INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE SBF-1 CIRCUIT BREAKER FAILURE RELAY

CAUTION: It is recommended that the user of this equipment become acquainted with the information in these instructions before energizing the relay. Failure to do so may result in damage to the equipment. Before putting the relay into service, operate the relay to check the electrical connections.

Printed circuit modules should not be removed or inserted while the relay is energized. Failure to observe this precaution may result in an undesired tripping output or cause component damage.

APPLICATION

The SBF-1 is a solid state breaker failure detection relay with contact output. It is used in conjunction with the primary and backup relays. Other logic inputs (such as the 52a contact) may be used where the fault current is insufficient to operate the current detector.

The relay is applicable with any of the bus/breaker schemes in general use.

Provision is included in the relay for "retripping" the breaker without time delay. This may avoid clearing a bus during incorrect maintenance procedure or due to the failure of a trip contact to close.

CONSTRUCTION

The SBF-1 Relay consists of a phase and ground current detector, a breaker failure timer, a control timer, a seal-in (X) relay and an output relay (AR) along with 2 indicating contactor switches (ICS).

Overcurrent Detector

The detector consists of 3 or 4 input transformers and a plug in module. The primary of the transformer is tapped and brought out to a tap block located on the front of the relay. Each transformer has three taps which cover the range of pickup.

The secondary of the transformers are connected to the input of the plug-in detector module where the phase and ground signals are connected to separate pickup level adjustments located on the front of the module. A comparator circuit consists of a plug-in operational amplifer whose output is connected to logic circuitry which controls the AR output relay.

Also located on the module is a reed relay (RR) which is controlled by the breaker failure (BF) timer on the timer module. The normally open contacts of the reed relay are connected in the current detector circuit and controls the operation of the circuit.

BF and Control Timer

These timers are located on the timer plug-in module.

The BF timer can be continuously varied over the range by means of an adjusting knob located at the front of the module. A calibrated scale permits setting the desired time delay. A test jack is also located at the front if it is desired to check the setting with an electronic test timer.

At the bottom of the front plate is an access hole which permits adjusting the control timer

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.

trimpot. A test jack is also supplied to change the control timer delay in conjunction with a tester if other than the factory setting is desired.

Power Supply

Consists of a zener diode (Zs) mounted on an L shaped heat sink. The zener is connected to a 2 inch tubular resistor (RS). A small capacitor (C3) located on the timer module is connected across the zener diode.

Telephone Relay (X)

This is a clapper type auxiliary relay with two normally open contacts.

Output Relay (AR)

This is a 4 pole normally open high speed auxiliary output relay used for tripping duty.

The relay coil is connected in series with a 2 inch tubular resistor (RA).

Indicating Contactor Switch Unit (ICS)

The dc indicating contactor switch is a small 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 front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

OPERATION

The operation of the SBF-1 is somewhat different than the conventional breaker failure relay. It may be summarized by saying that the breaker failure relay timer is started by only the BFI (62X) input rather than the BFI and the overcurrent fault detector. The breaker failure timer controls the fault detector so that after it times out, the overcurrent signal (if present) is connected to the level detector. This arrangement keeps the overcurrent input transformer load at a low level. This permits fast reset of the secondary voltage of 3 ms or less, even at very high multiples of pickup current. By use of an additional timer (called the control timer) the breaker failure timer as well as the X seal-in relay is reset after it times out. The circuit operation can be explained by referring to the internal schematic drawing 775B813 (Fig. 2) and detailed internal schematic 1326D19 (Fig. 3).

During stand-by condition the dc input to the relay (terminal 9 positive) is zero since the dc control voltage is connected through the breaker failure initiate contact (see the external schematic) which is normally open.

Upon the closing of the BFI contact and providing the dc voltage is 80% or greater (of rated value) a level detector zener diode Z1 (connected to terminal 9) will permit transistor Q2 and Q1 to turn on. The power supply consisting of a 10 watt zener Zs and 25 watt resistor Rs is also energized which supplies a regulated 24Vdc to the modules and the X relay. When transistor Q2 and Q1 turn on it connects the regulated power supply to the control timer which consists of ½ of IC1, trimpot P2 and timing capacitor C1. Resistor R26 and R27 form a voltage divider which requires approximately one time constant [(P2+R22) x C1)] before the output terminal 12 goes from 24Vdc to less than 2.5Vdc. At the same time the control timer receives power through Q1, the 24Vdc output of the control timer (term. 12 of IC1) is used to turn on transistor Q7 which operates the X relay. One X contact is brought out to relay terminal 15 to permit seal-in of the initiate contact. This is desirable where the BFI contact is only picked up for a short time. The initiate contact must be closed for 8 ms in order for seal-in to take place. While the control timer is timing out, the BF timer will time out first since it is always set for a shorter delay. The output of the BF timer is connected to terminal 9 of the timer module which is wired to terminal 2 of the overcurrent detector module. Since operation of the BF timer is indicated by a voltage drop to less than 2.5V, transistor Q1 turns off and transistor Q2 turns on to pickup the reed relay (RR). In addition, the output of the BF timer also supplies one of the two inputs to transistor Q5 which controls the AR relay switching transistor

(Q6). The other input controlling transistor Q5 is either the 52a contact input (if used) connected to relay terminal 18 or operation of the overcurrent unit circuit. This is obtained when the reed relay operates to remove the 100 ohm resistor (R19) from capacitor C1 and to apply the input current signal to terminal 5 of the IC1 on the overcurrent detector module. If this signal voltage is higher than the reference voltage at terminal 5 of IC1 the output voltage at terminal 10 (of IC1) will drop from its high state to less than 2.5 volts. This output change is then applied to the transistor logic circuit consisting of transistor Q3, Q4 and Q5 (on the timer module).

CHARACTERISTICS

Overcurrent Detector

The overcurrent detector has a range of 0.5 to 13.5 amperes. This is obtained by means of three tap settings in conjunction with the tap multiplier to give a continuous adjustment over the range. The pickup point is determined by multiplying the tap value by the tap multiplier setting. The operate speed varies from 3 ms to 8 ms. The reset time is 3 ms maximum and would be measured as the time for the secondary voltage to decay to 10 volts peak (with the reed relay RR contacts open). This reset time applies whether the input current is reduced to zero or up to 95% of pickup current.

Continuous rating is 10 amperes. One second rating is 250 amperes.

The accuracy of the pickup setting is 5% over the full range and 10% from -20 to +55°C. Since the setting is continously adjustable, closer setting accuracy can be obtained by using a current source and a precision ammeter.

CAUTION: Since the tap block connector screw carries operating current, be sure that the screw is turned tight.

In order to avoid opening the current transformer circuits when changing taps under load, connect the spare tap screw in the desired tap position before removing the other tap screw from the original tap position.

Control Timer

The range of the control timer is 150 to 250 ms. The timer as received should be set for approximately 200 ms.

The timer setting can be changed by means of a screwdriver through the hole on the front plate of the timer module.

The accuracy is 5% over the temperature and voltage range.

BF Timer

The range of the RFI timer is 18 to 175 ms. It is set by means of a knob and calibrated scale at the front of the timer module.

The accuracy of the pickup setting is 5%. Since the setting is continuously adjustable, the timer may be set closer by instrumentation.

The accuracy is 5% over the temperature and voltage range.

Power Supply

Consists of a 10 watt zener diode (Zs), a resistor (Rs) and provides a regulated voltage of 24Vdc $\pm$10% over the voltage and temperature range. A capacitor C3 is connected across the zener diode to decrease the rate of rise and fall of the output voltage to reduce transient effects.

Both modules and the telephone relay (X) are energized by the power supply.

Temperature and Voltage

The relay is operative over a range of 80 to 110% of rated voltage and from -20 to +55°C.

It can be energized continuously at 110% of rated input voltage.

Capacitive Effect

The capacitive surge immunity is as follows (considering the 52a contact input present):

Relay Rating	BF Timer Setting	Capacitance
48 Vdc	18 ms or higher	18 MFD
125 Vdc	18 ms or higher	6 MFD
125 Vdc	35 ms or higher	13 MFD
250 Vdc	18 ms or higher	2.5 MFD
250 Vdc	35 ms or higher	13 MFD

Any value of capacitance effectively in series with the input greater than that shown above might result in an undesired trip operation.

Ordinarily capacitance should not be connected from the lead connecting the 52a contact to the relay and ground. A value of 0.5 MFD could cause the 52a input to stay on for 1.5 ms (48V relay), 4.5 ms (125V relay) and 20 ms (250V relay) after the 52a contact opened.

X RELAY

Coil resistance is 1500 ohms ±5% and rated for 24Vdc operation. The seal-in contact will pickup providing the BFI (62X, 62Y) initiate contacts are closed for a minimum of 8 ms. A second contact is wired to the relay terminal to provide a retrip feature.

AR RELAY

The coil resistance is 630 ohms ±5% and will operate in series with the appropriate resistor from 80% to 110% of rated voltage.

The operate speed is 3 to 5 ms at rated voltage. The dropout time is 30 to 45 ms (diode around the coil). There are 4 normally open contacts available.

INDICATING CONTACTOR SWITCH (ICS)

The coil resistance is approximately 6.5 ohms on the 0.2 amp tap and 0.15 ohms on the 2.0 amp tap.

TRIP CIRCUIT

The main contacts will safely close 30 amperes at 250 Vdc and the seal-in contacts of the ICS will safely carry this current long enough to trip a circuit breaker.

SETTINGS

OVERCURRENT DETECTOR

The pickup of the overcurrent unit is obtained by means of a tap screw and tap block in conjunction with the tap multiplier knob setting located at the front of the overcurrent unit module. This permits a continuous adjustment over the range of 0.5 to 13.5 amperes. Each tap setting permits adjusting the pickup over a 3 to 1 range.

There are 2 or 3 phase inputs depending on the relay style. Each one has its own tap block. Normally all the phase settings should be in the same tap. The operate point for each phase should be within 5% of each other. There are trimpots for each input located on the overcurrent module which are factory adjusted but which may be readjusted if the 5% accuracy must be improved at any one pickup point.

The ground unit pickup is obtained similar to the phase above and is independent of the phase pickup. This permits the ground setting to be lower than the phase setting.

The phase units must be set below the minimum expected fault current and the ground unit set below the minimum expected residual (3I0) current. Settings should be made to assure a multiple of pickup of at least 2 under minimum fault conditions.

CONTROL TIMER

The control timer can be set by use of a screwdriver to adjust the trimpot which is accessible through the hole in the front plate of the timer module. Clockwise rotation will increase the on time. An oscilloscope or electronic timing device can be connected between the bottom red test jack on the timer module front plate and terminal 8 of the relay (common negative).

The control timer should be set for at least 16 milliseconds longer than the BF timer. This allows for pickup time of the reed relay (1 to 3 ms), AR

relay pickup (3 to 5 ms) and operate time of the o/c unit (3 to 8 ms).

The range of adjustment is a minimum of 100 ms (150 to 250 ms).

The control timer must be set at least 16 ms longer than the breaker failure timer. The control timer acts essentially as a pulse stretcher on the BFI input and then resets. Since the overcurrent unit never picks up on successful clearing, it cannot be used as a cutoff for the breaker failure timer.

BF TIMER

A calibrated scale located on the front of the timer module permits setting the time delay from 18 to 175 milliseconds. The scale is calibrated in 25 ms increments. If more accurate settings are desired an oscilloscope or electronic timer may be connected between the upper red test jack on the timer module and terminal 8 of the relay (Common Negative). Jumpering test point TP6 and TP7 on the timer module prevents the control timer from resetting the BF timer and will help in setting the BF timer. Remember that if the control timer is set shorter than the BF timer, the BF timer will not be able to operate the reed relay (RR).

A locking tab is provided to hold the BF timer setting from being accidentally changed.

The breaker failure timer should be set to exceed the breaker normal clearing time by an appropriate margin. Where the breaker contains a resistor that is inserted on tripping and the overcurrent fault detectors are set below the resistor current, the additional time for this interruption must be included. A secure margin for the SBF-1 is 2 cycles. (33 ms)

INDICATING CONTACTOR SWITCH (ICS)

Connect the lead located in front of the tap block to the desired setting by means of the connecting screw.

When the relay energizes a 125 or 250 Vdc type WL relay switch or equivalent use the 0.2 amp tap. For 48 Vdc applications set the unit in the 2 amp tap and use a type WL relay with a S#304C209G01 coil or equivalent.

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 rear mounting stud or studs for the type FT projection case or by means of the four mounting holes 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.

ADJUSTMENTS AND MAINTENANCE

The proper adjustment to insure correct operation of this relay have been made at the factory and should not be disturbed.

Routine Test

The following check is recommended to insure that the relay is in proper working order. Refer to Fig. 10 for test connections.

Overcurrent Detector

Check for correct scale marking by placing all the tap settings in the 0.5 Amp. position and rotate the Phase and Ground tap multiplier knob (on the overcurrent unit knob) to the X1 calibration mark.

Jumper test point TP 6 and TP7 on the timer

module and apply rated dc voltage. Also apply phase current to phase A input. The voltage at test point TP3 on the overcurrent module should drop from approximately 23.5 volts to less than 2.5 Vdc when the ac current input is between .48 and .52 amperes. The AR output relay will pickup at the same time.

Use the same test with applying current to phase C (and also phase B if used). Pickup should be within 5% of the phase A pickup.

Rotate Tap Multiplier Knob to the X3 setting and repeat above. The operate current should be between 1.44 and 1.56 amperes on phase A input and within 5% of phase A pickup for phase C (and phase B if used).

For setting Phase A current operate level, set the tap screw in the proper range location and set the phase tap multiplier at the point at which the voltage at TP3 changes from high to low at the desired input current. The phase C and Phase B (if used) tap screws should be set for the same current range.

The Ground overcurrent setting is checked and set exactly like the phase overcurrent circuit.

A locking feature is provided to hold the tap multiplier knob at the desired setting.

Control Timer

Use a low bounce initiate contact in series with relay terminal 9 (positive). Connect an electronic timer to the relay so that the start input is connected to relay terminal 9 (through a voltage divider, if necesary). The stop input should be connected to the bottom test jack on the timer module. The common should be connected to terminal 8. The test timer start input should be adjusted to commence timing on a positive going slope and to stop timing on a negative going slope.

The control timer output should go from a high state to a low state in 190 to 210 milliseconds.

If some other time interval is desired, the timer setting may be changed by means of a screw driver adjustment through the access hole on the timer module to a multiturn potentiometer. Use the electronic test timer in the manner described to obtain the desired time interval. Remember that the Control Timer should always be set at least 16 milliseconds longer than the BF timer. The adjustment range is 150 to 250 ms.

BREAKER FAILURE (BF) TIMER

This may be checked in the same way as the Control Timer.

First jumper test points TP6 and TP7 on the timer module. Connect the test timer stop lead to the upper test jack on the timer module. Output of the BF timer takes place when it goes from a high state to low state (similar to the Control Timer output).

Set the timer knob at the desired setting and verify setting by operating the timer several times. The timer should operate within 5% of the setting. The setting may be made closer by means of the electronic test timer.

When the desired setting has been obtained it may be locked in place by means of the locking tab.

Overall operation may be checked by connecting rated dc voltage to relay terminal 18 (52A breaker auxiliary contact input).

Remove jumper from test point TP6 and TP7 on the timer module.

Now when the test switch to terminal 9 is closed, the AR output relay should pickup momentarily and reset even though the test switch is left closed. Remember that the BF timer setting should be 16 ms or more longer than the Control Timer.

Reduce voltage to relay terminal 18 to 60% of rated relay voltage. Close test switch and note that AR relay does not pickup.

Return voltage to normal and reduce voltage to terminal 9 to 60% of rated relay voltage. Close test switch and note that AR relay does not pick up.

Indicating Contactor Switch (ICS)

There are two ICS units used. Each may be checked by placing the ICS tap screw in the desired tap (0.2 or 2 Amps). Adjust the dc current to the tap value.

Test for seal-in by closing switch to terminal 9 and see that each ICS picks up and seals itself in the closed position.

The contact gap should be approximately .047". Both stationary contacts should make with the moving contacts simultaneously. The indicating target should drop just prior to or at the same time the contacts make.

Routine Maintenance

The relay should be inspected periodically. The operation of the overcurrent circuits, timers and indicating contactor switch should be checked similar to procedure described under SETTINGS. In addition inspect the X and AR relay contacts. A contact burnisher S#182A836H01 is recommended for cleaning contacts. The use of abrasive material for cleaning contacts should be avoided because of the danger of embedding small particles in the face of the contact material which might impair the contact operation.

Calibration

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments have been disturbed. This procedure should not be used unless it is apparent that the relay is not in proper working order.

Overcurrent Detector

Refer to Fig. 7 and 8 or 9 when replacing components.

If a new module is inserted, it will require calibration of the dial plate. Other replacement parts such as a transformer or certain components on the module such as the reference zener, operational amplifier, rheostat, etc. might require new scale markings. In that case a new dial plate will be necessary.

To mark the dial, first jumper test point TP6 and TP7 on the timer board. Energize the relay with rated dc voltage and apply 0.48 Amps ac current to phase A. With the tap in the 0.5 position and the phase multiplier dial knob fully counterclockwise, rotate the phase A trimpot slowly CCW (to lower pickup). Operation of the overcurrent unit is indicated when the AR output relay picks up. Verify this adjustment by increasing the ac current until the relay again picks up. This should be between 0.47 and 0.49 amps. Now turn the front panel dial knob fully CW. Check to see that pickup is 1.55 to 1.80 amps. If it is slightly below 1.55 amps, rotate the phase A trimpot CW slightly clockwise to raise the pickup to 1.55 amps. Go back and check to see that the pickup with the dial knob fully CCW is no higher than .495 amps. Adjust knob on shaft so that the high and low operate point are equidistant from the knob lock. Apply 0.5, 0.7, 0.9, 1.1, 1.3, and 1.5 amps and scribe the scale at the knob pointer setting at which the output relay just operates.

After scribing the scale, set the dial at 0.5 amp (X1) pickup and note what value current the output relay operates. Apply current source to phase C and note at what current value the output relay operates. If the difference is greater than .025 amp from phase A, adjust the phase C trimpot to bring the operate point within .025 amps of phase A. Repeat for phase B if used.

The same procedure should be followed for the ground overcurrent circuit as was used for phase A input.

Remove jumper from TP6 and TP7 on the timer module.

Control Timer

Refer to Fig. 4 and 5 or 6 when replacing components.

If components in the control timer circuit have been replaced or if it is desired to change the control timer setting the same procedure should be used as described under acceptance testing.

Breaker Failure (BF) Timer

If the scale appears to be off calibration due to

slippage of the knob pointer on the shaft, this can be corrected by rotating the shaft fully CCW. Now adjust the knob at the pin prick mark. This should return the knob to its original position on the shaft and bring the scale markings back into calibration.

If components in the breaker failure timer circuit have been replaced it may be necessary to change the scale plate and recalibrate. First jumper test points TP6 and TP7. Using a low bounce initiate switch adjust timer knob until a 25 ms time delay has been obtained. Use test procedure described under acceptance testing for measuring time delay. Note the knob position for 25 ms delay. Also note the knob position for 175 ms delay. Loosen the set screw and position the knob on the shaft so that the 25 and 175 ms locations are equidistant about the knob locking tab. Scribe lines at the 25 ms setting and for each 25 ms increment up to 175 ms.

Indicating Contactor Switch (ICS)

Adjust the contact gap for approximately .047" by adjusting the stationary contacts. Both contacts should make simultaneously.

Check to see that the contacts close at rated tap value current. The indicating target should drop at or just prior to the contacts closing. The targer should drop freely.

If the target does not drop or does not reset it may be necessary to remove the cover and bend the tab on the spring that supports the target.

TROUBLE SHOOTING

The components in the SBF-1 relay are operated well within their rating and normally will give long and trouble free service. However, if a relay gives indication of trouble in service or during routine checks the following information will prove helpful. All measurements are approximate and may vary as much as 20%. All voltages are positive with reference to common negative (relay terminal 8) except ac voltages.

Timer Module

1. Jumper test points TP6 and TP7.
   a. Apply rated relay voltage. Voltage at lower test jack=23.5V
   b. Remove jumper. Apply rated voltage. Voltage at lower test jack=less than 2.5 Vdc.
2. Jumper test points TP6 and TP7
   a. Apply rated relay voltage. Voltage at upper test jack=less than 2.5 Vdc.
   b. Remove jumper. Apply rated voltage. Voltage at upper test jack=less than 2.5 Vdc.
3. Jumper test points TP6 and TP7.
   a. Apply rated voltage. Voltage at terminal 6 of IC1=18.3V.
   b. Remove jumper. Apply rated voltage. Voltage at terminal 6 of IC1 should be approximately 0.1 Vdc less than voltage measured in section a.
4. Jumper test points TP6 and TP7.
   a. Apply rated relay voltage. Voltage at terminal 7 of IC1=20.8V with timer knob fully CW.
   b. Voltage at terminal 7 of IC1=23.8V with timer knob fully CCW.
5. Jumper test points TP6 and TP7.
   a. Apply rated relay voltage. Voltage at terminal 2 of IC1=16.5V.
   b. Remove jumper and apply voltage. Voltage at terminal 2 of IC1 should be approximately 0.1V less than voltage measured in section a.
6. Apply twice tap value ac current.
   a. Apply rated relay voltage. Voltage at TP3=12.7V. Voltage at TP4=less than 0.5V.
   b. Interrupt ac current. Voltage at TP3=less than 0.5V. Voltage at TP4=12.7V.
7. Apply rated voltage to relay terminal 18 (52a input).
   a. Apply rated relay voltage to terminal 9. Voltage at TP4=less than 0.5V.
   b. Reduce voltage to terminal 18 to 60% of rated relay voltage. Voltage to TP4=12.7V.

