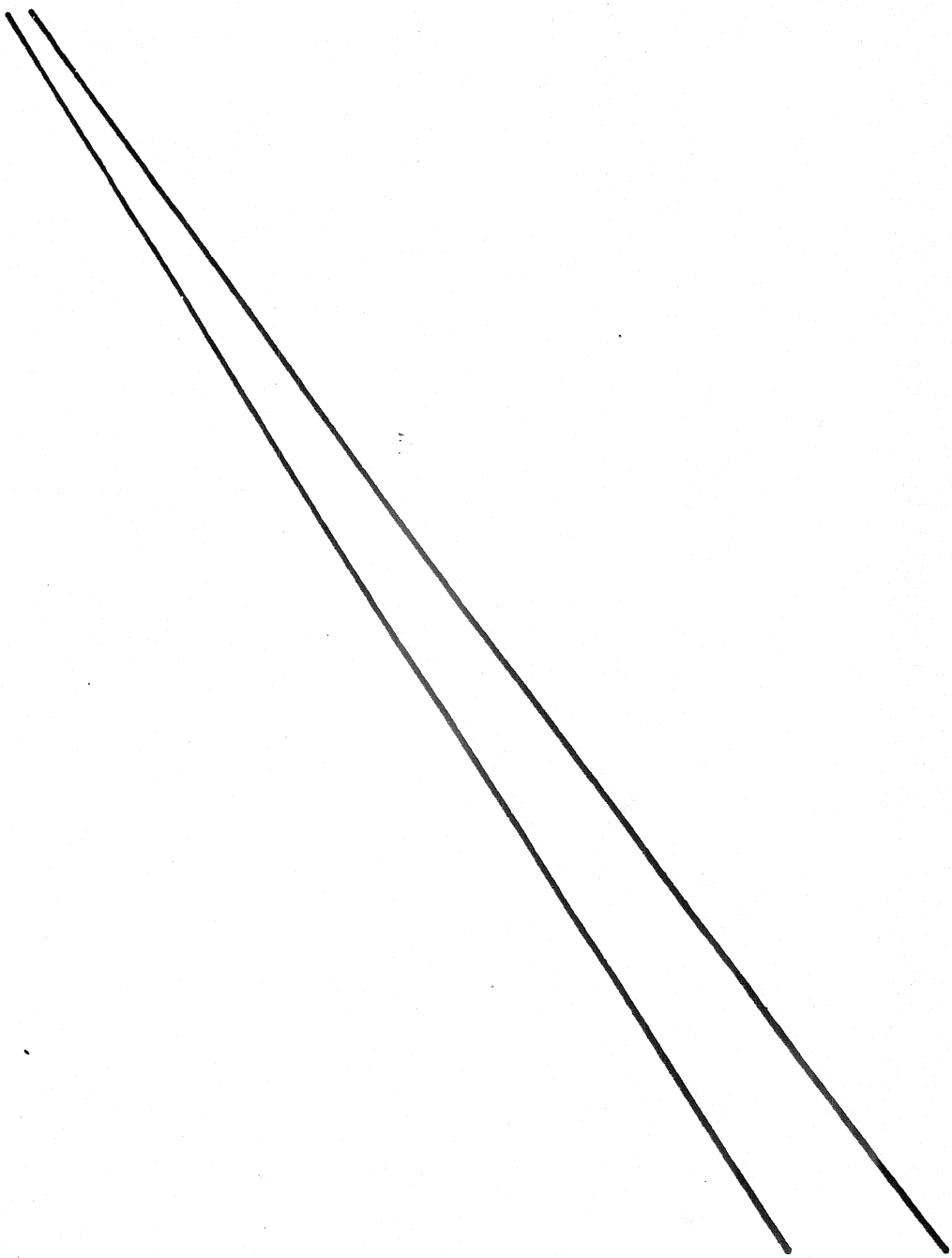
service MANUAL



Basler Electric
Highland, Illinois

RECLOSING RELAY
(Multi-Shot)
Model Number: BEI-79
Part Number: 9 1368 00

Publication
Number: 9 1368 00 620
Date: February 1980

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION

The contents of this manual are presented at the electrical/electronic engineer or advance technician level. The objective of this manual is to permit calibration and troubleshooting to the individual components of the BE1-79 Three Shot Reclosing Relay. Included in this manual, as aids toward this end, are:

1. Detailed theory of operation.
2. Detailed calibration procedures and test setup diagrams,
3. Schematic diagrams showing waveforms and test voltages as aids in troubleshooting.

Read the Instruction Manual supplied with the relay to become familiar with its overall characteristics prior to using this manual. The information contained therein is not repeated in this manual, except where deemed necessary for clarification of the content of this manual.

Be sure to read the "Summary of Printed Circuit Board Handling Precautions" and "Summary of Relay Operating Precautions" following this introduction. They are significantly important to the proper servicing and maintenance of this device.

SUMMARY OF PRINTED CIRCUIT BOARD HANDLING PRECAUTIONS

This device uses CMOS Intergrated Circuits (IC) on the printed circuit boards. These IC's are susceptible to damage from ordinary static electrical discharge if not handled properly. To avoid damage to these IC's observe the following precautions:

1. Always remove power from the relay before removal or installation of the printed circuit cards.

2. Never place CMOS printed circuit cards on or remove from metal surfaces before first neutralizing static body charge. This can be effectively done by placing the hand on the metal surface before removal or placement of printed circuit cards on the work area.

3. Never hand a CMOS device to another person whose static charge has not been neutralized.

4. Always transport, troubleshoot, test, etc. CMOS circuit cards and devices on or in an electrically conductive surface or container. Never transport these devices in ordinary plastic bags. Static charge build up will result.

5. Do not attempt to test a CMOS device circuit board with an ohmeter, even those with "low-power-ohms functions". Circuit boards may be dynamically checked with an oscilloscope using a circuit board extender. Basler part number 9 1129 30 100 is recommended for this purpose.

SUMMARY OF RELAY OPERATING PRECAUTIONS

Before installation or operation of the relay observe the following precautions:

1. Do not apply high potential voltage tests to the relay as damage to the solid-state circuits may result. If a control wiring insulation test is required, remove connecting plug and withdraw the relay cradle from its case.

2. Be sure that the relay case is hardwired to earth ground using the GROUND terminal on the rear of the unit. Never "daisy-chain" relay grounds; always use a separate ground lead to the ground bus for each relay.

3. Remember, when the connecting plug is removed the relay is disconnected from the operating circuit and will not allow automatic reclosing. Always be sure before removing relay for inspection or service that the external operating process is stable. Be sure too that the connecting plug is in place before installing the front cover.

WARNING

TO PREVENT POSSIBLE PERSONAL INJURY OR EQUIPMENT DAMAGE, ONLY QUALIFIED TECHNICIANS OR ELECTRICAL/ELECTRONIC ENGINEERS SHOULD PERFORM THE PROCEDURES PRESENTED IN THIS MANUAL.

CAUTION

READ THE SUMMARIES OF HANDLING AND OPERATING PRECAUTIONS IN THE FRONT OF THIS MANUAL PRIOR TO INSTALLATION, CALIBRATION OR REPAIR OF THE DEVICE DESCRIBED HEREIN TO PREVENT DAMAGE TO THE DEVICE.

CAUTION

REMOVAL AND DIRECT SUBSTITUTION OF PRINTED CIRCUIT BOARDS OR INDIVIDUAL COMPONENTS DOES NOT NECESSARILY MEAN THE RELAY WILL OPERATE PROPERLY WITHOUT FURTHER CALIBRATION OR VERIFICATION. ALWAYS CHECK CALIBRATE RELAY PRIOR TO PLACING RELAY INTO THE OPERATING SYSTEM.

SECTION 1.0

THEORY OF OPERATION

1.1 GENERAL

The BE1-79 Three Shot Reclosing Relay (Relay), figure 1-1, is a device that provides a means of automatically reclosing circuit breakers that have been tripped by a protective relay.

The relay provides up to three sequential reclosures with the time to reclose selectable by front panel controls. The controls allow each reclosure to be independently programmed over the range of 0.2 to 60 seconds. Available options allow the the maximum number of reclosures to be reduced and provide for resetting the relay automatically after the circuit breaker has remained closed for a predetermined interval.

1.2 POWER SUPPLIES

1.2.1 Type A Power Supply (Figure 5-1)

The Type A Power Supply is a series regulator (linear) supply for use in either 125 Vdc or 100/120 Vac 50/60 Hz, external power sources.

External operating power is applied at terminals 3 and 4 on the rear of the relay case, through the motherboard, and then to pins 21 and 25 of the power supply PC board.

The input voltage, applied through current limiting resistors R1 and R2, is full-wave bridge rectified and filtered by diodes CR1, CR2, CR3, CR4 and capacitor C1. Transient voltage suppressor CR5 provides surge protection for the supply by clipping voltages above 160 volts. Zener diodes VR6 and VR7, together with Q2, Q3 and associated components, comprise a "snap-on" circuit. This circuit inhibits an output from the power supply until the input voltage reaches a level that snaps the supply on at its nominally rated output voltage level.

Integrated circuit U1 is a voltage regulator that maintains 5 Vdc between its output and ground pins. Zener diodes VR1 and VR2 protect regulator U1 from overvoltage by limiting the input supply voltage. Transistor Q1 is the series pass element for the supply and reduces the input voltage (up to 160 volts) to the required level. Resistor network R4, R5 and R6 scales the regulator voltage to 24 Vdc. Output of the supply can be adjusted by R5.

The supply is protected against output overvoltage by CR6, a 27-volt transient voltage suppressor. Monitoring of the output voltage is provided by an LED on the front panel. The LED is in series with zener VR3, and current limiting resistor R7. This circuit provides a coarse monitor of the power supply voltage as the LED will not illuminate unless the voltage is greater than 22 Vdc. The supply output is split into +12 volts and -12 volts by R8, VR4, and VR5. C3 provides filtering for the +12 volts dc supply.

