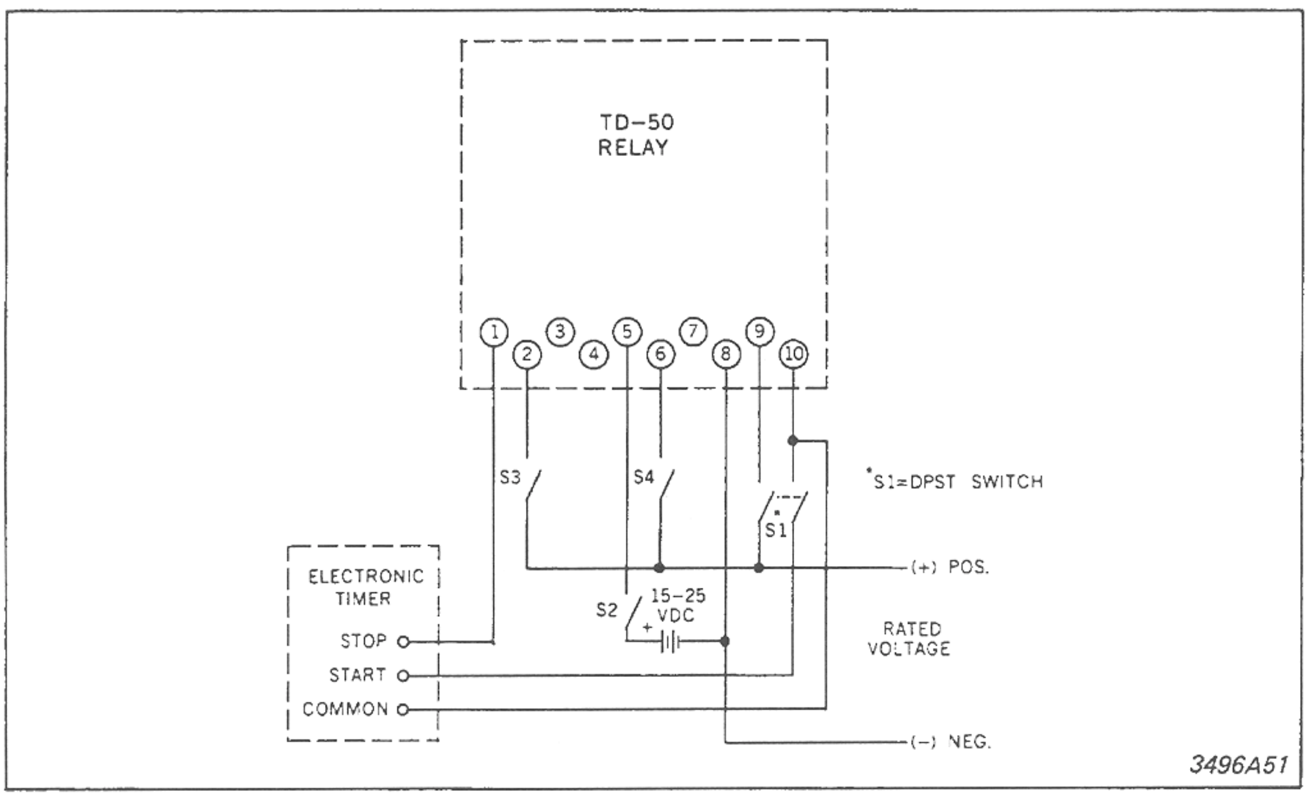

Fig. 5. Test circuit for TD-50 relay with X telephone relay.