8. Jumper test point TP6 and TP7. Apply twice tap value ac current.

   a. Apply rated relay voltage. Voltage at TP5=6.2V.
   b. Remove jumper. Apply rated voltage. Voltage at TP5=less than 0.5V.

9. Jumper test point TP6 and TP7.

   a. Apply rated relay voltage. Voltage at printed circuit board terminal 10 or 11=less than 0.5V (X and AR relay picked up).
   b. Remove jumper. Apply rated voltage. Voltage at pc terminal 10=24V (X relay not picked up). Voltage at pc terminal 11=rated relay voltage (AR relay not picked up).

Overcurrent Module

1. Jumper test points TP6 (timer module). Set tap in 0.5 hole and turn tap multiplier knob to X1 position.

   a. Apply 0.5 amp ac current to the particular input in question. Then apply rated relay voltage. Measure 6.6 Vac at the transformer secondary terminals. The same voltage should be read with the tap in the 1.5 amp tap and 1.5 amps ac applied. Likewise with the 4.5 amp tap.

2. Jumper test points TP6 and TP7. Set tap in 0.5 hole and turn tap multiplier to X1 position.

   a. With 0.4 amp ac current flowing apply rated relay voltage. Measure voltage at terminal 5 of IC1 to be 6.4V. Now increase the current until the output relay operates. The voltage should now read approx. 5.4V. At this point the voltage at terminal 4 should measure 6.4V. The voltage at printed circuit board terminal 3 should measure 23.5Vdc before the output relay operates and less than 2.5V after it operates.

3. Jumper test points TP6 and TP7. Set tap in 0.5 hole and turn tap multiplier knob fully CW.

   a. Apply 0.5 amp ac and apply rated relay voltage. Measure 4.2 volts at the brush terminal of the tap multiplier rheostat.

4. Jumper test points TP6 and TP7 (timer module).

   a. Apply rated relay voltage. Measure 6.2V at TP1 and less than 0.5V at TP2.
   b. Remove jumper. Apply rated relay voltage. Measure less the 0.5V at TP1 and 24V at TP2.

5. Check of Reed relay (RR) contact.

   a. Resistance should be greater than 500 ohms when measured from jumper J1 to common negative.
   b. Jumper test points TP6 and TP7 and apply rated relay voltage. Resistance should drop to less than 5 ohms.

6. Check coil resistance of reed relay (RR) (1000 ohms), AR relay (630 ohms) and X telephone relay (1500 ohms). Attention should be paid to polarity since each of the coils have a diode connected across it.

RENEWAL PARTS

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

TABLE I
ENERGY REQUIREMENTS
60 HZ

TAP	0.5							
TAP MULT.	1 (0.5A PICKUP)				3 (1.5A PICKUP)			
REED (RR) CONTACT	OPEN*		CLOSED		OPEN*		CLOSED	
Current	0.5A	5.0A	0.5A	5.0A	1.5A	1.5A	0.5A	5.0A
VA	.15	2.1	.04	2.2	.53	2.1	.33	2.2
OHMS	.6	.08	.16	.09	.23	.08	.15	.09
P.F. Angle**	75	25	15	27	63	25	20	27

TAP	1.5							
TAP MULT.	1 (1.5A PICKUP)				3 (4.5A PICKUP)			
REED (RR) CONTACT	OPEN*		CLOSED		OPEN*		CLOSED	
Current	1.5A	5.0A	1.5A	5.0A	4.5A	5.0A	4.5A	5.0A
VA	.165	.75	.06	.60	.63	.75	.50	.60
OHMS	.073	.03	.027	.024	.031	.03	.024	.024
P.F. Angle**	45	36	15	15	36	36	15	15

TAP	4.5							
TAP MULT.	1 (4.5A PICKUP)				3 (13.5A PICKUP)			
REED (RR) CONTACT	OPEN*		CLOSED		OPEN*		CLOSED	
Current	4.5A	5.0A	4.5A	5.0A	13.5A	5.0A	13.5A	5.0A
VA	.23	.28	.16	.20	1.6	.28	1.5	.20
OHMS	.011	.011	.008	.008	.008	.011	.008	.008
P.F. Angle**	36	18	5	4	9	18	3	4

* = Saturated Burden
** = Current Lagging Voltage

TABLE 2
BATTERY DRAIN

CONDITION	48Vdc	125Vdc	250Vdc
Standby	0	0	0
During Timing	120mA	95mA	90mA
Trip (AR Relay Picked up)	155	130	125

TABLE 3
CURRENT RATING

CURRENT RANGE (Phase and Ground)		0.5 to 13.5 Amperes
TAP RANGES	**CONTINUOUS**	**1 SECOND**
0.5 to 1.5 Amps	10 Amps	250 Amps
1.5 to 4.5	10	250
4.5 to 13.5	15	300

TABLE 4
AR CONTACT RATINGS

			INTERRUPTING RATING	
CONTACT CIRCUIT RATING	**TRIP RATING**	**CARRY RATING CONTINUOUS**	**RESISTIVE**	**INDUCTIVE L/R=.005**
48Vdc	30 Amps	3 Amps	3.75 Amps	1.75 Amps
125	30	3	.5	.35
250	30	3	.25	.15

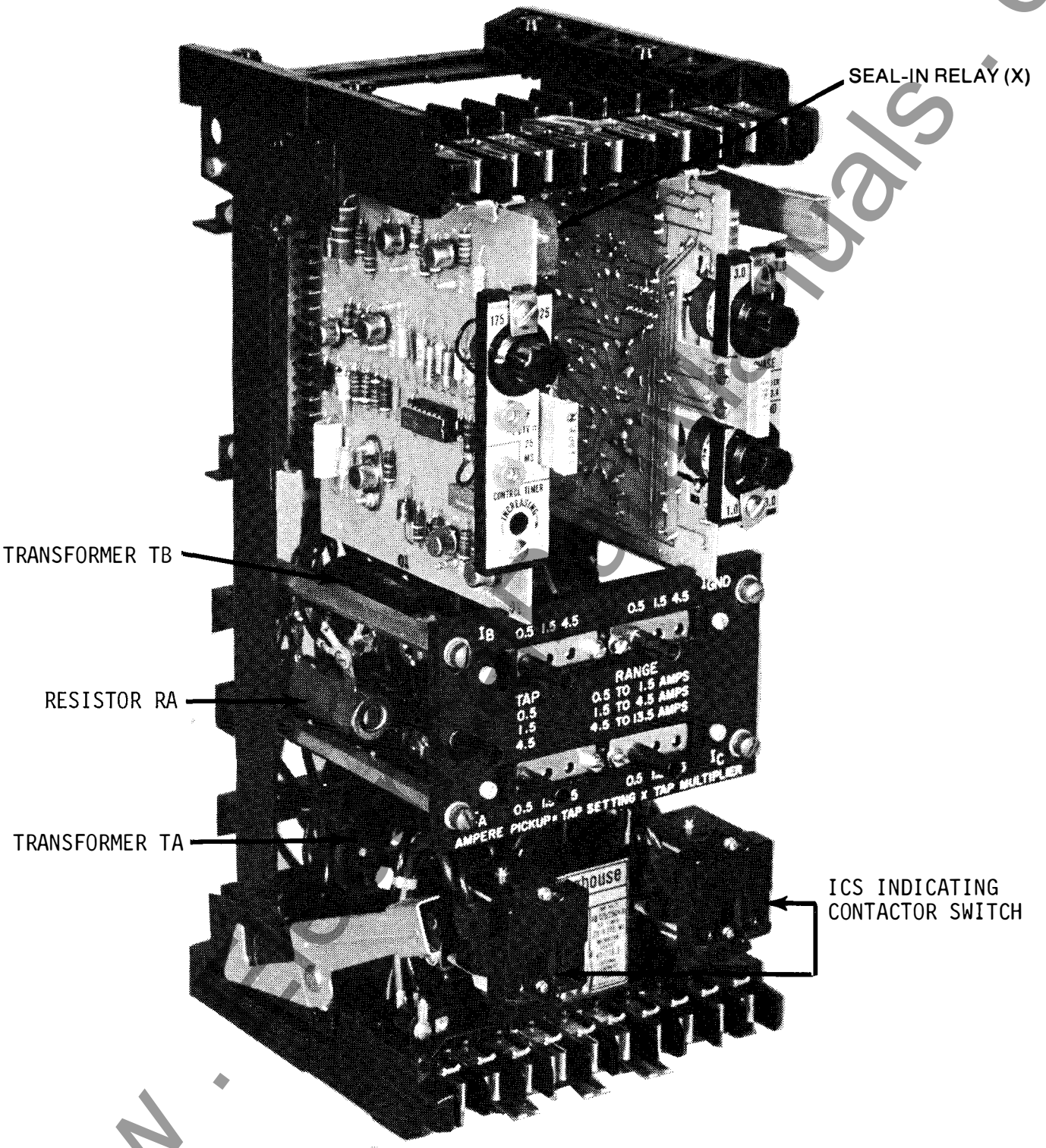
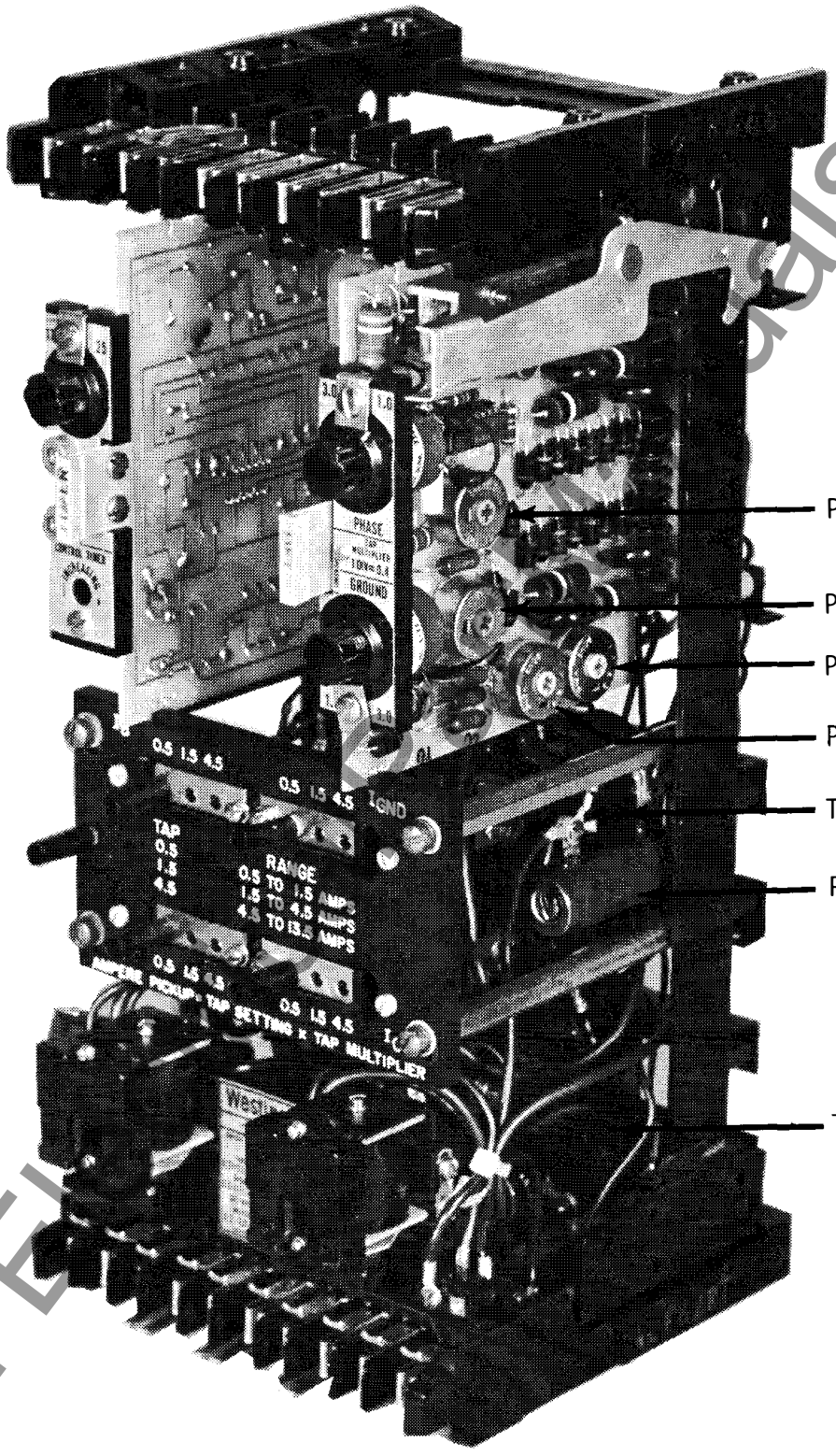
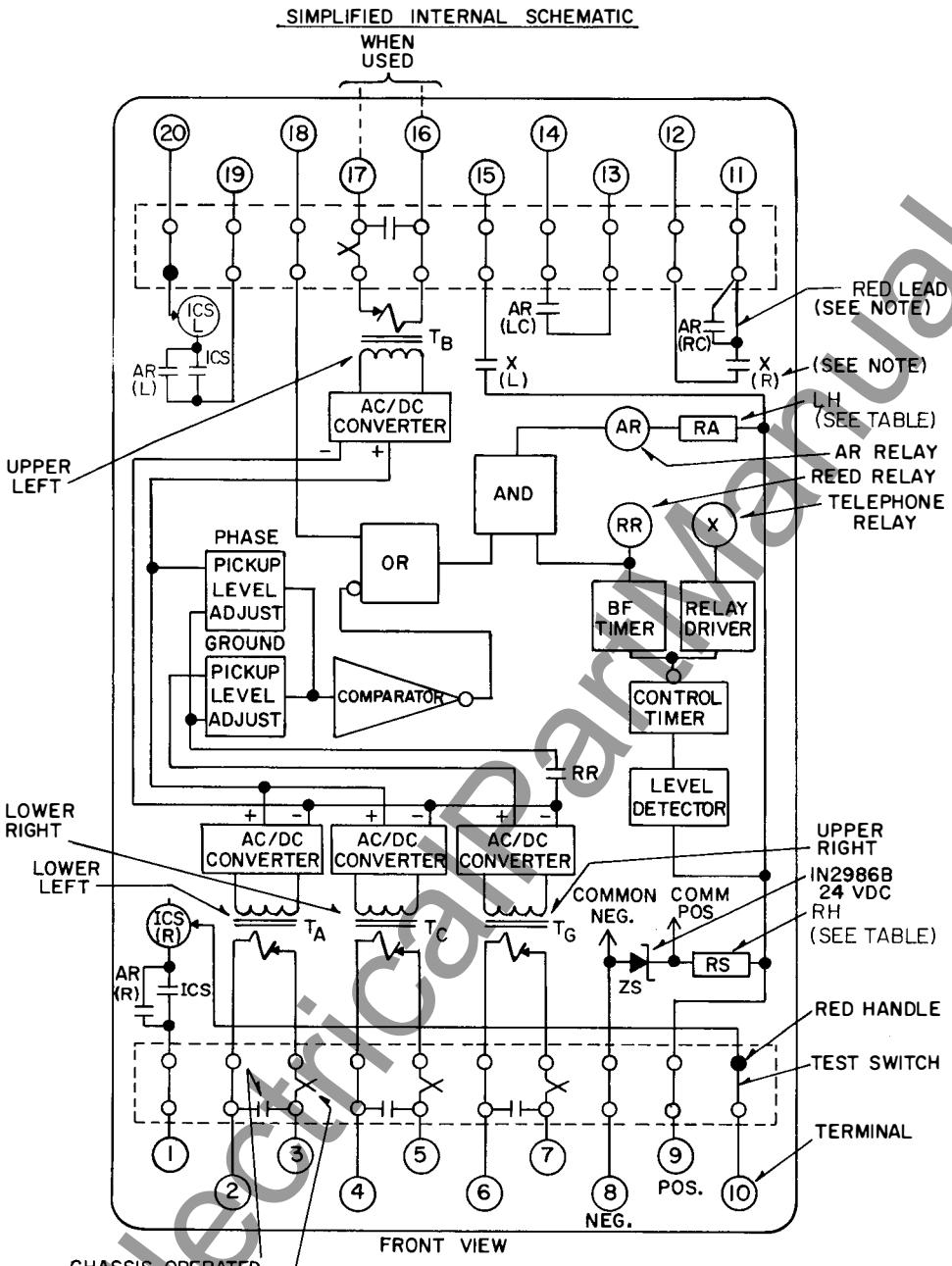


Fig. 1. Photograph of SBF-1 Relay, (without case) with four overcurrent input. Front view



(right oblique).



NOTES:

TO OBTAIN AR CONTACT OUTPUT, MOVE RED LEAD FROM TERMINAL 11 TO TERMINAL 12.

(L),(R),(LC) & (RC) DENOTE LEFT HAND, RIGHT HAND, LEFT CENTER & RIGHT CENTER POSITIONS.

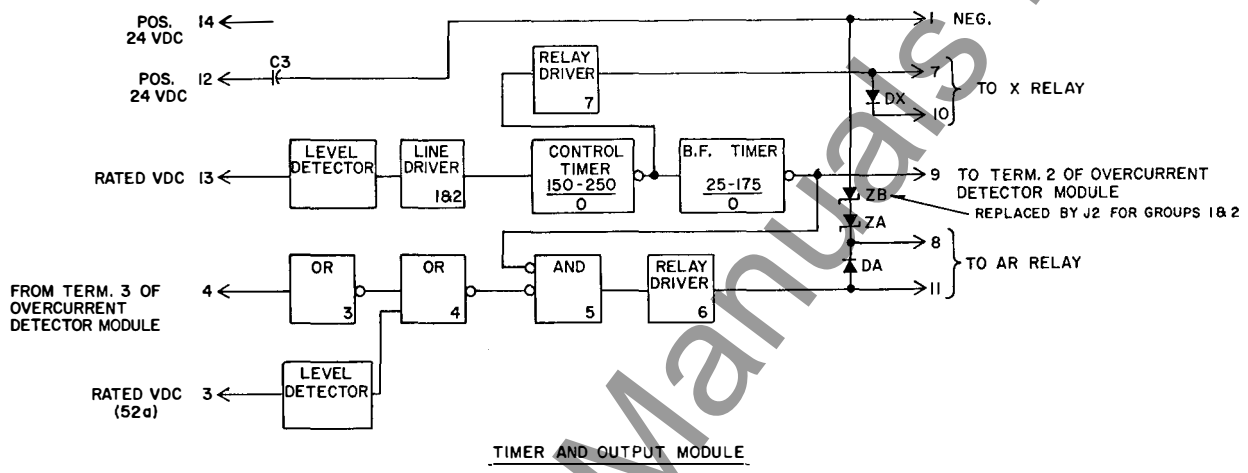
REF. DWG.

1326D19 - DETAILED SCHEMATIC
1326D31 - (4 OVERCURRENT UNITS) WIRING
1326D83 - (3 OVERCURRENT UNITS) WIRING

25W RESISTORS		
VOLTS DC	RA	RS
48	900Ω	200Ω
125	3150Ω	1000Ω
250	7100Ω	2500Ω

Dwg. 775B813

Fig. 2. Simplified Internal Schematic SBF-1 Relay.



