ABB

Addendum to
I.L. 41-776.5C

Effective: September 1992
This Addendum Supersedes
All Previous Addenda

TYPE SBF-1
Circuit Breaker Failure Relay

A - Add New Information • C - Change Existing Information • D - Delete Information

C

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Figure 3. Simplifed Internal Schematic SBF-1 Relay (0.5 to 13.5 Amps):

The schematic reference of a red lead to terminal 11, has been substituted. The lead is now ***black with a white marker.***

C

Page 18

Figure Description should read: Figure 4 Simplified Internal Schematic SBF-1 Relay (0.05 to 1.35 amps)

C

Pages 19-20

Figure Description should read: Figure 5 Detailed Internal Schematic SBF-1 Relay (0.5 to 13.5 Amps):

The schematic reference of a red lead to terminal 11, has been substituted. The lead is now ***black with a white marker.***

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Figure 15. Test Diagram for SBF-1 Relay:

The schematic reference of a red lead to terminal 11, has been substituted. The lead is now ***black with a white marker.***

THIS PAGE RESERVED FOR NOTES

Instruction Leaflet
I.L. 41-776.5C

Type SBF-1 Circuit Breaker Failure Relay

Effective: September 1989
Supersedes I.L. 41-776.5B Dated October 1985
* Denotes Change Since Previous Issue

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.

1. 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 the trip contact of the * initiating relay to close.

2. 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).

2.1 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 amplifier 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 control the operation of the circuit.

2.2 BF and Control Timer

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

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.

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 trimpot. A test jack is also supplied to change the control timer delay in conjunction with a timer 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.

2.3 Power Supply

The power supply circuit 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.

2.4 Telephone Relay (X)

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

2.5 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).

2.6 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.

* 3. OPERATION

The operation of the SBF-1 is somewhat different from that of conventional breaker failure relays or schemes.

A conventional scheme operates by these principles:

1. The breaker-failure overcurrent detector 50 always monitors breaker currents. It picks up for all faults, and drops out after successful clearing.

2. The breaker-failure initiation (BFI) contacts 62X, 62Y energize the breaker failure (BF) timer 62 through the picked-up overcurrent detector output contacts, or equivalent logic.

3. If the breaker clears the fault, 50 drops out and stops timer 62. If the breaker fails, 50 stays picked up and 62 times out initiating backup cleaning.

The SBF-1 scheme operates as follows:

1. The overcurrent detector 50 cannot measure currents at all until told to do so by the breaker failure timer. It is not allowed to pick up when the fault first occurs and relays operate.

2. The BFI contacts 62X, 62Y directly start the breaker failure timer, plus a second parallel timer called the control timer, which has a somewhat longer delay.

3. The breaker failure timer runs to timeout on every breaker failure initiation.

4. When the BF timer times out it enables the overcurrent detection. If the breaker has cleared the fault, there is no current and 50 doesn't pick up. If the breaker has failed, current is still flowing and 50 picks up.

5. The pickup of the overcurrent detector 50 causes a breaker-failure trip output and initiates backup clearing.

6. The checking of current by 50 must be cut off before reclosing occurs on a temporary line fault. The control timer supervises the backup tripping by 50, and cuts off all relay operation after enough checking time has been allowed.

   The setting of the control time delay isn't critical, but see SETTINGS for more information. After the control time delay expires, all logic and timers reset, and the X relay used for BFI seal-in and protected-breaker retripping drops out.

The circuit operation can be explained by referring to the internal schematic drawing 775B813 (Fig. 2) and detailed internal schematic 1326D19 (Fig. 4).

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 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 transistors Q2 and Q1 turn on, it connects the regulated power supply to the control timer which consists of 1/2 of IC1, trimpot P2 and timing capacitor C1. Resistors 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).

4. CHARACTERISTICS

4.1 Overcurrent Detector

The overcurrent detector has a range of 0.5 to 13.5 amperes or a range of 0.05 to 1.35 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 continuously 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, the relay must be first removed from the case. Chassis operating shorting switches on the case will short the secondary of the current transformer. The taps should then be changed with the relay outside of the case and then re-inserted into the case.

4.2 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 or a 0.2 to 1.1 sec. timer is available and is shipped set at 600 ms or 1.1 sec. respectively.

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.

4.3 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 or a 0.1 to 1.0 sec. 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.

4.4 Power Supply

The 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.

4.5 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 the input voltage.

4.6 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.

4.7 X Relay

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

4.8 AR Relay

The coil resistance is 630 ohms $\pm$ 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.

4.9 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.

4.10 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.

5. SETTINGS

5.1 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. A range of 0.05 to 1.35 amps is also available. Each tap setting permits adjusting the pickup over a 3 to 1 range.

There are 2 or 3 phase-current 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 unit 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 (3Io) current. Settings should be made to assure a multiple of pickup of at least 2 under minimum fault conditions.

5.2 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 32 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), operate time of the overcurrent unit (3 to 8 ms) and the maximum pickup time of the 86 BF (16 ms).

The control timer should not be set longer than the reclosing time minus the dropout time of the X relay (20 to 25 ms) if the retrip feature is used.

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 or a 0.2 to 1.1 sec. timer is available and is shipped with the timer set for 600 ms or 1.1 sec. respectively.

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.

5.3 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 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 or a 0.1 to 1.0 sec. timer with 0.1 sec. 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 0.1 to 1.0 ms timer is shipped set at 1.0 sec.

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)

5.4 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.

6. 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 detailed information on the FT case refer to I.L. 41-076.

6.1 Adjustments and Maintenance

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

NOTE: DO NOT use an oscillograph to monitor TP1, Lower Test Jack and Upper Test Jack. The noise or sparks generated from the oscillograph may damage or reset the timers. The time delay can be obtained with the oscillograph by connecting the probe to TP2 on the overcurrent module as described in the Acceptance Test section.

6.2 Acceptance Test

The following check is recommended to insure that the relay is in proper working order. Refer to Fig. 14 for test connections.

6.2.1. Overcurrent Detector

The following description is for the range of 0.5 to 13.5 amperes. With a range of 0.05 to 1.35 amperes, reduce the current by a factor of 10.

a. Place all the tap settings in the 0.5 amp position and rotate the phase and ground tap multiplier knob on the overcurrent (O/C) module to the 1.0 calibration mark.

b. Jumper test points TP6 and TP7 on the timer module and apply rated dc voltage to terminals 8 and 9. Also apply a single-phase current to terminals 2 and 3.

c. Connect a scope probe to TP3 (on O/C module) and increase the input current until the trace drops from approximately 23.5 volts to less than 2.5 Vdc. The ac current input should be between 0.48 and 0.52 amperes.

The AR relay should pickup at the same time. When TP6 and TP7 are jumped, the dropout time of the O/C output at TP3 will be slow. Opening the switch to terminal 9 or disconnecting the jumper between TP6 and TP7 momentarily will speed up the dropout time.

d. Remove the jumper between TP6 and TP7. The voltage at TP3 should jump from low to high and the AR relay should dropout.

e. Repeat steps (a), (b), and (c) for phase C, phase B (if used) and ground current. The error should be within 5% of the phase A pickup.

f. Rotate the Tap Multiplier knobs to the 3.0 setting and repeat steps (a), (b), (c) and (e). The operate currents should be 1.5 amps ± 5%.

g. For setting of the phase or ground current operate levels, connect a jumper between TP6 and TP7, set the tap screw in the proper range location and set the multiplier knob at the point at which the voltage at TP3 changes from high to low at the desired input current.

h. Remove the jumper between TP6 and TP7. *

6.2.2 Control Timer

a. Connect the scope probe to the Lower Test Jack (on timer module) and set scope trigger on the internal and positive position.

* b. Turn on the input switch. The positive waveform at the Lower Test Jack should last for 200 ± 10 ms (or 600 ± 30 ms or 1100 ± 55 ms for the longer range timers).

It is possible to use an electronic digital timer to measure the delay time if the digital timer is equipped with a dc bias adjustment for the timer stop since the low state at the Lower Test Jack will be approximately 2 volts. Another alternate way is to connect the timer stop to terminal 7 on the timer module.

6.2.3 Breaker Failure (BF) Timer

* a. Connect a jumper between TP6 and TP7.

* b. Connect the scope probe to the Upper Test Jack (on timer module) and set scope trigger on the internal and positive position.

c. Turn on the input switch. The positive waveform at the Upper Test Jack should last for 175 ± 5 ms (or 500 ± 15 ms or 1000 ± 30 ms for the longer range timers). Turn off the dc input switch.

* d. Remove the jumper between TP6 and TP7.

A digital timer can also be used for this test by connecting the timer start to TP1 (on timer module) and the timer stop to TP2 (on O/C module).

6.2.4 Overall Operation

Use a digital timer to measure the delay time. Connect the timer start and stop leads to the dc input switch (or TP1 on timer module) and AR output contacts respectively. Make sure that the control timer setting is 32 ms or more longer than BF timer.

a. Turn on the dc input switch. The AR relay should not close momentarily. Turn off the switch.

b. Apply a rated voltage through the 52a switch and then turn on the dc input switch. The AR relay should close momentarily and the timer should read between BF time and BF time + 16 ms, where BF time is the setting of the BF timer. Turn off switches.

c. Apply 55% of rated relay voltage through the 52a switch then turn on rated dc to the input switch. The AR relay should not close. Turn off the dc input switches.

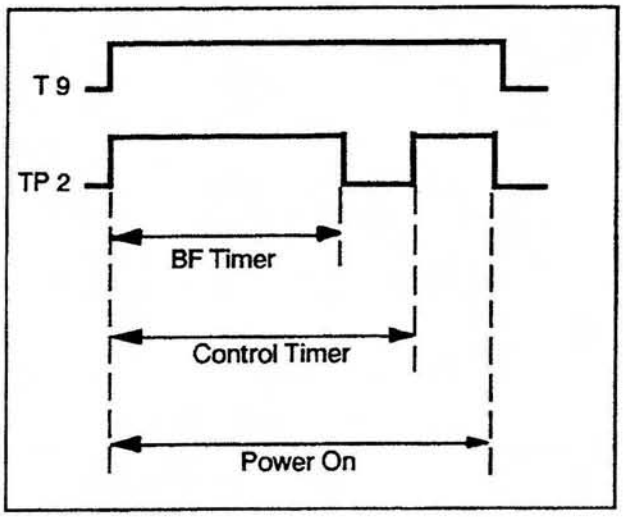
* d. Apply a current at 2X pickup setting to terminal 2 and 3 (phase A). The AR relay should not close.

e. Repeat step (d) and then switch on rated voltage to the dc input switch. The AR relay should close momentarily and the timer should read between BF time and BF time + 16 ms.

f. Reverse step (e) and (d), i.e. close the dc input switch for at least 1 sec. and then apply 2X pickup current. The AR relay should not close. Turn off switches.

g. Apply 2X pickup current, then turn on the dc input at 55% of rated voltage. The AR relay should not close. Turn off the switches.

h. A scope probe or an oscillograph can be connected to TP2 on O/C module in order to monitor the Control and BF timers. Fig. 1 shows the input voltage at terminal 9 (T9) and output waveform at TP2 on O/C module.



6.2.5 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 the switch to terminal 9 checking that each ICS picks up and seals itself in the closed position.

The contacts are adjusted so that contact follow * is approximately 1/64" to 3/64". 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.

* 7. 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.

8. 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.

8.1 Overcurrent Detector

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 points 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 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 1.0 pickup, at the 0.5 amp tap, 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 as was used for phase A input.

For an overcurrent module with a range of 0.05 to 1.35 amperes, use the same procedure except reduce the input current by a factor of 10.

Remove jumper from TP6 and TP7 on the timer module.

8.2 Control Timer

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 a described under acceptance testing.

8.3 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 replace 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 the timer knob until a 25 ms time delay has been obtained. Use the test procedure * described under the Acceptance Test 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 from the knob locking tab. Scribe lines at the 25 ms setting and for each 25 ms increment up to 175 ms.

8.4 Indicating Contactor Switch (ICS)

For proper contact adjustment, insert a .030" feeler gauge between the core pin and the armature. Hold the armature closed against the core pin and gauge and adjust the stationary contacts such that they just make with the moving contact. Both stationary contacts shoiuld make at approximately the same time . The contact follow will be approximately 1/64" to 3/64".

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 target 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.

9. TROUBLESHOOTING

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.