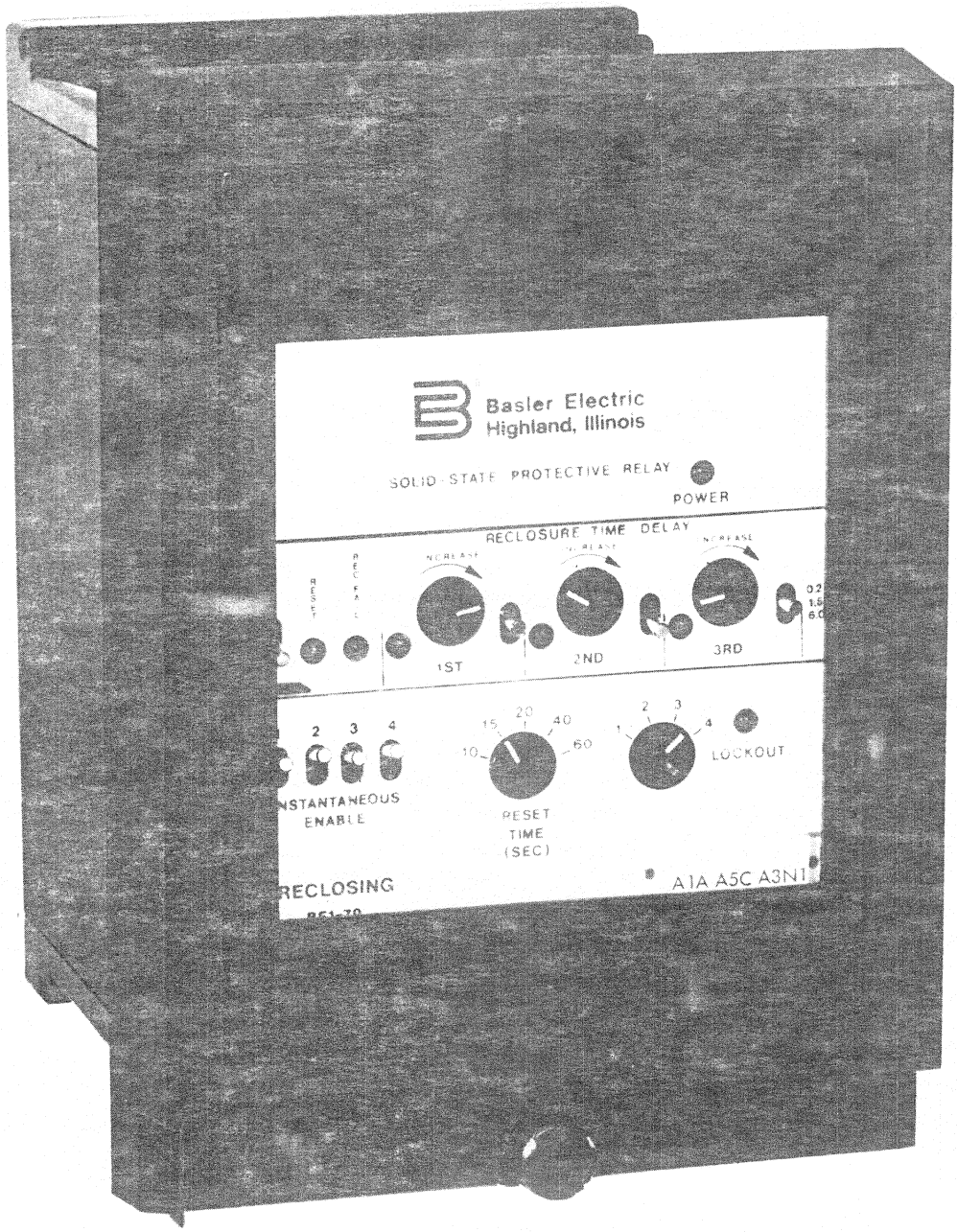


Figure 1-1 BE1-79 Multi-Shot Reclosing Relay (Typical)

1.2.2 Type B Power Supply (Figure 5-2)

The Type B power supply is a series regulator (linear) supply, which is compatible with 48 Vdc systems.

Operation of this supply is identical to that described for Type A above, except that input resistors R1 and R2 are removed and the values of resistors R3 and R10 and zener diode VR6 have been changed in order to operate at the lower 48 Vdc input voltage.

1.2.3 Type C Power Supply (Figure 5-3)

The Type C power supply is a low burden switching regulator supply for use with either 125 Vdc or 100/120 Vac, 50/60 Hz, external power sources.

External operating power is applied at terminals 3 and 4 on the rear of the relay case, through the motherboard, and then to pins 21 and 25 of the power supply PC board.

The input voltage, applied through current limiting resistors R18 and R19, is full-wave bridge rectified and filtered by CR1, CR2, CR3, CR4, and capacitor C1. Capacitor C4 provides high frequency filtering of the supply input. Zener diode VR7, transistors Q3, and Q4 and associated components, comprise a "snap-on" circuit. This circuit inhibits power supply outputs until the input voltage reaches a level that snaps the supply on at its nominally rated output voltage level. Switching is controlled by high frequency voltage comparator U1. Zener VR3 sets the reference voltage level at pin 2 for the comparator (waveform C, figure 5-4). The other input, which is the power supply output voltage, is connected to U1 through resistor network R4, R5, and R6. Resistor R5 is the power supply output adjustment potentiometer.

The supply operates as follows. When the supply output voltage falls below the regulated level, pin 7 of U1 goes high (waveform B, figure 5-4). This high places VR4 into conduction, biasing Q2 on. With Q2 on, the base of Q1 is forward biased into conduction switching the input voltage appearing across C1 to inductor L1. The current in L1 continues to incrase until C2 is charged and the output voltage rises above the regulated level (waveform D, figure 5-4). When this occurs, output pin 7 of U1 returns to the low state, turning Q1 and Q2 off. With Q2 off, current through the inductor continues to flow through flyback diode CR5 until the energy stored in L1 decreases sufficiently so the output voltage falls below the regulation point. When the regulator voltage again decreases below the regulation point, the cycle is repeated.

The power supply uses overcurrent shutdown circuitry that monitors the current through R13. The current sensing voltage developed by R13 will cause Darlington transistor Q6

to conduct at approximately 300 mA when an overcurrent condition exists. When Q6 turns on it latches and turns Q5 off. This removes the power supply output. Q6 will remain on until C8 is charged sufficiently to stop base current flow in Q6. With Q6 off, Q5 is turned on again, thus providing a discharge path for C8 to reset the power supply. If the overcurrent condition persists, this cycle repeats.

Transient voltage suppressor VR2 protects the output of the supply from overvoltage. Monitoring of the output voltage is provided by an LED on the front panel. The LED is in series with zener VR1 and current limiting resistor R7. This circuit provides a coarse monitor of the power supply voltage as the LED will not illuminate unless the voltage is greater than 22 Vdc. Zeners VR5 and VR6 and resistor R12 converts the 24-volt supply to +12 Vdc, -12 Vdc, and signal ground.

1.3 MOTHER BOARD

The mother board provides interconnection between the circuit boards of the relay and the relay enclosure. Form A contacts are provided for the relay's output signals. Input sensing is provided by two contact sensing circuits.

Relay power (48 VDC, 125 VDC, 100/125 VAC) is applied through a full wave bridge rectifier to provide a sensing current to the contact sensing circuits. Each circuit comprises on optical isolator in series with the sensing current source and, through the enclosure terminals, to the sensed contacts. A transistor amplifier in each isolator provides a signal to the logic board that represents the state of the sensed contacts.

1.4 LOGIC PRINTED CIRCUIT BOARD. (Figures 5-6 and 5-7).

The logic printed circuit board provides the basic function of the reclosing relay. It senses the opening of the controlled breaker, counts the number of reclosures, provides programmed intervals and recloses the controlled breaker.

When the controlled breaker opens, auxiliary form b contacts of the breaker close, causing a logic one at BKR (pin 11) input to the logic printed circuit board. An input filter, comprising single shots U3, prevents the board from responding to a change-of-state of BKR of less than 4.5 milliseconds duration (See waveforms A figure 5.8).

The output pulse generated while the controlled breaker is open resets close flip flop U5-1, generating $\overline{\text{CLOSE}}$ low to the mother board and clocks cycle counter U12. When the breaker is tripped for the first time, cycle counter U12 is advanced by this clock to a count of 1 (CT1 The count of 1 selects the first programmed time interval and then attempts to reclose the breaker.

In reclosing relays supplied with continuously adjustable reclosure time delay (timing option A5) the CT 1 output of the cycle counter selects a resistance network to control clock generator U13, establishing the frequency of the clock output. The resistance in the network (hence, the frequency of the clock) is controlled by the 1ST RECLOSURE TIME DELAY potentiometer on the relay front panel. The clock output is counted by U15 and one of the counter outputs is selected by 1ST range select switch S2 and ANDed with CT1 to determine the timing for the first reclose attempt.

In reclosing relays supplied with definite reclosing time delay (timing option A1), the CT1 output of the cycle counter selects five position rotary switch S5, 1ST RECLOSURE TIME DELAY (SECONDS). The clock generator (U15) is running at a fixed frequency. The five position switch is set to one of its positions (0.2, 2, 15, 45, 60) which selects the output of one of five decoders connected to counter U15. When the selected number of seconds have expired, the decoded output is ANDed with CT1 to determine the timing for the first reclose attempt.

If a continuous reclose signal is selected (option 1-0), the TIME OUT signal at U8-9 (C on figure 5-6) clocks U6-1, setting it. U6-1 set causes relay driver Q1 to generate RECLOSE as an output at pin 35. RECLOSE remains on, energizing the breaker reclose coils, until the breaker closes and BKR (pin 11) goes to logic zero. When BKR goes to logic zero, it clocks reclose memory U10-15 and U11 through half-enabled gate U9-3 and, resets U6-1 terminating the RECLOSE output. Reclose memory flip flop U10-15 is set when CT1 is high, illuminating 1ST LED (DS2). (If the breaker was closed by some other means before TIMEOUT occured, the reclose memory would not have been clocked).

If a limited (2 to 3 or 5 to 6 second) reclose signal is selected (option 1-2 or 1-3), the TIMEOUT signal at U8-9 (C on figure 5-6) clocks U6-1, setting it. U6-1 set causes relay driver Q1 to generate RECLOSE as an output at pin 35, selects a different resistive value (U14) for clock generator U13, and places a logic one at the D input to reclose fail flip flop U6-13. RECLOSE remains on, energizing the breaker close coils, until the breaker closes (BKR goes to logic zero)or counter U15 has counted 2^{13} (Option 1-2) or 2^{14} (Option 1-3) clock pulses from U13. When BKR goes to logic zero, it clocks reclose memory U10-15 and U11 through half-enabled gate U9-3 and, after a short delay, resets U6-1 terminating the RECLOSE output. Reclose memory flip flop U10-15 is set when CT1 is high, illuminating 1ST LED (DS2).

If the breaker does not close within the 2-3 or 5-6 seconds (depending on the reclose option provided) the output of U15 sets reclose fail flip flop U6-13. U6-13 set: resets U6-1, terminating the RECLOSE output; illuminates the REC FAIL LED; stops clock generator U13; and resets counter U15. No further reclosure attempt is made.

If the breaker is closed before RECLOSE occurs (during the reclosure time delay) or after RECLOSE (after reclose fail) the reclose memory is not clocked and the 1ST LED (DS2) is not illuminated.

When the breaker closes (before the reclose fail time has expired) auxiliary breaker b contacts open, BKR changes state. Filter U3 performs as before requiring 4.5 milliseconds before generating on output pulse which sets close flip flop U5. U5 set makes $\overline{\text{CLOSE}}$ low and advances the cycle counter to CT2.

The operation of the logic board for the second and third breaker trip operations in the sequence is similar to the above operations. When the breaker trips the second time, the cycle counter which is at CT2 at the end of the first reclose is advanced to CT3. The second reclose advances the cycle counter to CT4. The third trip advances the cycle counter to CT5. The third reclose advances the cycle counter to CT6 and the fourth (final) trip advances it to CT7. Count CT7 inhibits the clock input to U12, preventing further reclosing relay operation until the relay is reset.