TIMER AND OUTPUT MODULE

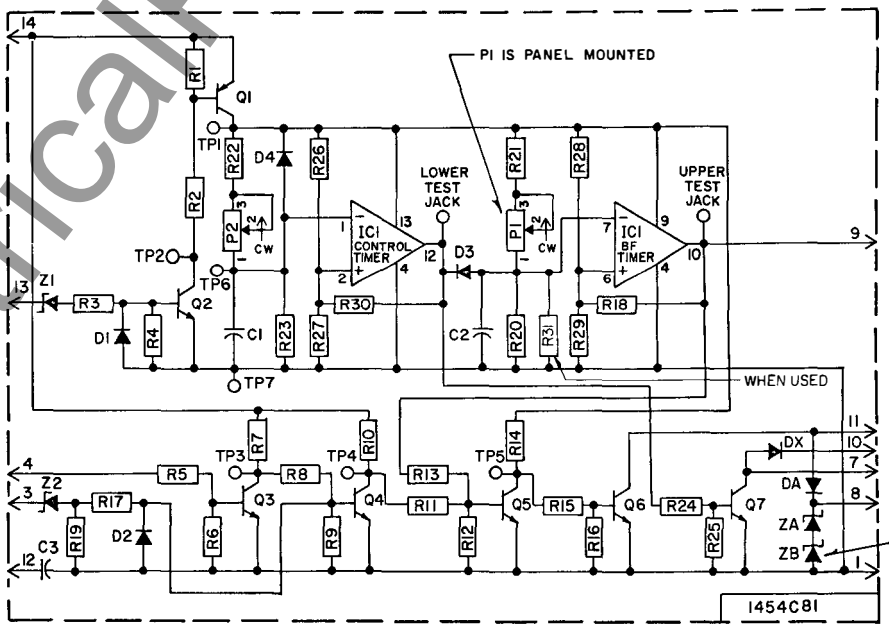


Fig. 4. Internal Sch

1454C81G01 (48 VDC)

CAPACITOR	DESCRIPTION	STYLE NO.
C3	.270UF 200V	188A669H05
C2	3.300UF 35V	862A530H01
C1	6.800UF 35V	184A661H21

DIODE	DESCRIPTION	STYLE NO.
D1-2	1N645	184A855H13
D3-4-A	1N459A	184A855H08
DX	1N5053	188A342H12

INT CKT	DESCRIPTION	STYLE NO.
IC1	747DM	1443C52H01

JUMPER	DESCRIPTION	STYLE NO.
J1-2	0 OHM RESISTOR	862A478H01

POT	DESCRIPTION	STYLE NO.
P2	20.0K .50W	862A406H02
P1	**25.0K .50W**	**880A687H02**

TRANSISTOR	DESCRIPTION	STYLE NO.
Q1	2N2905A	762A672H10
Q2-3-4-5-7	2N1711	762A585H08
Q6	2N4063	878A432H01

RESISTOR	DESCRIPTION	STYLE NO.
R4-6-9-12-15-25	2000.0 .50W 2%	629A531H39
R2-14	6800.0 .50W 2%	629A531H52
R1-16	10.0K .50W 2%	629A531H56
R7-8-10-11-22	15.0K .50W 2%	629A531H60
R3-17	20.0K .50W 2%	629A531H63
R5-13-24	27.0K .50W 2%	629A531H66
R20	162.0K .50W 1%	848A821H62
R26-28	20.0K .50W 1%	848A820H74
R27	40.2K .50W 1%	848A821H04
R21	3320.0 .50W 1%	848A819H98
R19	10.0K2.00W 5%	185A207H51
R29	60.4K .50W 1%	848A821H21
R23	499.0K .50W 1%	848A822H10
R18-30	2.2M .50W 5%	187A290H26

ZENER	DESCRIPTION	STYLE NO.
ZA	1R200 200.0V	629A369H01
Z1-2	1N971B 27.0V	862A606H11

1454C81G02 (125 VDC)

CAPACITOR	DESCRIPTION	STYLE NO.
C3	.270UF 200V	188A669H05
C2	3.300UF 35V	862A530H01
C1	6.800UF 35V	184A661H21

DIODE	DESCRIPTION	STYLE NO.
D1-2	1N645	184A855H13
D3-4-A	1N459A	184A855H08
DX	1N5053	188A342H12

INT CKT	DESCRIPTION	STYLE NO.
IC1	747DM	1443C52H01

JUMPER	DESCRIPTION	STYLE NO.
J1-2	0 OHM RESISTOR	862A478H01

POT	DESCRIPTION	STYLE NO.
P2	20.0K .50W	862A406H02
P1	**25.0K .50W**	**880A687H02**

TRANSISTOR	DESCRIPTION	STYLE NO.
Q1	2N2905A	762A672H10
Q2-3-4-5-7	2N1711	762A585H08
Q6	2N4063	878A432H01

RESISTOR	DESCRIPTION	STYLE NO.
R4-6-9-12-15-25	2000.0 .50W 2%	629A531H39
R2-14	6800.0 .50W 2%	629A531H52
R1-16	10.0K .50W 2%	629A531H56
R7-8-10-11-22	15.0K .50W 2%	629A531H60
R5-13-24	27.0K .50W 2%	629A531H66
R3-17	47.0K .50W 2%	629A531H72
R20	162.0K .50W 1%	848A821H62
R26-28	20.0K .50W 1%	848A820H74
R27	40.2K .50W 1%	848A821H04
R21	3320.0 .50W 1%	848A819H98
R19	10.0K2.00W 5%	185A207H51
R29	60.4K .50W 1%	848A821H21
R23	499.0K .50W 1%	848A822H10
R18-30	2.2M .50W 5%	187A290H26

ZENER	DESCRIPTION	STYLE NO.
ZA	1R200 200.0V	629A369H01
Z1-2	UZ8870 70.0V	837A693H14

1454C81G03 (250 VDC)

CAPACITOR	DESCRIPTION	STYLE NO.
C3	.270UF 200V	188A669H05
C2	3.300UF 35V	862A530H01
C1	6.800UF 35V	184A661H21

DIODE	DESCRIPTION	STYLE NO.
D1-2	1N645	184A855H13
D3-4-A	1N459A	184A855H08
DX	1N5053	188A342H12

INT CKT	DESCRIPTION	STYLE NO.
IC1	747DM	1443C52H01

JUMPER	DESCRIPTION	STYLE NO.
J1	0 OHM RESISTOR	862A478H01

POT	DESCRIPTION	STYLE NO.
P2	20.0K .50W	862A406H02
P1	**25.0K .50W**	**880A687H02**

TRANSISTOR	DESCRIPTION	STYLE NO.
Q1	2N2905A	762A672H10
Q2-3-4-5-7	2N1711	762A585H08
Q6	2N4063	878A432H01

RESISTOR	DESCRIPTION	STYLE NO.
R6-12-15-25	2000.0 .50W 2%	629A531H39
R4-9	5600.0 .50W 2%	629A531H50
R2-14	6800.0 .50W 2%	629A531H52
R1-16	10.0K .50W 2%	629A531H56
R7-8-10-11-22	15.0K .50W 2%	629A531H60
R3-13-24	27.0K .50W 2%	629A531H66
R3-17	100.0K .50W 2%	629A531H80
R20	162.0K .50W 1%	848A821H62
R26-28	20.0K .50W 1%	848A820H74
R27	40.2K .50W 1%	848A821H04
R21	3320.0 .50W 1%	848A819H98
R29	60.4K .50W 1%	848A821H21
R23	499.0K .50W 1%	848A822H10
R19	36.0K2.00W 5%	185A207H64
R18-30	2.2M .50W 5%	187A290H26
R31	1.0M 50W 1%	848A822H39

ZENER	DESCRIPTION	STYLE NO.
ZA-B	1N3050B 180.0V	187A936H17
Z1-2	1N3049B 160.0V	187A936H13

REF. DWG.

COMPONENT LOCATION (48/125 VDC)--3517A76
COMPONENT LOCATION (250 VDC)----3517A77

J2
3 2

1325D61

ematic of Timer Module.

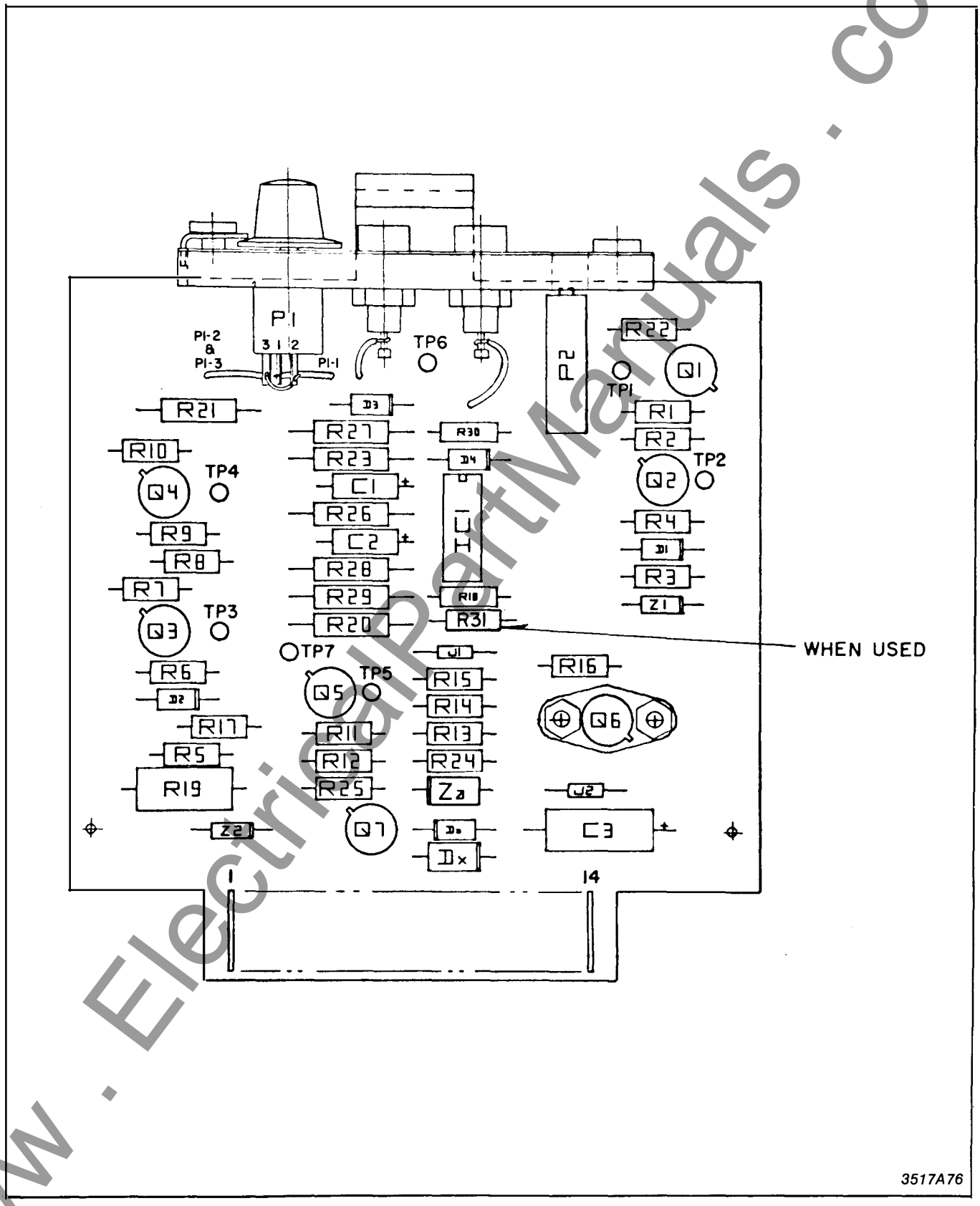


Fig. 5. Component Location for Timer Module 48 or 125Vdc rated relay

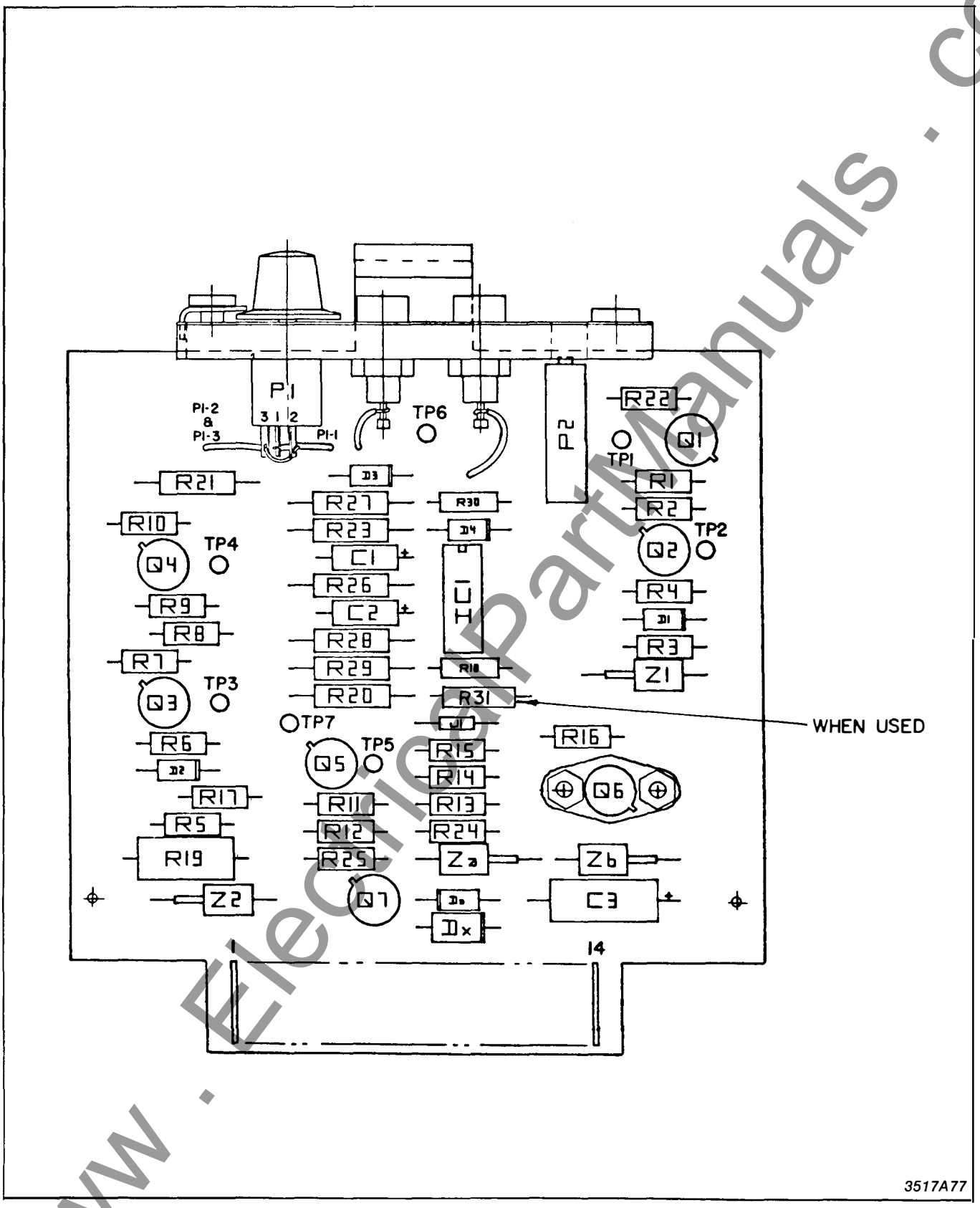


Fig. 6. Component Location for Timer Module 250Vdc rated relay.

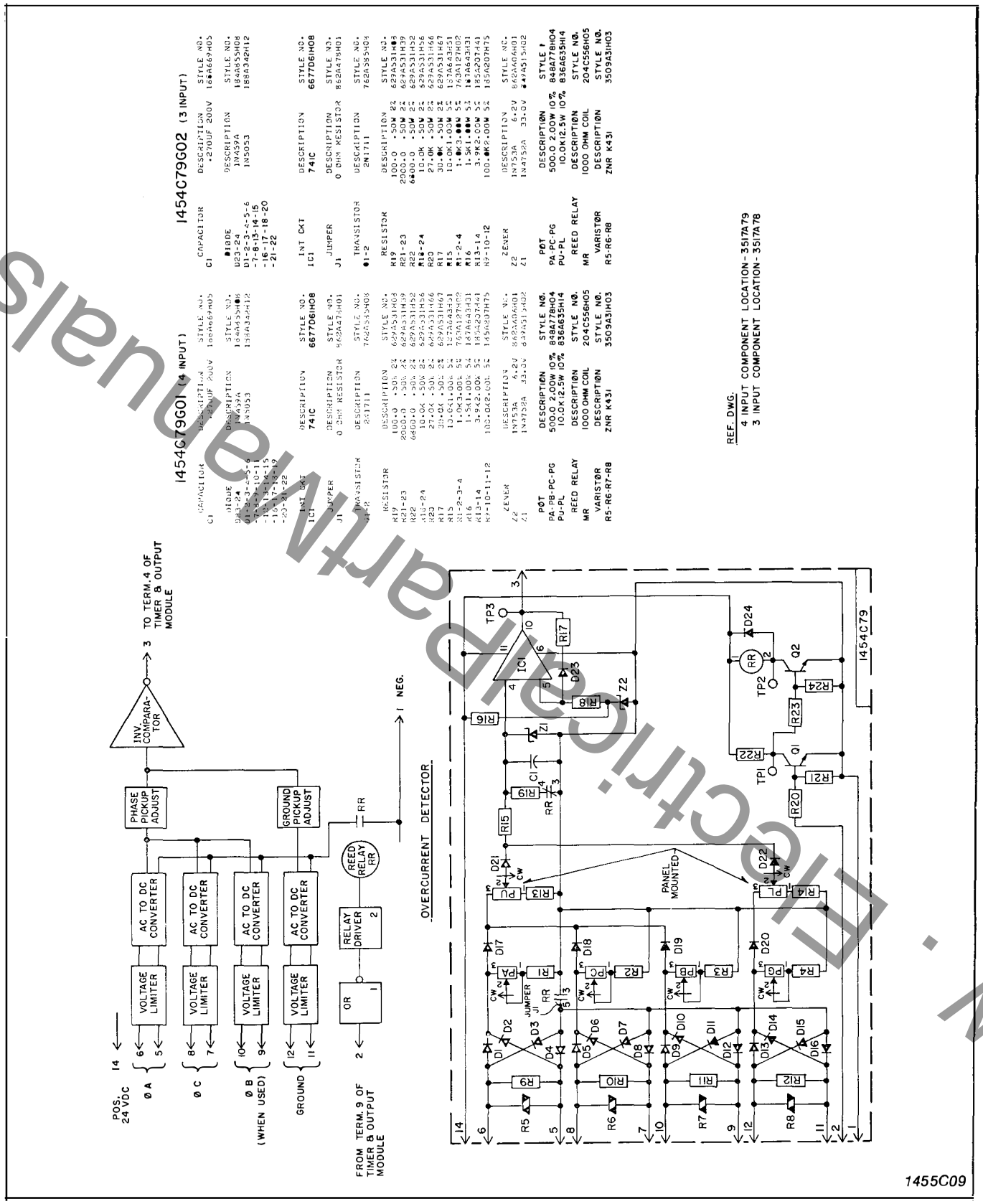
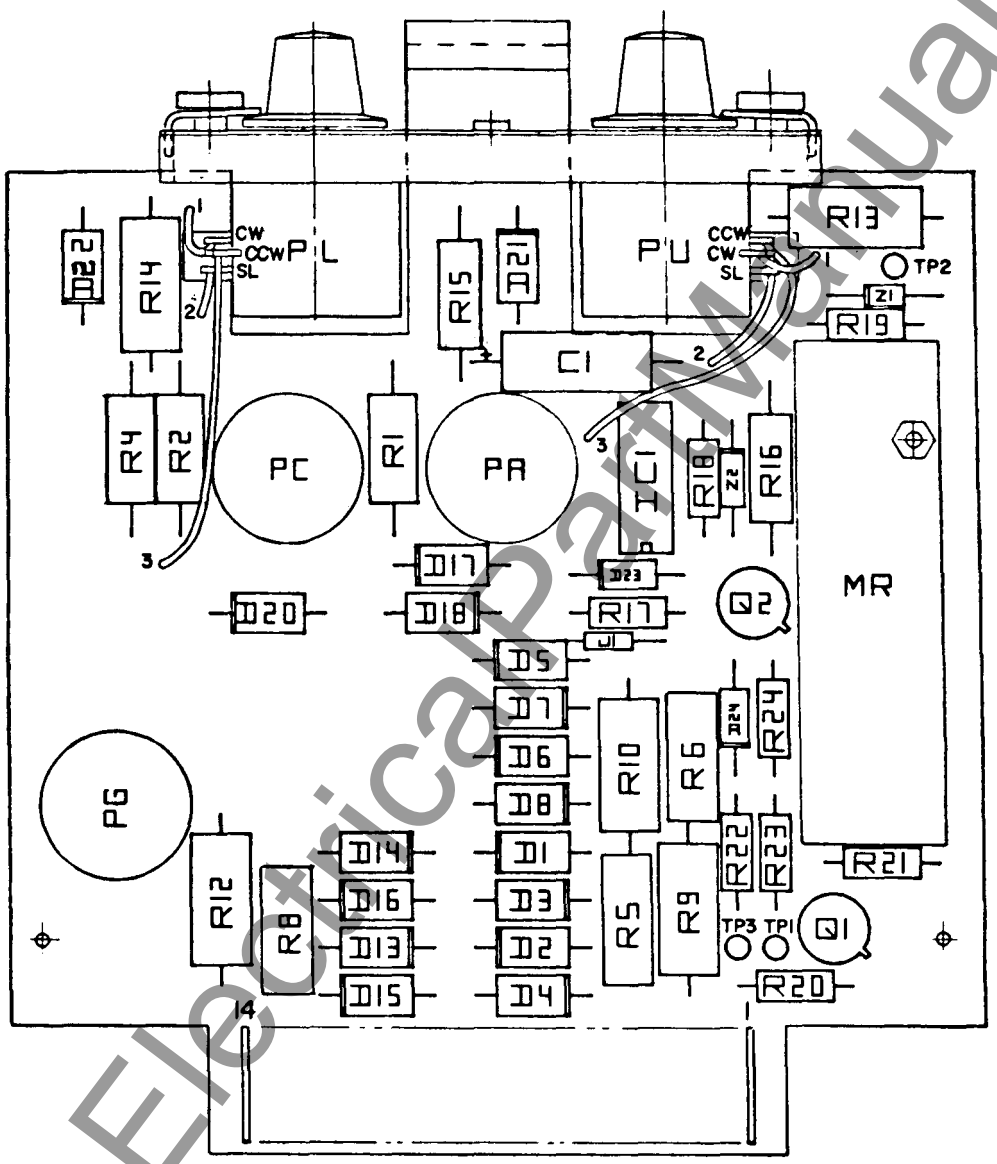


Fig. 7. Internal Schematic of Overcurrent Detector Module.



3517A78

Fig. 8. Component Location for 3 Current Input Overcurrent Detector Module.