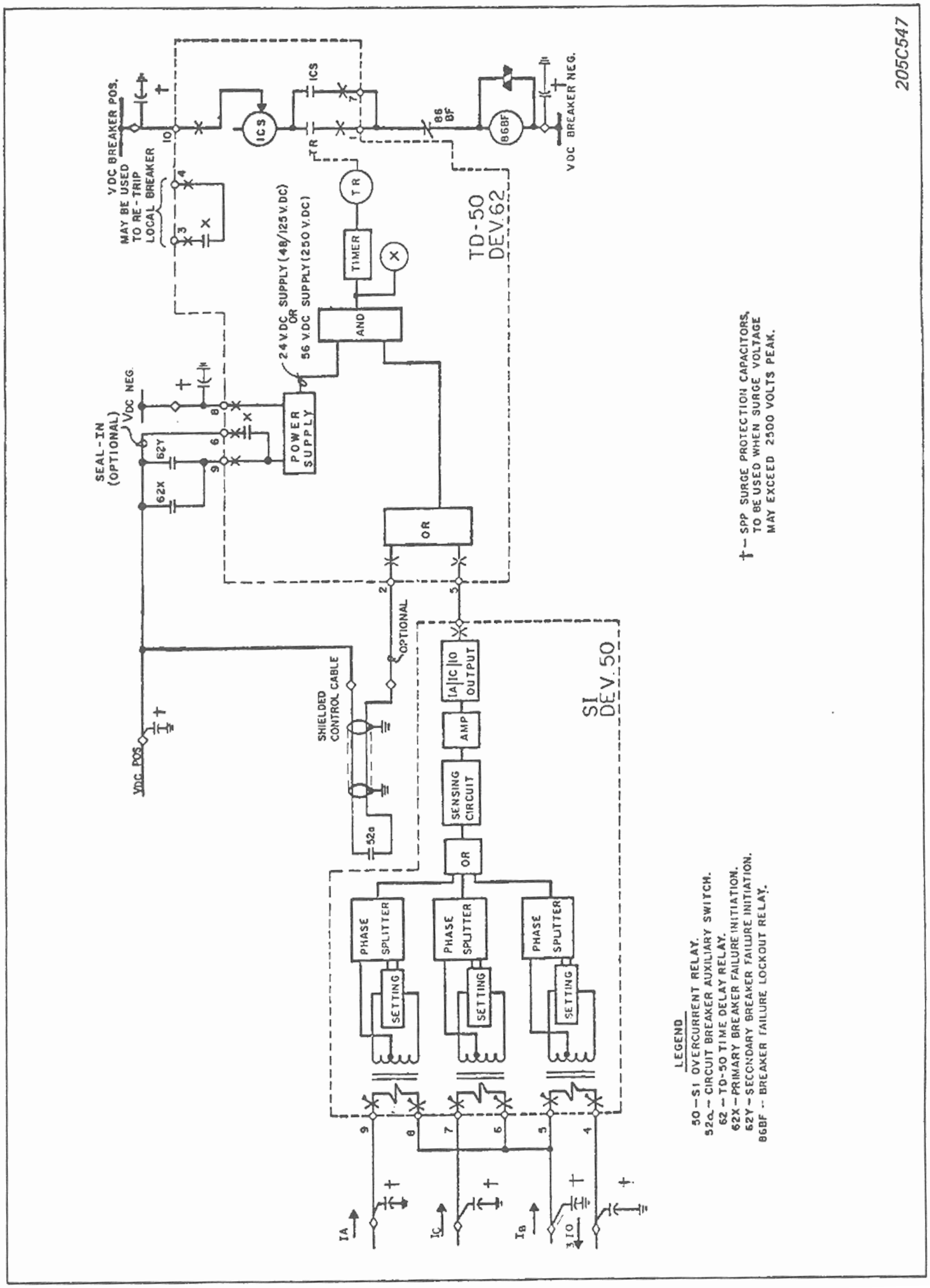

Fig. 6. External schematic of TD-50 relay with X telephone relay.

