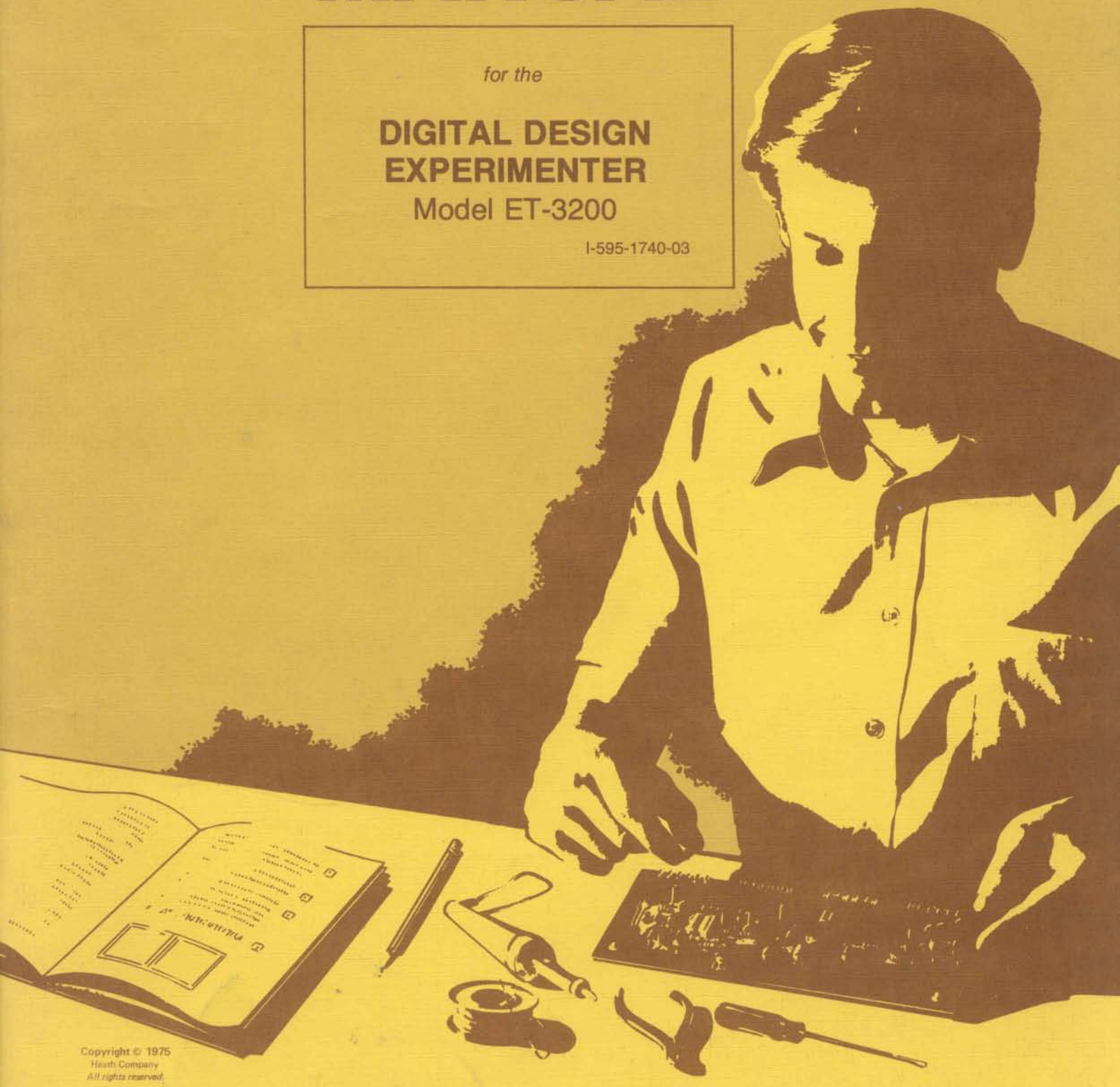
HEATHKIT®
MANUAL

for the

DIGITAL DESIGN EXPERIMENTER
Model ET-3200

I-595-1740-03



HEATH COMPANY • BENTON HARBOR, MICHIGAN

HEATH COMPANY PHONE DIRECTORY

The following telephone numbers are direct lines to the departments listed:

Kit orders and delivery information	(616) 982-3411
Credit	(616) 982-3561
Replacement Parts	(616) 982-3571
Technical Assistance:	
R/C, Audio, and Electronic Organs	(616) 982-3310
Amateur Radio	(616) 982-3296
Test Equipment, Strobe Lights, Calculators, Clocks, Weather Instruments	(616) 982-3315
Television	(616) 982-3307
Automotive, Marine, Appliances, Security, General Products	(616) 982-3496

YOUR HEATHKIT 90-DAY FULL WARRANTY

If you are not satisfied with our service - warranty or otherwise - or with our products, write directly to our Director of Customer Services, Heath Company, Benton Harbor, Michigan 49022. He will make certain your problems receive immediate, personal attention.

Our attorney, who happens to be quite a kitbuilder himself, insists that we describe our warranty using all the necessary legal phrases in order to comply with the new warranty regulations. Fine. Here they are:

For a period of ninety (90) days after purchase, Heath Company will replace or repair free of charge any parts that are defective either in materials or workmanship. You can obtain parts directly from Heath Company by writing us at the address below or by telephoning us at (616) 982-3571. And we'll pay shipping charges to get those parts to you — anywhere in the world.

We warrant that during the first ninety (90) days after purchase, our products, when correctly assembled, calibrated, adjusted and used in accordance with our printed instructions, will meet published specifications.

If a defective part or error in design has caused your Heathkit product to malfunction during the warranty period through no fault of yours, we will service it free upon proof of purchase and delivery at your expense to the Heath factory, any Heathkit Electronic Center (units of Schlumberger Products Corporation), or any of our authorized overseas distributors.

You will receive free consultation on any problem you might encounter in the assembly or use of your Heathkit product. Just drop us a line or give us a call. Sorry, we cannot accept collect calls.

Our warranty does not cover and we are not responsible for damage caused by the use of corrosive solder, defective tools, incorrect assembly, misuse, fire, or by unauthorized modifications to or uses of our products for purposes other than as advertised. Our warranty does not include reimbursement for customer assembly or set-up time.

This warranty covers only Heathkit products and is not extended to allied equipment or components used in conjunction with our products. **We are not responsible for incidental or consequential damages.** Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

HEATH COMPANY
BENTON HARBOR, MI. 49022

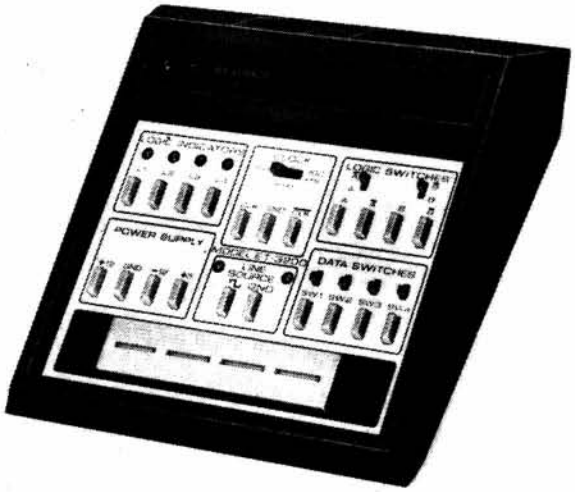
Prices and specifications subject to change without notice.