Manually resetting the relay is accomplished by momentarily lifting the reset lever on the front of the relay, closing reset switch S1. Actuating the reset switch places a high on the reset inputs to flip flops U10 and U11 in the reclose memory, resetting the memory; (clocks flip flop U10-1, inhibiting the cycle counter if BKR is open) and resets U6-1, U13, U15, and cycle counter U12.

An automatic reset that resets the reclosing relay a programmed interval after a successful reclosure is available as an option. The option circuits are described in paragraph 1.5.2. The option affects the logic board by generating a $\overline{\text{RESET}}$ signal which enters the board at pin 5. $\overline{\text{RESET}}$ functions the same way as actuating the RESET lever with the exception that it does not reset the reclosure memory.

A Reclose Failure option may be provided on the logic board. It is controlled by Reclose Fail flip flop U6-13. When the reclosing relay is unable to close the breaker within the 2-6 second interval, this flip flop is set. When U6-13 is set, as described above, it illuminates a RECLOSE FAILURE LED and turns on relay driver Q2.

A disable contact input to the logic board, CONT entering at pin 7, permits disabling of the reclosing feature by remote control. When the control contacts are closed before the breaker is tripped, a high is received at pin 7. If the high remains for at least 3 milliseconds filter U4, which is similar to filter U3, puts out a logic one. The one at U4-10 sets disable flip flop U5-13. U5-13 high holds U6-1, U13, U15 reset and sets U10-1 to inhibit clocks to the cycle counter. This effectively prevents the reclosing relay from responding to operations of its controlled breaker.

1.5 Option Board (Figure 5-9)

The option board, when present, provides the circuits for the Lockout, Lockout Alarm, Automatic Reset and Instantaneous Trip options when they are supplied with the relay. The option board receives the cycle counter outputs; CTØ through CT7 and the CLOSE signal from the logic board through the mother board. ±12 volts from the power supply is applied to the option board. Depending on the options supplied, the option board sends $\overline{\text{LOCKOUT}}$ and $\overline{\text{RESET}}$ to the logic board and L.O. ALARM and INSTANTANEOUS to output relays on the mother board.

1.5.1 Lockout Option

The lockout option permits programming of the reclosing relay to prevent operation of the relay after any predetermined trip. The option is controlled by four position lockout switch S5.

The lockout switch in positions 1, 2, 3, and 4 selects cycle counter outputs CT1, CT3, CT5 and CT7 respectively. When the cycle counter reaches the selected count, the option circuit sends $\overline{\text{LOCKOUT}}$ to the logic board and illuminates the LOCKOUT LED. Relay driver Q1 on the option board is energized when the selected count occurs. The relay driver controls a dedicated lockout alarm relay on the mother board.

1.5.2 Reset Option

The reset option resets the cycle counter in the reclosing relay to CT0 when the circuit breaker is reclosed and remains closed for a programmed interval. The reset option is controlled by a five position RESET TIME switch, S6, which provides intervals of 10, 15, 20, 40, and 60 seconds.

The reset option circuit receives CT0 and $\overline{\text{CLOSE}}$ from the logic circuit board. When the cycle counter is at CT0 (reset) or the close flip flop U5-1 on the logic board is reset ($\overline{\text{CLOSE}}$ is high) clock generator U2 is held reset. When the breaker trips, the cycle counter advances off of CT0 and $\overline{\text{CLOSE}}$ is high. As soon as the breaker is reclosed, the reset is removed from clock generator U2, which puts out a continuous pulse train, and from counter U3. The pulses are counted by the counter and the 2^{11}, 2^{12}, 2^{13}, and 2^{14} outputs are decoded and made available to contacts of RESET TIME switch S6.

The frequency of the clock generator is such that 2^{11} counts is equal to 5 seconds. Switch S6, with AND gates U4-3 and U4-4 detects when the programmed time has elapsed. Switch S6 selects 10 (2^{12} counts) seconds, 15 (2^{11} and 2^{12} counts) seconds, 20 (2^{13} counts) seconds, 40 (2^{14} counts) seconds or 60 (2^{13} and 2^{14} counts) seconds. The output, S6-C, of the switch is high. When the counter output is decoded for the desired interval, inverter U1-2 sends $\overline{\text{RESET}}$ at logic zero to the logic circuit board previously described. RESET is also sent to AND gate U4-10, where it inhibits counting of additional clock pulses.

1.5.3 Instantaneous Trip Enable Option

The instantaneous trip enable option permits a relay (located on the mother board) to be controlled as desired for each trip. Inputs to the option board are CT0, CT2, CT4, and CT6 from the logic circuit board representing the cycle counter count present during the first, second, third, and fourth trips respectively.

Four INSTANTANEOUS ENABLE toggle switches on the front of the reclosing relay are labeled 1, 2, 3, and 4. Each switch is connected to its corresponding cycle counter output. One side of each switch is ORed with the other switches and the ORed output controls relay driver Q2.

Relay driver Q2 drives instantaneous trip enable relay K4 on the mother board. Contacts of K4 are typically closed 15 milliseconds after the previous closing of the controlled breaker is recognized. Output relay K4 is then closed to enable instantaneous tripping of the controlled breaker by the protective scheme.

SECTION 2.0

REPLACEMENT PARTS

2.1 GENERAL

CAUTION

THE PRINTED CIRCUIT BOARDS ARE CONFORMALLY COATED AS A PROTECTION AGAINST ENVIRONMENTAL DAMAGE. GREAT CARE MUST BE EXERCISED IN PRINTED CIRCUIT BOARD COMPONENT REPLACEMENT. SPECIAL SOLDERING EQUIPMENT MUST BE USED TO HEAT AND REMOVE THE CONFORMAL COATING AND AT THE SAME TIME PREVENT DAMAGE TO THE DELICATE SOLID-STATE COMPONENT. CARE MUST ALSO BE TAKEN TO PREVENT THERMAL DAMAGE TO THE COMPONENTS AND NOT TO DAMAGE OR BRIDGE OVER THE PRINTED CIRCUIT BOARD SOLDER LANDS OR BUSSES. THE REPAIRED AREA MUST BE RECOVERED WITH A SUITABLE HIGH-DIELECTRIC PLASTIC COATING (ACRYLIC) TO PREVENT POSSIBLE BREAKDOWN ACROSS THE PRINTED BUSSES AND LANDS DUE TO MOISTURE OR DUST.

Component values may be obtained from the schematics (Section 5.0) and replacement parts purchased locally. Where special components are involved (transformers, terminal blocks, printed circuit board, etc.) B.E. part numbers may be obtained from the schematics and ordered from Basler Electric. Replacement printed circuit boards with all components mounted may be ordered by supplying the following information: (1) the complete model and style number, (2) relay serial number, (3) the board part and serial number stamped on the board, and (4) the name of the board.

Due to the fact that most components are on conformally coated printed circuit boards, in-house replacement of individual components may be difficult and should not be attempted unless appropriate equipment and adequately trained personnel are available.

2.2 QUALITY OF REPLACEMENT PARTS

The quality of replacement parts must be at least equal to the type in the original circuit for proper operation.

NOTE

It is recommended that the relay be returned to the factory for repairs and recalibration due to the availability of production test and calibration equipment as well as parts. If returned as a minimum, the entire relay cradle should be shipped as an assembly preferably in a case.

2.3 EXTENDER BOARD

The extender board is designed to permit access to individual components for troubleshooting of a printed circuit board while extended from the relay cradle. Order Basler P/N 9 1129 30 100 if an extender board is desired.

CAUTION

WHEN USING THE EXTENDER BOARD WITH THE MULTI-SHOT RECLOSING RELAY, THE OPTION BOARD IS INSERTED COMPONENT SIDE DOWN. ALL OTHER BOARDS ARE INSERTED COMPONENT SIDE UP. IMPROPER INSERTION OF A CIRCUIT BOARD WILL DAMAGE THE BOARD OR THE RELAY.

2.4 TEST PLUG

The relay is designed to permit testing from the front of the relay case without disturbing the case wiring or removing the relay from the case. The test plug may be either a Basler P/N 10095 or a G.E. model XLA12A.

SECTION 3.0

CALIBRATION PROCEDURES

3.1 GENERAL

The essentiality of protective relays for the detection of abnormal conditions that could result in a serious outage or damage to protected systems or equipment cannot be over-emphasized. For this reason, a periodic test program is recommended. The calibration and verification procedures in this section are presented for use as an integral part of this test program to assure the user that the protective device will perform its intended function.

3.2 PRINTED CIRCUIT BOARD REMOVAL AND INSTALLATION

To remove or install a printed circuit board, proceed as follows:

CAUTION

NEVER REMOVE OR INSTALL A PRINTED CIRCUIT BOARD WITH POWER APPLIED TO THE RELAY.

Step 1. Remove the front cover from the case (figure 3-1).

Step 2. Remove the two Phillips head screws from both sides of each applicable front cover plate.

CAUTION

BE SURE TO OBSERVE THE PRINTED CIRCUIT BOARD HANDLING PRECAUTION PROCEDURES OUTLINE IN THE FRONT OF THIS MANUAL WHEN HANDLING PC BOARDS.

Step 3. Remove applicable printed circuit board from the mother board by pulling straight out. (See figure 3-2 for PC board identification and location within the cradle and table 3-1 for board name and function).

Step 4. Installation of PC board is the reverse of removal.

3.3 EXTENDER BOARD REMOVAL AND INSTALLATION (Figure 3-1)

Step 1. After the desired PC board has been removed, insert the extender board (Basler Part No. 9 1129 30 100) in the cradle and press firmly into the mother board connector.

CAUTION

THE OPTION PC BOARD MUST ALWAYS BE INSTALLED COMPONENT SIDE DOWN.