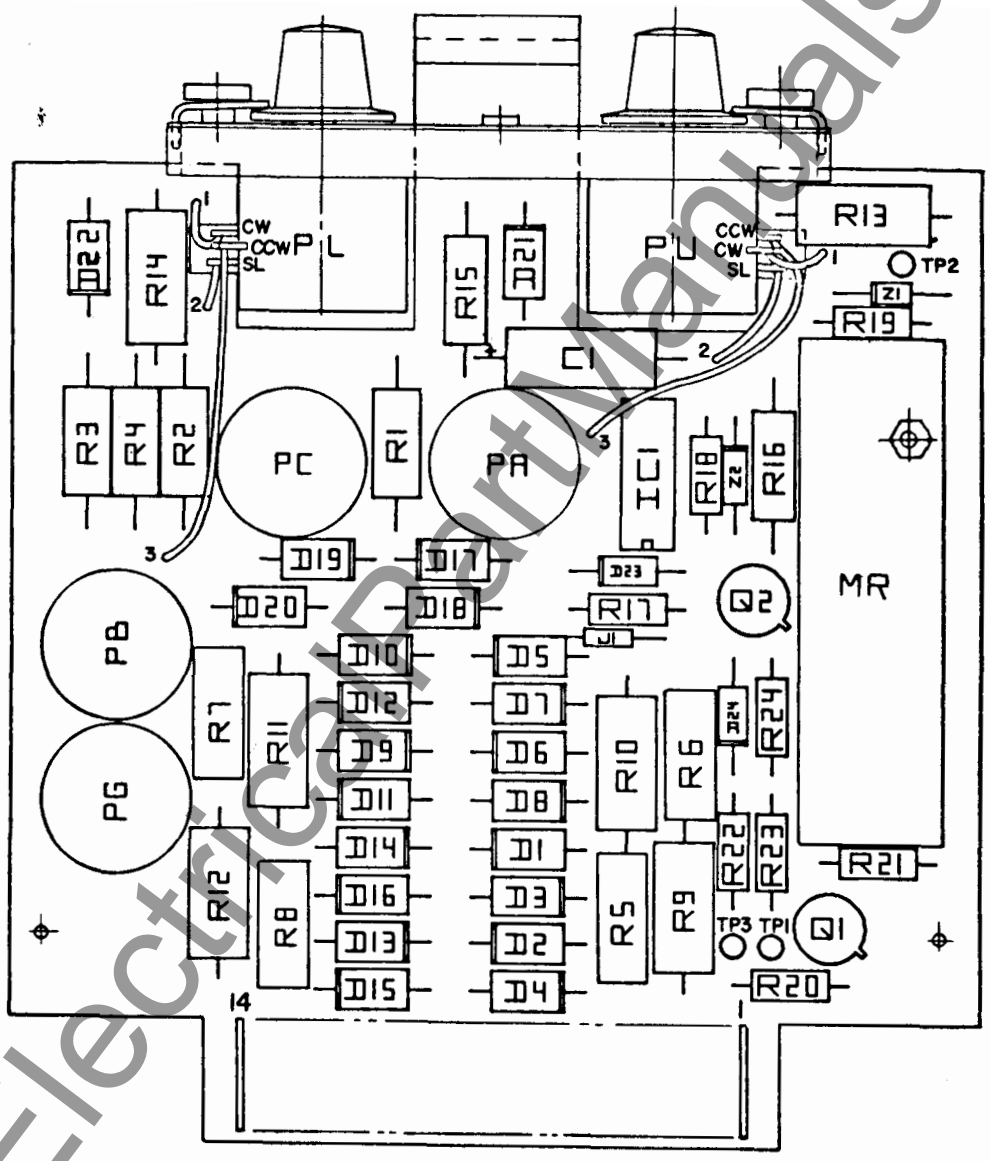
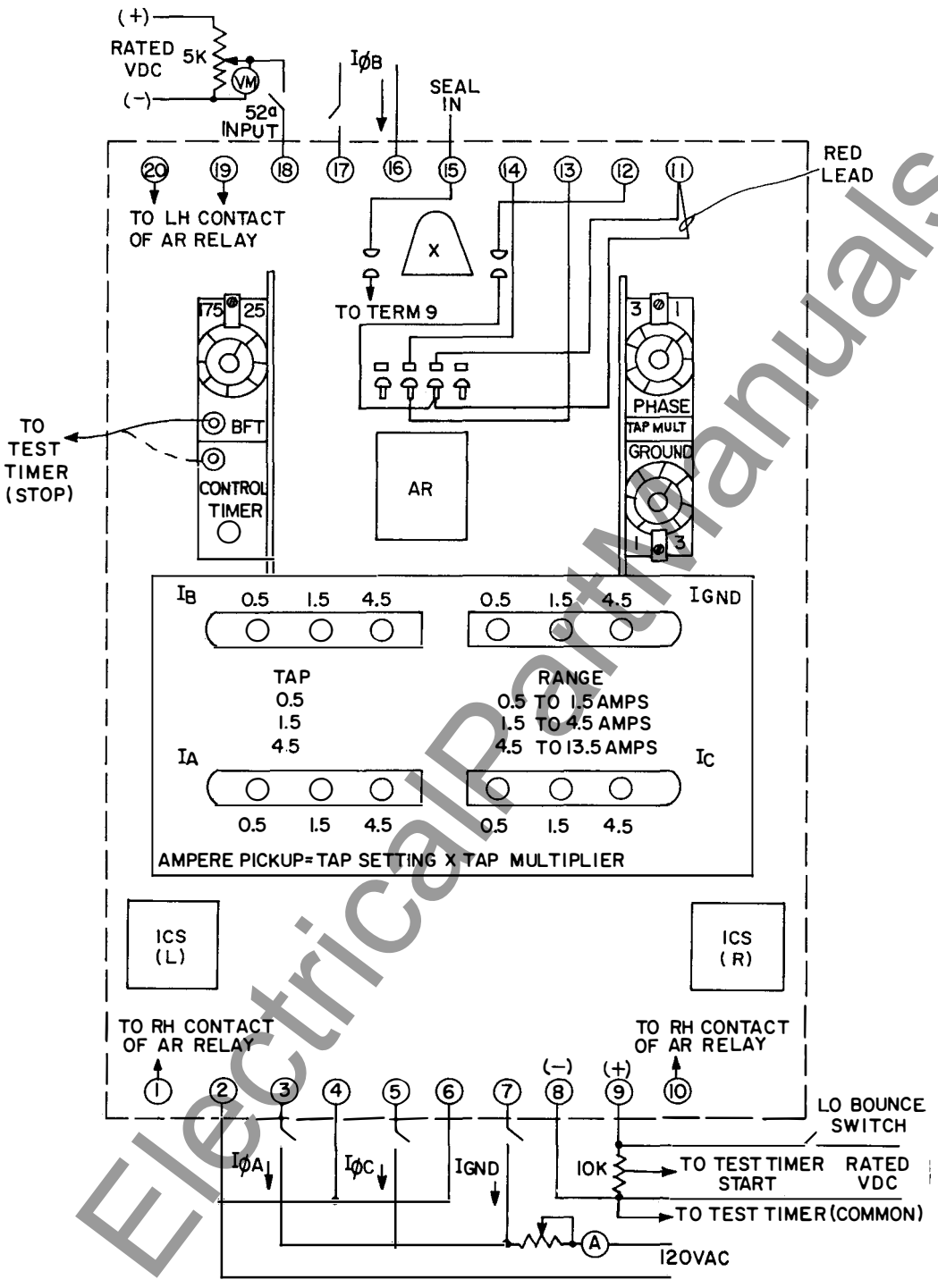


Fig. 9. Component Location for 4 Current Input Overcurrent Detector Module.



NOTE: TO TEST FOR OVERCURRENT UNIT PICKUP, JUMPER TIMER BOARD TEST POINT TP6 AND TP7 BEFORE ENERGIZING RELAY.
TEST BKR FL TIMER IN SIMILAR MANNER.

1479B29

Fig. 10. Test Diagram for SBF-1 Relay.

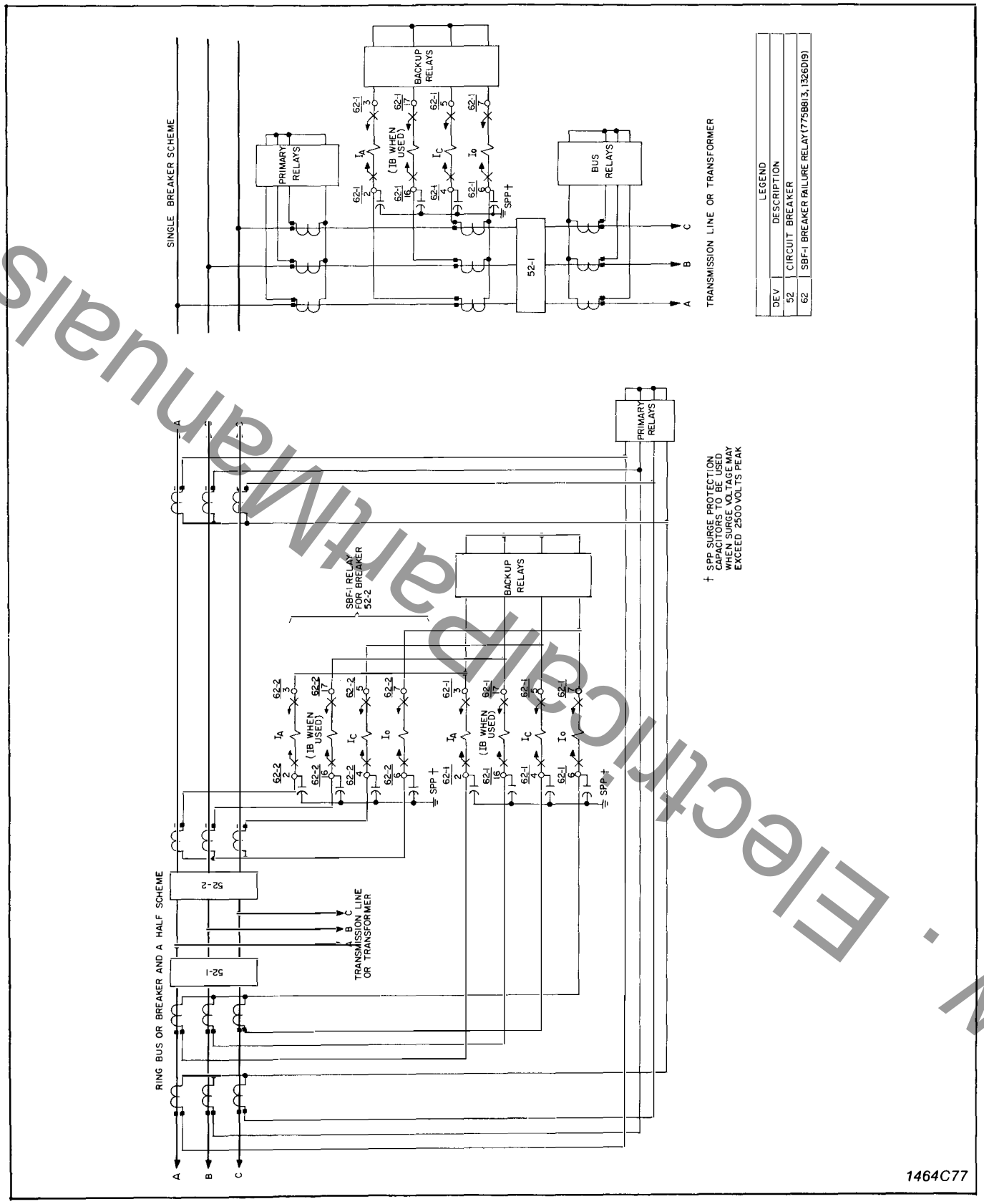


Fig. 11. External AC Schematic for SBF-1 Relay.

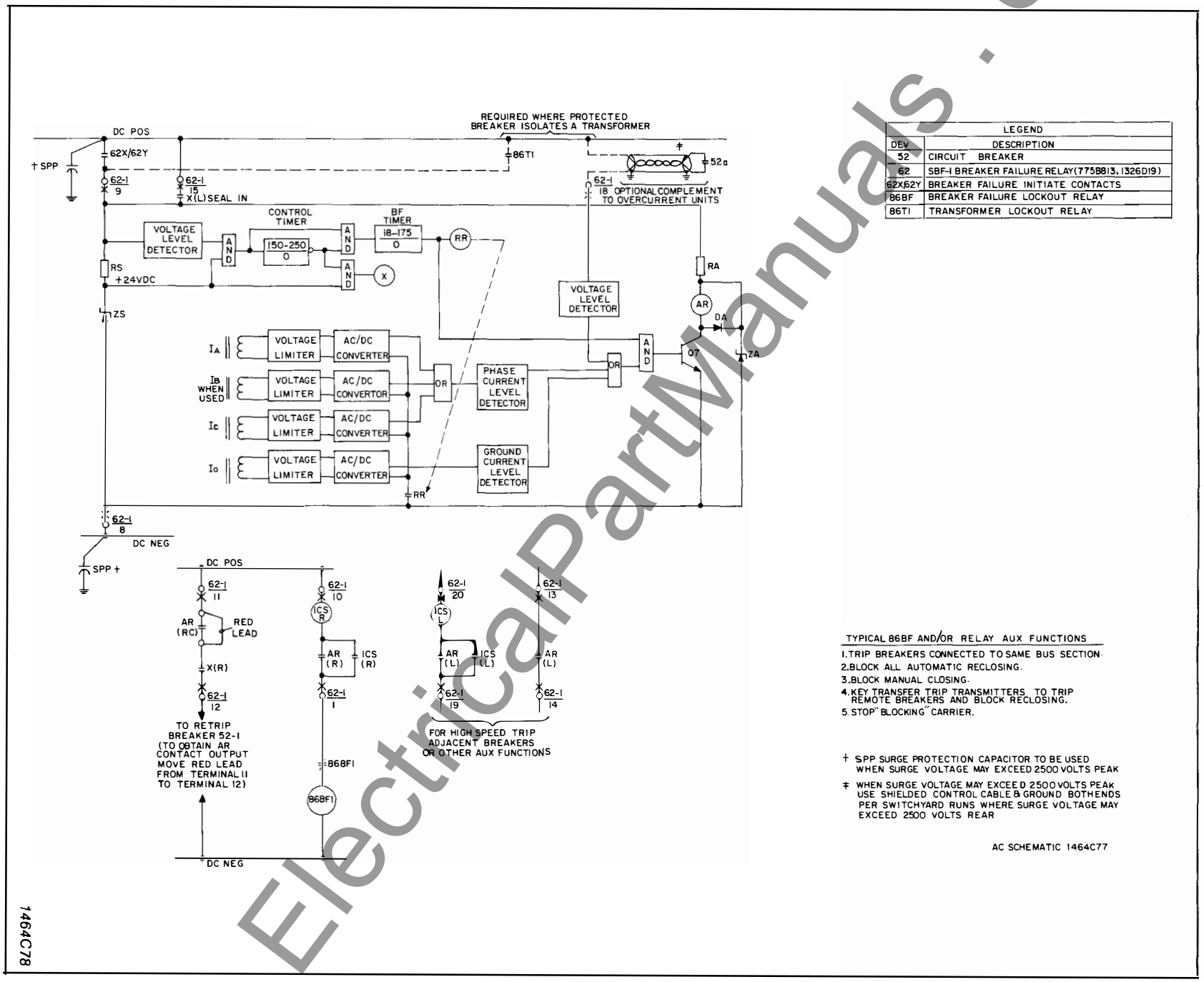


Fig. 12. External DC Schematic for SBF-1 Relay.

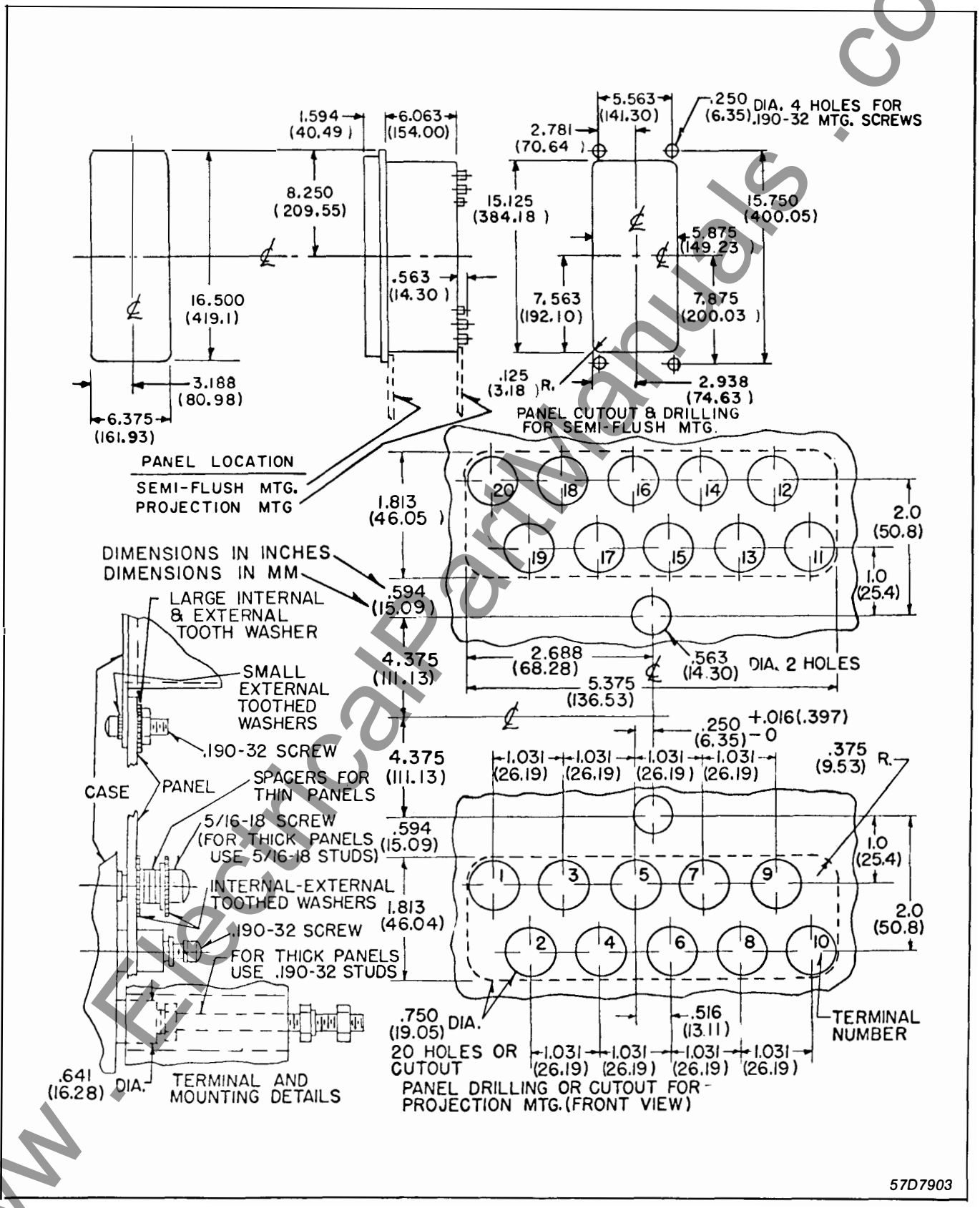
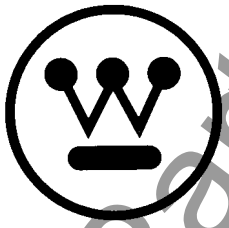


Fig. 13. Outline and Drilling Plan for SBF-1 relay in the Type FT-32 Case. Dwg.



WESTINGHOUSE ELECTRIC CORPORATION

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

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE SBF-1 CIRCUIT BREAKER FAILURE RELAY

CAUTION: It is recommended that the user of this equipment become acquainted with the information in these instructions before energizing the relay. Failure to do so may result in damage to the equipment. Before putting the relay into service, operate the relay to check the electrical connections.

Printed circuit modules should not be removed or inserted while the relay is energized. Failure to observe this precaution may result in an undesired tripping output or cause component damage.

APPLICATION

The SBF-1 is a solid state breaker failure detection relay with contact output. It is used in conjunction with the primary and backup relays. Other logic inputs (such as the 52a contact) may be used where the fault current is insufficient to operate the current detector.

The relay is applicable with any of the bus/breaker schemes in general use.

Provision is included in the relay for "retripping" the breaker without time delay. This may avoid clearing a bus during incorrect maintenance procedure or due to the failure of a trip contact to close.

CONSTRUCTION

The SBF-1 Relay consists of a phase and ground current detector, a breaker failure timer, a control timer, a seal-in (X) relay and an output relay (AR) along with 2 indicating contactor switches (ICS).

Overcurrent Detector

The detector consists of 3 or 4 input transformers and a plug in module. The primary of the transformer is tapped and brought out to a tap block located on the front of the relay. Each transformer has three taps which cover the range of pickup.

The secondary of the transformers are connected to the input of the plug-in detector module where the phase and ground signals are connected to separate pickup level adjustments located on the front of the module. A comparator circuit consists of a plug-in operational amplifer whose output is connected to logic circuitry which controls the AR output relay.

Also located on the module is a reed relay (RR) which is controlled by the breaker failure (BF) timer on the timer module. The normally open contacts of the reed relay are connected in the current detector circuit and controls the operation of the circuit.

BF and Control Timer

These timers are located on the timer plug-in module.

The BF timer can be continuously varied over the range by means of an adjusting knob located at the front of the module. A calibrated scale permits setting the desired time delay. A test jack is also located at the front if it is desired to check the setting with an electronic test timer.

At the bottom of the front plate is an access hole which permits adjusting the control timer

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. 41-776.5, DATED NOVEMBER 1978 EFFECTIVE NOVEMBER 1979
✪DENOTES CHANGED SINCE PREVIOUS ISSUE.

trimpot. A test jack is also supplied to change the control timer delay in conjunction with a tester if other than the factory setting is desired.

- A level detector circuit consisting of zener diode Z1 and resistor R3 is connected to terminal 13 of the module for controlling the dc voltage supply to the timer circuit.