Assembly and Operation of the

HEATHKIT

DIGITAL DESIGN EXPERIMENTER

MODEL ET-3200



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HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

INTRODUCTION

The Heathkit Model ET-3200 Digital Design Experimenter is compact and self-contained so you can quickly design and experiment with digital electronic circuits. The Experimenter has the following built-in features:

- Three power supplies – to power both digital and linear circuits.
- Four logic Data switches.
- Two "no bounce" logic switches.
- A 3-frequency pulse generator (clock).
- Four LED logic-state indicators.
- Internal circuitry compatible with most of today's commonly used logic families.
- Connector blocks for "solderless" connections between parts and wires.

The ET-3200 is also an excellent learning tool and is a recommended supplement to the individual learning programs of Heathkit Continuing Education.

Most of the components are mounted on the circuit board. This makes the kit easy to assemble. The compact size and light weight allow you to move or place the Experimenter almost anywhere.

Refer to the "Kit Builder's Guide" for complete information on unpacking, parts identification, tools, wiring, soldering, and step-by-step assembly procedure.

PARTS LIST

Check each part against the following list. Make a check (√) in the space provided as you identify each part. Any part that is packed in an individual envelope with the part number on it should be placed back in the envelope after you identify it until it is called for in a step. Do not throw away any packing materials until all parts are accounted for.

To order a replacement part, use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover of the Manual. For pricing information, refer to the separate "Heath Parts Price List."

Each circuit part in this kit has its own component number (R2, C4, etc.). Use these numbers when you want to positively identify the same part in the various sections of the Manual. These numbers, which are especially useful if a part has to be replaced, appear:

- In the Parts List,
- At the beginning of each step where a component is installed,
- In some illustrations,
- In the Schematic,
- In the sections at the rear of the Manual.

QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.

RESISTORS, 1/2-Watt

Composition

NOTES:

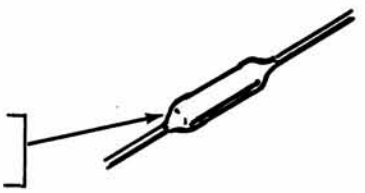
1. The following resistors have 10% tolerance (silver fourth band) unless they are otherwise noted. A 5% resistor has a gold fourth band.
2. The resistors may be packed in more than one envelope. Open all the resistor envelopes before you check the resistors against the Parts List.

( )	2	4.7 Ω (yellow-violet-gold)	1-129	R4, R14
( )	4	150 Ω (brown-green-brown)	1-66	R23, R26, R32, R37
( )	1	220 Ω (red-red-brown)	1-45	R5
( )	1	470 Ω (yellow-violet-brown)	1-6	R39
( )	2	510 Ω, 5% (green-brown-brown-gold)	1-63	R2, R12
( )	8	1000 Ω (brown-black-red)	1-9	R3, R13, R44, R45, R28, R31, R34, R36
( )	1	2700 Ω (red-violet-red)	1-13	R7
( )	5	4700 Ω (yellow-violet-red)	1-16	R22, R25, R29, R35, R43
( )	2	10 kΩ (brown-black-orange)	1-20	R41, R42
( )	1	15 kΩ (brown-green-orange)	1-21	R46

	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
Resistor (cont'd.)				
( )	1	27 kΩ (red-violet-orange)	1-23	R101
( )	1	68 kΩ (blue-gray-orange)	1-60	R47
( )	4	100 kΩ (brown-black-yellow)	1-26	R21, R24, R27, R33

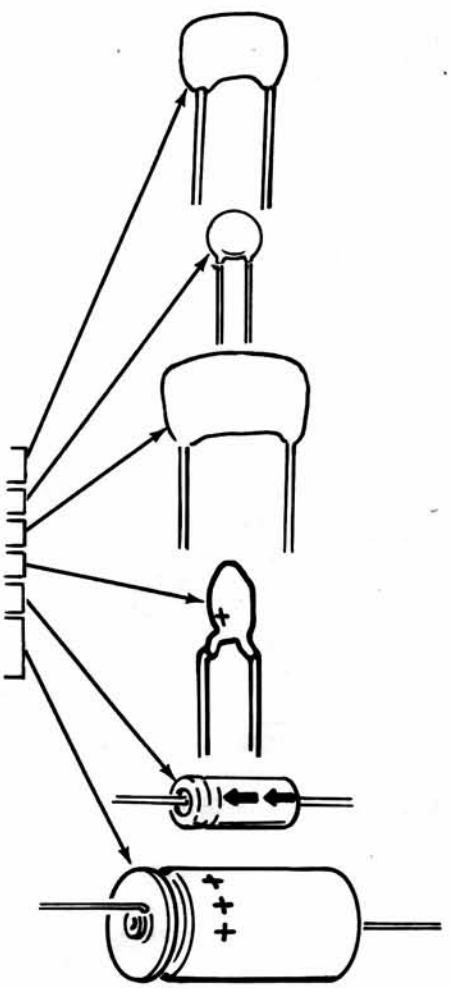
Precision

( )	1	2000 Ω (2k)	2-228	R17
( )	1	2250 Ω (2.25k)	2-177	R18



CAPACITORS

( )	1	62 pF mica	20-109	C11
( )	2	.001 μF disc	21-163	C4, C7
( )	1	.01 μF Mylar*	27-44	C10
( )	1	10 μF tantalum	25-220	C9
( )	3	10 μF electrolytic	25-283	C3, C5, C8
( )	2	1200 μF electrolytic	25-241	C1, C6
( )	1	2000 μF electrolytic	25-230	C2

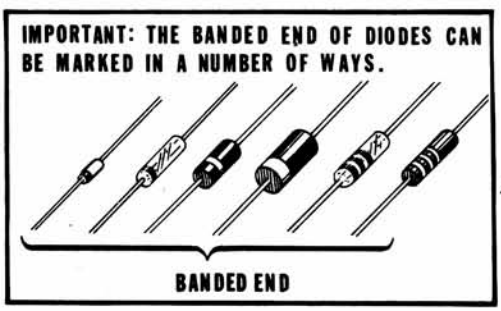


*DuPont Registered Trademark

	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.