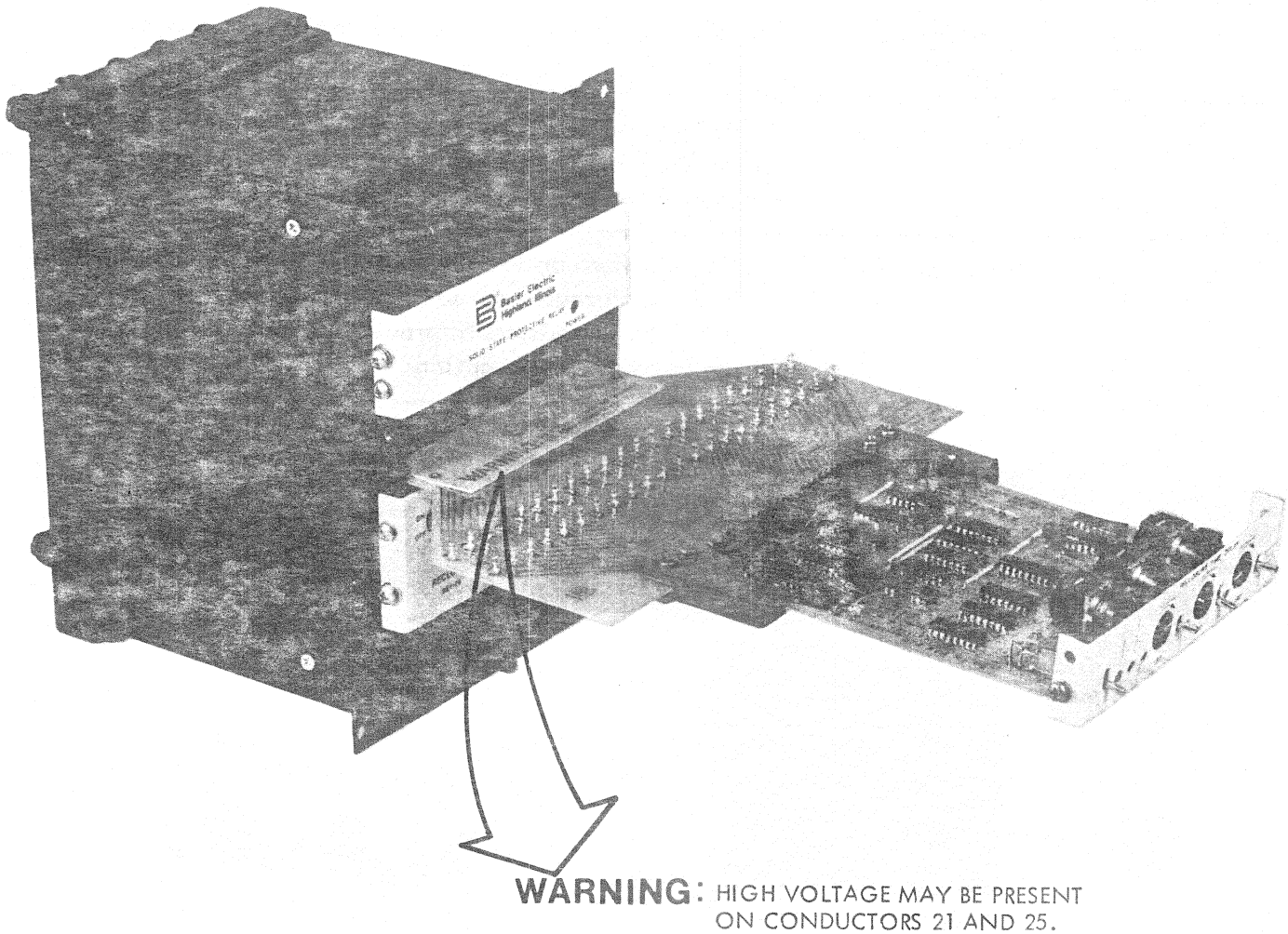


Figure 3-1. Typical Use of Extender Board

Table 3-1. PC Boards and Components Identification and Location

INDEX	BOARD TITLE	FUNCTION
A	Mother Board	Contains output relays and optical isolators for trip sensing circuitry and provides interconnections between power supply board, logic board and option board.
B	Power Supply Board	Provides regulated ± 12 vdc to internal circuitry of relay.
C	Logic Board	Contains reclosure time delay adjust potentiometers, diodes, transistors, and integrated circuits for timing and controlling automatic reclosure of associated breaker.
D	Option Board	Contains (when options are selected) instantaneous enable, lockout, and reset time select switches and integrated circuits and transistors to provide lockout, reset, and instantaneous enable options.

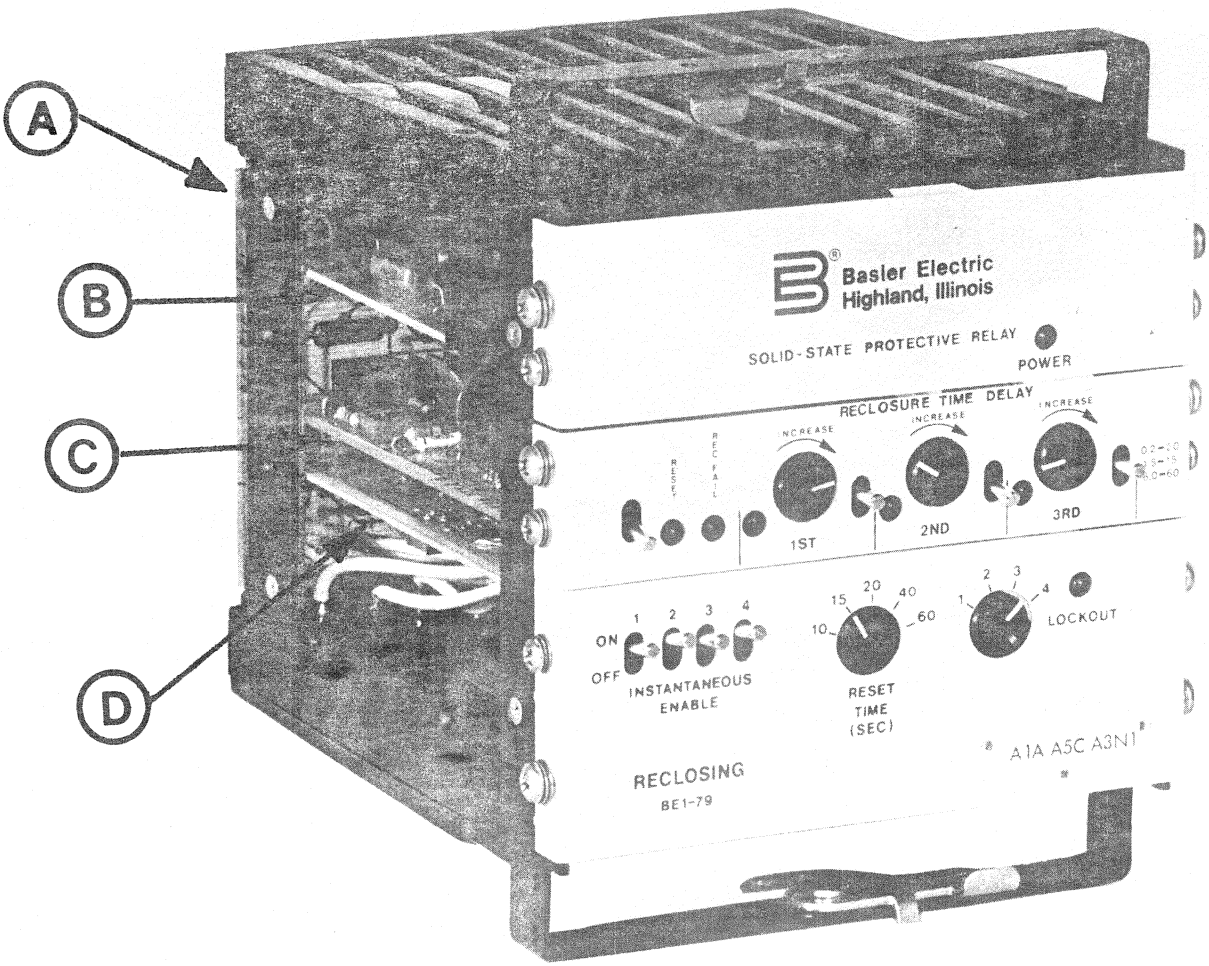


Figure 3-2. PC Board Identification and Location

Step 2. Insert the applicable PC board into extender board connector for troubleshooting or testing.

NOTE

The PC boards are keyed to the mother board connectors and cannot be interchanged. The extender board is keyed to fit all PC board locations.

Step 3. Removal of the extender board is the reverse of installations.

3.4 TEST EQUIPMENT REQUIRED

The test equipment required for relay calibration should consist of the following: (See figure 3-3 for a typical test setup.)

N.O. momentary contact pushbutton switch
N.C. momentary contact pushbutton switch
Relay with N.O. and N.C. contacts
Energizing source for relay
Appropriate AC or DC power source for relay operation
Extender board - Basler part number 9-1129-30-100
Electronic timer
Digital voltmeter
Indicator (continuity tester)

3.5 POWER SUPPLY CALIBRATION PROCEDURES

Step 1. Remove connecting plug(s) from relay.

Step 2. Connect 125 Vdc or 100/120 Vac, 50/60 Hz power source to relay case terminals 3 and 4 for relay with Type A or C power supply. Connect 48 Vdc power source at terminals 3 and 4 for relay with Type B power supply.

Step 3. With power off and connecting plug(s) removed, remove the power supply PC board.

Step 4. Install the extender board into relay in the power supply PC board slot.

Step 5. Install concerning plug(s) and apply appropriate external power to relay.

Step 6. If necessary, slowly adjust R5 for, an indication of +24 $\pm$0.1 Vdc on digital voltmeter as measured between TP1 (+) and TP 17 (-).

Step 7. Verify that TP 1 is +12 ± 0.8 Vdc with respect to ground (TP43).

Step 8. Verify that TP 17 is -12 ±0.7 Vdc with respect to ground (TP43).

Step 9. Check that front panel POWER indicator is illuminated.

Step 10. Turn power off, remove connecting plug(s), and re-install power supply PC board into the relay.

3.6 LOGIC BOARD CALIBRATION PROCEDURES

Step 1. Remove connecting plug(s) from relay.

Step 2. Connect 125 Vdc or 100/120 Vac, 50/60 Hz power source to relay case terminals 3 and 4 for relay with Type A or C power supply. Connect 48 Vdc power source at terminals 3 and 4 for relay with Type B power supply.

Step 3. With power off and connecting plug(s) removed, remove the logic board.

Step 4. Install the extender board into the relay in the logic PC board slot.

Step 5. Install logic PC board on the extender board.

Step 6. Connect test setup as shown in figure 3-3.

Step 7. Install connecting plugs and apply appropriate external power to relay.

NOTE

Steps 8 through 13 below provide the calibration for continuous time delay relays. For definite time delay calibration, proceed to Step 15.

Step 8. If automatic reset option is provided, set RESET TIME switch on relay to 60.

Step 9. If lockout option is provided, set LOCKOUT switch to 4.

Step 10. Set 1ST RECLOSURE TIME DELAY 0.2-2.0/1.5-15/6.0-60 switch to 1.5-15.

Step 11. Rotate 1ST RECLOSURE TIME DELAY potentiometer fully counter-clockwise.

Step 12. Momentarily depress momentary contact switch S1 on test setup.

NOTE

Allow for errors caused by output relay closing time in step 13.