- A second level detector consisting of zener diode Z2 and resistor R17 is connected to terminal 3 of the module for controlling the turn on voltage level from the 52a input.

Power Supply

Consists of a zener diode (Zs) mounted on an L shaped heat sink. The zener is connected to a 2 inch tubular resistor (RS). A small capacitor (C3) located on the timer module is connected across the zener diode.

Telephone Relay (X)

This is a clapper type auxiliary relay with two normally open contacts.

Output Relay (AR)

This is a 4 pole normally open high speed auxiliary output relay used for tripping duty.

The relay coil is connected in series with a 2 inch tubular resistor (RA).

Indicating Contactor Switch Unit (ICS)

The dc indicating contactor switch is a small 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 front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

OPERATION

The operation of the SBF-1 is somewhat different than the conventional breaker failure relay. It may be summarized by saying that the breaker failure relay timer is started by only the BFI (62X) input rather than the BFI and the overcurrent fault detector. The breaker failure timer controls the fault detector so that after it times out, the overcurrent signal (if present) is connected to the level detector. This arrangement keeps the overcurrent input transformer load at a low level. This permits fast reset of the secondary voltage of 3 ms or less, even at very high multiples of pickup current. By use of an additional timer (called the control timer) the breaker failure timer as well as the X seal-in relay is reset after it times out. The circuit operation can be explained by referring to the internal schematic drawing 775B813 (Fig. 2) and detailed internal schematic 1326D19 (Fig. 3).

During stand-by condition the dc input to the relay (terminal 9 positive) is zero since the dc control voltage is connected through the breaker failure initiate contact (see the external schematic) which is normally open.

Upon the closing of the BFI contact and providing the dc voltage is 80% or greater (of rated value) a level detector zener diode Z1 (connected to terminal 9) will permit transistor Q2 and Q1 to turn on. The power supply consisting of a 10 watt zener Zs and 25 watt resistor Rs is also energized which supplies a regulated 24Vdc to the modules and the X relay. When transistor Q2 and Q1 turn on it connects the regulated power supply to the control timer which consists of ½ of IC1, trimpot P2 and timing capacitor C1. Resistor R26 and R27 form a voltage divider which requires approximately one time constant [(P2+R22) x C1)] before the output terminal 12 goes from 24Vdc to less than 2.5Vdc. At the same time the control timer receives power through Q1, the 24Vdc output of the control timer (term. 12 of IC1) is used to turn on transistor Q7 which operates the X relay. One X contact is brought out to relay terminal 15 to permit seal-in of the initiate contact. This is desirable where the BFI contact is only picked up for a short time. The initiate contact must be closed for 8 ms in order for seal-in to take place. While the control timer is timing out, the BF timer will

time out first since it is always set for a shorter delay. The output of the BF timer is connected to terminal 9 of the timer module which is wired to terminal 2 of the overcurrent detector module. Since operation of the BF timer is indicated by a voltage drop to less than 2.5V, transistor Q1 turns off and transistor Q2 turns on to pickup the reed relay (RR). In addition, the output of the BF timer also supplies one of the two inputs to transistor Q5 which controls the AR relay switching transistor (Q6). The other input controlling transistor Q5 is either the 52a contact input (if used) connected to relay terminal 18 or operation of the overcurrent unit circuit. This is obtained when the reed relay operates to remove the 100 ohm resistor (R19) from capacitor C1 and to apply the input current signal to terminal 4 of the IC1 on the overcurrent detector module. If this signal voltage is higher than the reference voltage at terminal 5 of IC1 the output voltage at terminal 10 (of IC1) will drop from its high state to less than 2.5 volts. This output change is then applied to the transistor logic circuit consisting of transistor Q3, Q4 and Q5 (on the timer module).

CHARACTERISTICS

Overcurrent Detector

The overcurrent detector has a range of 0.5 to 13.5 amperes. This is obtained by means of three tap settings in conjunction with the tap multiplier to give a continuous adjustment over the range. The pickup point is determined by multiplying the tap value by the tap multiplier setting. The operate speed varies from 3 ms to 8 ms. The reset time is 3 ms maximum and would be measured as the time for the secondary voltage to decay to 10 volts peak (with the reed relay RR contacts open). This reset time applies whether the input current is reduced to zero or up to 95% of pickup current.

Continuous rating is 10 amperes. One second rating is 250 amperes.

The accuracy of the pickup setting is 5% over the full range and 10% from -20 to +55°C. Since the setting is continously adjustable, closer setting accuracy can be obtained by using a current source and a precision ammeter.

CAUTION: Since the tap block connector screw carries operating current, be sure that the screw is turned tight.

In order to avoid opening the current transformer circuits when changing taps under load, connect the spare tap screw in the desired tap position before removing the other tap screw from the original tap position.

Control Timer

The range of the control timer is 150 to 250 ms. The timer as received should be set for approximately 200 ms. A 150 to 600 ms timer is available and is shipped set at 600 ms.

The timer setting can be changed by means of a screwdriver through the hole on the front plate of the timer module.

The accuracy is 5% over the temperature and voltage range.

BF Timer

The range of the BF timer is 18 to 175 ms. It is set by means of a knob and calibrated scale at the front of the timer module. A 50 to 500 ms timer is also available.

The accuracy of the pickup setting is 5%. Since the setting is continuously adjustable, the timer may be set closer by instrumentation.

The accuracy is 5% over the temperature and voltage range.

Power Supply

Consists of a 10 watt zener diode (Zs), a resistor (Rs) and provides a regulated voltage of 24Vdc $\pm$10% over the voltage and temperature range. A capacitor C3 is connected across the zener diode to decrease the rate of rise and fall of the output voltage to reduce transient effects.

Both modules and the telephone relay (X) are energized by the power supply.

Temperature and Voltage

The relay is operative over a range of 80 to 110% of rated voltage and from -20 to +55°C.

It can be energized continuously at 110% of rated input voltage.

Capacitive Effect

The capacitive surge immunity is as follows (considering the 52a contact input present):

Relay Rating	BF Timer Setting	Capacitance
48 Vdc	18 ms or higher	18 MFD
125 Vdc	18 ms or higher	6 MFD
125 Vdc	35 ms or higher	13 MFD
250 Vdc	18 ms or higher	2.5 MFD
250 Vdc	35 ms or higher	13 MFD

Any value of capacitance effectively in series with the input greater than that shown above might result in an undesired trip operation.

Ordinarily capacitance should not be connected from the lead connecting the 52a contact to the relay and ground. A value of 0.5 MFD could cause the 52a input to stay on for 1.5 ms (48V relay), 4.5 ms (125V relay) and 20 ms (250V relay) after the 52a contact opened.

X RELAY

Coil resistance is 1500 ohms ±5% and rated for 24Vdc operation. The seal-in contact will pickup providing the BFI (62X, 62Y) initiate contacts are closed for a minimum of 8 ms. A second contact is wired to relay terminal 11 and 12 to provide a retrip feature.

AR RELAY

The coil resistance is 630 ohms ±5% and will operate in series with the appropriate resistor from 80% to 110% of rated voltage.

The operate speed is 3 to 5 ms at rated voltage. The dropout time is 30 to 45 ms (diode around the coil). There are 4 normally open contacts available.

INDICATING CONTACTOR SWITCH (ICS)

The coil resistance is approximately 6.5 ohms on the 0.2 amp tap and 0.15 ohms on the 2.0 amp tap.

TRIP CIRCUIT

The main contacts will safely close 30 amperes at 250 Vdc and the seal-in contacts of the ICS will safely carry this current long enough to trip a circuit breaker.

SETTINGS

OVERCURRENT DETECTOR

The pickup of the overcurrent unit is obtained by means of a tap screw and tap block in conjunction with the tap multiplier knob setting located at the front of the overcurrent unit module. This permits a continuous adjustment over the range of 0.5 to 13.5 amperes. Each tap setting permits adjusting the pickup over a 3 to 1 range.

There are 2 or 3 phase inputs depending on the relay style. Each one has its own tap block. Normally all the phase settings should be in the same tap. The operate point for each phase should be within 5% of each other. There are trimpots for each input located on the overcurrent module which are factory adjusted but which may be readjusted if the 5% accuracy must be improved at any one pickup point.

The ground unit pickup is obtained similar to the phase above and is independent of the phase pickup. This permits the ground setting to be lower than the phase setting.

The phase units must be set below the minimum expected fault current and the ground unit set below the minimum expected residual (3I0) current. Settings should be made to assure a multiple of pickup of at least 2 under minimum fault conditions.

CONTROL TIMER

The control timer can be set by use of a screwdriver to adjust the trimpot which is accessible through the hole in the front plate of the timer module. Clockwise rotation will increase the on time. An oscilloscope or electronic timing device can be connected between the bottom red test jack

on the timer module front plate and terminal 8 of the relay (common negative).

The control timer should be set for at least 16 milliseconds longer than the BF timer. This allows for pickup time of the reed relay (1 to 3 ms), AR relay pickup (3 to 5 ms) and operate time of the o/c unit (3 to 8 ms).

The range of adjustment is a minimum of 100 ms (150 to 250 ms). The control timer is shipped from the factory set for 200 ms.

A 150 to 600 ms timer is available and is shipped with the timer set for 600 ms.

The control timer acts essentially as a pulse stretcher on the BFI input and then resets. Since the overcurrent unit never picks up on successful clearing, it cannot be used as a cutoff for the breaker failure timer.

BF TIMER

A calibrated scale located on the front of the timer module permits setting the time delay from 18 to 175 milliseconds. The scale is calibrated in 25 ms increments. If more accurate settings are desired an oscilloscope or electronic timer may be connected between the upper red test jack on the timer module and terminal 8 of the relay (Common Negative). Jumpering test point TP6 and TP7 on the timer module prevents the control timer from resetting the BF timer and will help in setting the BF timer. Remember that if the control timer is set shorter than the BF timer, the BF timer will not be able to operate the reed relay (RR).

A 50 to 500 ms BF timer with 50 ms scale increments is also available.

A locking tab is provided to hold the BF timer setting from being accidentally changed.

The timer is shipped set at 175 ms. The 50 to 500 ms timer is shipped set at 500 ms.

The breaker failure timer should be set to exceed the breaker normal clearing time by an appropriate margin. Where the breaker contains a resistor that is inserted on tripping and the overcurrent fault detectors are set below the resistor current, the additional time for this interruption must be included. A secure margin for the SBF-1 is 2 cycles. (33 ms)

INDICATING CONTACTOR SWITCH (ICS)

Connect the lead located in front of the tap block to the desired setting by means of the connecting screw.

When the relay energizes a 125 or 250 Vdc type WL relay switch or equivalent use the 0.2 amp tap. For 48 Vdc applications set the unit in the 2 amp tap and use a type WL relay with a S#304C209G01 coil or equivalent.

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 rear mounting stud or studs for the type FT projection case or by means of the four mounting holes 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.

ADJUSTMENTS AND MAINTENANCE

The proper adjustment to insure correct operation of this relay have been made at the factory and should not be disturbed.

✪ Acceptance Test

The following check is recommended to insure that the relay is in proper working order. Refer to Fig. 10 for test connections.

Overcurrent Detector

Check for correct scale marking by placing all the tap settings in the 0.5 Amp. position and rotate the Phase and Ground tap multiplier knob (on the overcurrent unit knob) to the X1 calibration mark.

Jumper test point TP 6 and TP7 on the timer module and apply rated dc voltage. Also apply phase current to phase A input. The voltage at test point TP3 on the overcurrent module should drop from approximately 23.5 volts to less than 2.5 Vdc when the ac current input is between .48 and .52 amperes. The AR output relay will pickup at the ✪ same time. When TP6 and TP7 is jumpered the dropout time of the o/c output at TP3 will be slow. Opening switch to terminal 9 momentarily will speed up the dropout time.

Use the same test with applying current to phase C (and also phase B if used). Pickup should be within 5% of the phase A pickup.

Rotate Tap Multiplier Knob to the X3 setting and repeat above. The operate current should be between 1.44 and 1.56 amperes on phase A input and within 5% of phase A pickup for phase C (and phase B if used).

For setting Phase A current operate level, set the tap screw in the proper range location and set the phase tap multiplier at the point at which the voltage at TP3 changes from high to low at the desired input current. The phase C and Phase B (if used) tap screws should be set for the same current ✪ range. The AR output relay will also pickup and can be used for an indication.

The Ground overcurrent setting is checked and set exactly like the phase overcurrent circuit.

A locking feature is provided to hold the tap multiplier knob at the desired setting.

Control Timer

Use a low bounce initiate contact in series with relay terminal 9 (positive). Connect an electronic timer to the relay so that the start input is connected to relay terminal 9 (through a voltage divider, if necesary). The stop input should be connected to the bottom test jack on the timer module. The common should be connected to terminal 8. The test timer start input should be adjusted to commence timing on a positive going slope and to stop timing on a negative going slope.

The control timer output should go from a high state to a low state in 190 to 210 milliseconds (or ✪ in 570 to 630 ms for the longer range timer).

If some other time interval is desired, the timer setting may be changed by means of a screw driver adjustment through the access hole on the timer module to a multiturn potentiometer. Use the electronic test timer in the manner described to obtain the desired time interval. Remember that the Control Timer should always be set at least 16 milliseconds longer than the BF timer. The adjustment ✪ range is 150 to 250 ms (or 150 to 600 ms in the longer range timer).

BREAKER FAILURE (BF) TIMER

This may be checked in the same way as the Control Timer.

First jumper test points TP6 and TP7 on the timer module. Connect the test timer stop lead to the upper test jack on the timer module. Output of the BF timer takes place when it goes from a high state to low state (similar to the Control Timer ✪ output). Close switch to terminal 9 and see that the timer output switches in 170 to 180 ms (or 485 to 515 ms for the longer range timer).

Set the timer knob at the desired setting and verify setting by operating the timer several times. The timer should operate within 5% of the setting. The setting may be made closer by means of the electronic test timer.

When the desired setting has been obtained it may be locked in place by means of the locking tab.

Overall operation may be checked by connecting rated dc voltage to relay terminal 18 (52A breaker auxiliary contact input).

Remove jumper from test point TP6 and TP7 on the timer module.

Now when the test switch to terminal 9 is closed, the AR output relay should pickup momentarily and reset even though the test switch is left closed. Remember that the BF timer setting should be 16 ms or more longer than the Control Timer.

Reduce voltage to relay terminal 18 to 60% of rated relay voltage. Close test switch and note that AR relay does not pickup.

Return voltage to normal and reduce voltage to terminal 9 to 60% of rated relay voltage. Close test switch and note that AR relay does not pick up.

✪ Set voltage to terminal 9 and 18 to 80% of rated relay voltage. Close switch to terminal 18 and then 9. See that AR relay picks up momentarily.

Indicating Contactor Switch (ICS)

There are two ICS units used. Each may be checked by placing the ICS tap screw in the desired tap (0.2 or 2 Amps). Adjust the dc current to the tap value.

Test for seal-in by closing switch to terminal 9 and see that each ICS picks up and seals itself in the closed position.

The contact gap should be approximately .047". Both stationary contacts should make with the moving contacts simultaneously. The indicating target should drop just prior to or at the same time the contacts make.

Routine Maintenance

The relay should be inspected periodically. The operation of the overcurrent circuits, timers and indicating contactor switch should be checked similar to procedure described under SETTINGS. In addition inspect the X and AR relay contacts. A contact burnisher S#182A836H01 is recommended for cleaning contacts. The use of abrasive material for cleaning contacts should be avoided because of the danger of embedding small particles in the face of the contact material which might impair the contact operation.

Calibration

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments have been disturbed. This procedure should not be used unless it is apparent that the relay is not in proper working order.

Overcurrent Detector

Refer to Fig. 7 and 8 or 9 when replacing components.

If a new module is inserted, it will require calibration of the dial plate. Other replacement parts such as a transformer or certain components on the module such as the reference zener, operational amplifier, rheostat, etc. might require new scale markings. In that case a new dial plate will be necessary.

To mark the dial, first jumper test point TP6 and TP7 on the timer board. Energize the relay with rated dc voltage and apply 0.48 Amps ac current to phase A. With the tap in the 0.5 position and the phase multiplier dial knob fully counterclockwise, rotate the phase A trimpot slowly CCW (to lower pickup). Operation of the overcurrent unit is indicated when the AR output relay picks up. Verify this adjustment by increasing the ac current until the relay again picks up. This should be between 0.47 and 0.49 amps. Now turn the front panel dial knob fully CW. Check to see that pickup is 1.55 to 1.80 amps. If it is slightly below 1.55 amps, rotate the phase A trimpot slightly clockwise to raise the pickup to 1.55 amps. Go back and check to see that the pickup with the dial knob fully CCW is no higher than .495 amps. Adjust knob on shaft so that the high and low operate point are equidistant from the knob lock. Apply 0.5, 0.7, 0.9, 1.1, 1.3, and 1.5 amps and scribe the scale at the knob pointer setting at which the output relay just operates.

After scribing the scale, set the dial at 0.5 amp (X1) pickup and note what value current the output relay operates. Apply current source to phase C and note at what current value the output relay operates. If the difference is greater than .025 amp from phase A, adjust the phase C trimpot to bring the operate point within .025 amps of phase A. Repeat for phase B if used.

The same procedure should be followed for the ground overcurrent circuit as was used for phase A input.

Remove jumper from TP6 and TP7 on the timer module.

Control Timer

Refer to Fig. 4 and 5 or 6 when replacing components.

If components in the control timer circuit have been replaced or if it is desired to change the control timer setting the same procedure should be used as described under acceptance testing.

Breaker Failure (BF) Timer

If the scale appears to be off calibration due to slippage of the knob pointer on the shaft, this can be corrected by rotating the shaft fully CCW. Now adjust the knob at the pin prick mark. This should return the knob to its original position on the shaft and bring the scale markings back into calibration.

If components in the breaker failure timer circuit have been replaced it may be necessary to change the scale plate and recalibrate. First jumper test points TP6 and TP7. Using a low bounce initiate switch adjust timer knob until a 25 ms time delay has been obtained. Use test procedure described under acceptance testing for measuring time delay. Note the knob position for 25 ms delay. Also note the knob position for 175 ms delay. Loosen the set screw and position the knob on the shaft so that the 25 and 175 ms locations are equidistant about the knob locking tab. Scribe lines at the 25 ms setting and for each 25 ms increment up to 175 ms.

Indicating Contactor Switch (ICS)

Adjust the contact gap for approximately .047" by adjusting the stationary contacts. Both contacts should make simultaneously.

Check to see that the contacts close at rated tap value current. The indicating target should drop at or just prior to the contacts closing. The targer should drop freely.

If the target does not drop or does not reset it may be necessary to remove the cover and bend the tab on the spring that supports the target.

TROUBLE SHOOTING

The components in the SBF-1 relay are operated well within their rating and normally will give long and trouble free service. However, if a relay gives indication of trouble in service or during routine checks the following information will prove helpful. All measurements are approximate and may vary as much as 20%. All voltages are positive with reference to common negative (relay terminal 8) except ac voltages.

Timer Module

1. Jumper test points TP6 and TP7.
   a. Apply rated relay voltage. Voltage at lower test jack = 23.5V
   b. Remove jumper. Apply rated voltage. Voltage at lower test jack = 23.5 Vdc.
2. Jumper test points TP6 and TP7
   a. Apply rated relay voltage. Voltage at upper test jack = less than 2.5 Vdc.
   b. Remove jumper. Apply rated voltage. Voltage at upper test jack = less than 2.5 Vdc.
3. Jumper test points TP6 and TP7.
   a. Apply rated voltage. Voltage at terminal 6 of IC1 = 18.3V.
   b. Remove jumper. Apply rated voltage. Voltage at terminal 6 of IC1 should be approximately 0.1 Vdc less than voltage measured in section a.
4. Jumper test points TP6 and TP7.
   a. Apply rated relay voltage. Voltage at terminal 7 of IC1 = 20.8V with timer knob fully CW.
   b. Voltage at terminal 7 of IC1 = 23.8V with timer knob fully CCW.
5. Jumper test points TP6 and TP7.
   a. Apply rated relay voltage. Voltage at terminal 2 of IC1 = 16.5V.
   b. Remove jumper and apply voltage. Voltage at terminal 2 of IC1 should be approxi-

mately 0.1V less than voltage measured in section a.

6. Apply twice tap value ac current.
   a. Apply rated relay voltage. Voltage at TP3=12.7V. Voltage at TP4=less than 0.5V.
   b. Interrupt ac current. Voltage at TP3=less than 0.5V. Voltage at TP4=12.7V.
7. Apply rated voltage to relay terminal 18 (52a input).
   a. Apply rated relay voltage to terminal 9. Voltage at TP4=less than 0.5V.
   b. Reduce voltage to terminal 18 to 60% of rated relay voltage. Voltage at TP4=12.7V.
8. Jumper test point TP6 and TP7. Apply twice tap value ac current.
   a. Apply rated relay voltage. Voltage at TP5=6.2V.
   b. Remove jumper. Apply rated voltage. Voltage at TP5=less than 0.5V.
9. Jumper test point TP6 and TP7.
   a. Apply rated relay voltage. Voltage at printed circuit board terminal 10 or 11=less than 0.5V (X and AR relay picked up).
   b. Remove jumper. Apply rated voltage. Voltage at pc terminal 10=24V (X relay not picked up). Voltage at pc terminal 11=rated relay voltage (AR relay not picked up).