DIODES

( )	1	1N4149	56-56	D9
( )	1	1N3017	56-97	ZD1
( )	8	1N4002	57-65	D1, D2, D3, D4, D5, D6, D7, D8

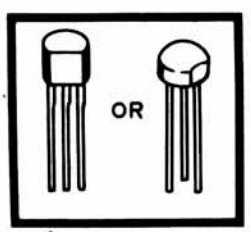


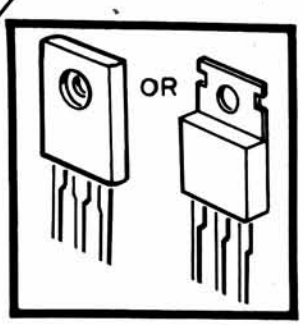
( )	4	LED	412-611	L1, L2, L3, L4

TRANSISTORS-INTEGRATED CIRCUITS

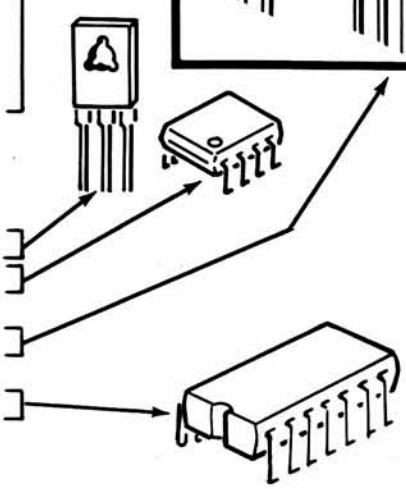
NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways:

1. Part number.
2. Type number.
3. Part number and type number.
4. Part number with a type number other than the one listed.

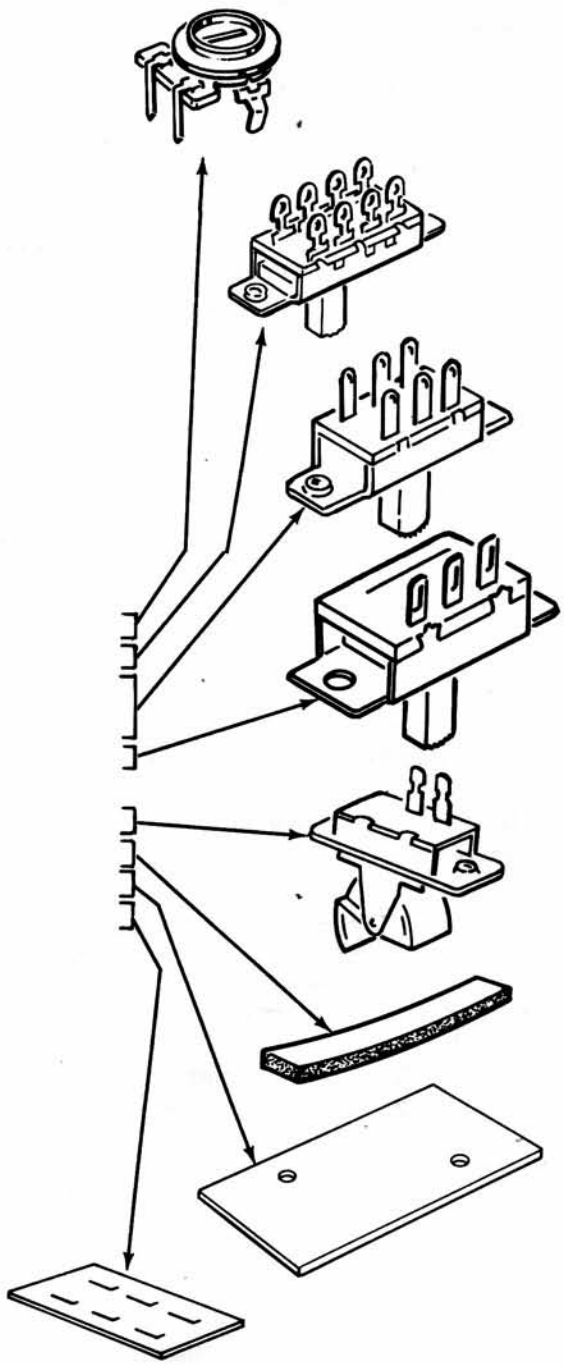




( )	3	2N4121 transistor	417-235	Q5, Q7, Q8
( )	12	MPSA20 transistor	417-801	Q1, Q3, Q4, Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16, Q17
( )	1	MJE181 transistor	417-818	Q2
( )	1	MJE171 transistor	417-819	Q6
( )	1	NE555V integrated circuit	442-53	IC3
( )	1	μA7805 integrated circuit	442-54	IC1
( )	2	SN7403N integrated circuit	443-54	IC2, IC4

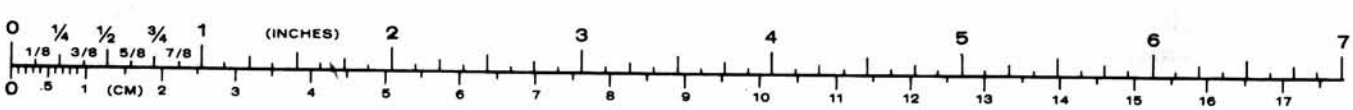


QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.



CONTROL-SWITCHES-INSULATORS

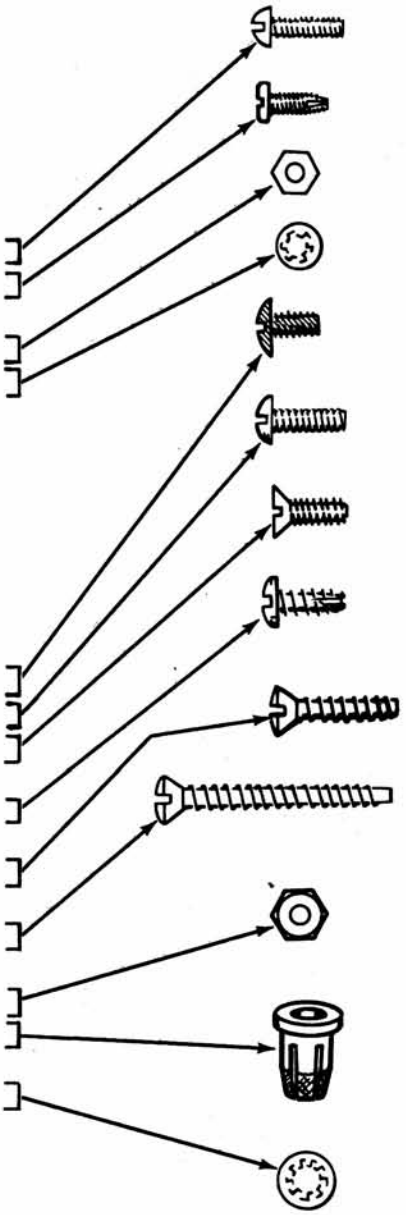
( )	1	2000 Ω (2K) control	10-382	R6
( )	1	DPTT slide switch	60-22	SW7
( )	4	DPDT slide switch	60-78	SW1, SW2, SW3, SW4
( )	2	SPDT slide switch (spring return)	60-86	SW5, SW6
( )	1	SPST rocker switch	60-607	SW101
( )	5"	Foam tape	73-92	
( )	1	Insulator plate	75-724	
( )	1	Switch insulator	75-52	



QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.