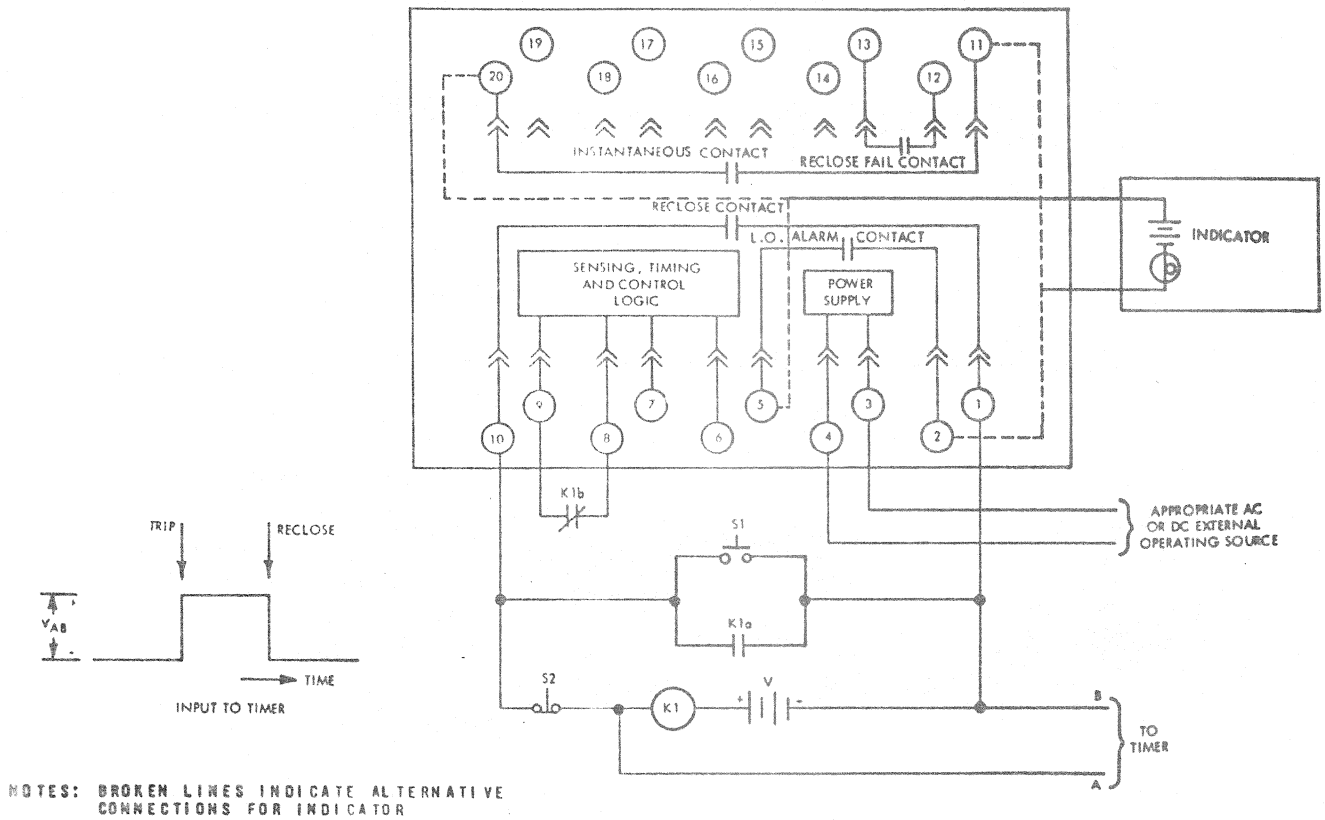


Figure 3-3. Test Setup

Step 13. Momentarily depress momentary contact switch S2 on test setup. Observe timer reads 1.50 + 0.0, -0.2 seconds.

Step 14. If 1.50 + 0.0, -0.2 seconds is not observed in step 13, adjust R17 on logic PC board and repeat steps 8 through 14. Adjust R17 clockwise to increase time and counterclockwise to decrease time.

NOTE

Steps 15 through 20 below provide the calibration for definite time delay relays. If the relay being calibrated has the continuous time delay option, proceed to step 21.

Step 15. If automatic reset option is provided, set RESET TIME switch on relay to 60.

Step 16. If lockout option is provided, set lockout switch to 4.

Step 17. Set 1ST RECLOSURE TIME DELAY switch to 15.

Step 18. Momentarily depress momentary contact switch S1 on test setup.

NOTE

Allow for errors caused by output relay closing time in step 19.

Step 19. Momentarily depress momentary contact switch S2 on test setup. Observe timer reads 15.00 $\pm$ 0.05 seconds.

Step 20. If 15.00 $\pm$ 0.05 seconds is not observed in step 19, adjust R17 on logic PC board and repeat steps 15 through 20. Adjust R17 clockwise to increase time and counterclockwise to decrease time.

Step 21. Turn power off, remove connecting plug(s), and re-install logic PC board into the relay.

3.7 OPTION BOARD CALIBRATION PROCEDURE

NOTE

The following procedures apply to optional features that may or may not be present on a given relay. Perform only those steps that apply to the reclosing relay under test.

Step 1. Remove connecting plug(s) from relay.

Step 2. Connect 125 Vdc or 100/120 Vac, 50/60 Hz power source to relay case terminals 3 and 4 for relay with type A or C power supply. Connect 48 Vdc power source at terminals 3 and 4 for relay with type B power supply.

Step 3. With power off and connecting plug(s) removed, remove the option board.

Step 4. Install the extender board into the relay in the option PC board slot.

CAUTION

IN STEP 5, BE SURE THE OPTION PC BOARD IS INSTALLED IN THE EXTENDER BOARD COMPONENT SIDE DOWN. INSTALLING IT COMPONENT SIDE UP WILL DAMAGE THE OPTION BOARD.

Step 5. Install the option PC board, component side down, on the extender board.

Step 6. Connect test setup as shown in figure 3-3.

Step 7. Install connecting plug(s) and apply appropriate external power to relay.

NOTE

Steps 8 through 13 below apply to the automatic reset option on the option board. If the reclosing relay is not supplied with this option, proceed to step 13.

Step 8. Set INSTANTANEOUS ENABLE 1, 2, 3, and 4 switches to OFF.

Step 9. Set RESET TIME (SEC) to 15.

Step 10. Set LOCKOUT to 4.

Step 11. Press and release the momentary pushbutton S2 on the test setup. Observe that RESET LED is extinguished and 1ST LED illuminates. With a stopwatch, observe that about 15 seconds later, 1ST LED extinguishes and RESET LED illuminates.

Step 12. If 15 seconds is not observed in step 11, adjust R7 on option PC board and repeat steps 11 and 12. Adjust R7 clockwise to increase time and counter clockwise to decrease time.

NOTE

Steps 13 through 15 below apply to relays supplied with the lockout option. If the reclosing relay is not supplied with this option, proceed to Step 16.

Step 13. Set RECLOSURE TIME DELAY for minimum setting for all trips.

Step 14. Set LOCKOUT switch on relay to 1.

Step 15. Press momentary pushbutton (S2) on test setup. Observe RESET and LOCKOUT LEDs are illuminated.

NOTE

Steps 16 and 17 below apply to relays supplied with the instantaneous trip enable option. If the reclosing relay is not supplied with this option, proceed to step 18.

Step 16. Set INSTANTANEOUS ENABLE 1 to on.

Step 17. Push RESET switch up and release. Observe RESET LED is illuminated and instantaneous enable relay closes immediately.

Step 18. Turn power off, remove connecting plug(s), and re-install option PC board into the relay.

SECTION 4.0

TROUBLESHOOTING

Waveforms and test voltages are provided at key points on the schematic diagrams, located in section 5.0 in this manual, as aids in troubleshooting the relay. The symbol ◯→ appearing on a schematic is a reference to a waveform diagram. The alpha character inside the symbol, for example Ⓑ→ , corresponds to the Ⓑ waveform illustration associated with that schematic. The waveforms and voltages shown on the diagrams are indicative of the waveform and voltage present if that stage of the circuitry is functioning properly.

SECTION 5.0

SCHEMATICS AND DIAGRAMS

Table 5-1 identifies specific schematics and waveform diagrams for each relay by style number. The style number of the relay is recorded on the front panel, drawout cradle, and inside the case assembly. This number should be entered in the circles above the chart.

Selection of the proper schematics and waveform diagrams is accomplished by going down each column and locating the number or letter corresponding to the number or letter of the style number entered in the circles at the top of the column. Follow the horizontal line to the left hand columns where the figure number of the schematic is recorded. The figure number in the waveform column pertains to the schematic in that particular row.

Table 5-1, Schematic and Diagram Selection Chart.

SCHEMATICS	WAVEFORMS	TYPE ○	Lockout and Reset ○	Inst. Trip Enable ○	Reclosing Time Delay ○○	Power Supply ○	Reset Timer ○	Option 1 ○	Option 2 ○	Option 3 ○
5-5		A							N	
5-1						A				
5-2						B				
5-3	5-4					C				
5-6	5-8				A1			2,3		
5-7	5-8				A5			2,3		
5-9	5-8		1,2, 3	A			A			1

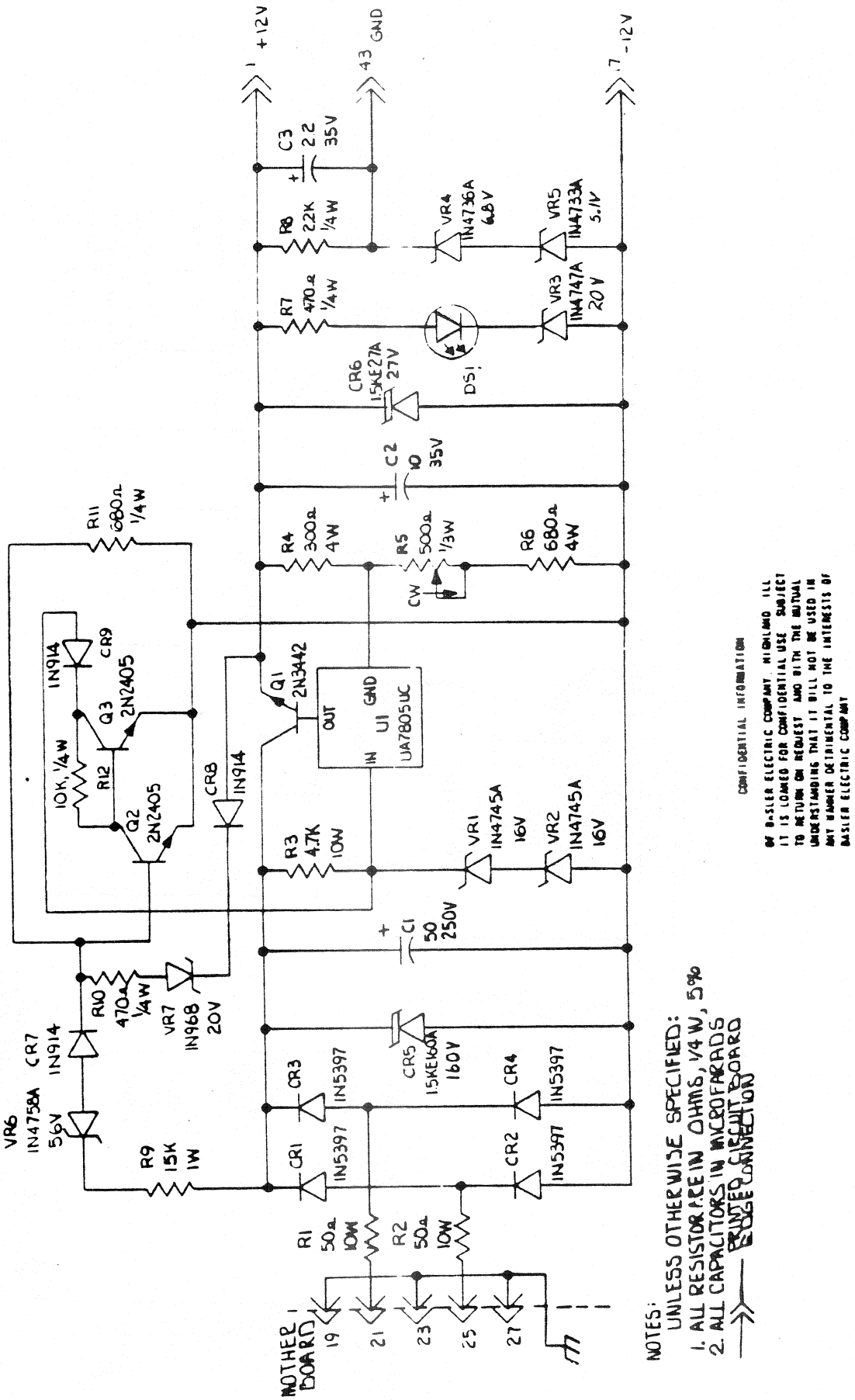


Figure 5-1. Type A Linear Power Supply, 125 Vdc or 100/120 Vac, 50/60 Hz Inputs - Schematic Diagram.