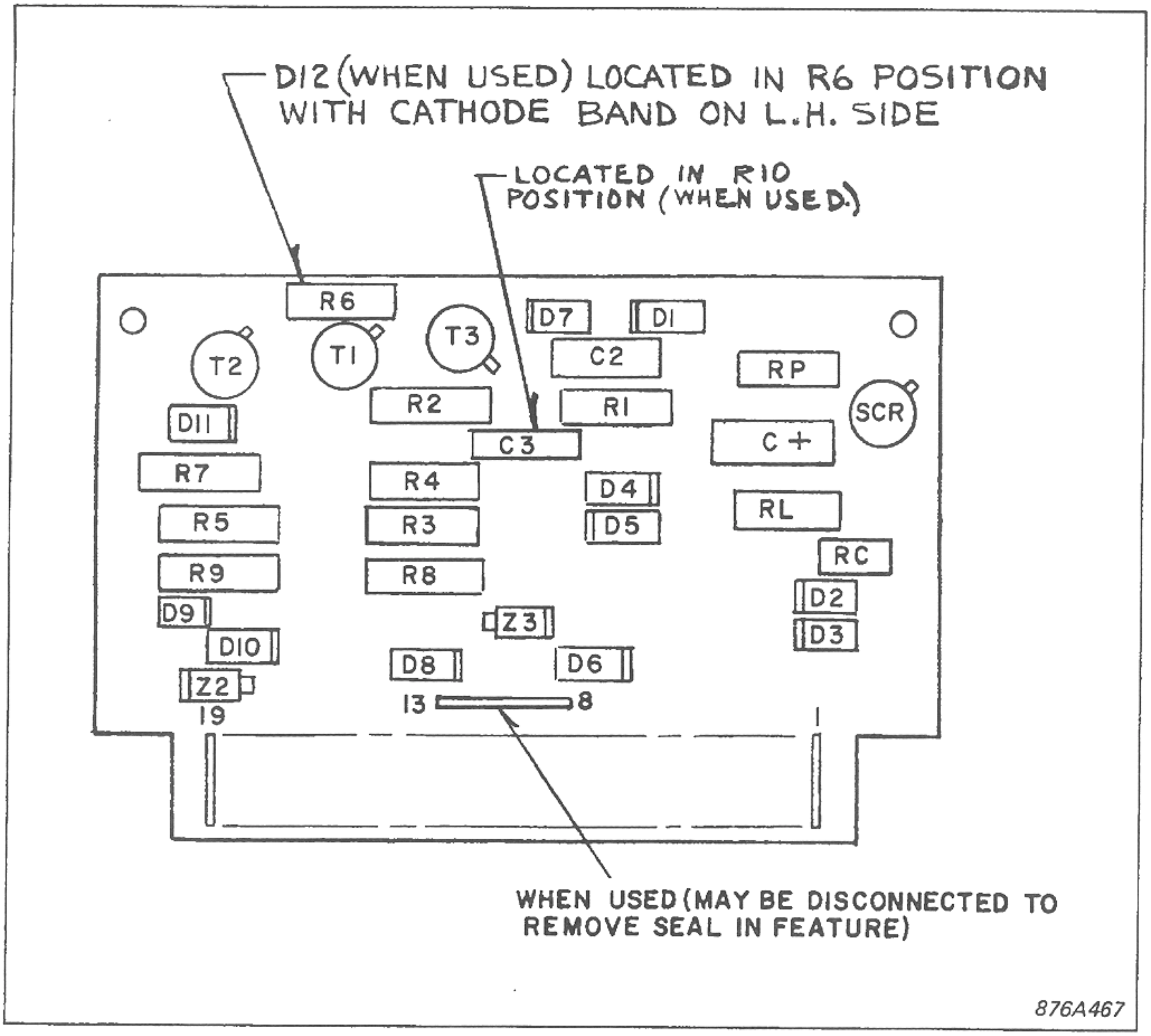

Fig. 7. Circuit Board Assembly Component Location.