HARDWARE

NOTE: The hardware may be in more than one packet. Open all the hardware packets before you check the hardware against the Parts List.



#4 Hardware

( )	2	4-40 x 3/8" screw	250-4
( )	3	#4 x 5/16" self-tapping screw	250-163
( )	2	4-40 nut	252-2
( )	2	#4 lockwasher	254-9

#6 Hardware

( )	4	6-32 x 1/4" black screw	250-116
( )	1	6-32 x 3/8" screw	250-9
( )	1	6-32 x 3/8" flat head screw	250-32
( )	10	#6 x 3/8" self-tapping screw	250-592
( )	8	#6 x 5/8" self-tapping screw	250-559
( )	2	#6 x 1-1/8" self-tapping screw	250-1137
( )	2	6-32 nut	252-3
( )	2	6-32 brass insert nut	252-170
( )	3	#6 lockwasher	254-1

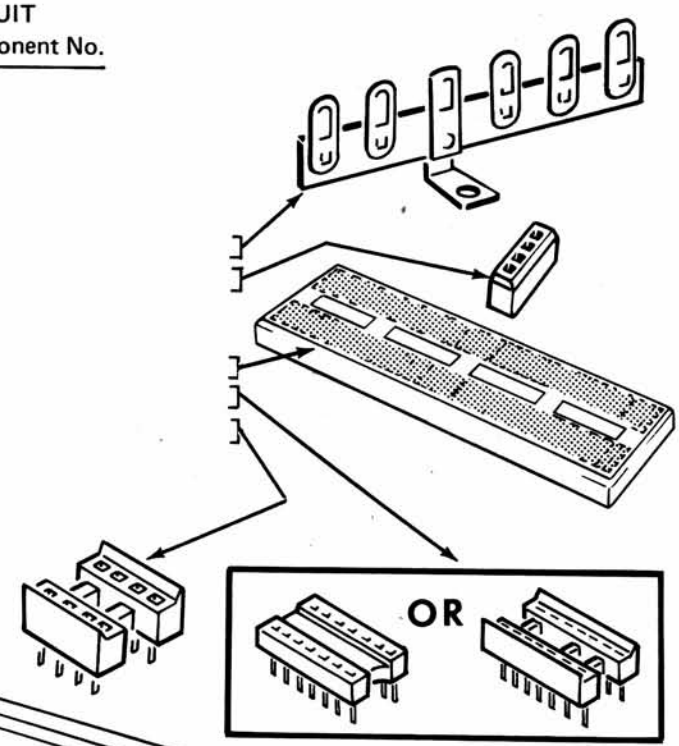
WIRE-SLEEVING-LINE CORD

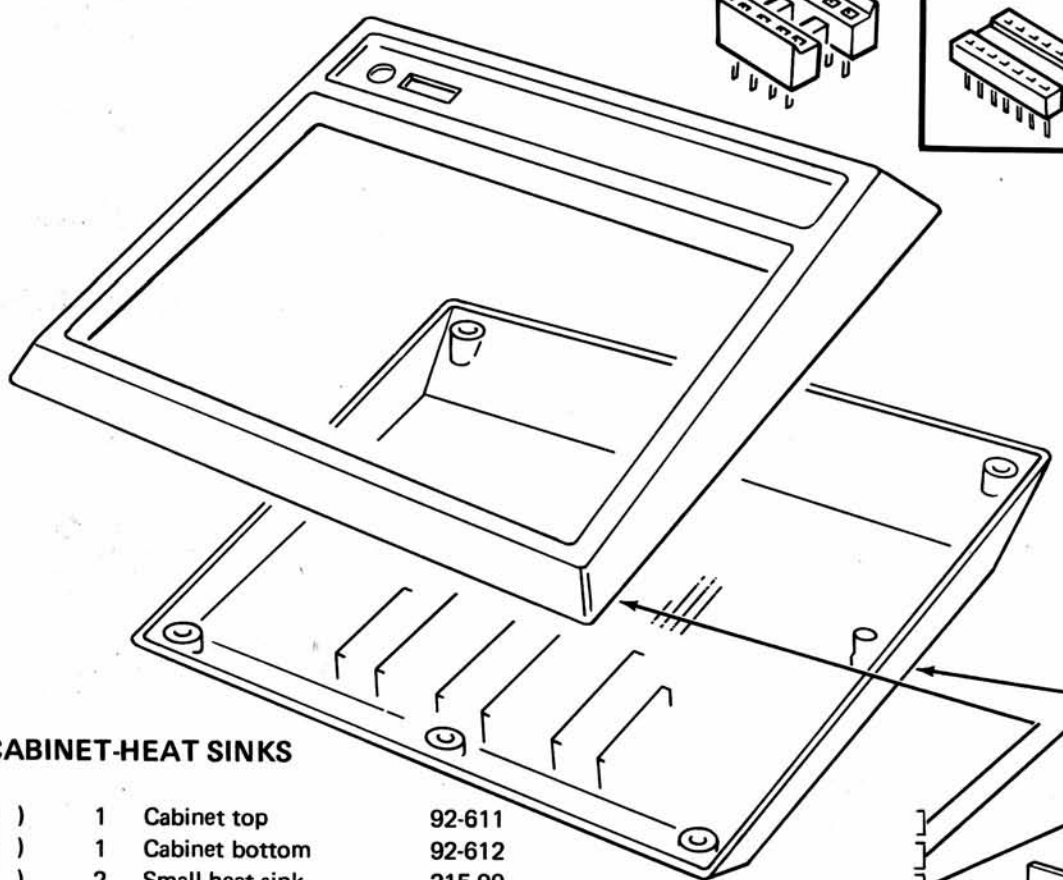
( )	2-1/2'	Red stranded wire	344-21
( )	6'	Red solid wire	344-52
( )	6'	Black wire	344-50
( )	4'	Brown wire	344-51
( )	4'	Orange wire	344-53
( )	6'	Yellow wire	344-54
( )	4'	Green wire	344-55
( )	4'	Blue wire	344-56
( )	6"	Sleeving	340-1
( )	1	Line cord	89-44

QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.