9.1 Timer Module

9.1.1 Jumper test points TP6 and TP7.

a. Apply rated relay voltage to terminal 9. Voltage at lower test jack = 23.5V.

b. Remove jumper. Apply rated voltage. Voltage at lower test jack = less than 2.5 Vdc.

9.1.2 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 22.5 Vdc.

9.1.3 Jumper test points TP6 and TP7.

a. Apply rated voltage. Voltage at pin 6 of IC1 = 18.3V.

b. Remove jumper. Apply rated voltage. Voltage at pin 6 of IC1 should be approximately 0.1 Vdc less than voltage measured in Step a.

9.1.4 Jumper test points TP6 and TP7.

a. Apply rated relay voltage. Voltage at pin 7 of IC1 = 20.8V with timer knob fully CW.

b. Voltage at pin 7 of IC1 = 23.8V with timer knob fully CCW.

9.1.5 Jumper test points TP6 and TP7.

a. Apply rated relay voltage. Voltage at pin 2 of IC1 = 16.5V.

b. Remove jumper and apply voltage. Voltage at pin 2 of IC1 should be approximately 0.1V less than voltage measured in step a.

9.1.6 Jumper test points TP6 and TP7 and 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.

9.1.7 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 at terminal 18 to 55% of rated relay voltage. Voltage at TP4 = 12.7V.

9.1.8 Jumper test points TP6 and TP7. Apply twice tap value ac current.

a. Apply rated relay voltage. Voltage at TP5 = 6.2V.

b. Remove jumper. Voltage at TP5 = less than 0.5V.

9.1.9 Jumper test points TP6 and TP7.

a. Apply rated relay voltage. Voltage at printed circuit board terminal 7 or 11 = less than 0.5V (X and AR relay picked up).

b. Remove jumper. Apply rated voltage. Voltage at printed circuit board terminal 7 = 24V (X relay not picked up). Voltage at printed circuit board terminal 11 = rated relay voltage (AR relay not picked up).

9.2 Overcurrent Module

9.2.1 Jumper test points TP6 and TP7 (timer module). Set tap in 0.5 position and turn tap multiplier knob to 1.0 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 volt age should be read with the tap in the 1.5 amp tap and 1.5 amps ac applied. Like wise with the 4.5 amp tap.

9.2.2 Jumper test points TP6 and TP7. Set tap in 0.5 amp position and turn tap multiplier to 1.0 position.

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

9.2.3 Jumper test points TP6 and TP7. Set tap in 0.5 position 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.

9.2.4 Jumper test points TP6 and TP7.

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.

9.2.5 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.

9.2.6 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.

10. 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 date, and style numbers from the electrical parts list.

TABLE 1
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

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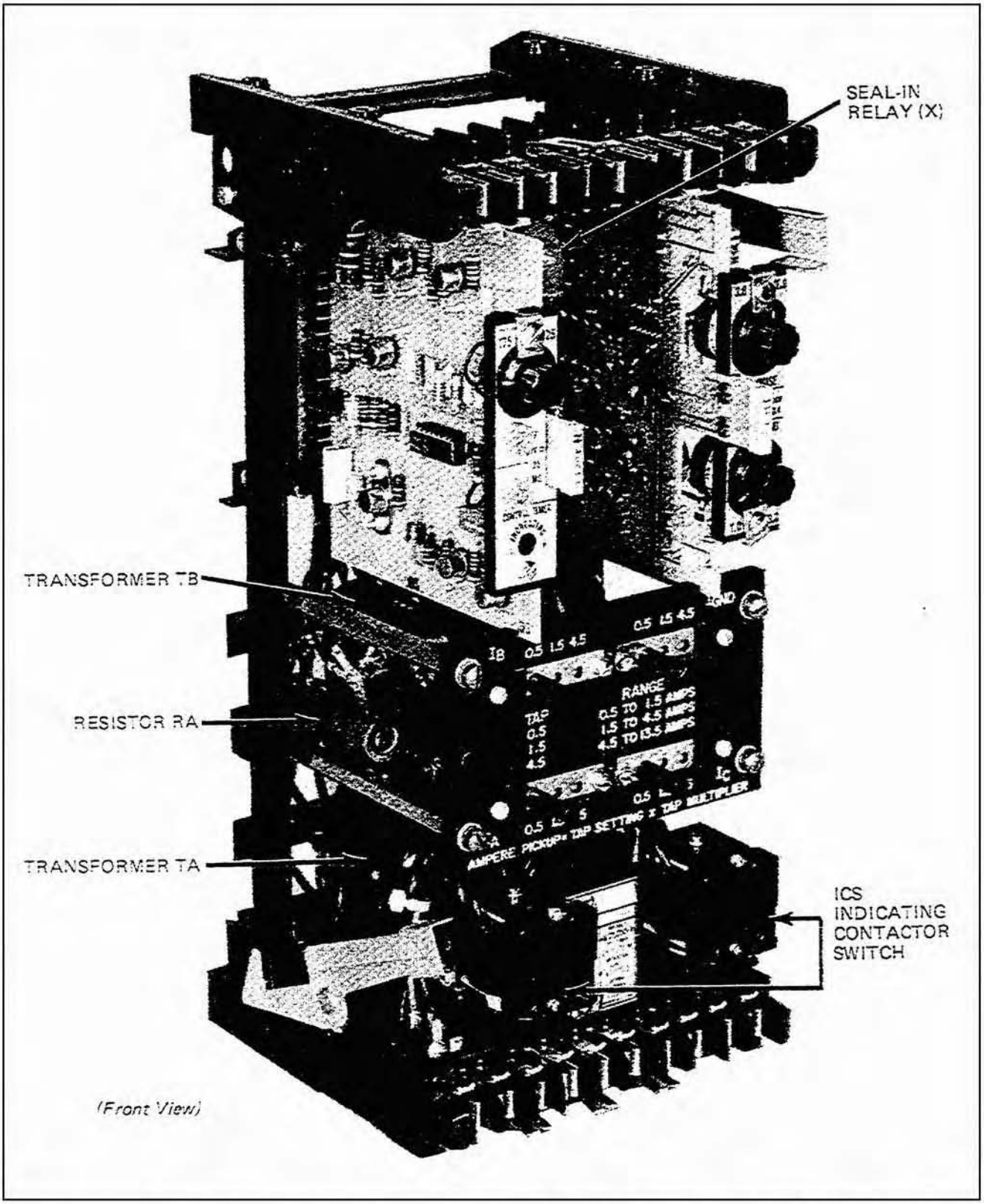


Fig. 1. Photograph of SBF-1 Relay (Without Case) With Four Overcurrent Input

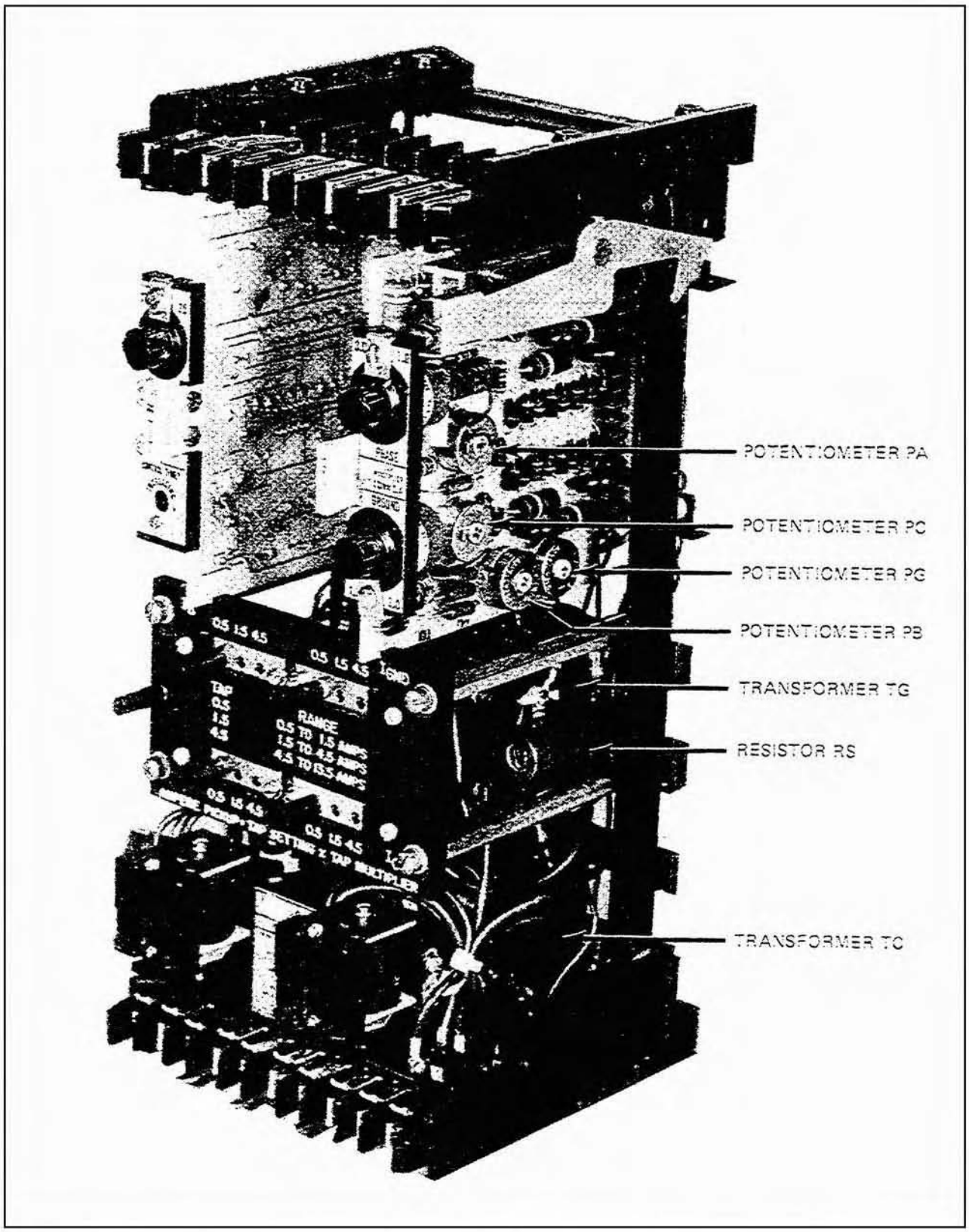
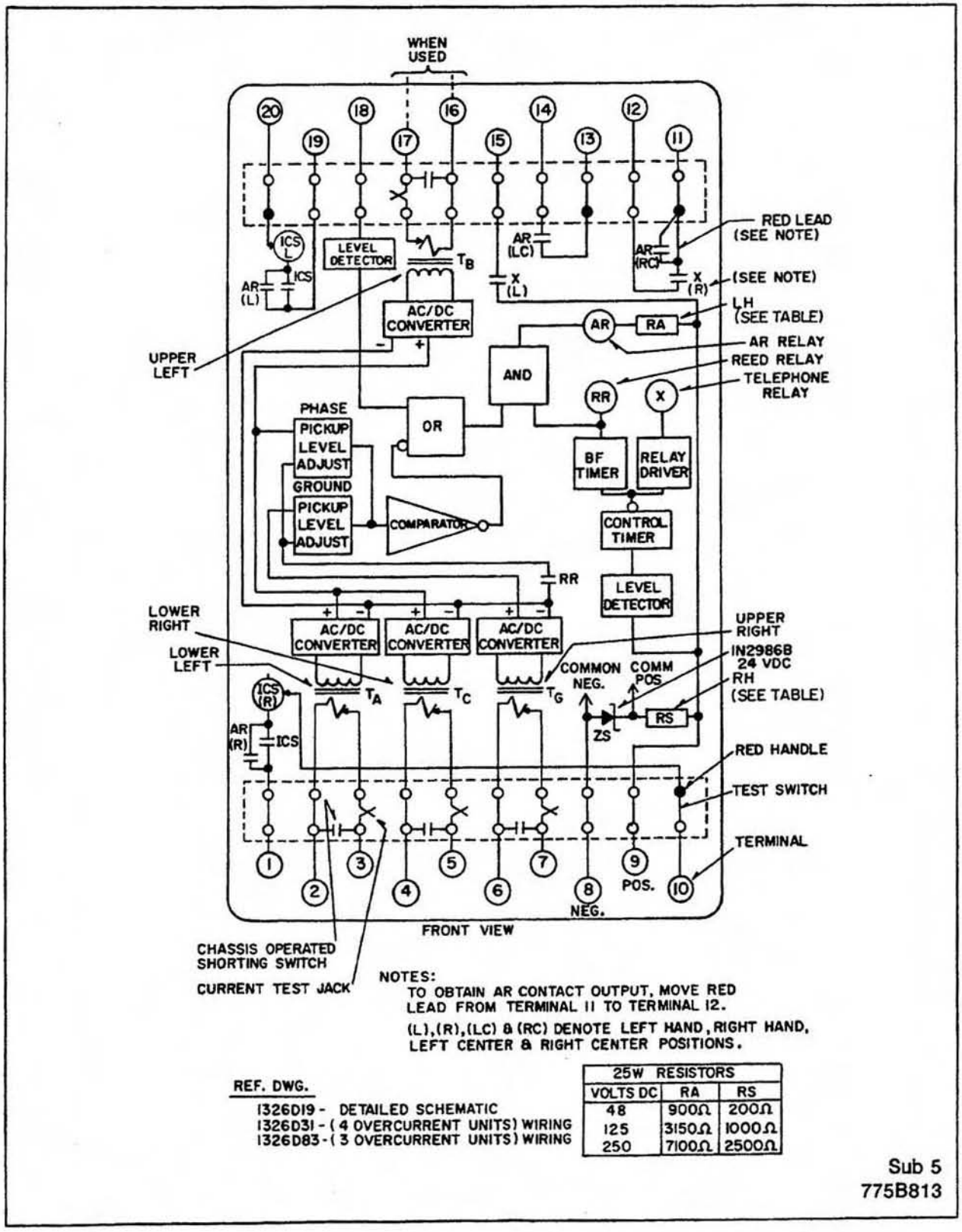