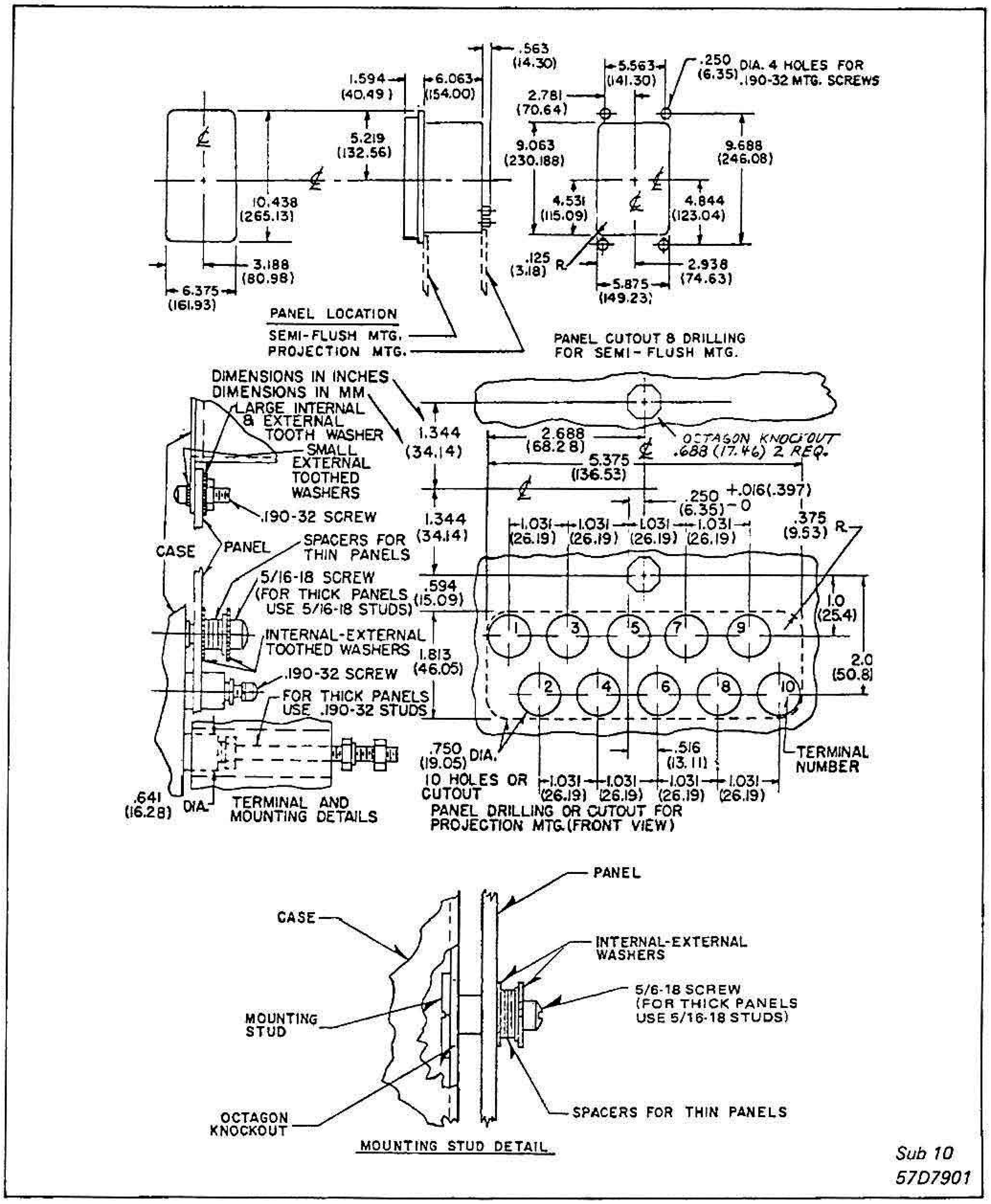

Fig. 8. Outline and Drilling Plan for Relay in FT-21 Case.

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