Overcurrent Module

1. Jumper test points TP6 and TP7 (timer module). Set tap in 0.5 hole and turn tap multiplier knob to X1 position.
   a. Apply 0.5 amp ac current to the particular input in question. Then apply rated relay voltage. Measure 6.6 Vac at the transformer secondary terminals. The same voltage should be read with the tap in the 1.5 amp tap and 1.5 amps ac applied. Likewise with the 4.5 amp tap.
2. Jumper test points TP6 and TP7. Set tap in 0.5 amp. hole and turn tap multiplier to X1 position.
   a. With 0.4 amp ac current flowing apply rated relay voltage. Measure voltage at terminal 5 of IC1 to be 6.4V. Now increase the current until the output relay operates. The voltage should now read approx. 5.4V. At this point the voltage at terminal 4 should measure 6.4V. The voltage at printed circuit board terminal 3 should measure 23.5Vdc before the output relay operates and less than 2.5V after it operates.
3. Jumper test points TP6 and TP7. Set tap in 0.5 hole and turn tap multiplier knob fully CW.
   a. Apply 0.5 amp ac and apply rated relay voltage. Measure 4.2 volts at the brush terminal of the tap multiplier rheostat.
4. Jumper test points TP6 and TP7 (timer module).
   a. Apply rated relay voltage. Measure 6.2V at TP1 and less than 0.5V at TP2.
   b. Remove jumper. Apply rated relay voltage. Measure less the 0.5V at TP1 and 24V at TP2.
5. Check of Reed relay (RR) contact.
   a. Resistance should be greater than 500 ohms when measured from jumper J1 to common negative.
   b. Jumper test points TP6 and TP7 and apply rated relay voltage. Resistance should drop to less than 5 ohms.
6. Check coil resistance of reed relay (RR) (1000 ohms), AR relay (630 ohms) and X telephone relay (1500 ohms). Attention should be paid to polarity since each of the coils have a diode connected across it.

RENEWAL PARTS

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

TABLE I
ENERGY REQUIREMENTS
60 HZ

TAP	0.5							
TAP MULT.	1 (0.5A PICKUP)				3 (1.5A PICKUP)			
REED (RR) CONTACT	OPEN*		CLOSED		OPEN*		CLOSED	
Current	0.5A	5.0A	0.5A	5.0A	1.5A	1.5A	0.5A	5.0A
VA	.15	2.1	.04	2.2	.53	2.1	.33	2.2
OHMS	.6	.08	.16	.09	.23	.08	.15	.09
P.F. Angle**	75	25	15	27	63	25	20	27

TAP	1.5							
TAP MULT.	1 (1.5A PICKUP)				3 (4.5A PICKUP)			
REED (RR) CONTACT	OPEN*		CLOSED		OPEN*		CLOSED	
Current	1.5A	5.0A	1.5A	5.0A	4.5A	5.0A	4.5A	5.0A
VA	.165	.75	.06	.60	.63	.75	.50	.60
OHMS	.073	.03	.027	.024	.031	.03	.024	.024
P.F. Angle**	45	36	15	15	36	36	15	15

TAP	4.5							
TAP MULT.	1 (4.5A PICKUP)				3 (13.5A PICKUP)			
REED (RR) CONTACT	OPEN*		CLOSED		OPEN*		CLOSED	
Current	4.5A	5.0A	4.5A	5.0A	13.5A	5.0A	13.5A	5.0A
VA	.23	.28	.16	.20	1.6	.28	1.5	.20
OHMS	.011	.011	.008	.008	.008	.011	.008	.008
P.F. Angle**	36	18	5	4	9	18	3	4

* = Saturated Burden
** = Current Lagging Voltage

TABLE 2
BATTERY DRAIN

CONDITION	48Vdc	125Vdc	250Vdc
Standby	0	0	0
During Timing	120mA	95mA	90mA
Trip (AR Relay Picked up)	155	130	125

TABLE 3
CURRENT RATING

CURRENT RANGE (Phase and Ground)		0.5 to 13.5 Amperes
TAP RANGES	**CONTINUOUS**	**1 SECOND**
0.5 to 1.5 Amps	10 Amps	250 Amps
1.5 to 4.5	10	250
4.5 to 13.5	15	300

TABLE 4
AR CONTACT RATINGS

			INTERRUPTING RATING	
CONTACT CIRCUIT RATING	**TRIP RATING**	**CARRY RATING CONTINUOUS**	**RESISTIVE**	**INDUCTIVE L/R=.005**
48Vdc	30 Amps	3 Amps	3.75 Amps	1.75 Amps
125	30	3	.5	.35
250	30	3	.25	.15

✪ TABLE 5
X RELAY CONTACT RATINGS

CONTACT CIRCUIT RATING	TRIP RATING	CARRY RATING CONTINUOUS
48Vdc	30 Amps	3 Amps
125	30	3
250	30	3

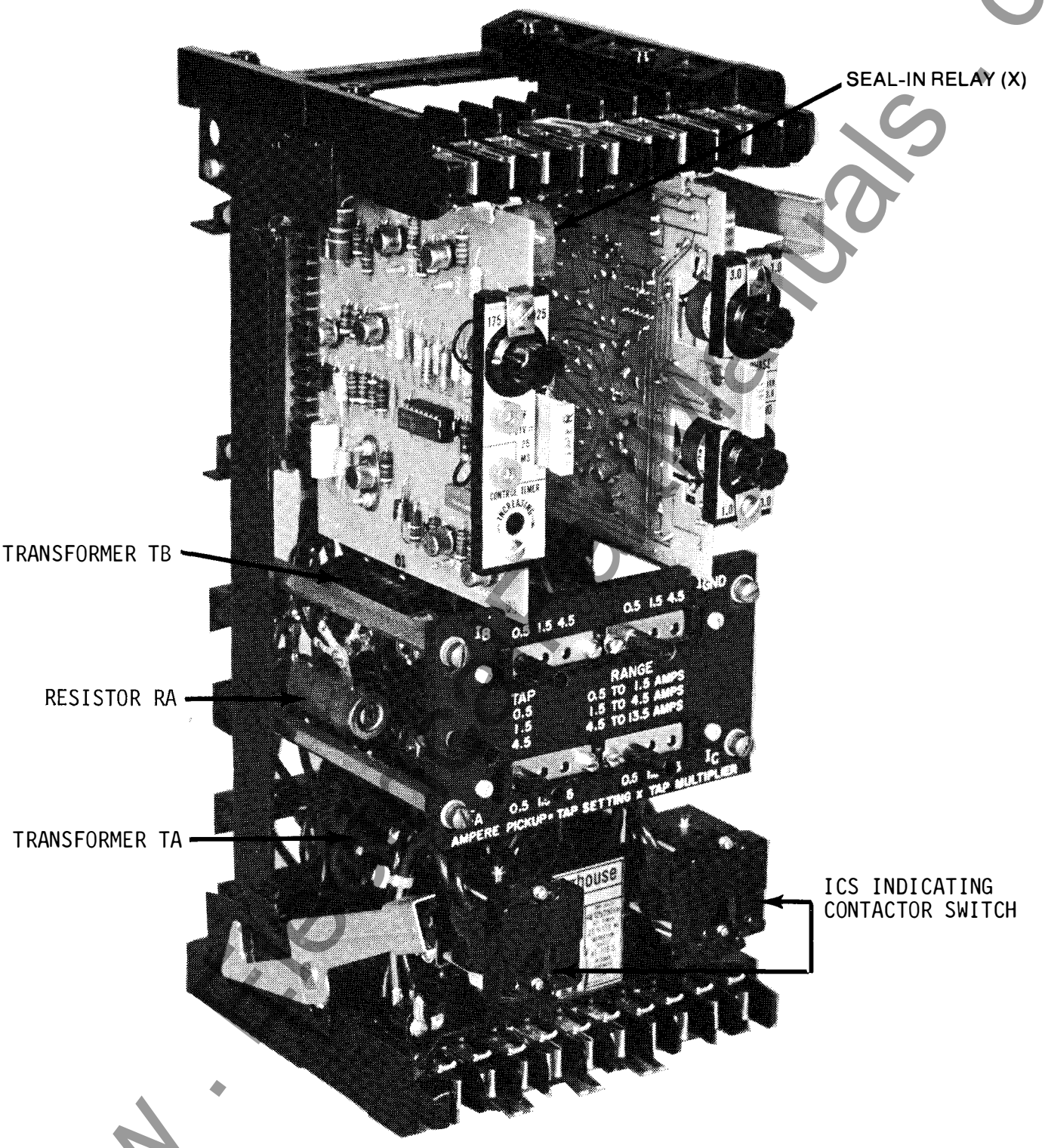
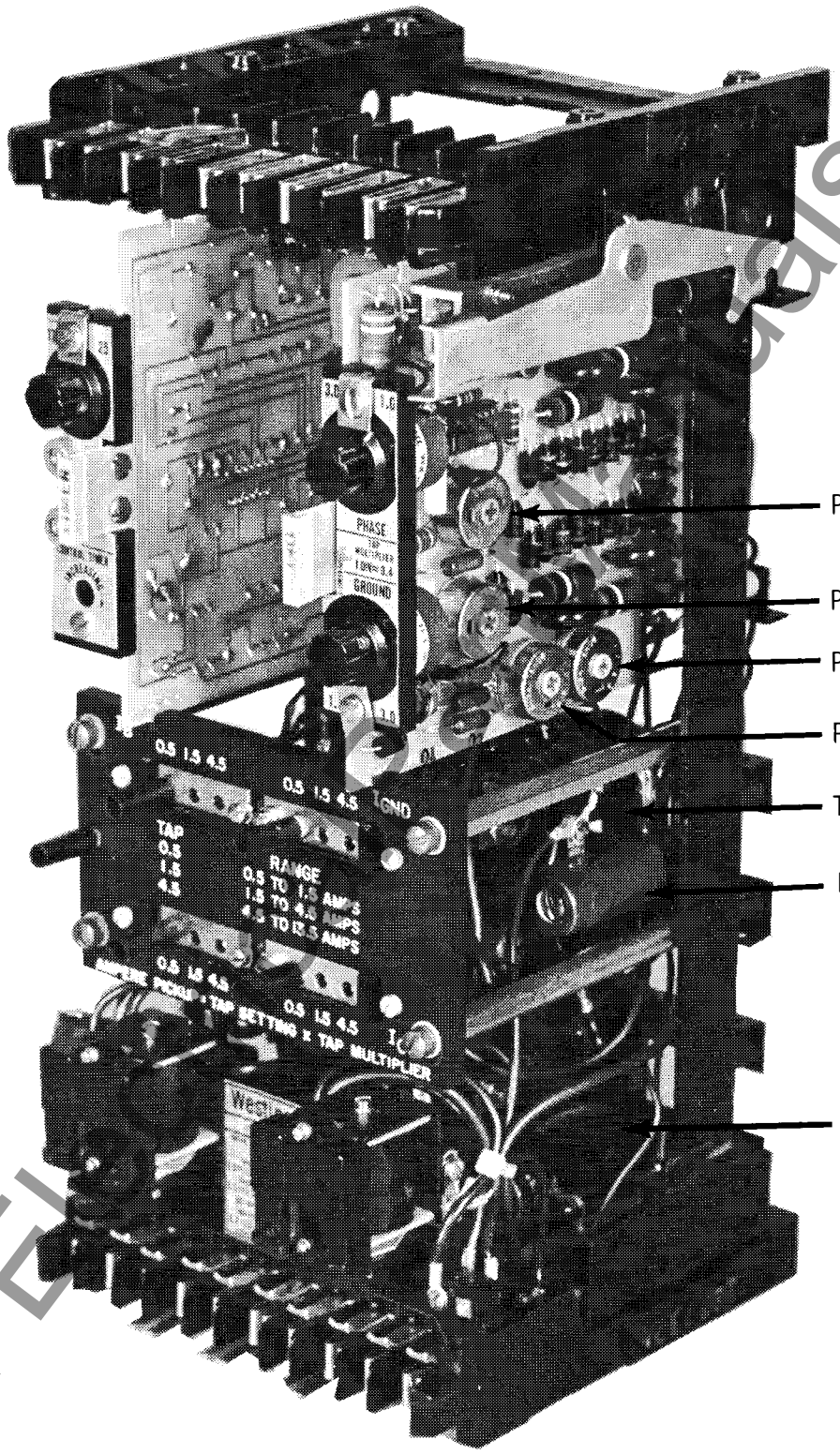
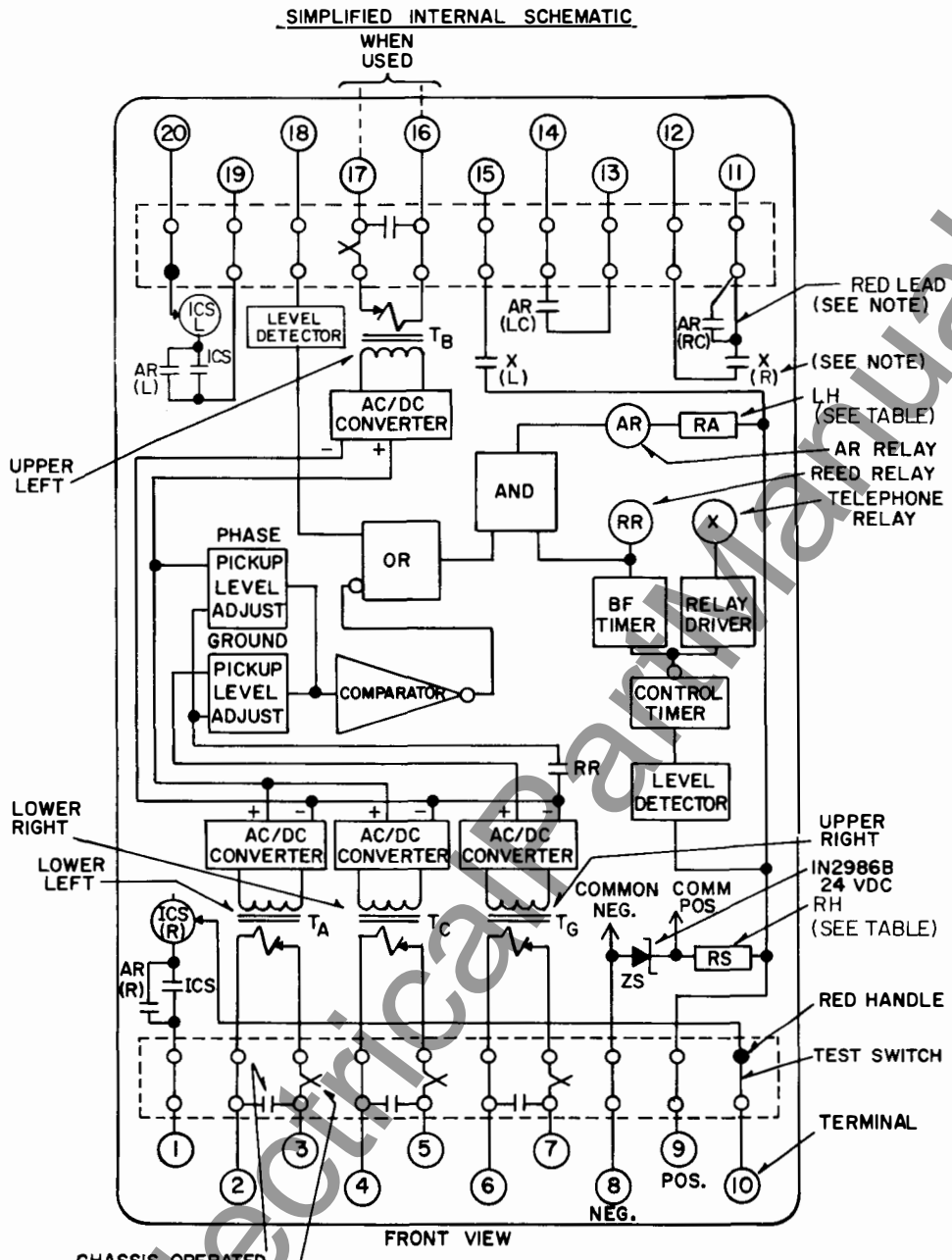


Fig. 1. Photograph of SBF-1 Relay, (without case) with four overcurrent input. Front view



(right oblique).



NOTES:

TO OBTAIN AR CONTACT OUTPUT, MOVE RED LEAD FROM TERMINAL 11 TO TERMINAL 12.

(L),(R),(LC) & (RC) DENOTE LEFT HAND, RIGHT HAND, LEFT CENTER & RIGHT CENTER POSITIONS.

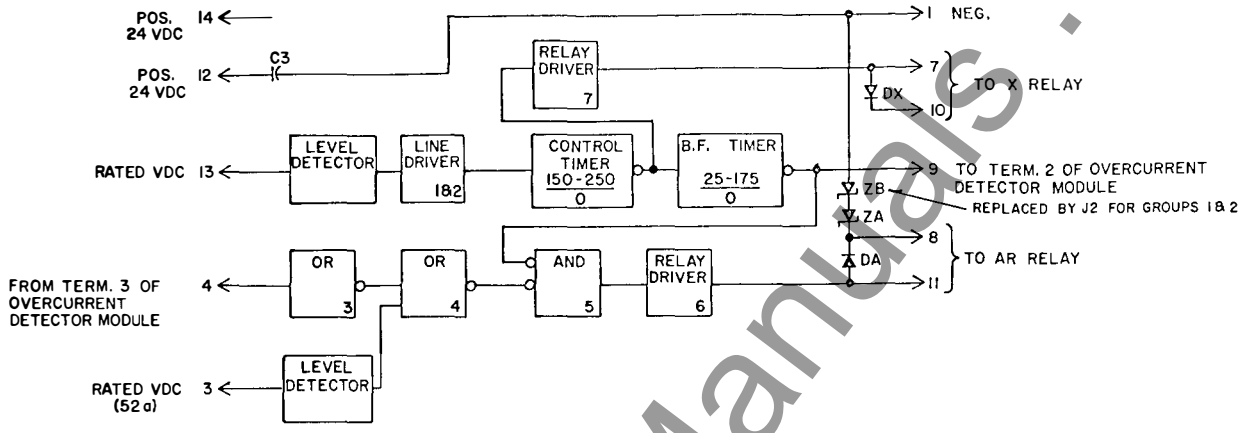
REF. DWG.

1326D19 - DETAILED SCHEMATIC
1326D31 - (4 OVERCURRENT UNITS) WIRING
1326D83 - (3 OVERCURRENT UNITS) WIRING

25W RESISTORS		
VOLTS DC	RA	RS
48	900Ω	200Ω
125	3150Ω	1000Ω
250	7100Ω	2500Ω

Sub. 4
Dwg. 775B813

Fig. 2. Simplified Internal Schematic SBF-1 Relay.