Fig. 2. Photograph of SBF-1 Relay (Without Case) With Four Overcurrent Input



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

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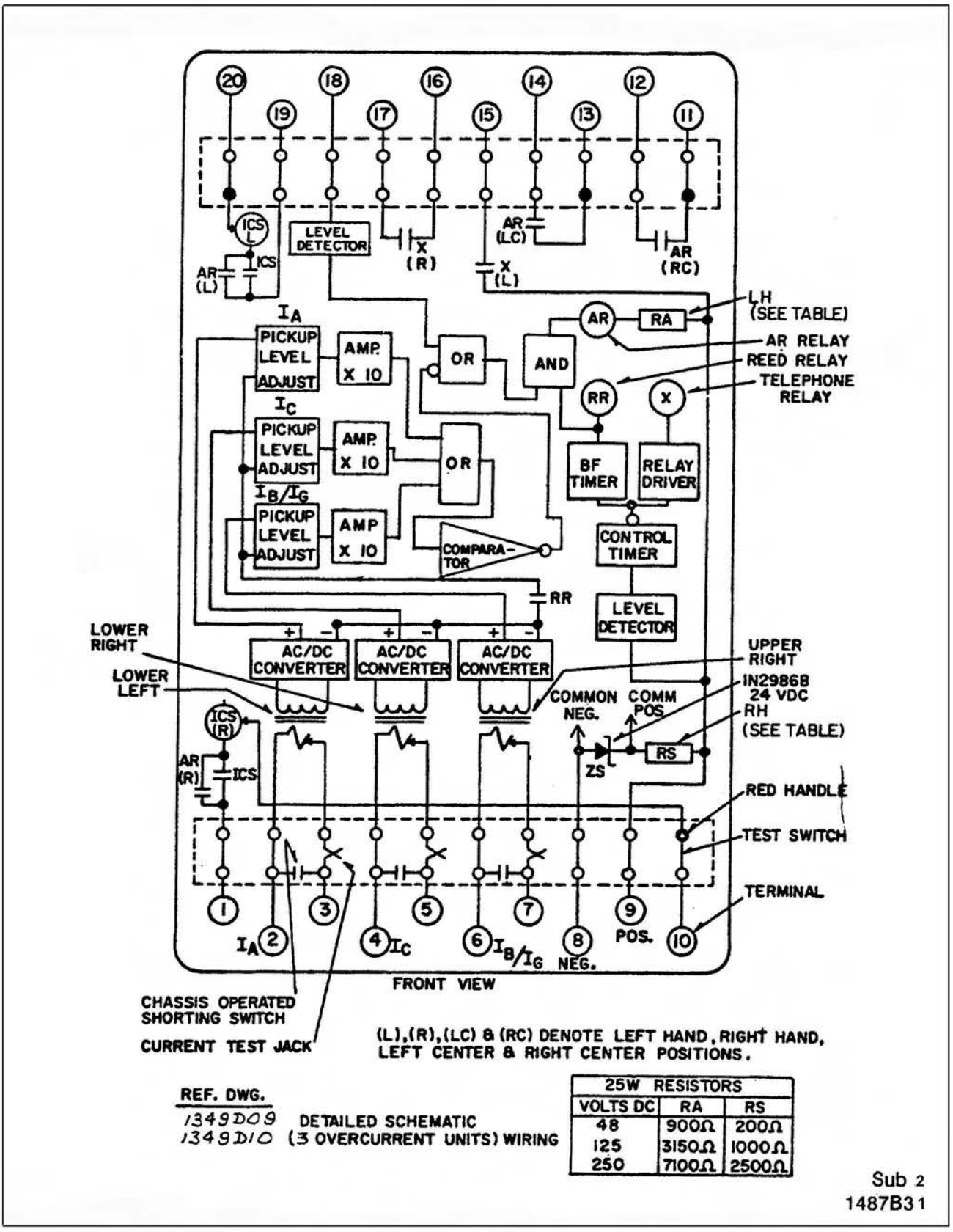
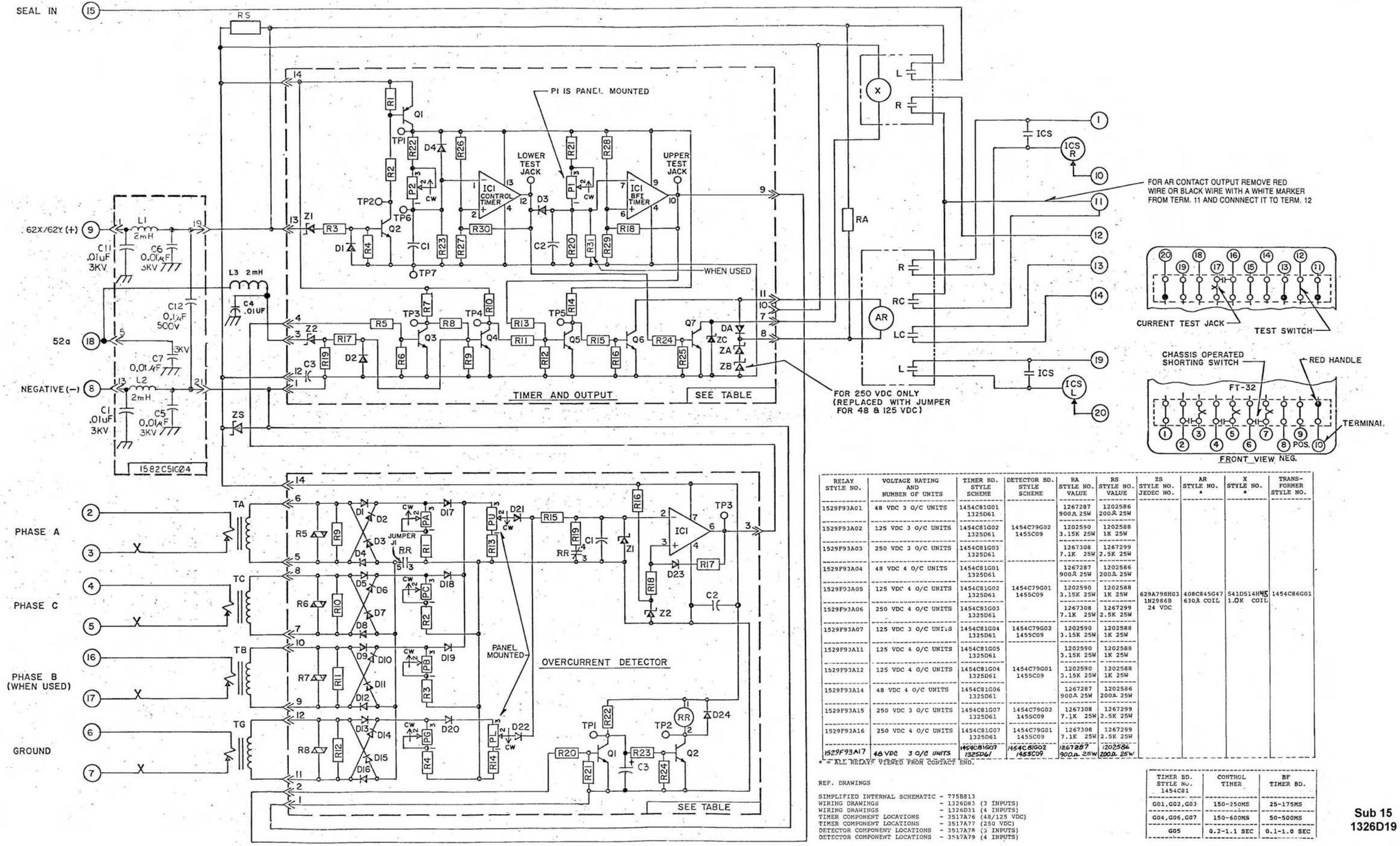
775B813

* *Fig. 3. Simplified Internal Schematic SBF-1 Relay (0.5 to 13.5 Amps)*



* *Fig. 4. Simplified Internal Schematic SBF-1 Relay (0.05 to 13.5 Amps)*



RELAY STYLE NO.	VOLTAGE RATING AND NUMBER OF UNITS	TIMER BD. STYLE SCHEME	DETECTOR BD. STYLE SCHEME	RA STYLE NO. VALUE	RS STYLE NO. VALUE	ZS STYLE NO. JEDEC NO.	AR STYLE NO. *	X STYLE NO. *	TRANS-FORMER STYLE NO.
1529F93A01	48 VDC 3 O/C UNITS	1454C81G01 1325D61		1267287 900Ω 25W	1202586 200Ω 25W				
1529F93A02	125 VDC 3 O/C UNITS	1454C81G02 1325D61	1454C79G02 1455C09	1202590 3.15K 25W	1202588 1K 25W				
1529F93A03	250 VDC 3 O/C UNITS	1454C81G03 1325D61		1267308 7.1K 25W	1267299 2.5K 25W				
1529F93A04	48 VDC 4 O/C UNITS	1454C81G01 1325D61		1267287 900Ω 25W	1202586 200Ω 25W				
1529F93A05	125 VDC 4 O/C UNITS	1454C81G02 1325D61	1454C79G01 1455C09	1202590 3.15K 25W	1202588 1K 25W	629A798H03 1N2986B 24 VDC	408C845G47 630Ω COIL	541D514H05 1.0K COIL	1454C86G01
1529F93A06	250 VDC 4 O/C UNITS	1454C81G03 1325D61		1267308 7.1K 25W	1267299 2.5K 25W				
1529F93A07	125 VDC 3 O/C UNITS	1454C81G04 1325D61	1454C79G02 1455C09	1202590 3.15K 25W	1202588 1K 25W				
1529F93A11	125 VDC 4 O/C UNITS	1454C81G05 1325D61		1202590 3.15K 25W	1202588 1K 25W				
1529F93A12	125 VDC 4 O/C UNITS	1454C81G04 1325D61	1454C79G01 1455C09	1202590 3.15K 25W	1202588 1K 25W				
1529F93A14	48 VDC 4 O/C UNITS	1454C81G06 1325D61		1267287 900Ω 25W	1202586 200Ω 25W				
1529F93A15	250 VDC 3 O/C UNITS	1454C81G07 1325D61	1454C79G02 1455C09	1267308 7.1K 25W	1267299 2.5K 25W				
1529F93A16	250 VDC 4 O/C UNITS	1454C81G07 1325D61	1454C79G01 1455C09	1267308 7.1K 25W	1267299 2.5K 25W				
1529F93A17	48 VDC 3 O/C UNITS	1454C81G07 1325D61	1454C81G02 1455C09	1267287 900Ω 25W	1202586 200Ω 25W				