TERMINAL STRIP-CONNECTOR BLOCKS-SOCKETS

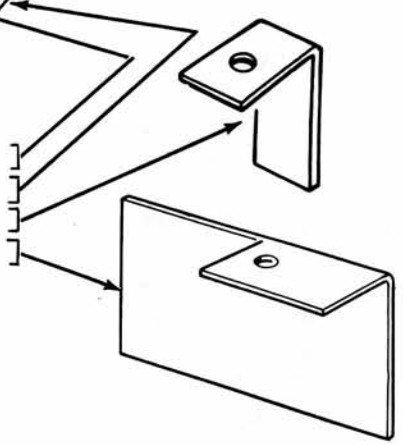
( )	1	Terminal strip	431-86
( )	21	Connector block	432-874
( )	1	Breadboarding socket (with connectors and vinyl strip)	432-880
( )	2	14-pin IC socket	434-298
( )	1	8-pin IC socket	434-230



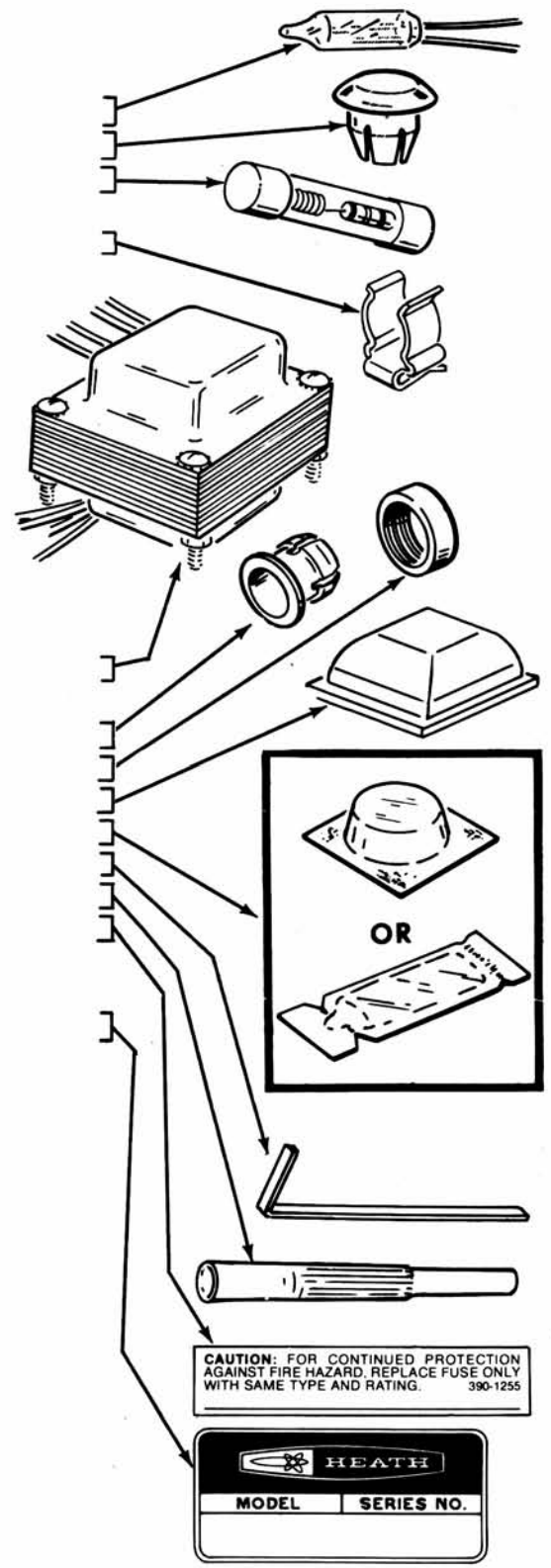


CABINET-HEAT SINKS

( )	1	Cabinet top	92-611
( )	1	Cabinet bottom	92-612
( )	2	Small heat sink	215-99
( )	1	Large heat sink	215-601



	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
LAMP-LENS-FUSE-CLIP				
( )	1	Neon lamp	412-15	PL101
( )	1	Red lens	413-15	
( )	1	3/16-ampere slow-blow fuse	421-31	F101
( )	2	Fuse clip	260-56	
MISCELLANEOUS				
( )	1	Power transformer	54-893	T101
( )	1	Circuit board	85-1599-2	
( )	4	Grommet	260-89	
( )	4	Retainer ring	260-90	
( )	4	Plastic foot	261-34	
( )	1	Silicone grease	352-13	
( )	1	IC puller	490-111	
( )	1	Nut starter	490-5	
( )	1	Fuse label	390-1255	
( )	1	Power label	390-1141	
( )	1	Heathkit label	390-1142	
( )	1	Blue and white label	391-34	
( )	1	Parts Order Form	597-260	
( )	1	Kit Builders Guide	597-308	
( )	1	Assembly Manual (See front cover for part number.)		
		Solder		



STEP-BY-STEP ASSEMBLY

ASSEMBLY NOTES

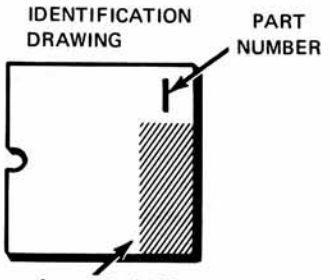
1. Before you start to assemble this kit, read the wiring, soldering, and step-by-step assembly information in the "Kit Builders Guide."

2. There are some small foil areas around some of the circuit board holes, and there are some small areas between foils. Therefore, use the utmost care to prevent solder bridges between adjacent foil areas. Use only a minimum amount of solder and use no larger than a 25-watt soldering iron with a small tip when you solder these small areas. Allow it to reach operating temperature, and then apply it only long enough to make a good solder connection.

3. Resistors will be called out by their resistance value in Ω, kΩ, or MΩ, and color code.

4. Capacitors will be called out by their capacitance value (in pF or μF) and type (disc, mica, or electrolytic).

SAFETY WARNING: Avoid eye injury when you cut off excess lead lengths. Hold the leads so the ends cannot fly toward your eyes.



The steps performed in this Pictorial are in this area of the circuit board.

START

Position the circuit board foil-side-down as shown in the identification drawing at the top of the page. Then complete each step on the Pictorial.

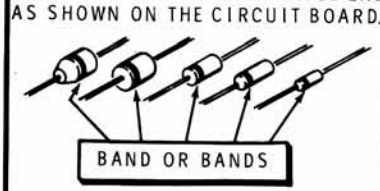
When a wire is called for, cut a yellow wire to the specified length. Then remove 1/4" of insulation from each end. Solder each wire end to the foil as you install it and cut of the excess wire ends.

( ) 1" wire.

( ) 3/4" wire. Remove all the insulation from the wire.

( ) 1-3/4" wire.

NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. ALWAYS POSITION THE BANDED END AS SHOWN ON THE CIRCUIT BOARD.