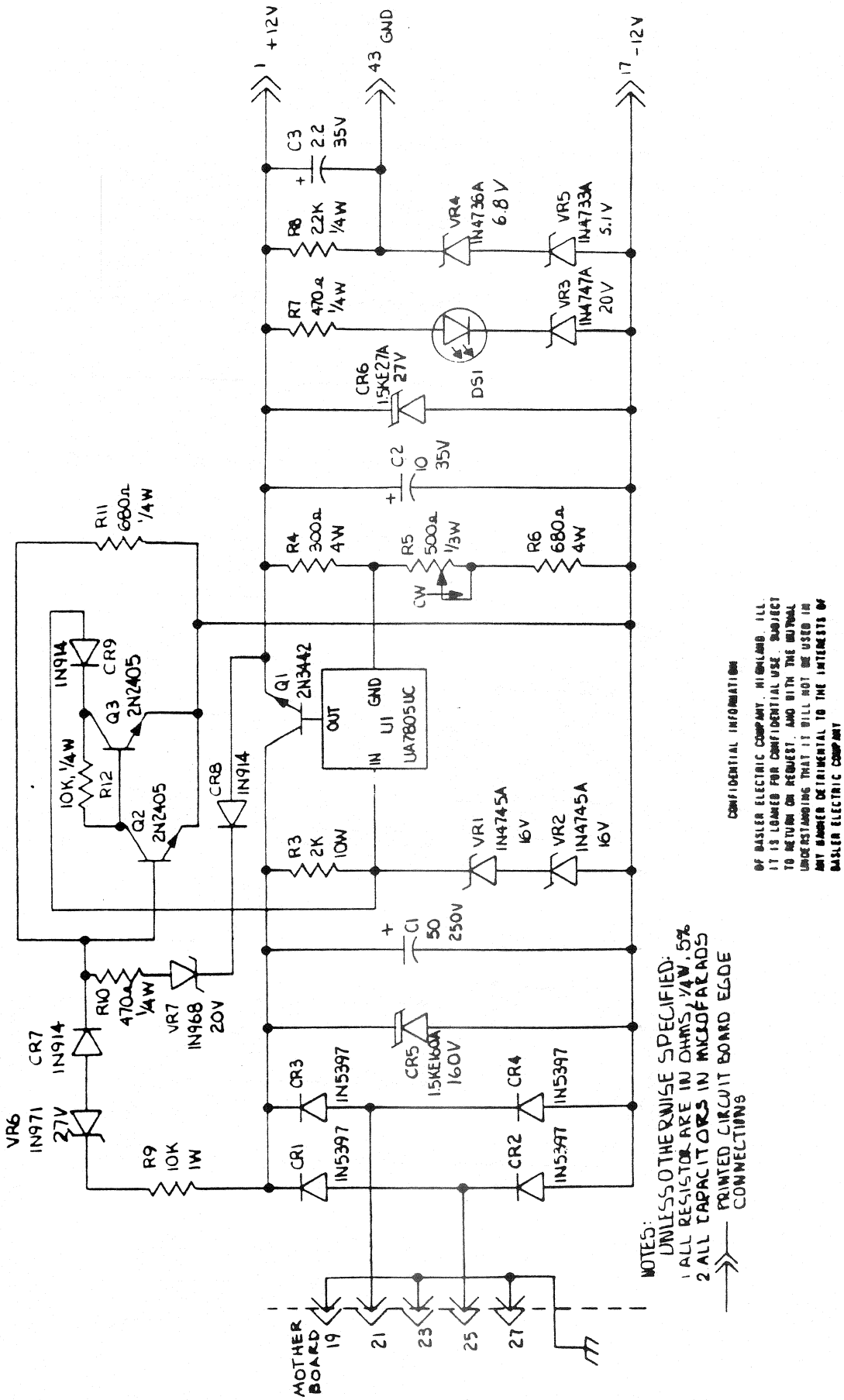


Figure 5-2. Type B Linear Power Supply, 48 Vdc Input - Schematic Diagram.

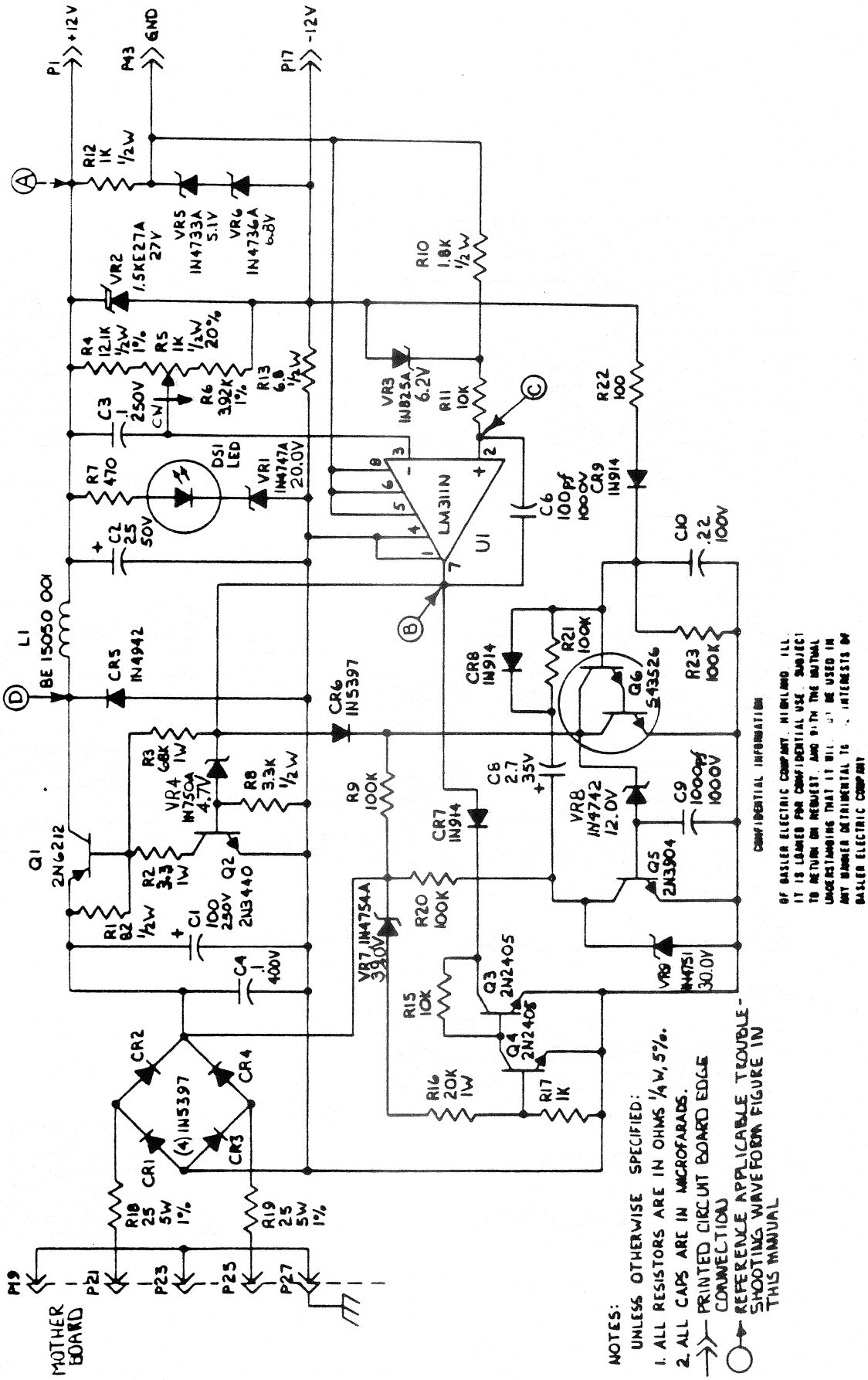
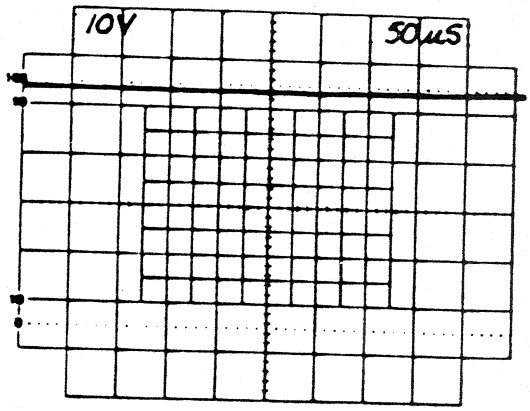
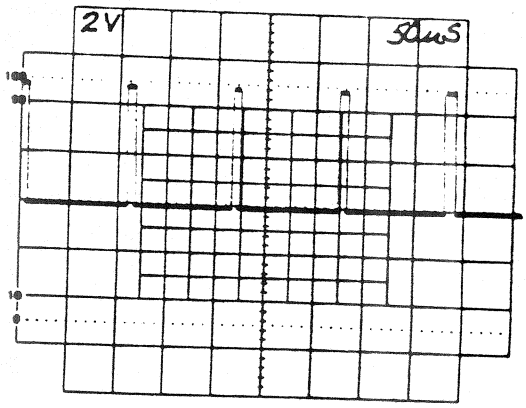


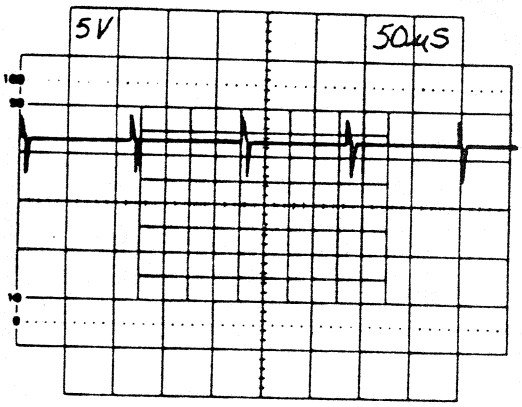
Figure 5-3. Type C Switching Power Supply, 125 Vdc or 100/120 Vac, 50/60 Hz Inputs, Schematic Diagram.