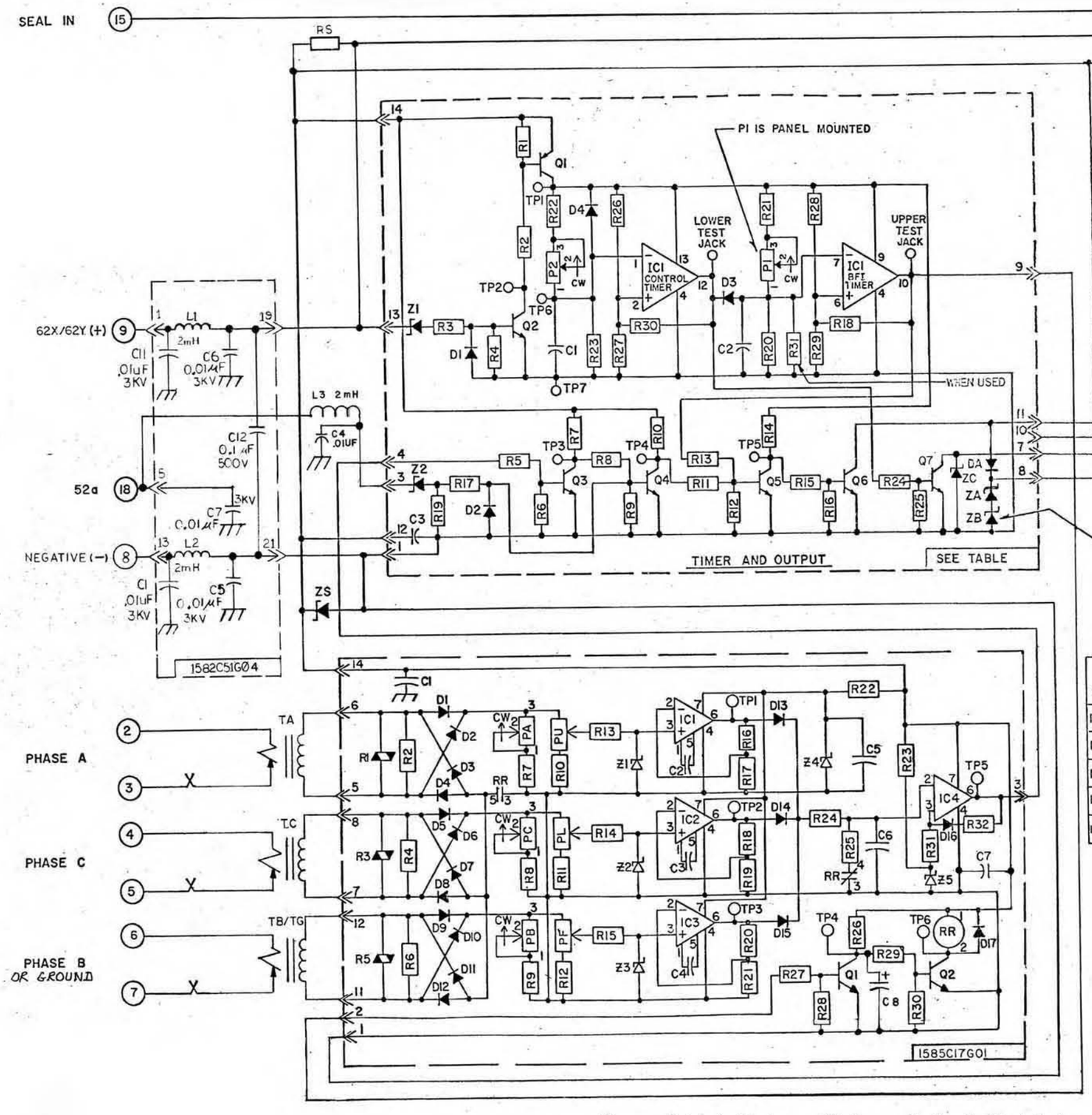
* = ALL RELAYS VIEWED FROM CONTACT END.

REF. DRAWINGS

SIMPLIFIED INTERNAL SCHEMATIC - 775B813
WIRING DRAWINGS - 1326D83 (3 INPUTS)
WIRING DRAWINGS - 1326D31 (4 INPUTS)
TIMER COMPONENT LOCATIONS - 3517A76 (48/125 VDC)
TIMER COMPONENT LOCATIONS - 3517A77 (250 VDC)
DETECTOR COMPONENT LOCATIONS - 3517A78 (3 INPUTS)
DETECTOR COMPONENT LOCATIONS - 3517A79 (4 INPUTS)

TIMER BD. STYLE NO. 1454C81	CONTROL TIMER	BF TIMER BD.
G01,G02,G03	150-250MS	25-175MS
G04,G06,G07	150-600MS	50-500MS
G05	0.2-1.1 SEC	0.1-1.0 SEC

Figure 5. Detail Schematic for SBF-1 Relay



RELAY STYLE NO.	VOLTAGE RATING AND NO. OF OVERCURRENT UNITS	TIMER BD. STYLE SCHEME	DETECTOR BD. STYLE SCHEME	RA STYLE NO. VALUE	RS STYLE NO. VALUE	ZS STYLE NO. JEDEC NO.	AR STYLE NO. *	X STYLE NO. *	TRANS-FORMER STYLE NO.
1529F93A08	48 VDC 3 O/C UNITS	1454C81G01 1325D61	1585C17G01 1585C14	1267287 900Ω 25W	1202586 200Ω 25W	629A798H03 IN2986B 24 VDC	408C845G47 630Ω COIL	541D514H45 1000Ω COIL	1454C86G01
1529F93A09	125 VDC 3 O/C UNITS	1454C81G02 1325D61		1202590 3150Ω 25W	1202588 1K 25W				
1529F93A10	250 VDC 3 O/C UNITS	1454C81G03 1325D61		1267308 7100Ω 25W	1267299 2.5K 25W				
1529F93A13	125 VDC 3 O/C UNITS	1454C81G04 1325D61		1202590 3150Ω 25W	1202588 1K 25W				
1529F93A18	250 VDC 3 O/C UNITS	1454C81G07 1325C61	"	1267308 7500Ω 25W	1267299 2.5K 25W	"	"	"	"

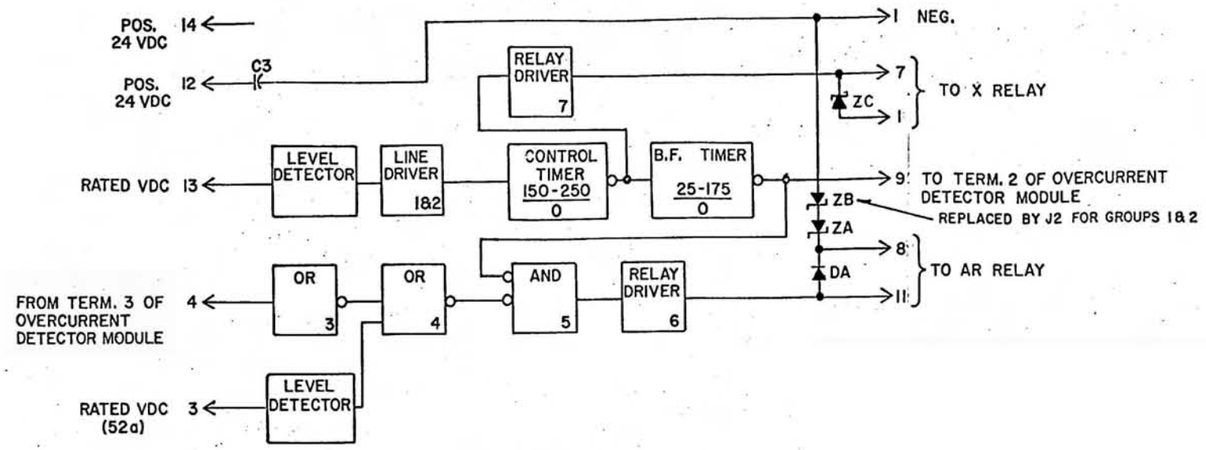
TIMER BD. 1454C81	CONTROL TIMER	BF TIMER
G01, G02, G03	150-250 MS	25-175 MS
G04, G06, G07	150-600 MS	50-500 MS
G05	0.2-1.1 SEC.	0.1-1.0 SEC.

* = ALL RELAYS VIEWED FROM CONTACT END.

REF. DWG.
SIMPLIFIED INTERNAL SCHEMATIC - 1487B31
WIRING DRAWINGS ------- 1349D10
TIMER COMPONENT LOCATIONS - 3517A76 (48/125 VDC), 3517A77 (250 VDC)
DETECTOR COMPONENT LOCATIONS - 1487B34

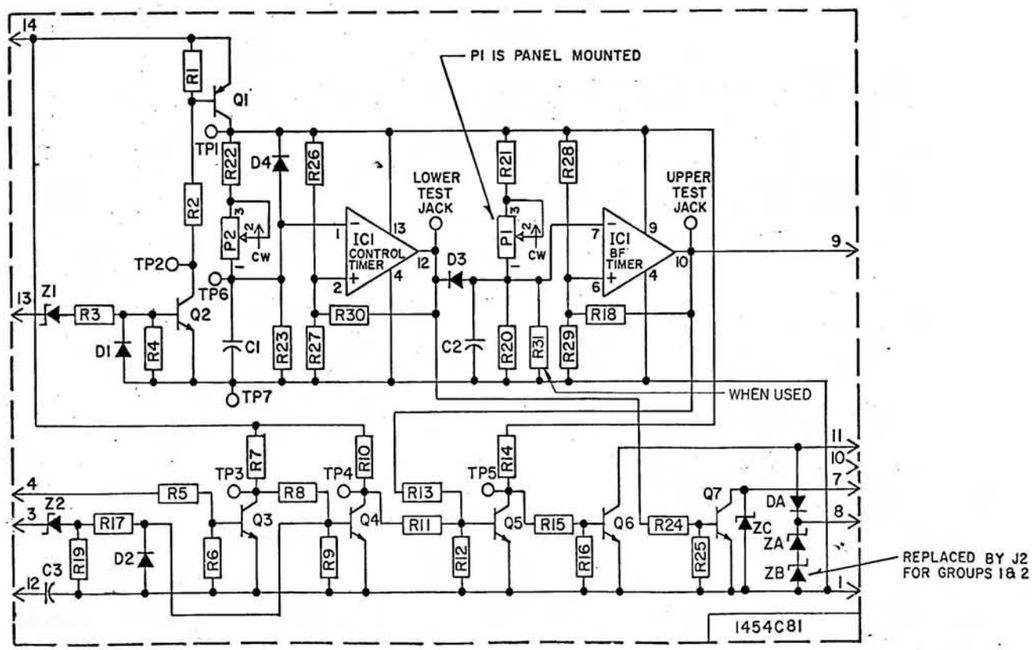
Sub 12
1349D09

Figure 6. Detail Internal Schematic for SBF-1 Relay (0.05 - 1.35 Amps)



TIMER AND OUTPUT MODULE

TIMER BD. STYLE NO.	VOLTAGE	CONTROL TIMER	BF TIMER
1454C81G01	48 VDC	150-250MS	25-175MS
1454C81G02	125 VDC	150-250MS	25-175MS
1454C81G03	250 VDC	150-250MS	25-175MS
1454C81G04	125 VDC	150-600MS	50-500MS
1454C81G05	125 VDC	0.2-1.1 SEC	0.1-1.0 S
1454C81G06	48 VDC	150-600MS	50-500MS
1454C81G07	250 VDC	150-600MS	50-500MS



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

Figure 7. Internal Schematic for Timer & Output Modules, SBF-1 Relay

CAPACITORS	DESCRIPTION	STYLE	
C1	6.8 UF 5% 35V TANTALUM	184A661H21	GRPS: 01,02,03,04,06,07
C1	18 UF 5% 35V TANTALUM	837A241H23	GRPS: 05
C2	6.8 UF 5% 35V TANTALUM	184A661H21	GRPS: 04,06,07
C2	3.3 UF 10% 35V TANTALUM	862A530H01	GRPS: 01,02,03
C2	15 UF 5% 35V TANTALUM	862A530H13	GRPS: 05
C3	0.27 UF 10% 200V MET POLYESTER	188A669H05	GRPS: 01,02,03,04,05,06,07

DIODES	DESCRIPTION	STYLE	
D1	1N645A 225V 0.4A	837A692H03	GRPS: 01,02,03,04,05,06,07
D2	1N645A 225V 0.4A	837A692H03	GRPS: 01,02,03,04,05,06,07
D3	1N459A 200V 0.2A	184A855H08	GRPS: 01,02,03,04,05,06,07
D4	1N459A 200V 0.2A	184A855H08	GRPS: 01,02,03,04,05,06,07
DA	1N459A 200V 0.2A	184A855H08	GRPS: 03,07