Install four 1N4002 diodes (#57-65), at:

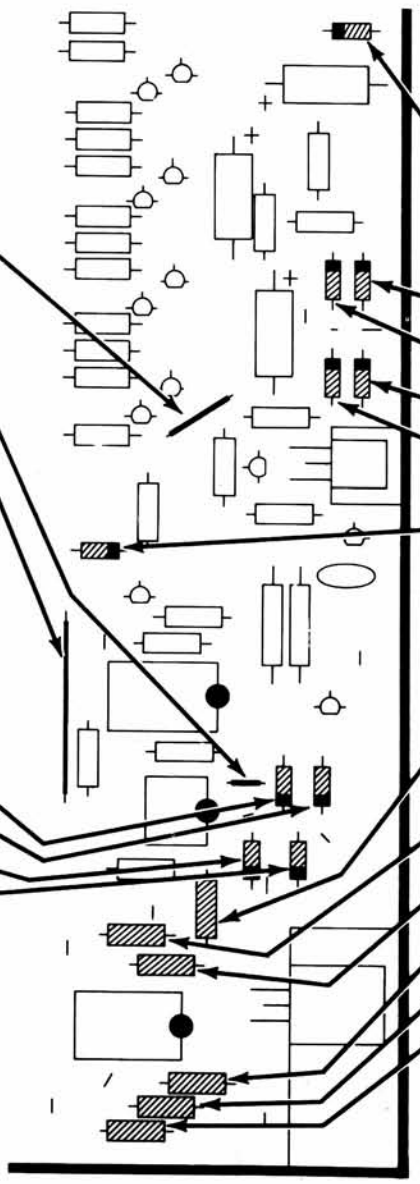
( ) D3. . . . . .

( ) D4. . . . . .

( ) D2. . . . . .

( ) D1. . . . . .

( ) Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE

( ) ZD1: 1N3017 zener diode (#56-97).

Install four 1N4002 diodes (#57-65), at:

( ) D5. . . . . .

( ) D6. . . . . .

( ) D8. . . . . .

( ) D7. . . . . .

( ) D9: 1N4149 diode (#56-56).

( ) Solder the leads to the foil and cut off the excess lead lengths.

( ) R46: 15 kΩ (brown-green-orange).

Install four 1000 Ω (brown-black-red) resistors, at:

( ) R31. . . . . .

( ) R28. . . . . .

( ) R36. . . . . .

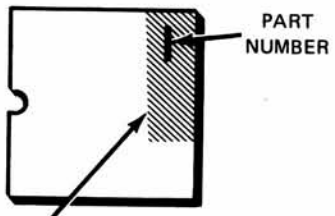
( ) R34. . . . . .

( ) R39: 470 Ω (yellow-violet-brown).

( ) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 1-1

IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.

START

FOR GOOD SOLDER CONNECTIONS, YOU MUST **KEEP THE SOLDERING IRON TIP CLEAN.**

WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.

( ) R22: 4700 Ω (yellow-violet-red).

( ) R21: 100 kΩ (brown-black-yellow).

( ) R23: 150 Ω (brown-green-brown).

( ) R25: 4700 Ω (yellow-violet-red).

( ) R24: 100 kΩ (brown-black-yellow).

( ) R26: 150 Ω (brown-green-brown).

( ) Solder the leads to the foil and cut off the excess lead lengths.

( ) R29: 4700 Ω (yellow-violet-red).

( ) R27: 100 kΩ (brown-black-yellow).

( ) R32: 150 Ω (brown-green-brown).

( ) R35: 4700 Ω (yellow-violet-red).

( ) R33: 100 kΩ (brown-black-yellow).

( ) R37: 150 Ω (brown-green-brown).

( ) R41: 10 kΩ (brown-black-orange).

( ) R42: 10 kΩ (brown-black-orange).

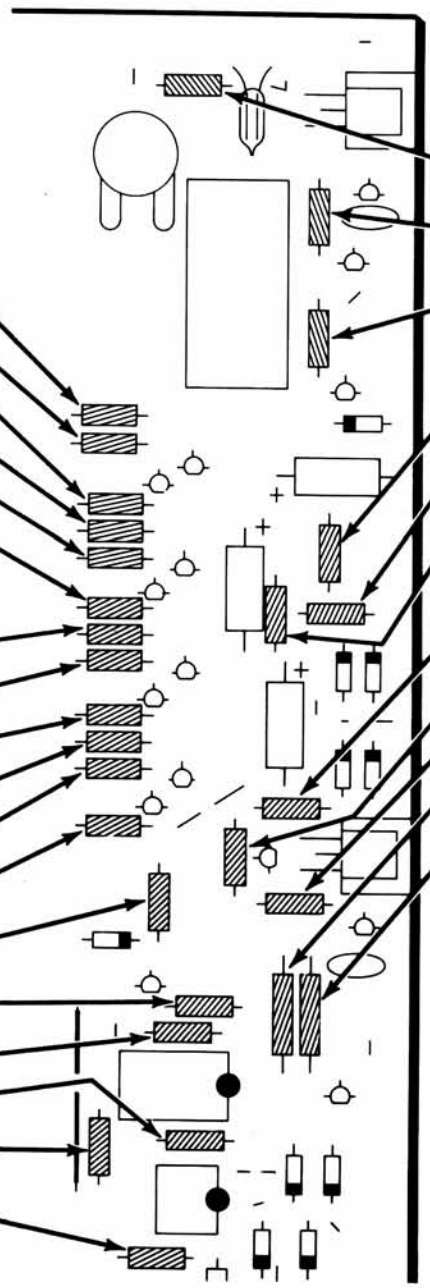
( ) R43: 4700 Ω (yellow-violet-red).

( ) R45: 1000 Ω (brown-black-red).

( ) R44: 1000 Ω (brown-black-red).

( ) R47: 68 kΩ (blue-gray-orange).

( ) Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE

( ) R101: 27 kΩ (red-violet-orange).

( ) R4: 4.7 Ω (yellow-violet-gold).

( ) R5: 220 Ω (red-red-brown).

( ) R3: 1000 Ω (brown-black-red).

( ) R2: 510 Ω (green-brown-brown).

( ) R7: 2700 Ω (red-violet-red).

( ) Solder the leads to the foil and cut off the excess lead lengths.

( ) R12: 510 Ω (green-brown-brown).

( ) R14: 4.7 Ω (yellow-violet-gold).

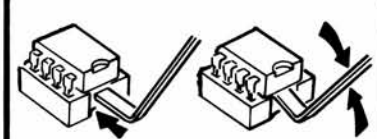
( ) R13: 1000 Ω (brown-black-red).

( ) R18: 2250 Ω, precision.

( ) R17: 2000 Ω (2k), precision.

( ) Solder the leads to the foil and cut off the excess lead lengths.

NOTE: On Pictorial 1-3 you will install the integrated circuits (IC's). If you ever have to remove an IC, use the IC puller supplied with your kit as shown below. Insert the foot beneath the IC; then gently rock the tool back and forth to lift the IC.