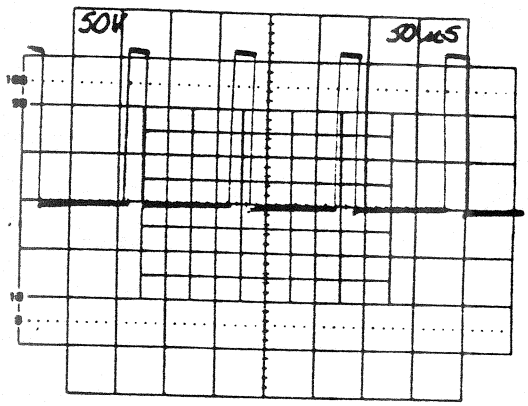
A.



B.



C. Scope is A.C. coupled.



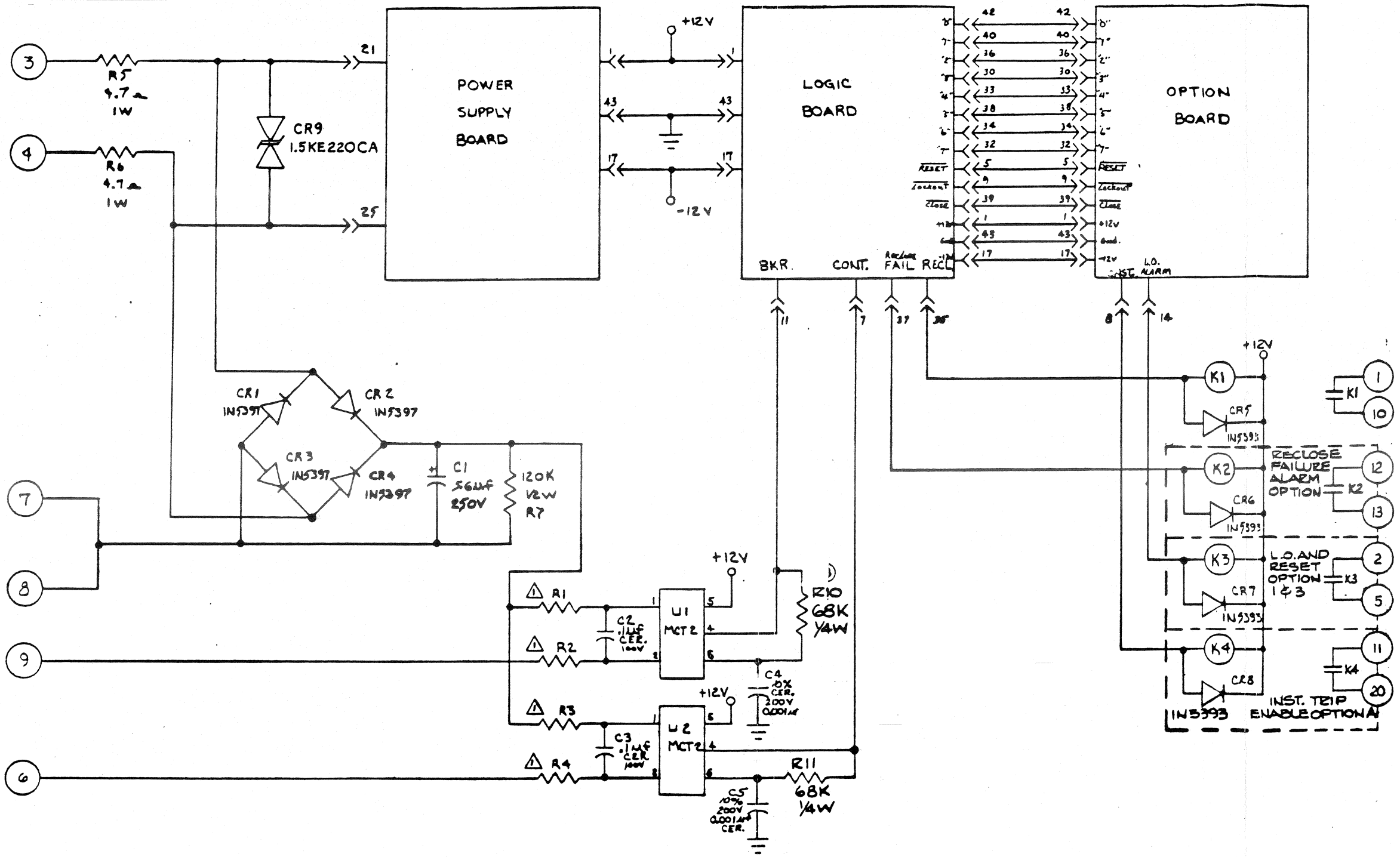
D.

NOTE:

1. ALL WAVEFORMS ARE TYPICAL. THE SWITCHING FREQUENCY IS DEPENDENT UPON POWER SUPPLY LOADING.

2. ALL WAVE FORMS ARE REFERENCED TO -12V POWER SUPPLY OUTPUT.

Figure 5-4. Troubleshooting Waveforms and Test Voltages for Type C Power Supplies.



NOTES:

⚠ R1, R2, R3, R4 = 3.3KΩ 4W FOR POWER SUPPLY A & C
R1, R2, R3, R4 = 1KΩ 4W FOR POWER SUPPLY B

Figure 5-5. Mother Board - Schematic Diagram.

INTEGRATED CIRCUIT			
IC	TYPE	Gnd	+12V
U1	4584B	7	14
U2	4030B	7	14
U3	4538B	8	16
U4	4538B	8	16
U5	4013B	7	14
U6	4013B	7	14
U7	4001B	7	14
U8	4023B	7	14
U9	4001B	7	14
U10	4027B	8	16
U11	4027B	8	16
U12	4017B	8	16
U13	SE555CV	1	8
U14	4016B	7	14
U15	4020B	8	16
U16	4049UB	8	1
U17	4081B	7	14
U18	4011B	7	14

NOTES:
1. ALL RESISTORS ARE IN OHMS AND ARE ¼ WATT, 5%, CC UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
3. USE J1 WHEN MAXIMUM RECLOSE SIGNAL OPTION IS 5-60 SEC (OPT. 1-3).
   USE J2 WHEN MAXIMUM RECLOSE SIGNAL OPTION IS 2-30 SEC (OPT. 1-2).
   USE J7 FOR OPTION 1-0
4. LETTERS IN CIRCLE REF. WAVEFORMS ON FIG. 5-8

Figure 5-6. Logic Printed Circuit Board A1 Reclosure Time Delay - Schematic Diagram.

INTEGRATED CIRCUIT			
IC	TYPE	Gnd	+12V
U1	4584B	7	14
U2	4030B	7	14
U3	4538B	8	16
U4	4538B	8	16
U5	4013B	7	14
U6	4013B	7	14
U7	4001B	7	14
U8	4023B	7	14
U9	4001B	7	14
U10	4027B	8	16
U11	4027B	8	16
U12	4017B	8	16
U13	SE555CV	1	8
U14	4016B	7	14
U15	4020B	8	16
U16	4049UB	8	1
U17	4081B	7	14
U18	4011B	7	14

NOTES:
1. ALL RESISTORS ARE IN OHMS AND ARE ¼ WATT 5% CC UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
3. USE J1 WHEN MAXIMUM RECLOSE SIGNAL OPTION IS 5-60 SEC (OPT. 1-3).
   USE J2 WHEN MAXIMUM RECLOSE SIGNAL OPTION IS 2-3 SEC (OPT. 1-2).
   USE J7 FOR OPTION 1-0
4. LETTERS IN CIRCLES REF. WAVEFORMS ON FIG. 5-8

Figure 5-7. Logic Printed Circuit Board A5 Reclosure Time Delay - Schematic Diagram.

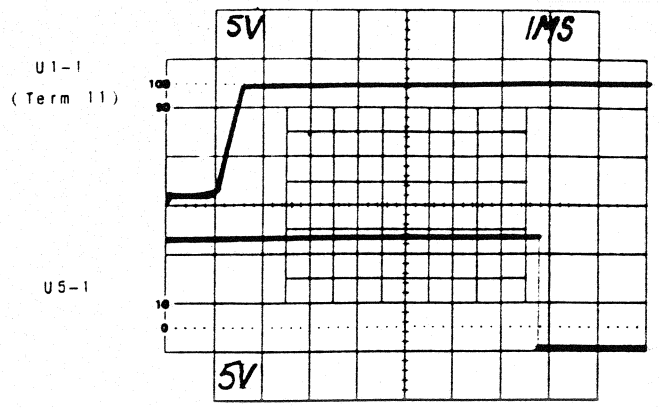


FIGURE 5-8A

LOGIC BOARD Breaker tripping

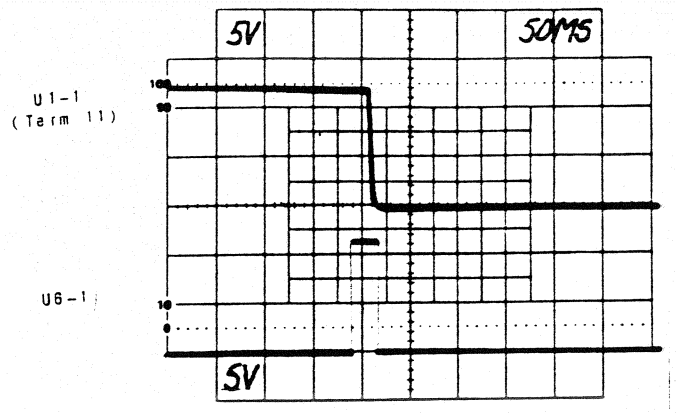


FIGURE 5-8B

LOGIC BOARD Breaker tripped, automatic timeout, and breaker reclose by relay.