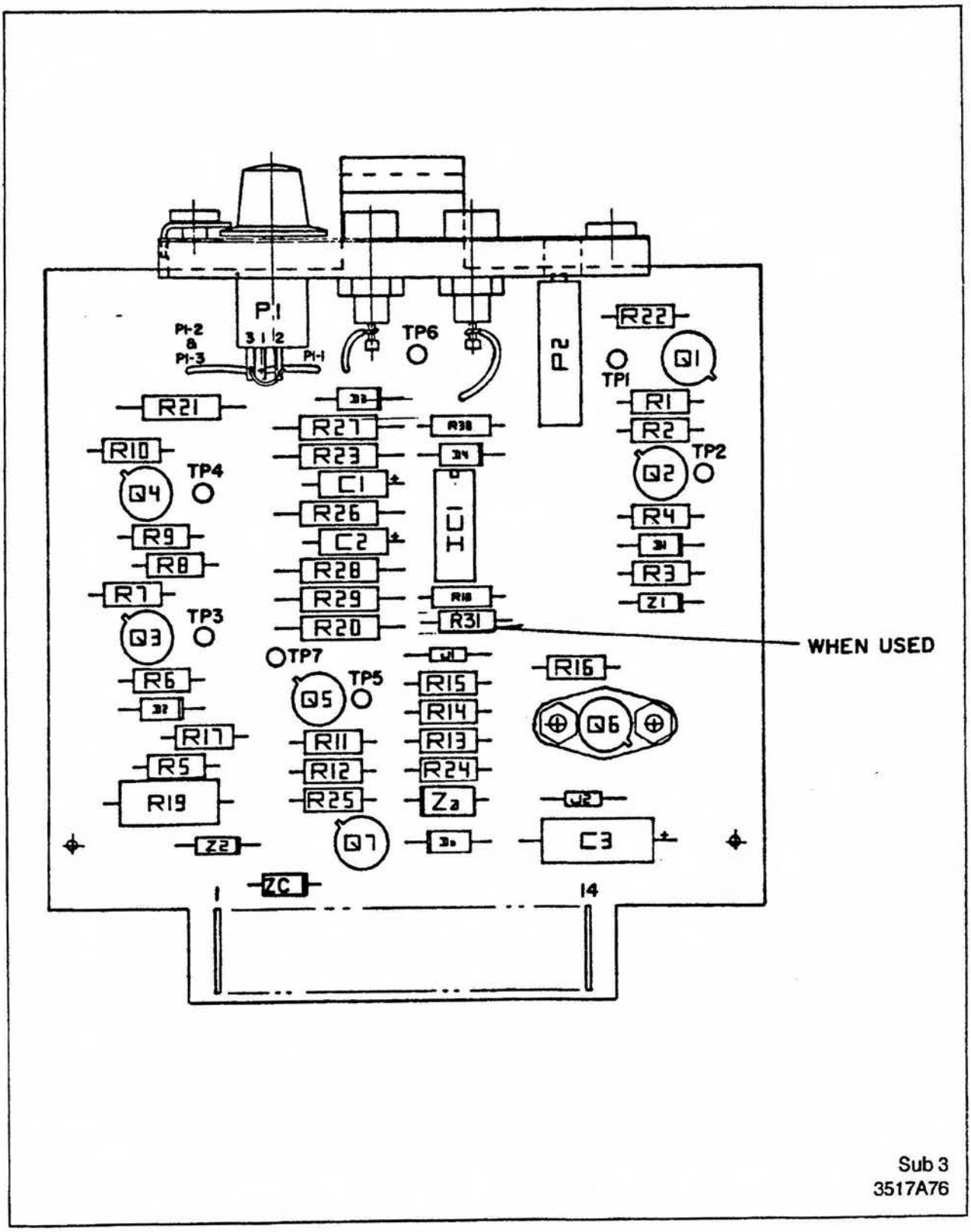
LINEAR IC	DESCRIPTION	STYLE	
IC1	MC1747L DUAL OP-AMP	1443C52H01	GRPS: 01,02,03,04,05,06,07

POTENTIOS	DESCRIPTION	STYLE	
P1	25 KILOHMS .50W	880A687H02	GRPS: 01,02,03
P1	50 KILOHMS .5W	880A687H03	GRPS: 04,05,06,07
P2	50 KILOHMS .75W	3528A37H01	GRPS: 04,05,06,07
P2	20 KILOHMS .50W	3528A37H02	GRPS: 01,02,03

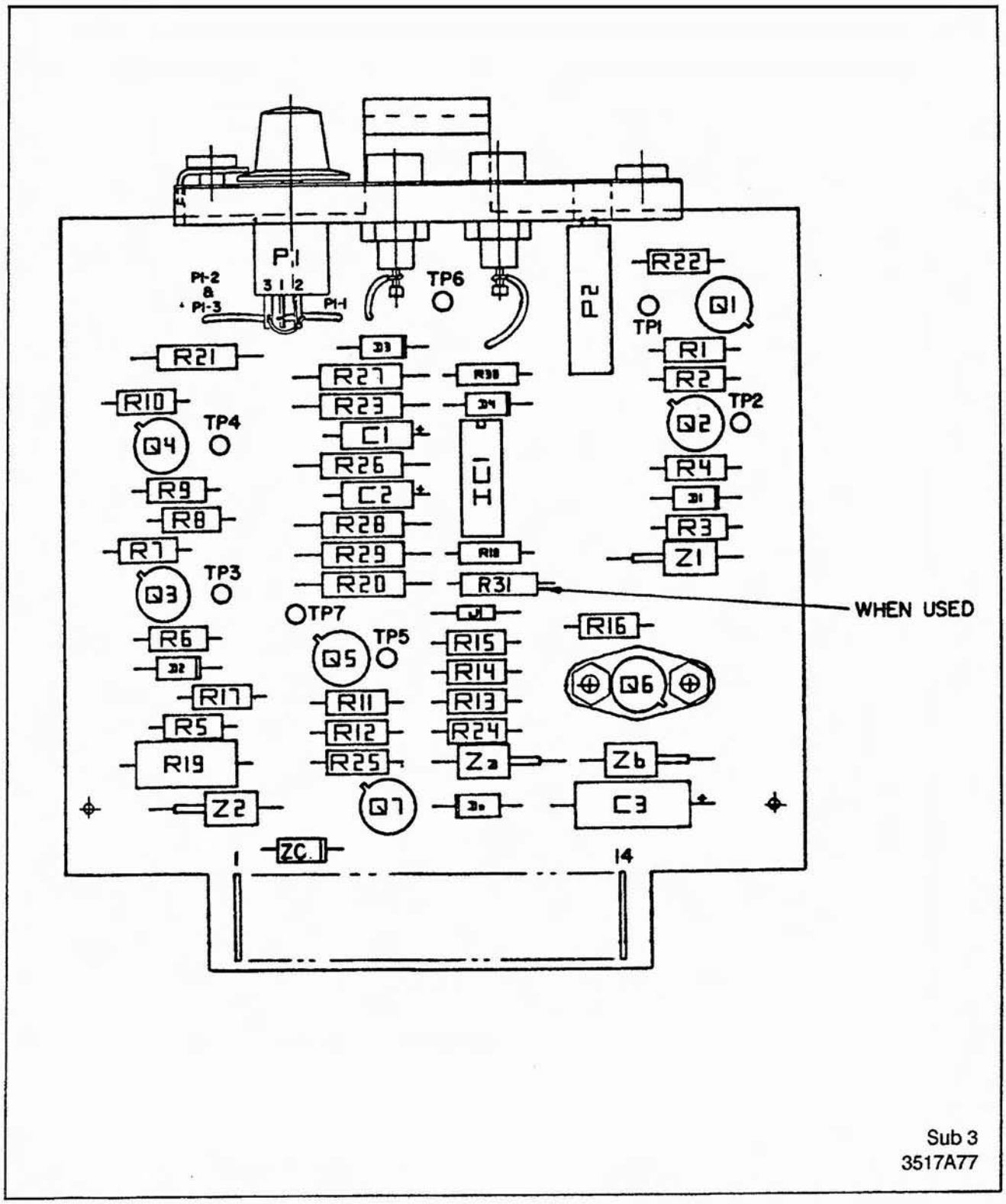
RESISTORS	DESCRIPTION	STYLE	
R1	10 KILOHMS 2% 1W METAL FILM	629A531H56	GRPS: 01,02,03,04,05,06,07
R2	6.8 KILOHMS 2% 1W METAL FILM	629A531H52	GRPS: 01,02,03,04,05,06,07
R3	20 KILOHMS 2% 1W METAL FILM	629A531H63	GRPS: 01,06
R3	47 KILOHMS 2% 1W METAL FILM	629A531H72	GRPS: 02,04,05
R3	100 KILOHMS 2% 1W METAL FILM	629A531H80	GRPS: 03,07
R4	2.0 KILOHMS 2% 1W METAL FILM	629A531H39	GRPS: 01,02,04,05,06
R4	5.6 KILOHMS 2% 1W METAL FILM	629A531H50	GRPS: 03,07
R5	27 KILOHMS 2% 1W METAL FILM	629A531H66	GRPS: 01,02,03,04,05,06,07
R6	2.0 KILOHMS 2% 1W METAL FILM	629A531H39	GRPS: 01,02,03,04,05,06,07
R7	15 KILOHMS 1% .5W METAL FILM	RM1502FHH5	GRPS: 01,02,03,04,05,06,07
R8	15 KILOHMS 1% .5W METAL FILM	RM1502FHH5	GRPS: 01,02,03,04,05,06,07
R9	2.0 KILOHMS 2% 1W METAL FILM	629A531H39	GRPS: 01,02,04,05,06
R9	5.6 KILOHMS 2% 1W METAL FILM	629A531H50	GRPS: 03,07
R10	15 KILOHMS 1% .5W METAL FILM	RM1502FHH5	GRPS: 01,02,03,04,05,06,07
R11	15 KILOHMS 1% .5W METAL FILM	RM1502FHH5	GRPS: 01,02,03,04,05,06,07
R12	2.0 KILOHMS 2% 1W METAL FILM	629A531H39	GRPS: 01,02,03,04,05,06,07
R13	27 KILOHMS 2% 1W METAL FILM	629A531H66	GRPS: 01,02,03,04,05,06,07
R14	6.8 KILOHMS 2% 1W METAL FILM	629A531H52	GRPS: 01,02,03,04,05,06,07
R15	2.0 KILOHMS 2% 1W METAL FILM	629A531H39	GRPS: 01,02,03,04,05,06,07
R16	10 KILOHMS 2% 1W METAL FILM	629A531H56	GRPS: 01,02,03,04,05,06,07
R17	20 KILOHMS 2% 1W METAL FILM	629A531H63	GRPS: 01,06
R17	47 KILOHMS 2% 1W METAL FILM	629A531H72	GRPS: 02,04,05
R17	100 KILOHMS 2% 1W METAL FILM	629A531H80	GRPS: 03,07
R18	2.2 MEGOHMS 5% 0.5W CARBON COMP	187A290H26	GRPS: 01,02,03,04,05,06,07
R19	10 KILOHMS 5% 2W CARBON COMP	185A207H51	GRPS: 01,02,04,05,06
R19	36 KILOHMS 5% 2W CARBON COMP	185A207H64	GRPS: 03,07
R20	162 KILOHMS 1% 0.5W METAL FILM	848A821H62	GRPS: 01,02,03
R20	255 KILOHMS 1% 0.5W METAL FILM	848A821H81	GRPS: 04,05,06,07
R21	3.32 KILOHMS 1% 0.5W METAL FILM	848A819H98	GRPS: 01,02,03
R21	4.99 KILOHMS 1% 0.5W METAL FILM	848A820H16	GRPS: 04,05,06,07
R22	15 KILOHMS 1% .5W METAL FILM	RM1502FHH5	GRPS: 01,02,03,04,06,07
R22	8.06 KILOHMS 1% 0.5W METAL FILM	848A820H36	GRPS: 05
R23	226 KILOHMS 1% 0.5W METAL FILM	848A821H76	GRPS: 04,05,06,07
R23	499 KILOHMS 1% 0.5W METAL FILM	848A822H10	GRPS: 01,02,03
R24	27 KILOHMS 2% 1W METAL FILM	629A531H66	GRPS: 01,02,03,04,05,06,07
R25	2.0 KILOHMS 2% 1W METAL FILM	629A531H39	GRPS: 01,02,03,04,05,06,07
R26	20.0 KILOHMS 1% 0.5W METAL FILM	848A820H74	GRPS: 01,02,03,04,05,06,07
R27	40.2 KILOHMS 1% 0.5W METAL FILM	848A821H04	GRPS: 01,02,03,04,05,06,07
R28	20.0 KILOHMS 1% 0.5W METAL FILM	848A820H74	GRPS: 01,02,03,04,05,06,07
R29	34.8 KILOHMS 1% 0.5W METAL FILM	848A820H97	GRPS: 05
R29	40.2 KILOHMS 1% 0.5W METAL FILM	848A821H04	GRPS: 04,06,07
R29	60.4 KILOHMS 1% 0.5W METAL FILM	848A821H21	GRPS: 01,02,03
R30	2.2 MEGOHMS 5% 0.5W CARBON COMP	187A290H26	GRPS: 01,02,03,04,05,06,07
R31	1.00 MEGOHMS 1% 0.5W METAL FILM	848A822H39	GRPS: 01,02,03,04,05,06,07