TIMER AND OUTPUT MODULE

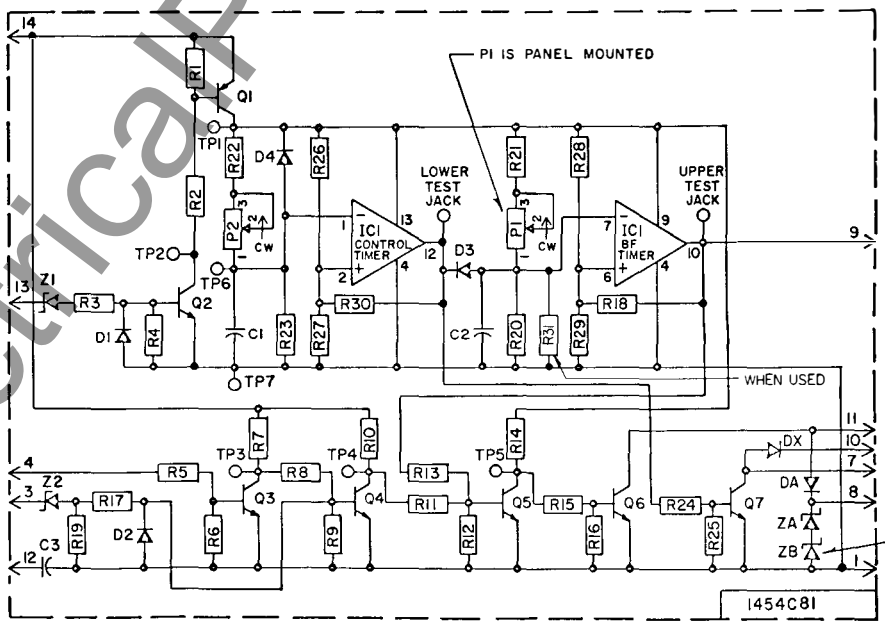


Fig. 4. Internal Sch

1454C81G01 (48 VDC)

CAPACITOR	DESCRIPTION	STYLE NO.
C3	.270UF 200V	188A669H05
C2	3.300UF 35V	862A530H01
C1	6.800UF 35V	184A661H21

DIODE	DESCRIPTION	STYLE NO.
D1-2	1N645	184A855H13
D3-4-A	1N459A	184A855H08
DX	1N5053	188A342H12

INT CKT	DESCRIPTION	STYLE NO.
IC1	747DM	1443C52H01

JUMPER	DESCRIPTION	STYLE NO.
J1-2	0 OHM RESISTOR	862A478H01

POT	DESCRIPTION	STYLE NO.
P2	20.0K .50W	862A406H02
P1	25.0K .50W	880A687H02

TRANSISTOR	DESCRIPTION	STYLE NO.
Q1	2N2905A	762A672H10
Q2-3-4-5-7	2N1711	762A585H08
Q6	2N4063	878A432H01

RESISTOR	DESCRIPTION	STYLE NO.
R4-6-9-12-15-25	2000.0 .50W 2%	629A531H39
R2-14	6800.0 .50W 2%	629A531H52
R1-16	10.0K .50W 2%	629A531H56
R7-8-10-11-22	15.0K .50W 2%	629A531H60
R3-17	20.0K .50W 2%	629A531H63
R5-13-24	27.0K .50W 2%	629A531H66
R20	162.0K .50W 1%	848A821H62
R26-28	20.0K .50W 1%	848A820H74
R27	40.2K .50W 1%	848A821H04
R21	3320.0 .50W 1%	848A819H98
R19	10.0K2.00W 5%	185A207H51
R29	60.4K .50W 1%	848A821H21
R23	499.0K .50W 1%	848A822H10
R18-30	2.2M .50W 5%	187A290H26
R31	1.0M .50W 1%	848A822H39

ZENER	DESCRIPTION	STYLE NO.
ZA	1R200 200.0V	629A369H01
Z1-2	1N9718 27.0V	862A606H11

1454C81G02 (125 VDC)

CAPACITOR	DESCRIPTION	STYLE NO.
C3	.270UF 200V	188A669H05
C2	3.300UF 35V	862A530H01
C1	6.800UF 35V	184A661H21

DIODE	DESCRIPTION	STYLE NO.
D1-2	1N645	184A855H13
D3-4-A	1N459A	184A855H08
DX	1N5053	188A342H12

INT CKT	DESCRIPTION	STYLE NO.
IC1	747DM	1443C52H01

JUMPER	DESCRIPTION	STYLE NO.
J1-2	0 OHM RESISTOR	862A478H01

POT	DESCRIPTION	STYLE NO.
P2	20.0K .50W	862A406H02
P1	25.0K .50W	880A687H02

TRANSISTOR	DESCRIPTION	STYLE NO.
Q1	2N2905A	762A672H10
Q2-3-4-5-7	2N1711	762A585H08
Q6	2N4063	878A432H01

RESISTOR	DESCRIPTION	STYLE NO.
R4-6-9-12-15-25	2000.0 .50W 2%	629A531H39
R2-14	6800.0 .50W 2%	629A531H52
R1-16	10.0K .50W 2%	629A531H56
R7-8-10-11-22	15.0K .50W 2%	629A531H60
R5-13-24	27.0K .50W 2%	629A531H66
R3-17	47.0K .50W 2%	629A531H72
R20	162.0K .50W 1%	848A821H62
R26-28	20.0K .50W 1%	848A820H74
R27	40.2K .50W 1%	848A821H04
R21	3320.0 .50W 1%	848A819H98
R19	10.0K2.00W 5%	185A207H51
R29	60.4K .50W 1%	848A821H21
R23	499.0K .50W 1%	848A822H10
R18-30	2.2M .50W 5%	187A290H26
R31	1.0M .50W 1%	848A822H39

ZENER	DESCRIPTION	STYLE NO.
ZA	1R200 200.0V	629A369H01
Z1-2	UZ8870 70.0V	837A693H14

1454C81G03 (250 VDC)

CAPACITOR	DESCRIPTION	STYLE NO.
C3	.270UF 200V	188A669H05
C2	3.300UF 35V	862A530H01
C1	6.800UF 35V	184A661H21

DIODE	DESCRIPTION	STYLE NO.
D1-2	1N645	184A855H13
D3-4-A	1N459A	184A855H08
DX	1N5053	188A342H12

INT CKT	DESCRIPTION	STYLE NO.
IC1	747DM	1443C52H01

JUMPER	DESCRIPTION	STYLE NO.
J1	0 OHM RESISTOR	862A478H01

POT	DESCRIPTION	STYLE NO.
P2	20.0K .50W	862A406H02
P1	25.0K .50W	880A687H02

TRANSISTOR	DESCRIPTION	STYLE NO.
Q1	2N2905A	762A672H10
Q2-3-4-5-7	2N1711	762A535H08
Q6	2N4063	878A432H01

RESISTOR	DESCRIPTION	STYLE NO.
R6-12-15-25	2000.0 .50W 2%	629A531H39
R4-9	5600.0 .50W 2%	629A531H50
R2-14	6800.0 .50W 2%	629A531H52
R1-16	10.0K .50W 2%	629A531H56
R7-8-10-11-22	15.0K .50W 2%	629A531H60
R5-13-24	27.0K .50W 2%	629A531H66
R3-17	100.0K .50W 2%	629A531H80
R20	162.0K .50W 1%	848A821H62
R26-28	20.0K .50W 1%	848A820H74
R27	40.2K .50W 1%	848A821H04
R21	3320.0 .50W 1%	848A819H98
R29	60.4K .50W 1%	848A821H21
R23	499.0K .50W 1%	848A822H10
R19	36.0K2.00W 5%	185A207H64
R18-30	2.2M .50W 5%	187A290H26
R31	1.0M 50W 1%	848A822H39

ZENER	DESCRIPTION	STYLE NO.
ZA-B	1N3050B 180.0V	187A936H17
Z1-2	1N3049B 160.0V	187A936H13

1454C81G04 (125 VDC)(50-500 MS BF TIMER 150-600 MS CONTROL TIMER)

CAPACITOR	DESCRIPTION	STYLE NO.
C3	.270UF 200V	188A669H05
C2	6.800UF 35V	184A661H21
C1	6.800UF 35V	184A661H21

DIODE	DESCRIPTION	STYLE NO.
D1-2	1N645	184A855H13
D3-4-A	1N459A	184A855H08
DX	1N5053	188A342H12

INT CKT	DESCRIPTION	STYLE NO.
IC1	747DM	1443C52H01

JUMPER	DESCRIPTION	STYLE NO.
J1-2	0 OHM RESISTOR	862A478H01

POT	DESCRIPTION	STYLE NO.
P2	500K .75W	3528A37H01
P1	50.0K .50W	880A687H03

TRANSISTOR	DESCRIPTION	STYLE NO.
Q1	2N2905A	762A672H10
Q2-3-4-5-7	2N1711	762A585H08
Q6	2N4063	878A432H01

RESISTOR	DESCRIPTION	STYLE NO.
R4-6-9-12-15-25	2000.0 .50W 2%	629A531H39
R2-14	6800.0 .50W 2%	629A531H52
R1-16	10.0K .50W 2%	629A531H56
R7-8-10-11-22	15.0K .50W 2%	629A531H60
R5-13-24	27.0K .50W 2%	629A531H66
R3-17	47.0K .50W 2%	629A531H72
R20	255.0K .50W 1%	848A821H21
R26-28	20.0K .50W 1%	848A820H74
R27	40.2K .50W 1%	848A821H04
R21	4.99K .50W 1%	848A820H16
R19	10.0K2.00W 5%	185A207H51
R29	40.2K .50W 1%	848A821H04
R23	226.0K .50W 1%	848A821H76
R18-30	2.2M .50W 5%	187A290H26
R31	1.0M .50W 1%	848A822H39

ZENER	DESCRIPTION	STYLE NO.
ZA	1R200 200.0V	629A369H01
Z1-2	UZ8870 70.0V	837A693H14

REF. DWG.

COMPONENT LOCATION (48/125 VDC) -- 3517A76
COMPONENT LOCATION (250 VDC)- - - - 3517A77

Sub. 3
1325D61

matic of Timer Module.

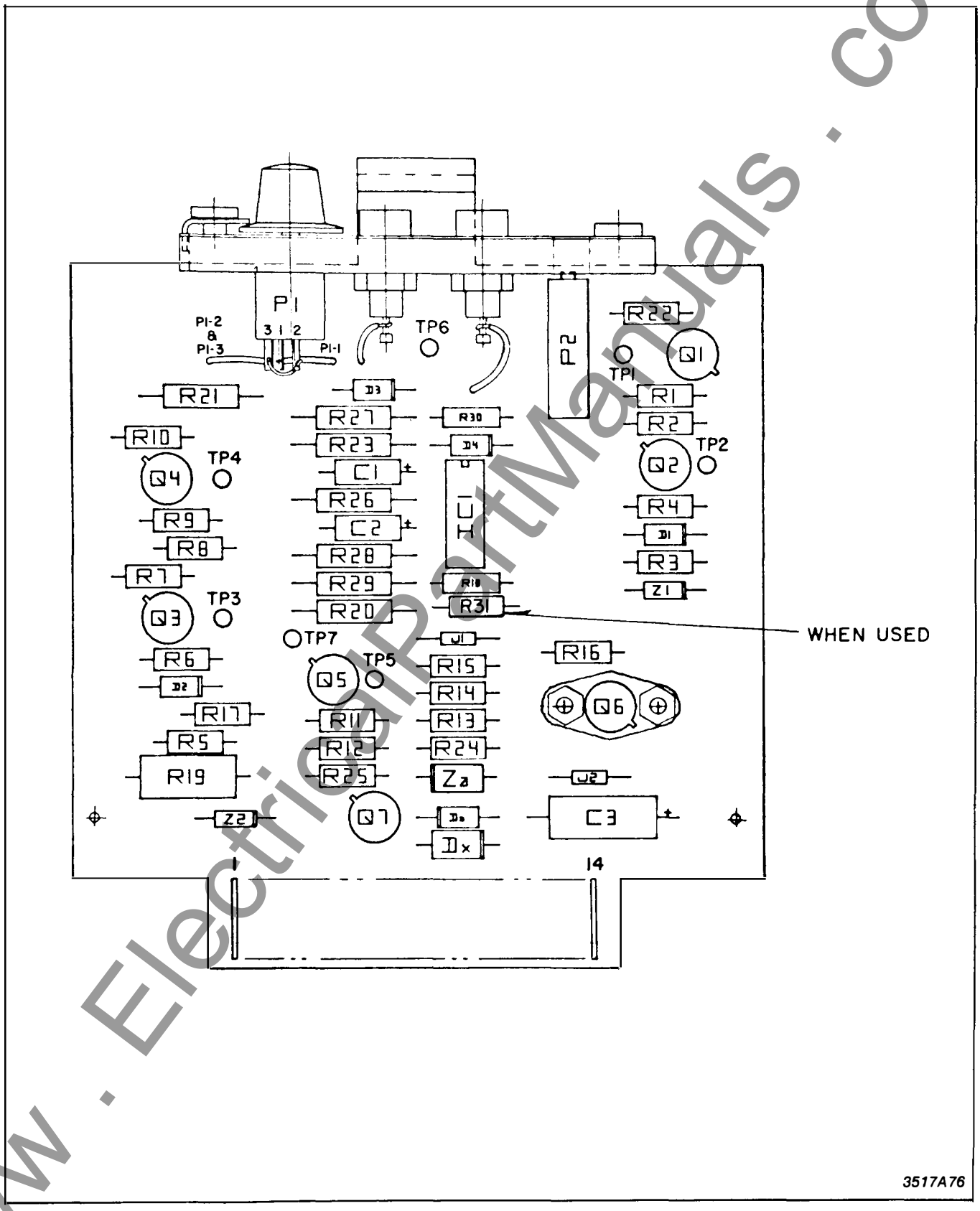


Fig. 5. Component Location for Timer Module 48 or 125Vdc rated relay

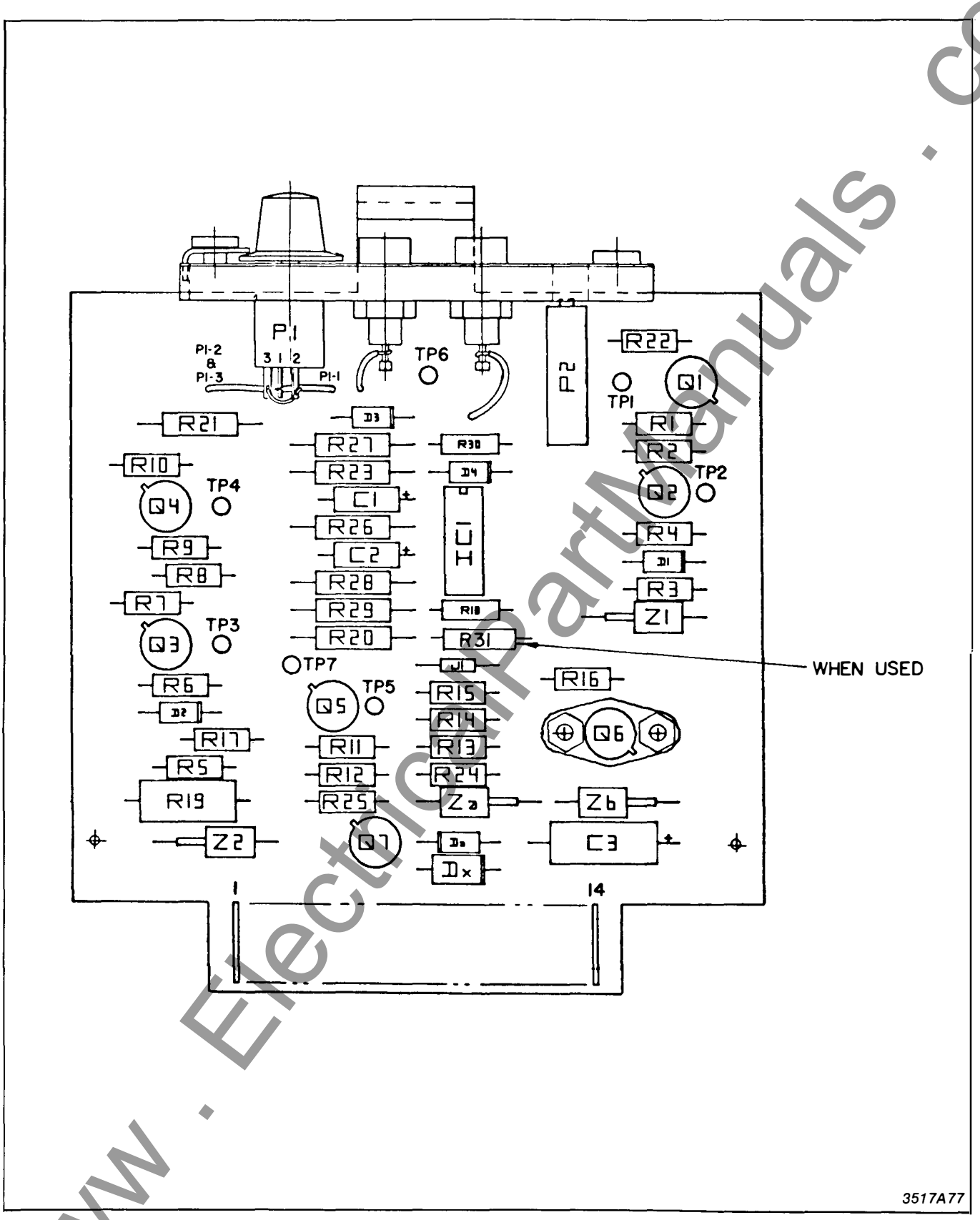


Fig. 6. Component Location for Timer Module 250Vdc rated relay.

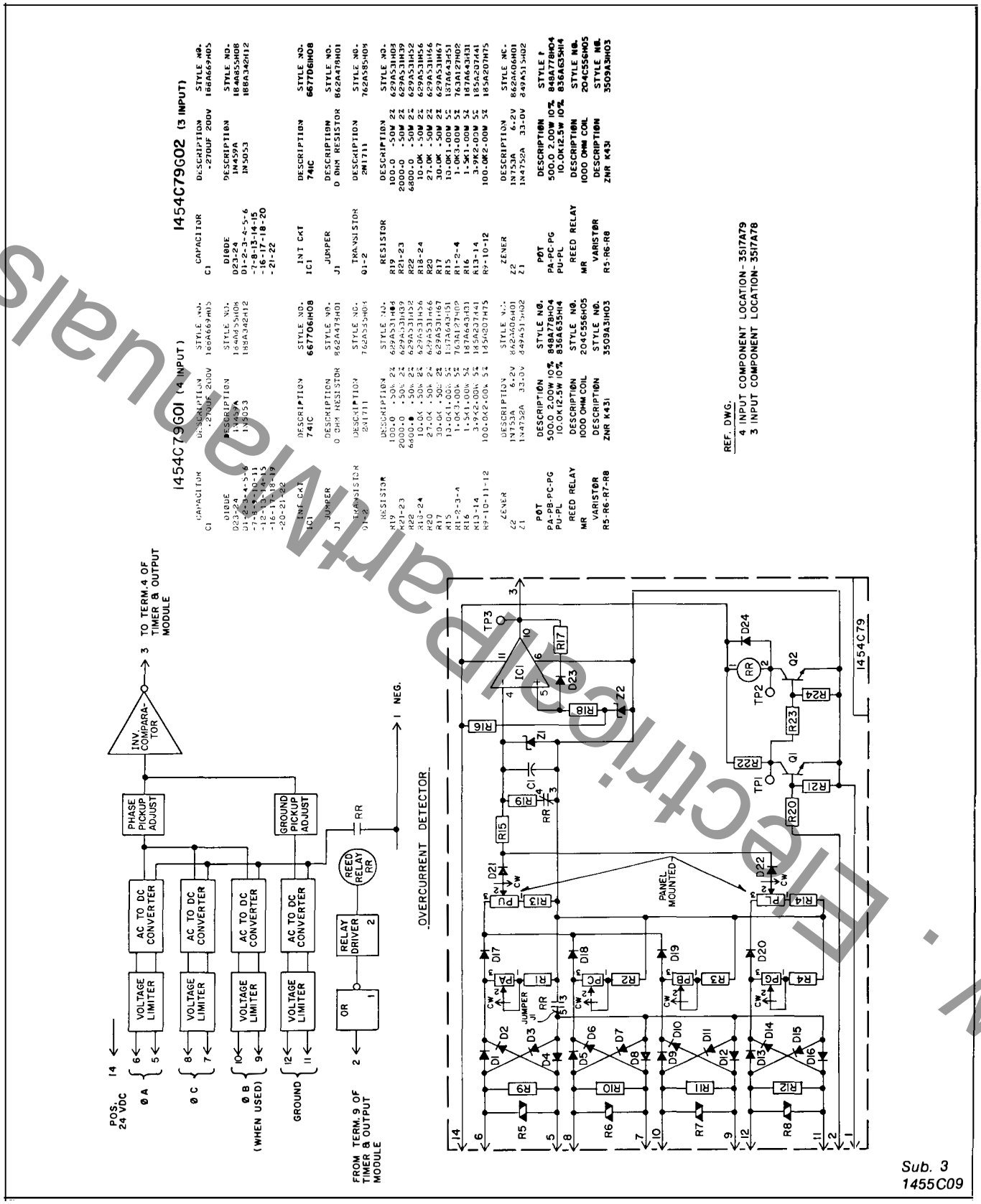


Fig. 7. Internal Schematic of Overcurrent Detector Module.

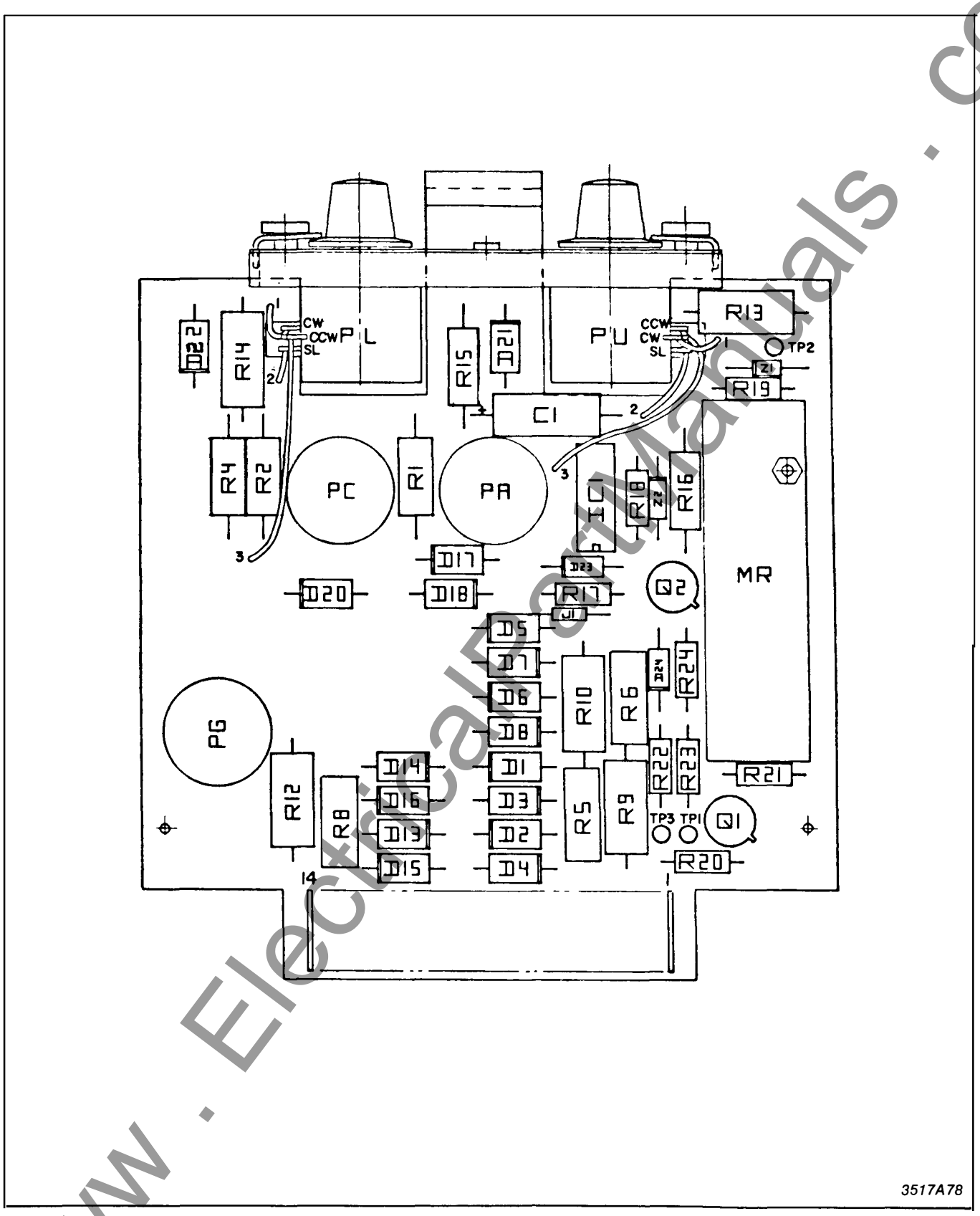


Fig. 8. Component Location for 3 Current Input Overcurrent Detector Module.