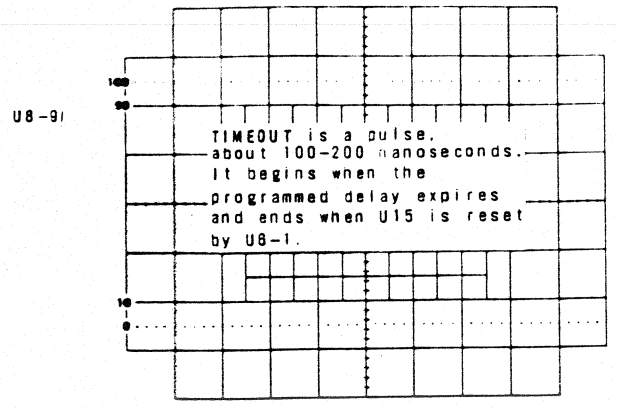


FIGURE 5-8C

LOGIC BOARD TIMEOUT pulse

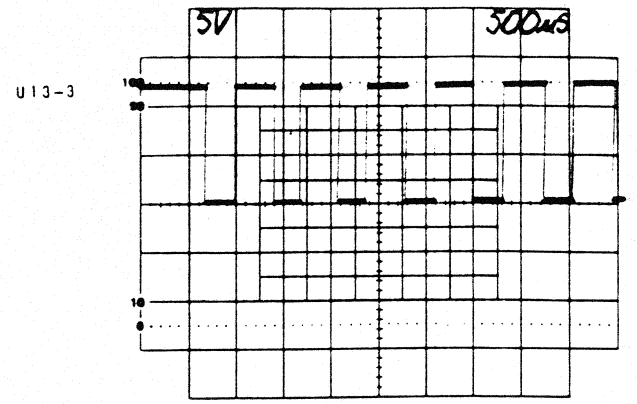


FIGURE 5-8D

LOGIC BOARD Typical clock (minimum reclose delay timing)

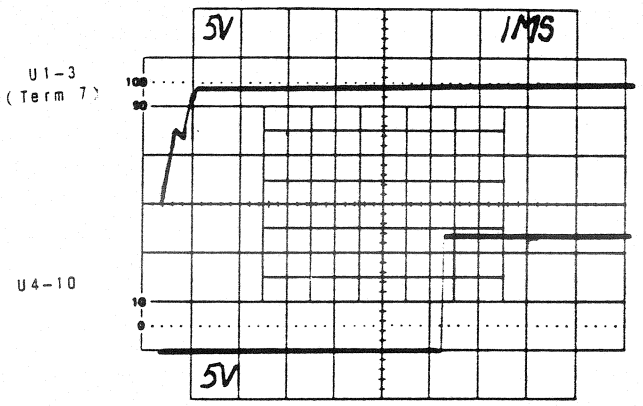


FIGURE 5-8E

LOGIC BOARD Disable contact closure

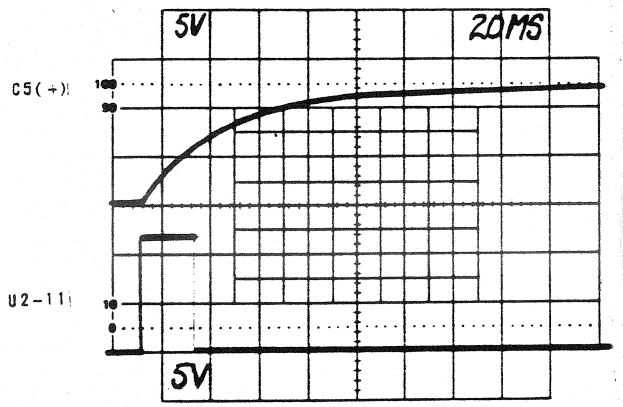


FIGURE 5-8F

LOGIC BOARD Power-up or manual reset

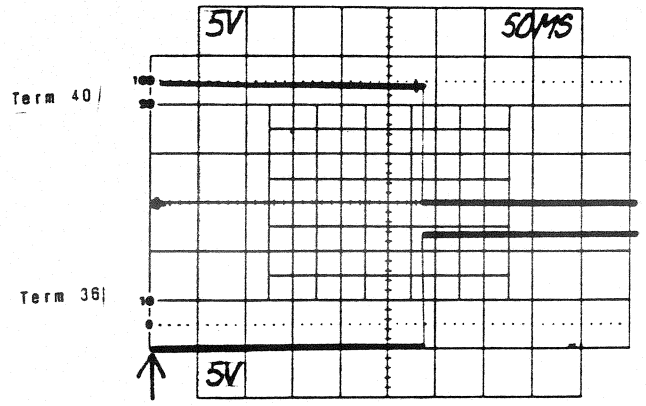


FIGURE 5-8G

LOGIC BOARD Reset. Breaker trip, first reclose, breaker closes

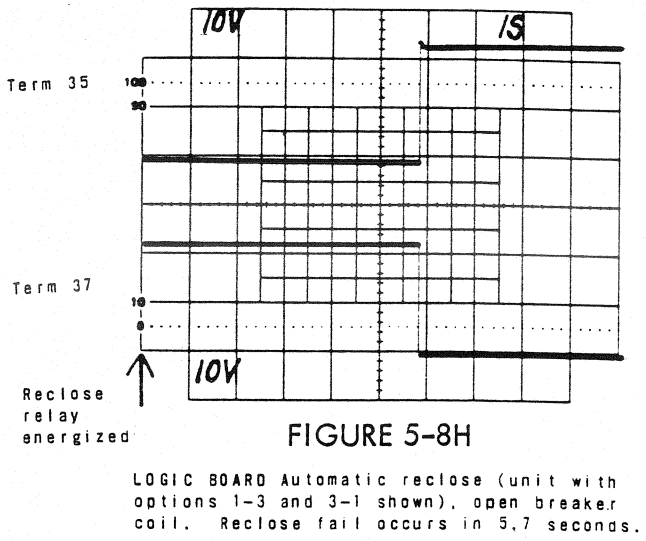


FIGURE 5-8H

LOGIC BOARD Automatic reclose (unit with options 1-3 and 3-1 shown), open breaker coil. Reclose fail occurs in 5.7 seconds.

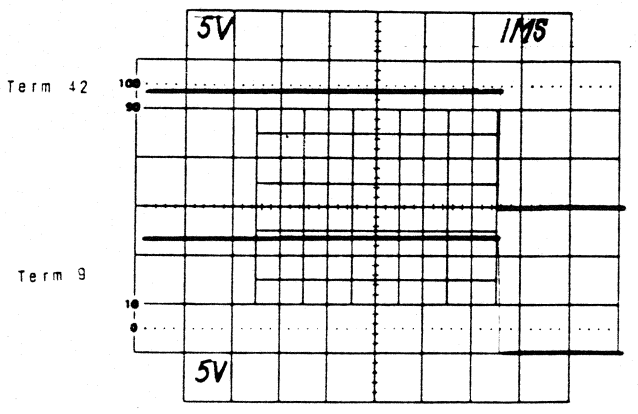


FIGURE 5-8I

OPTION BOARD LOCKOUT set to 1. Reset and then trip

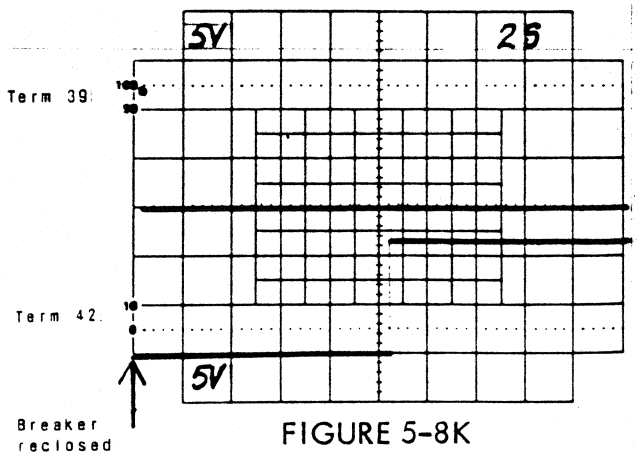


FIGURE 5-8K

OPTION BOARD Automatic reset set to 10 seconds. First automatic reclose, 10 second reset delay and automatic reset

Figure 5-8. Logic Printed Circuit Board-Waveform and Voltage Diagram.

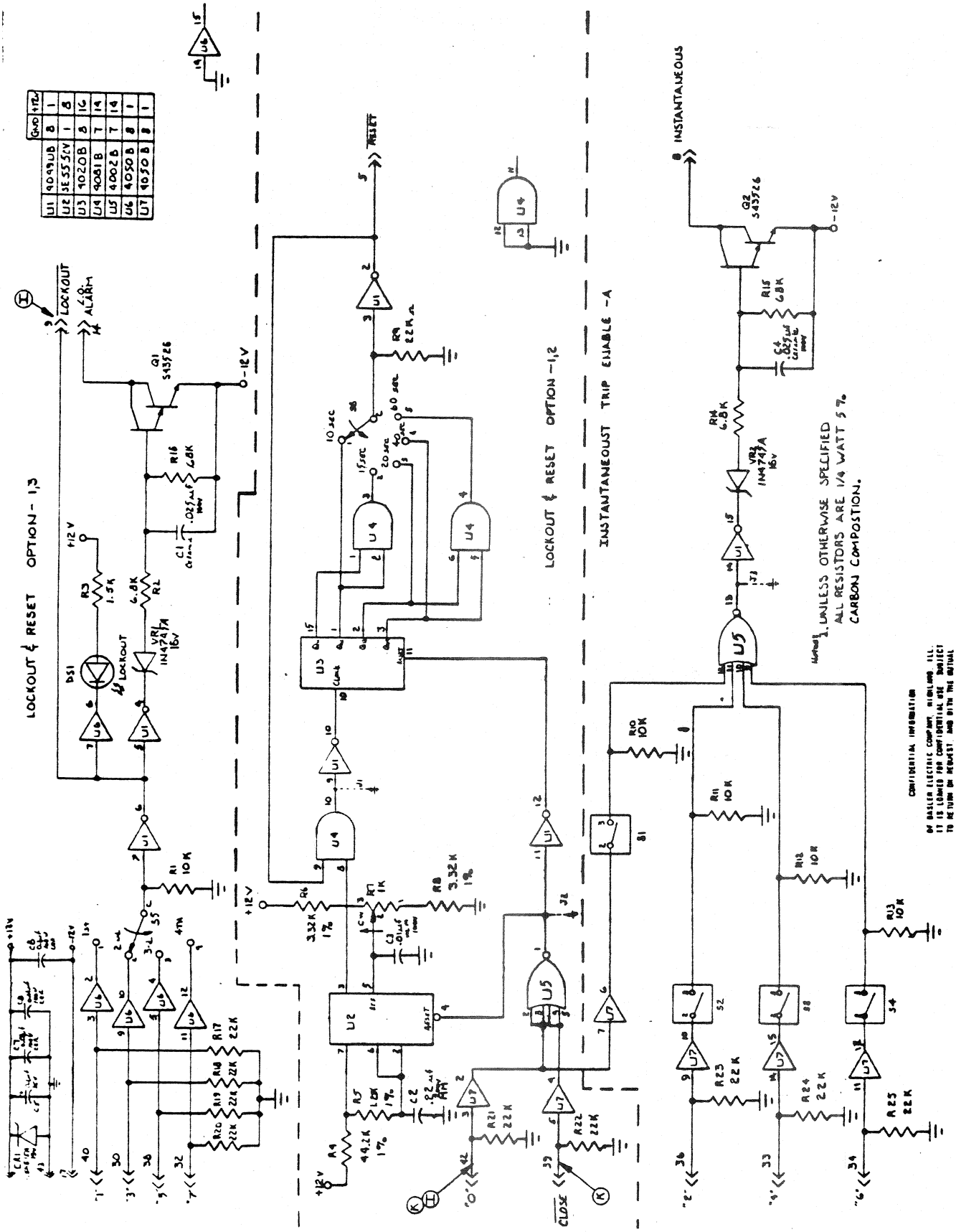


Figure 5-9. Option Printed Circuit Board Schematic Diagram.