TRANSISTORS	DESCRIPTION	STYLE	
Q1	2N2905A 60V 0.6A 0.6W PNP	762A672H10	GRPS: 01,02,03,04,05,06,07
Q2	2N3019 80V 1A 0.8W NPN	3439A90H02	GRPS: 01,02,03,04,05,06,07
Q3	2N3019 80V 1A 0.8W NPN	3439A90H02	GRPS: 01,02,03,04,05,06,07
Q4	2N3019 80V 1A 0.8W NPN	3439A90H02	GRPS: 01,02,03,04,05,06,07
Q5	2N3019 80V 1A 0.8W NPN	3439A90H02	GRPS: 01,02,03,04,05,06,07
Q6	2N4063 350V 1.0A 3.5W NPN	878A432H01	GRPS: 01,02,03,04,05,06,07
Q7	2N 0V 1A 0.8W NPN		GRPS: 01,02,03,04,05,06,07

ZENERS	DESCRIPTION	STYLE	
Z1	1N3049B 160V 5% 1W	187A936H13	GRPS: 03,07
Z1	1N4760A 68V 5% 1W	849A515H11	GRPS: 02,04,05
Z1	1N971B 27V 5% 0.4W	862A606H11	GRPS: 01,06
Z2	1N4760A 68V 5% 1W	849A515H11	GRPS: 02,04,05
Z2	1N971B 27V 5% 0.4W	862A606H11	GRPS: 01,06
Z2	1N3049B 160V 5% 1W	187A936H13	GRPS: 03,07
ZA	1.5KE200 200V 10% 5W 1.5KW SURGE	878A619H01	GRPS: 01,02,04,05,06
ZA	1N3050B 180V 5% 1W	187A936H17	GRPS: 03,07
ZB	1N3050B 180V 5% 1W	187A936H17	GRPS: 03,07
ZC	1N1789 56V 10% 1W	584C434H08	GRPS: 03,07



* *Fig. 8. Component Location for Timer Module 48 or 125 Vdc Rated Relay*



* *Fig. 9. Component Location for Timer Module 250 Vdc Rated Relay*

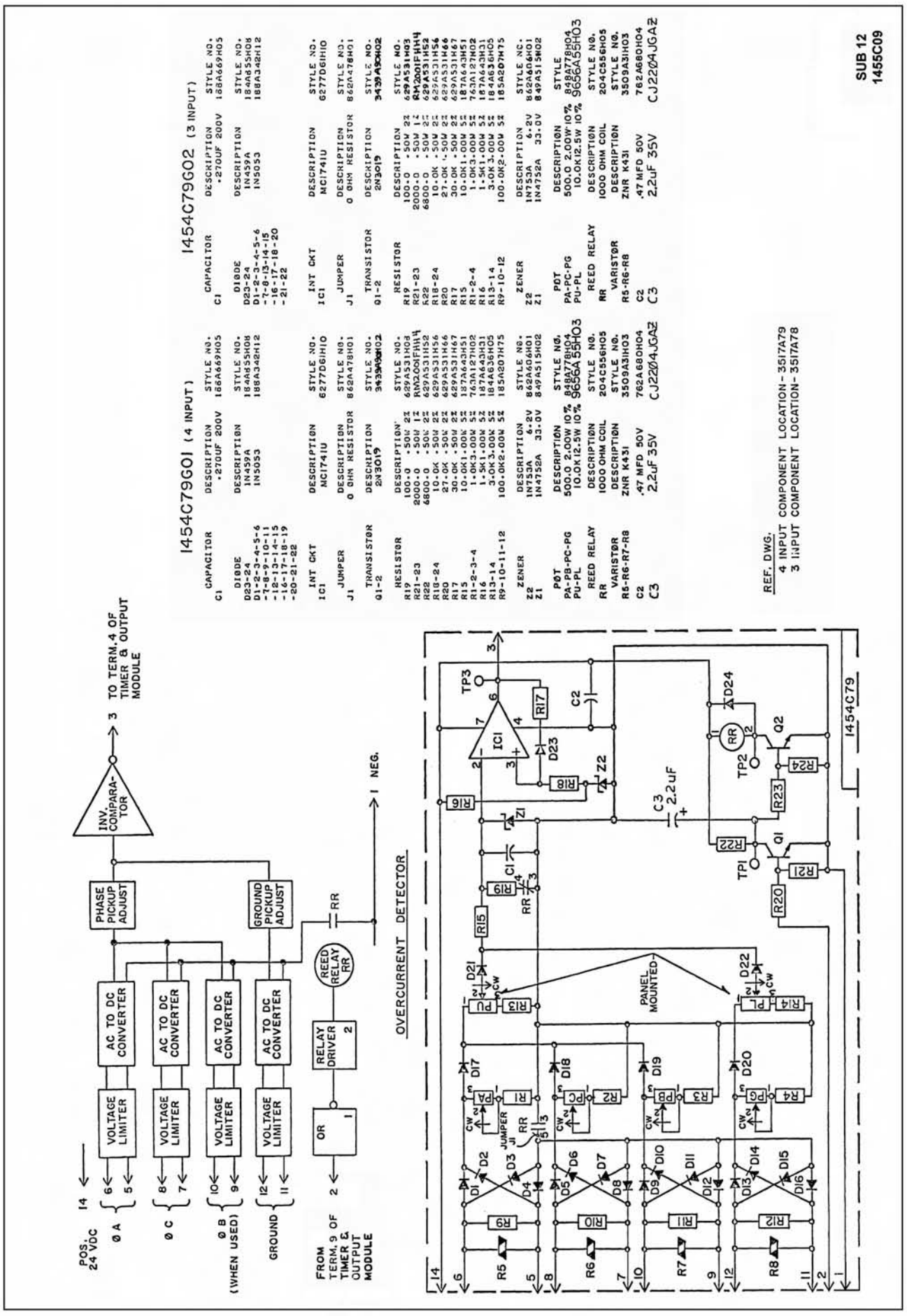
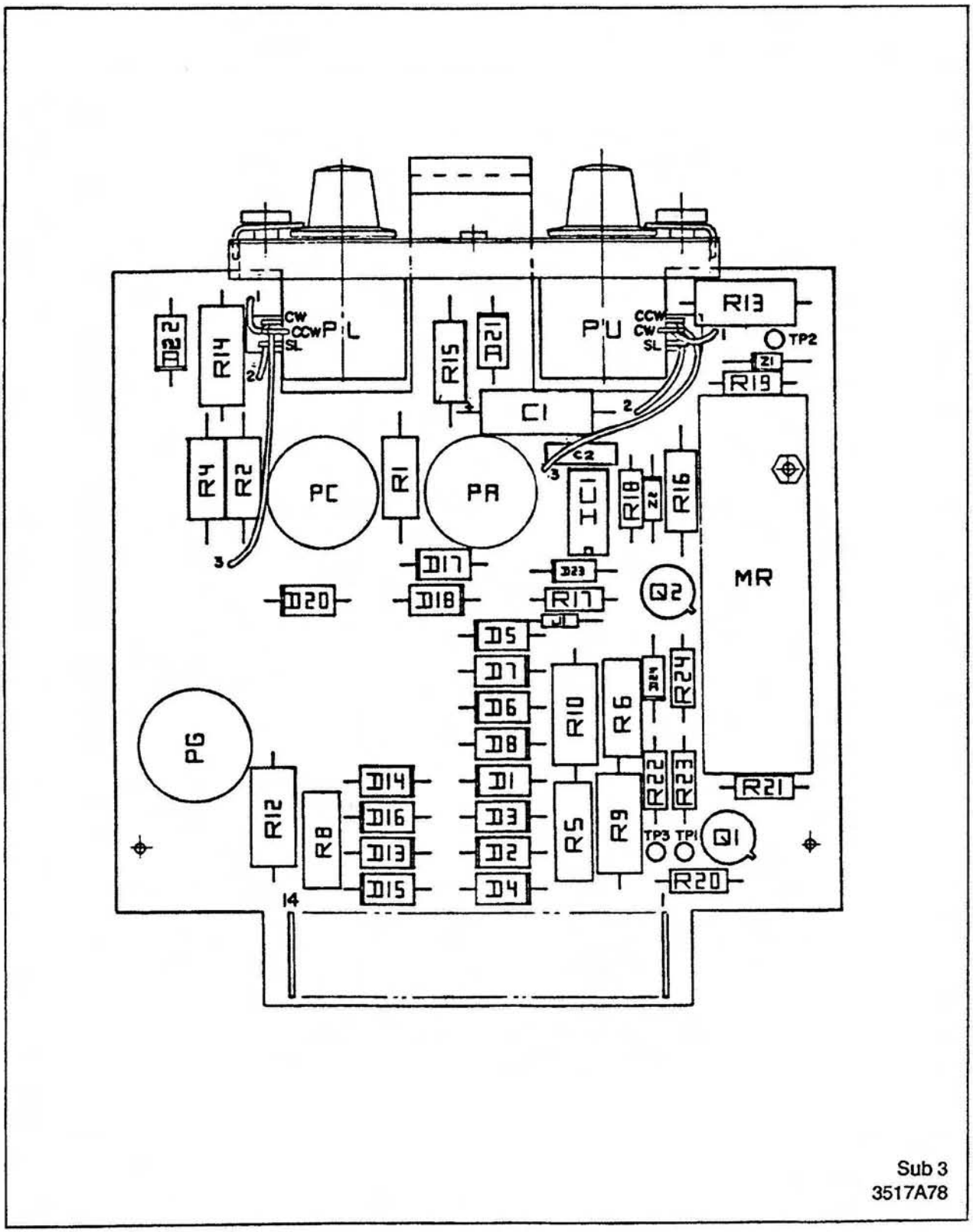
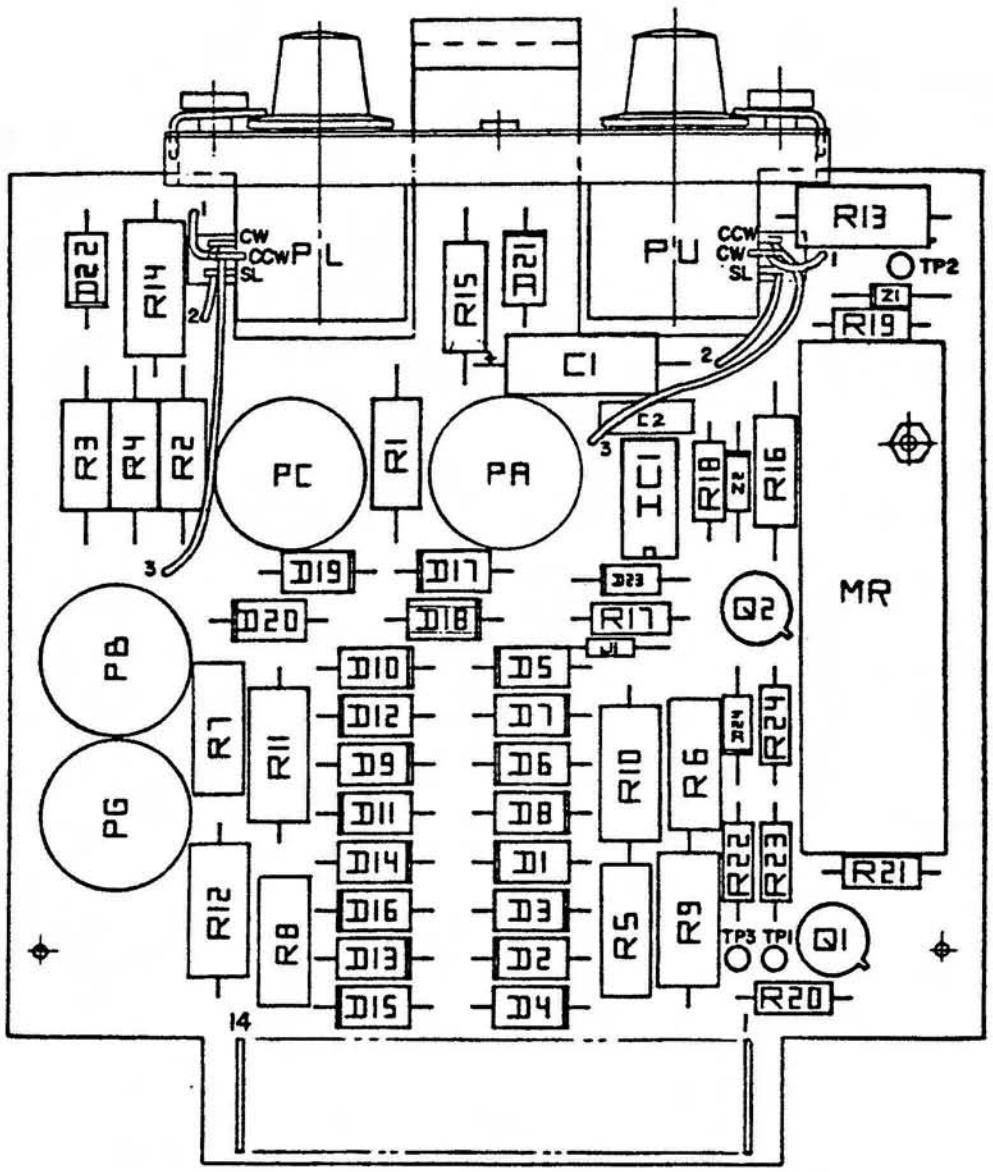