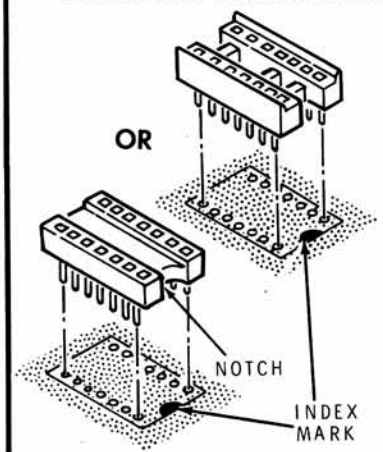


PICTORIAL 1-2

START

In each of the next three steps, install the IC socket as follows:

Insert the socket pins into the holes. The index mark on the circuit board should still be visible after it is installed. Solder the pins to the foil.



( ) 14-pin IC socket at IC2.

( ) 8-pin IC socket at IC3.

( ) 14-pin IC socket at IC4.

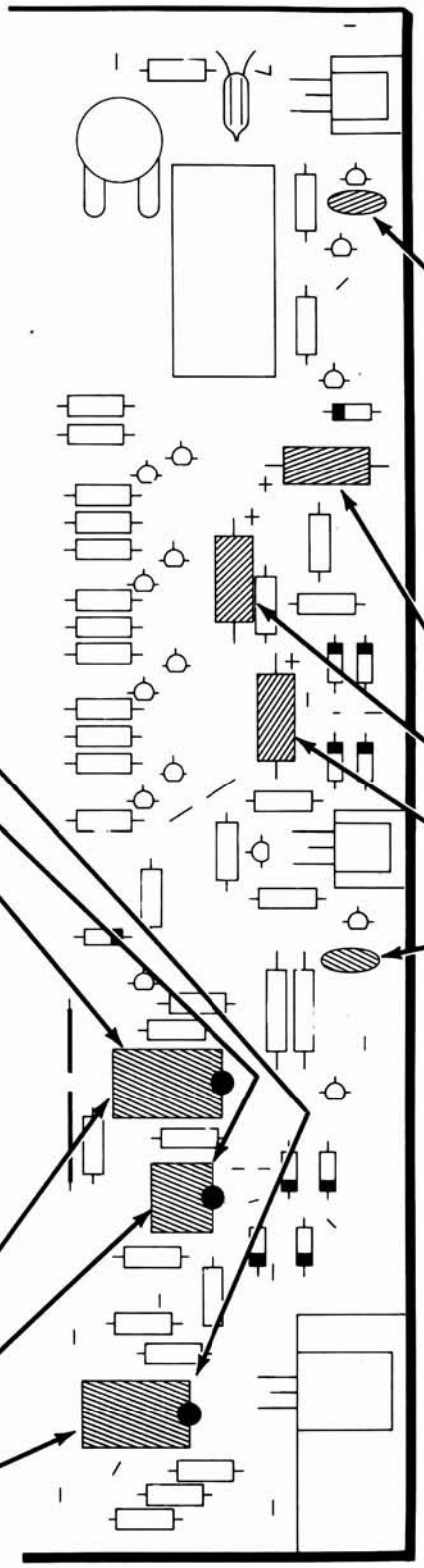
In the following steps, install the integrated circuits (IC's) as follows:

1. Refer to Detail 1-3A (at bottom of right-hand column) and identify the pin 1 end of the IC.
2. Be sure the IC pins are straight.
3. Position the pin 1 end of the IC over the half-moon mark on the circuit board.
4. Carefully install the IC. Make sure all the pins go in their respective holes.

( ) IC4: SN7403N integrated circuit (#443-54).

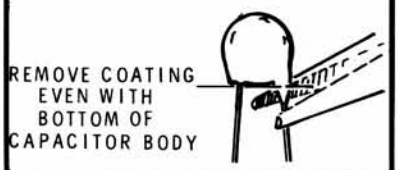
( ) IC3: NE555V integrated circuit (#442-53).

( ) IC2: SN7403N integrated circuit (#443-54).



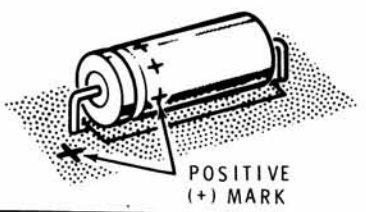
CONTINUE

NOTE: When you install disc capacitors, remove any excess coating from the leads. Use long-nose pliers to remove the coating.



( ) C4: .001 µF disc.

NOTE: When you install electrolytic capacitors, match the positive (+) marked end with the positive (+) mark on the circuit board.



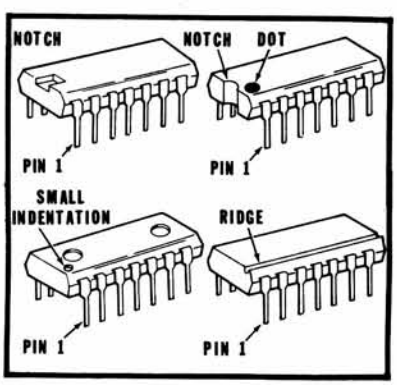
( ) C5: 10 µF electrolytic.

( ) C3: 10 µF electrolytic.

( ) C8: 10 µF electrolytic.

( ) C7: .001 µF disc.

( ) Solder the leads to the foil and cut off the excess lead lengths.



Detail 1-3A

PICTORIAL 1-3

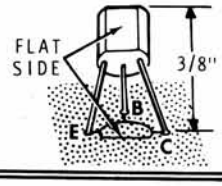
HEATHKIT

START

( ) R6: 2000 Ω (2K) control. Solder the four lugs to the foil.

NOTE: When you install transistors, be sure the top of each transistor is no more than 3/8" above the circuit board.

Insert the transistor leads into the corresponding E, B, and C holes in the circuit board as shown. Solder each lead to the foil and cut off the excess lead lengths.



Install twelve MPSA20 transistors (#417-801), at:

( ) Q1. . . . . .

( ) Q4. . . . . .

( ) Q3. . . . . .

( ) Q9. . . . . .

( ) Q10. . . . . .

( ) Q11. . . . . .

( ) Q12. . . . . .

( ) Q13. . . . . .

( ) Q14. . . . . .

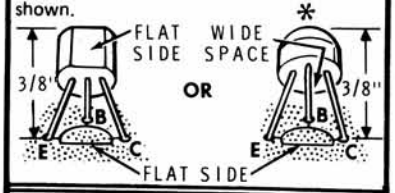
( ) Q15. . . . . .

( ) Q16. . . . . .

( ) Q17. . . . . .

NOTE: Install the next three transistors as shown.

*Notice that the transistor marked with an asterisk must be installed with its wide space opposite to the flat marked on the circuit board and its leads installed as shown.



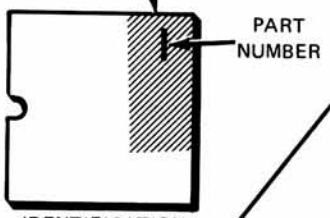
Install three 2N4121 transistors (#417-235), at:

( ) Q8. . . . . .