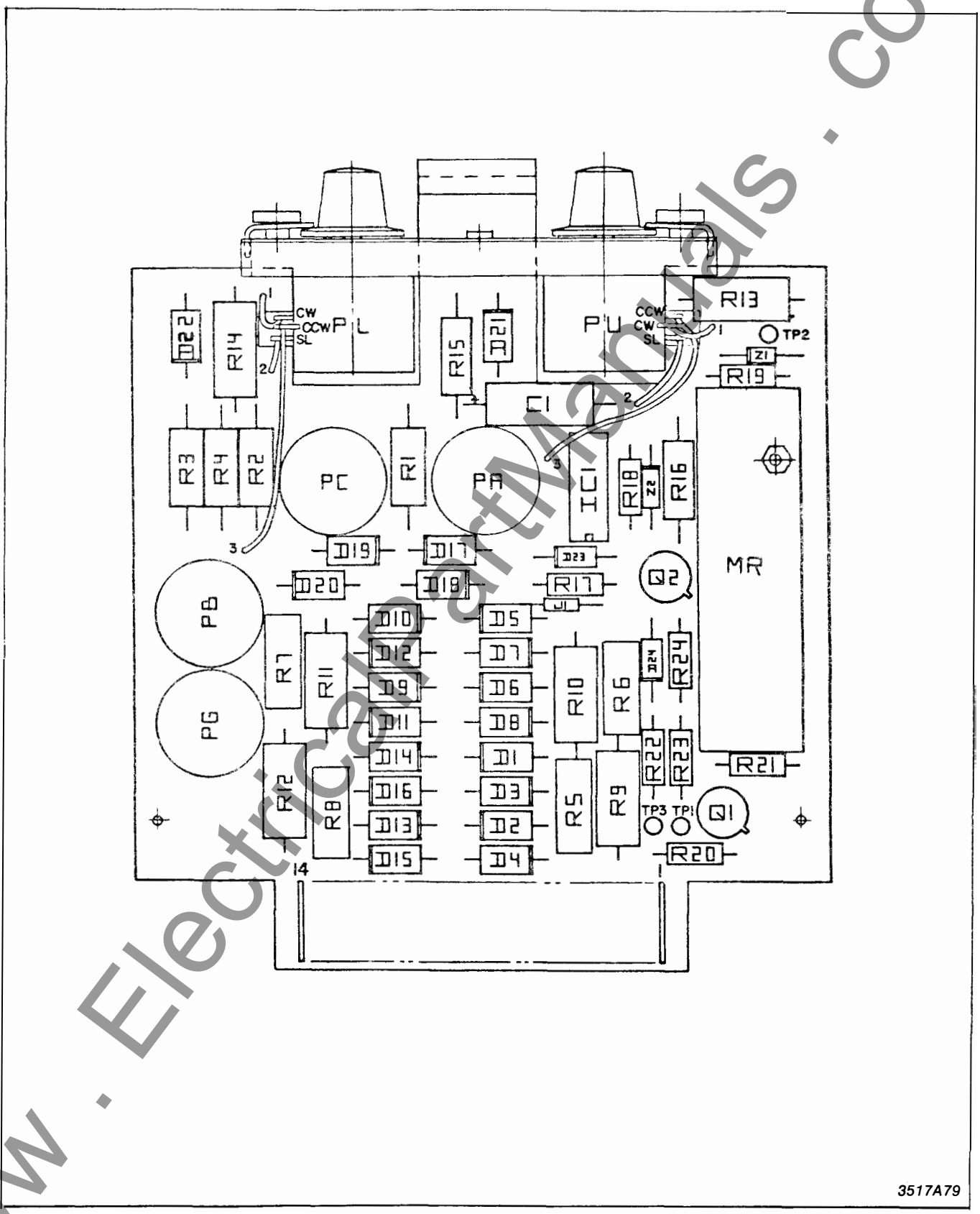
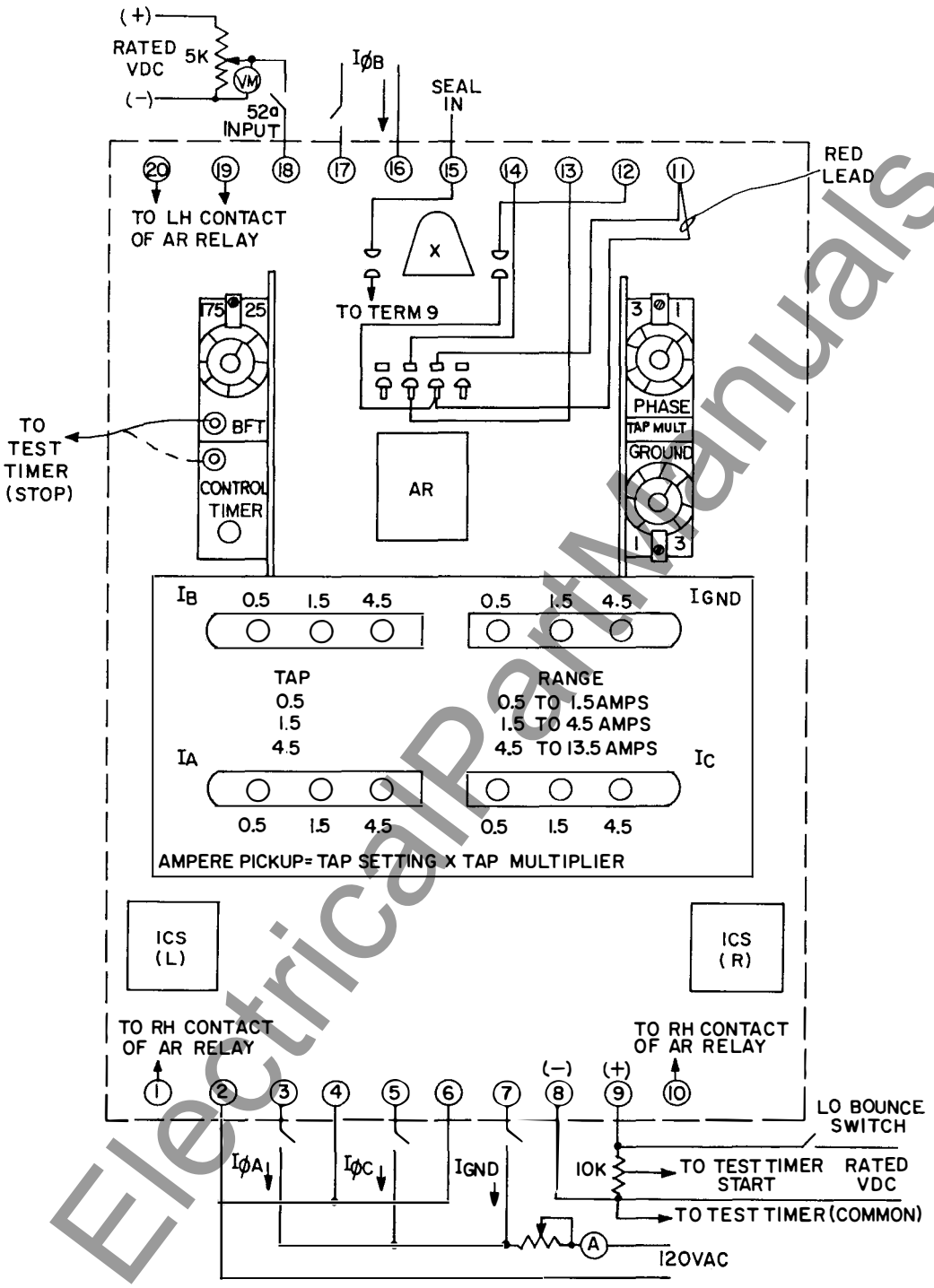


Fig. 9. Component Location for 4 Current Input Overcurrent Detector Module.



NOTE: TO TEST FOR OVERCURRENT UNIT PICKUP, JUMPER TIMER BOARD TEST POINT TP6 AND TP7 BEFORE ENERGIZING RELAY.
TEST BKR FL TIMER IN SIMILAR MANNER.

1479B29

Fig. 10. Test Diagram for SBF-1 Relay.

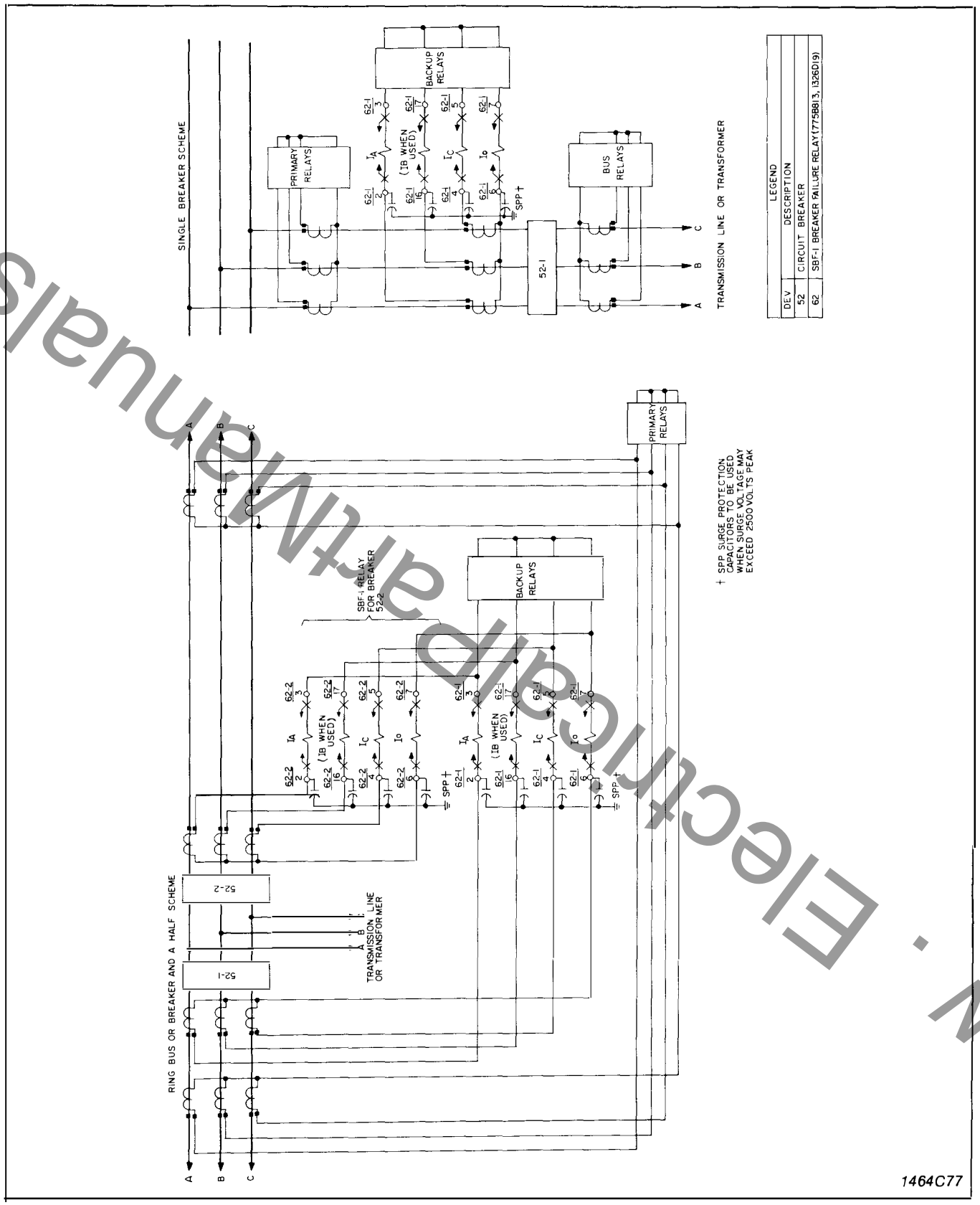
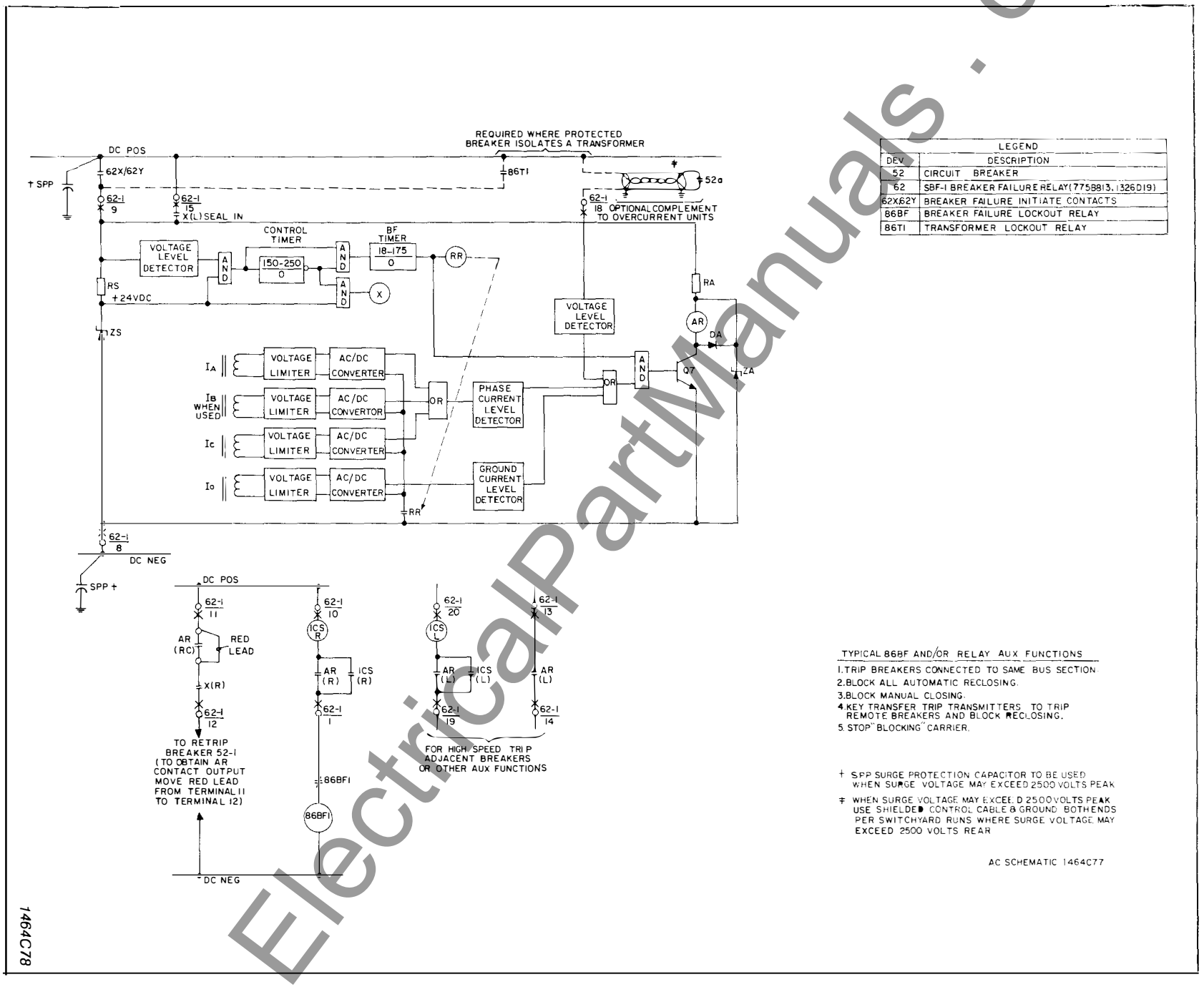


Fig. 11. External AC Schematic for SBF-1 Relay.



LEGEND	
DEV	DESCRIPTION
52	CIRCUIT BREAKER
62	SBF-1 BREAKER FAILURE RELAY (7758813, 1326D19)
62X,62Y	BREAKER FAILURE INITIATE CONTACTS
86BF	BREAKER FAILURE LOCKOUT RELAY
86TI	TRANSFORMER LOCKOUT RELAY

TYPICAL 86BF AND/OR RELAY AUX FUNCTIONS

1. TRIP BREAKERS CONNECTED TO SAME BUS SECTION.
2. BLOCK ALL AUTOMATIC RECLOSING.
3. BLOCK MANUAL CLOSING.
4. KEY TRANSFER TRIP TRANSMITTERS TO TRIP REMOTE BREAKERS AND BLOCK RECLOSING.
5. STOP "BLOCKING" CARRIER.

† SPP SURGE PROTECTION CAPACITOR TO BE USED WHEN SURGE VOLTAGE MAY EXCEED 2500 VOLTS PEAK

‡ WHEN SURGE VOLTAGE MAY EXCEED 2500 VOLTS PEAK USE SHIELDED CONTROL CABLE & GROUND BOTH ENDS PER SWITCHYARD RUNS WHERE SURGE VOLTAGE MAY EXCEED 2500 VOLTS PEAK

AC SCHEMATIC 1464C77

Fig. 12. External DC Schematic for SBF-1 Relay.

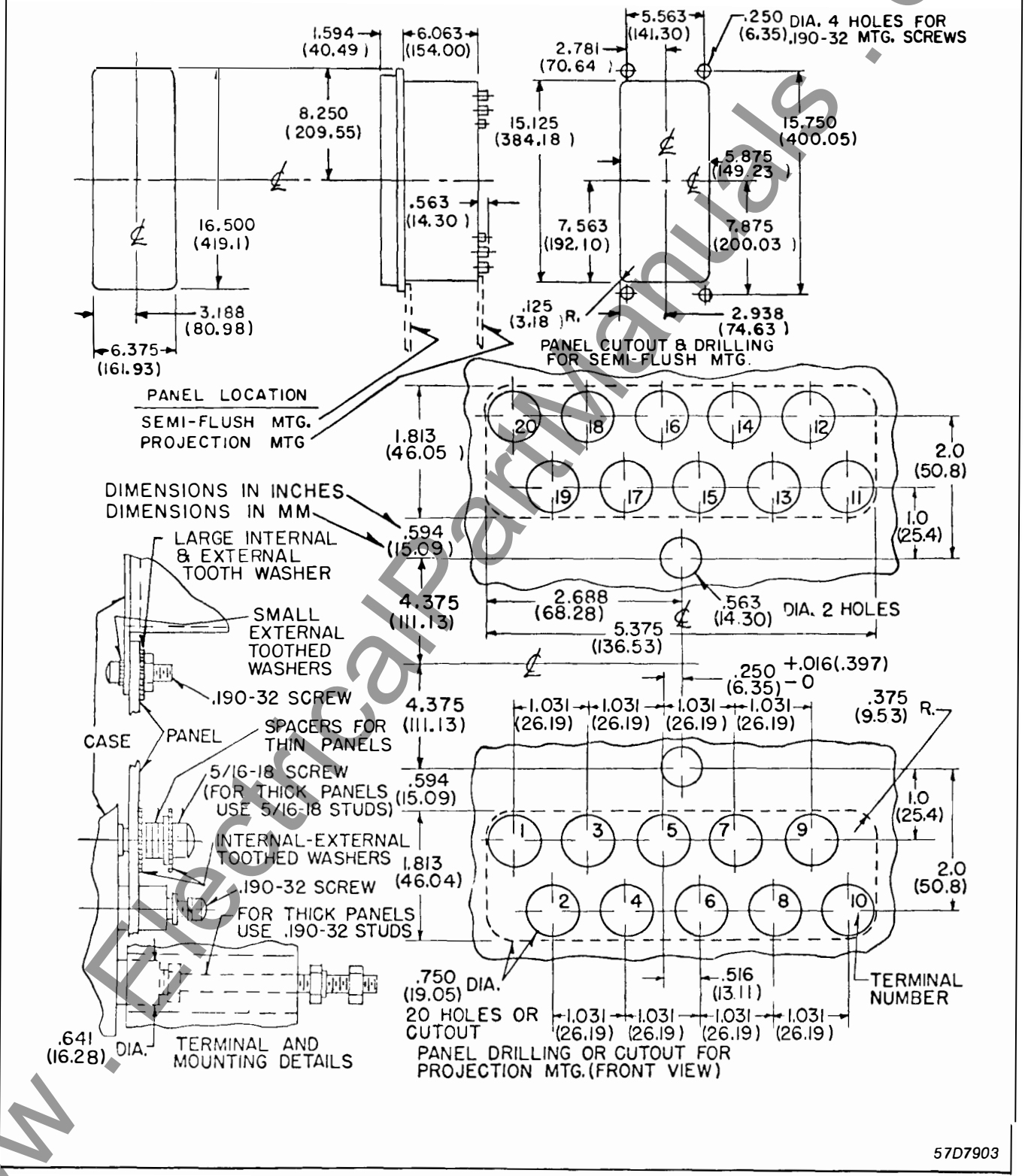


Fig. 13. Outline and Drilling Plan for SBF-1 relay in the Type FT-32 Case. Dwg.

WESTINGHOUSE ELECTRIC CORPORATION

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

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