Figure 10. Internal Schematic, Overcurrent Detector Module, SBF-1 Relay



* *Fig. 11. Component Location for 3 Current Input Overcurrent Detector Module (0.5 to 13.5 Amps)*



* *Fig. 12. Component Location for 4 Current Input Overcurrent Detector Module (0.5 to 13.5 Amps)*

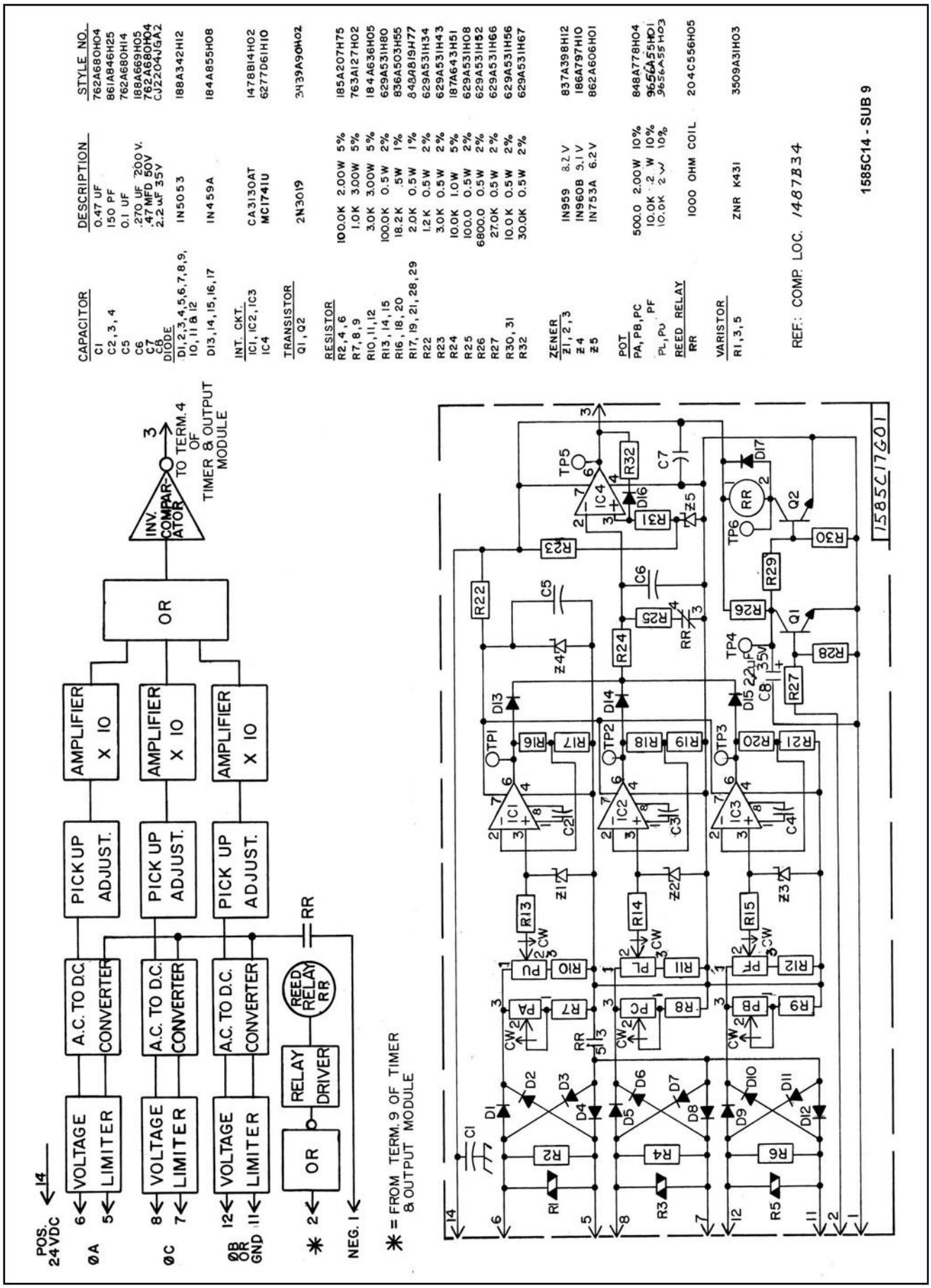
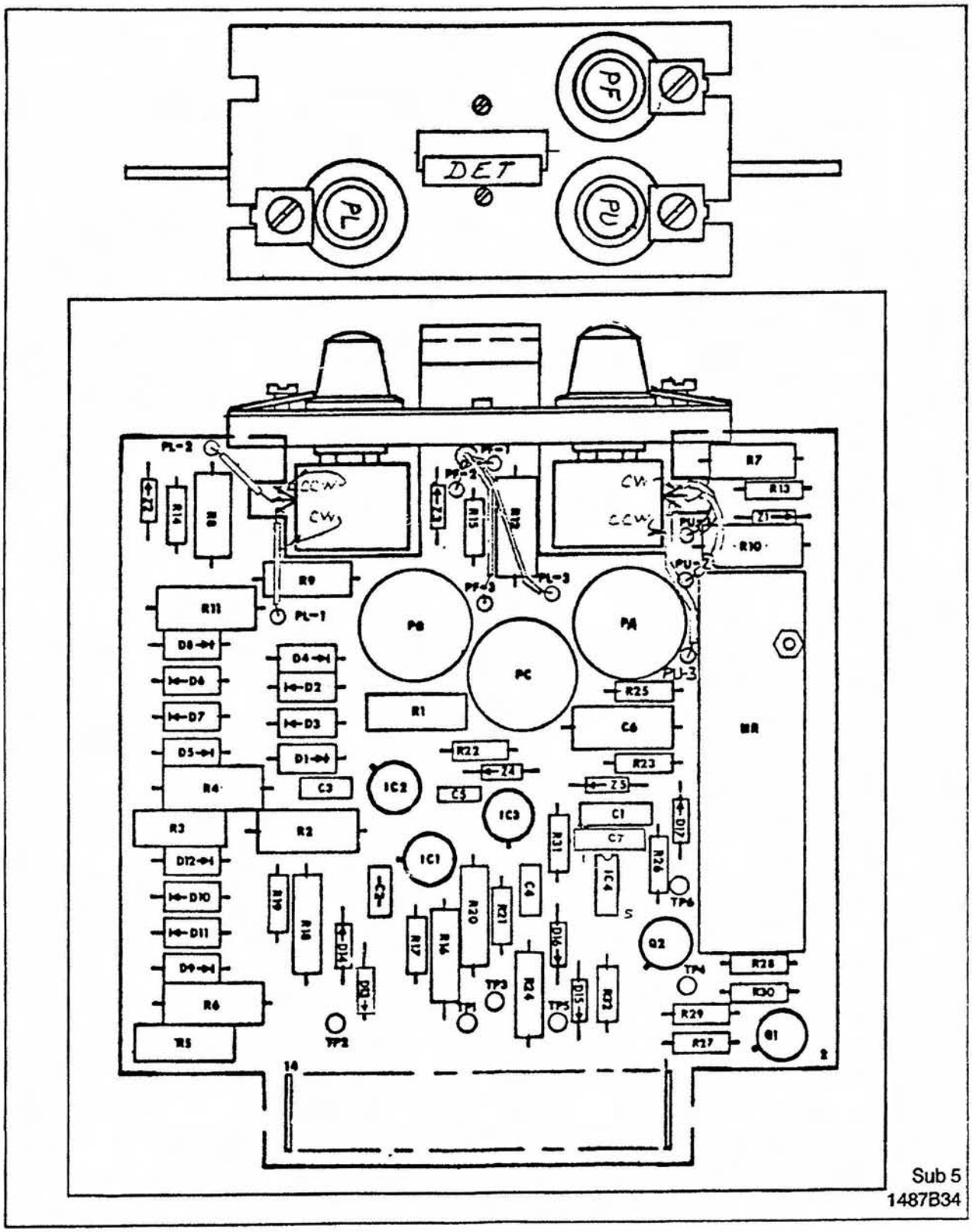
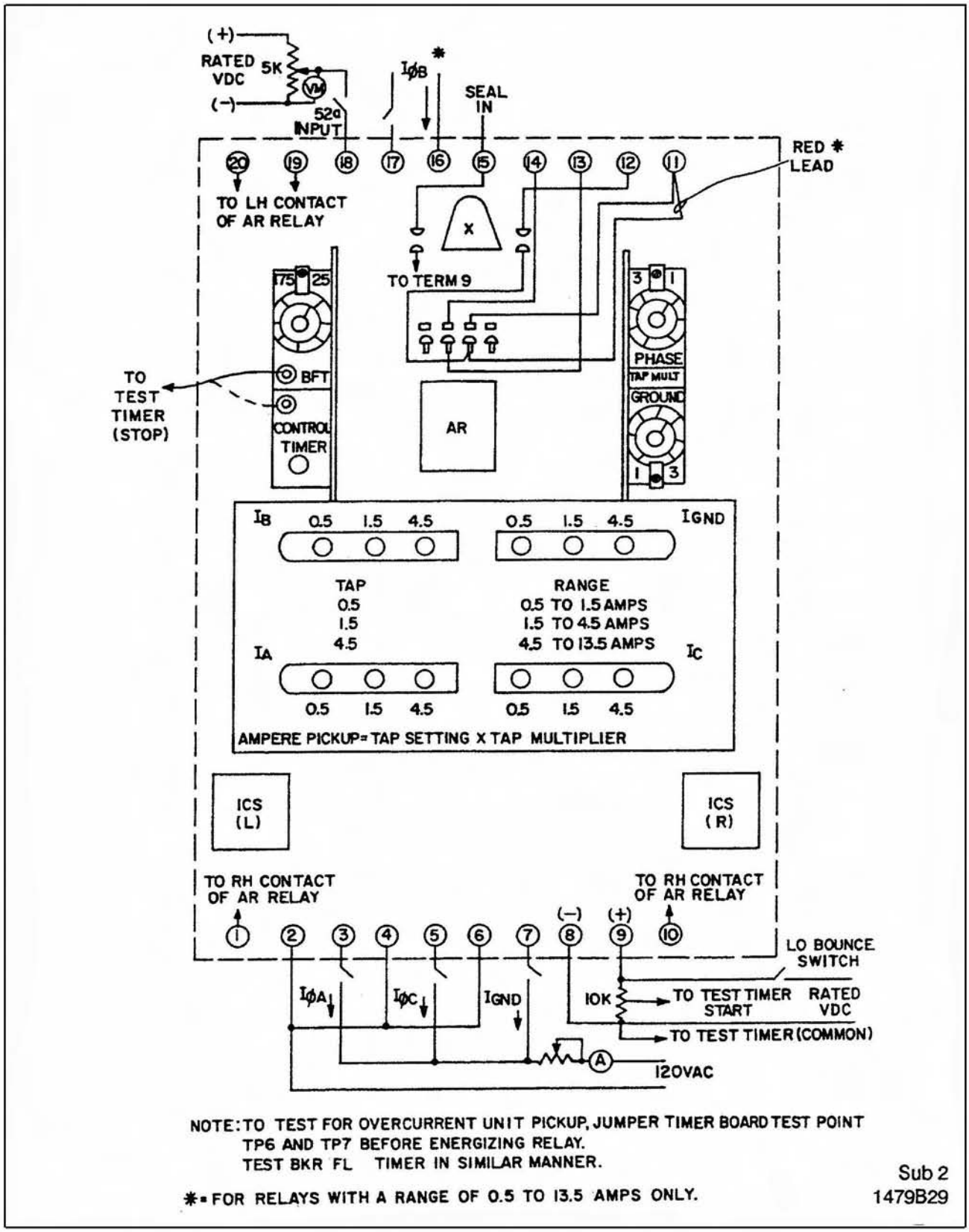


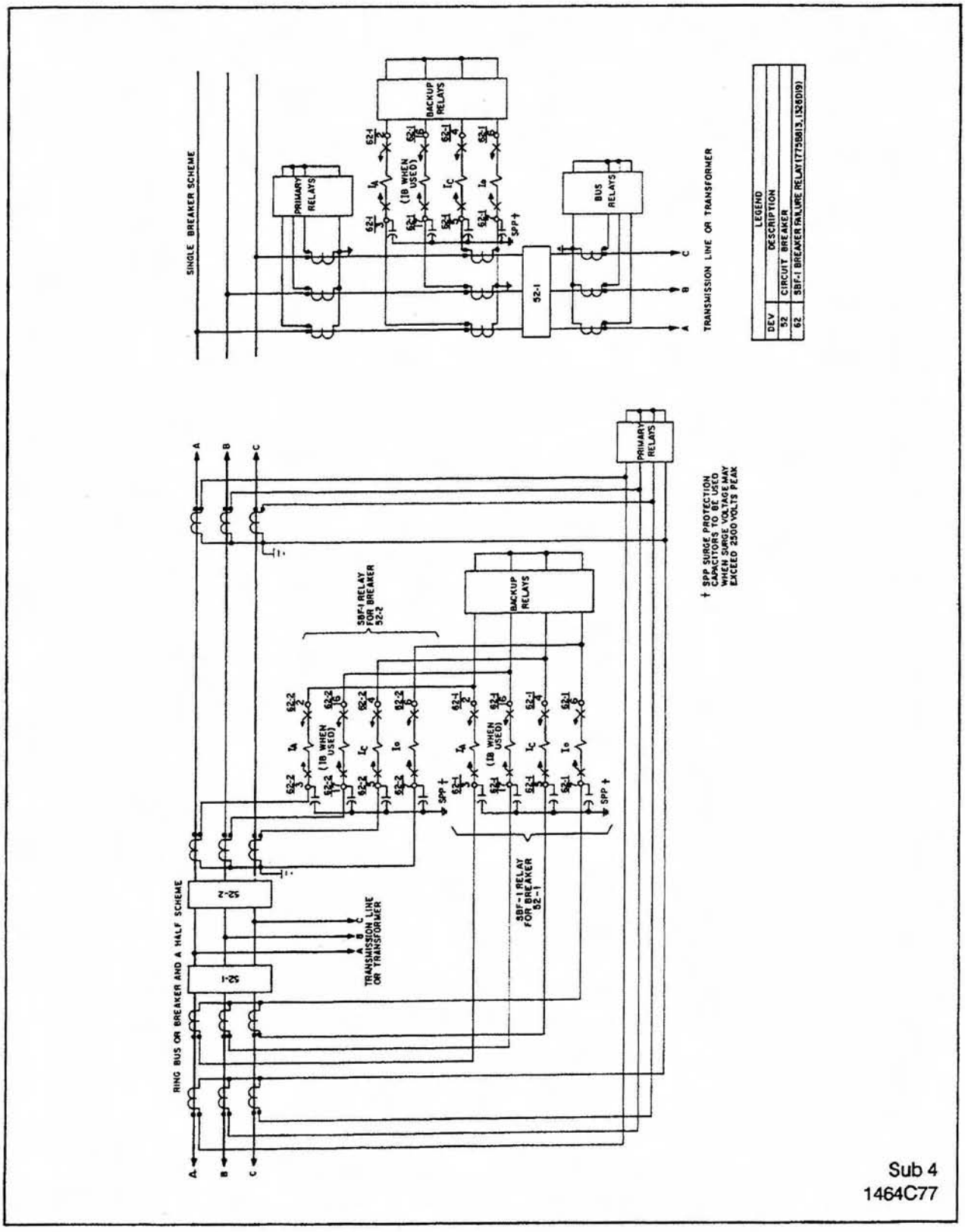
Figure 13. Internal Schematic, Overcurrent Detector Module, SBF-1 Relay



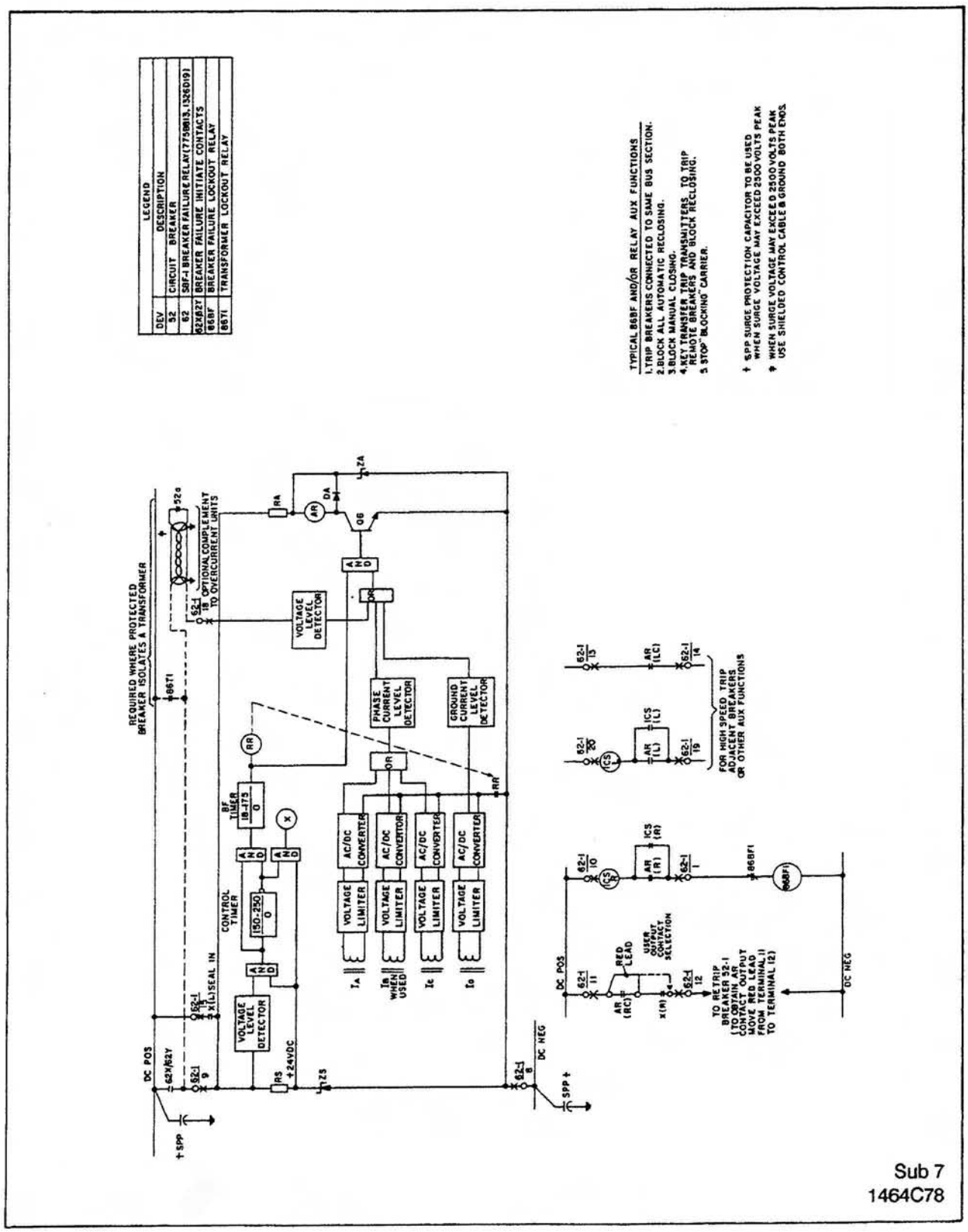
* *Fig. 14. Component Location for the Overcurrent Detector Module (0.05 to 1.35 Amps)*



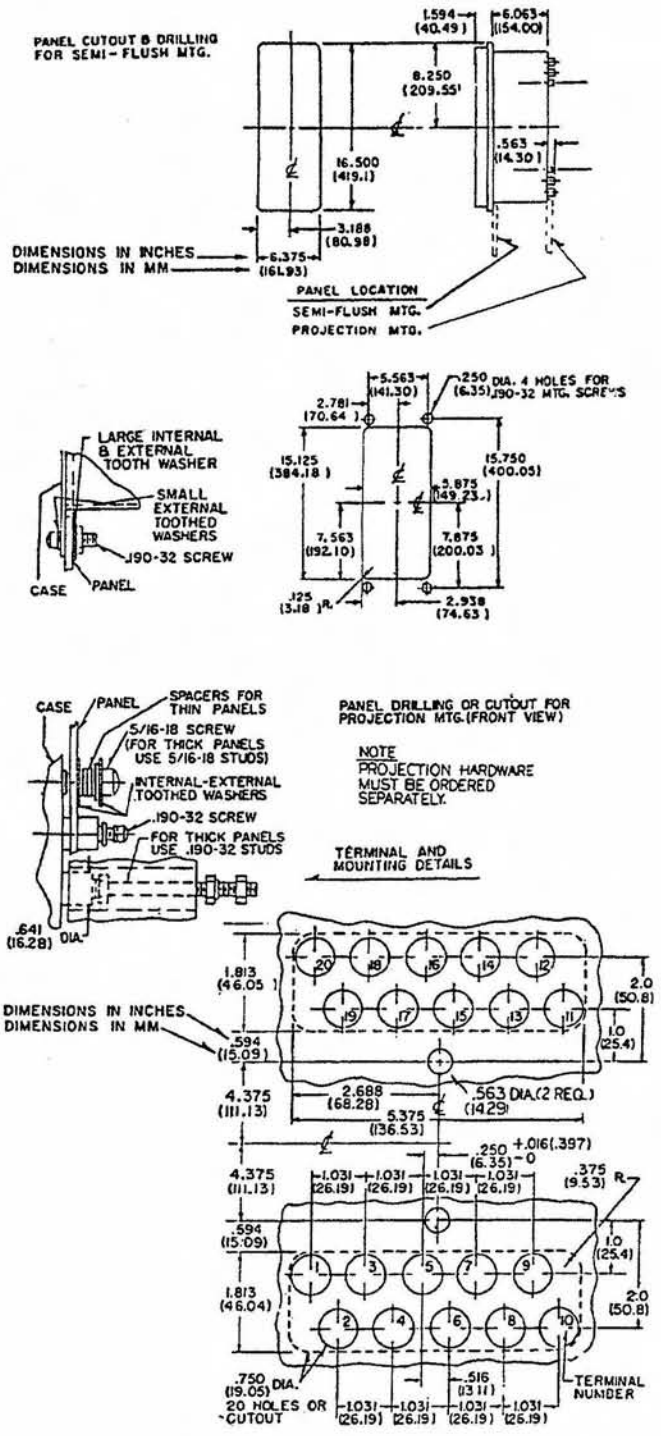
* *Fig. 15. Test Diagram for SBF-1 Relay*



* *Fig. 16. External AC Schematic for SBF-1 Relay*



* *Fig. 17. External DC Schematic for SBF-1 Relay*



* *Fig. 18. Outline and Drilling Plan for SBF-1 Relay in the Type FT-32 Case*

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