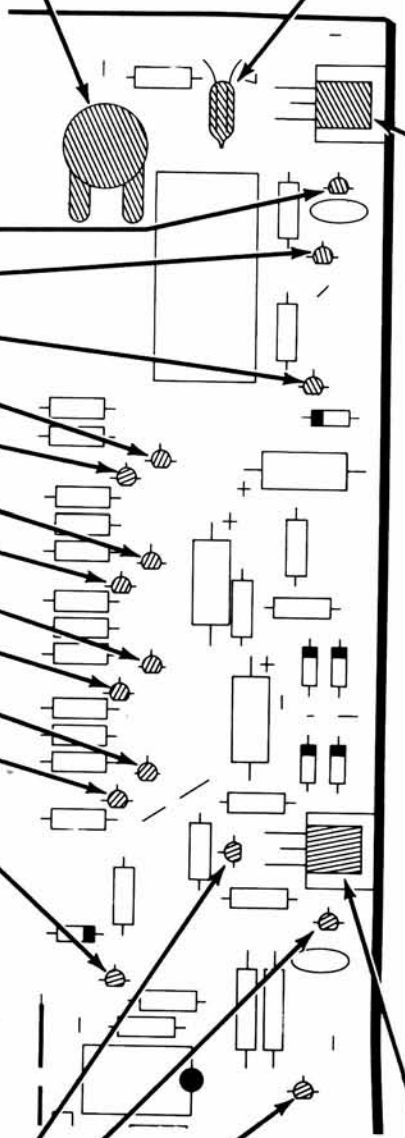
( ) Q5. . . . . .

( ) Q7. . . . . .

The steps performed in this Pictorial are in this area of the circuit board.



IDENTIFICATION DRAWING

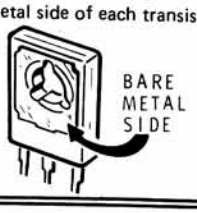


PICTORIAL 1-4

CONTINUE

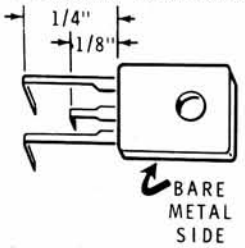
( ) PL101: Neon lamp. Lay the lamp down on the circuit board, solder the leads to the foil, and cut off the excess lead lengths.

( ) Locate the MJE181 transistor (#417-818) and the MJE171 transistor (#417-819). Then open the container of silicone grease and put a liberal amount of grease on the bare metal side of each transistor.



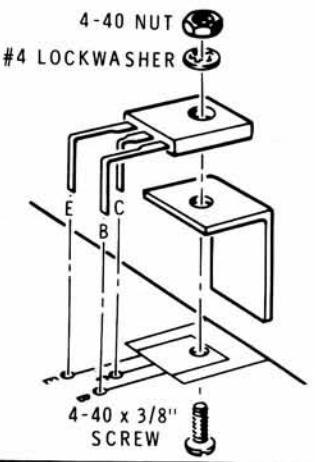
( ) Q2: MJE181 transistor (#417-818) as follows:

1. Position the bare metal side of the transistor down and bend the transistor leads as shown.



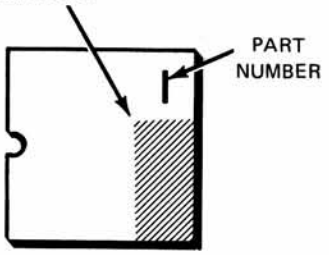
2. Install the E, C, and B leads into the corresponding holes in the circuit board and secure the transistor to the board with a heat sink, #4-40 x 3/8" screw, #4 lockwasher, and 4-40 nut. Use the plastic nut starter to hold and start the nuts on the screws. Do not overtighten the screws.

3. Solder the leads to the foil and cut off the excess lead lengths.

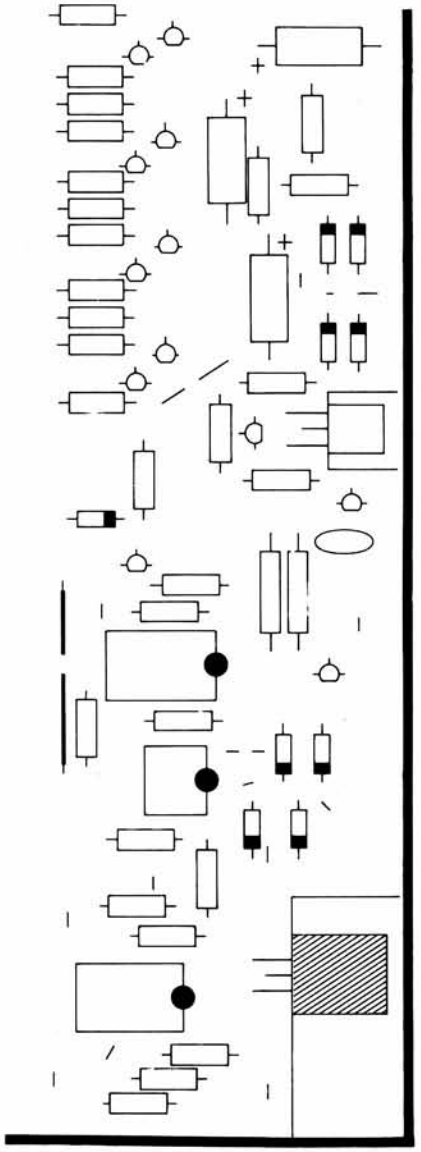


( ) Q6: MJE171 transistor (#417-819). Install this transistor as you did the previous one.

The steps performed in this Pictorial are in this area of the circuit board.

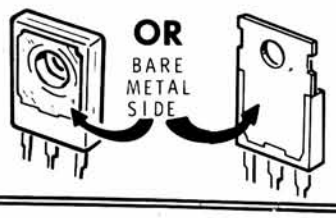


IDENTIFICATION DRAWING



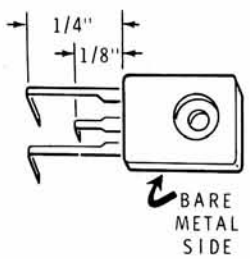
START

( ) Locate the μA7805 integrated circuit (#442-54). Then apply a liberal amount of silicone grease to the bare metal side.



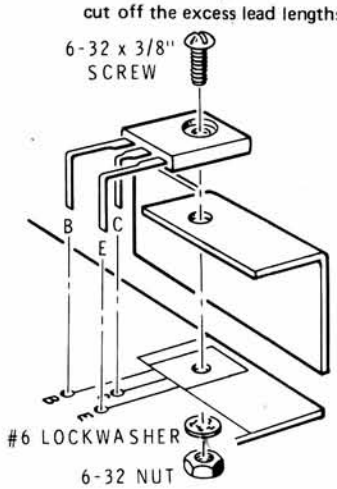
( ) IC1: Install the prepared integrated circuit as follows. Your integrated circuit may look different than the one shown.

1. Position the bare metal side of the integrated circuit down and bend the leads as shown.

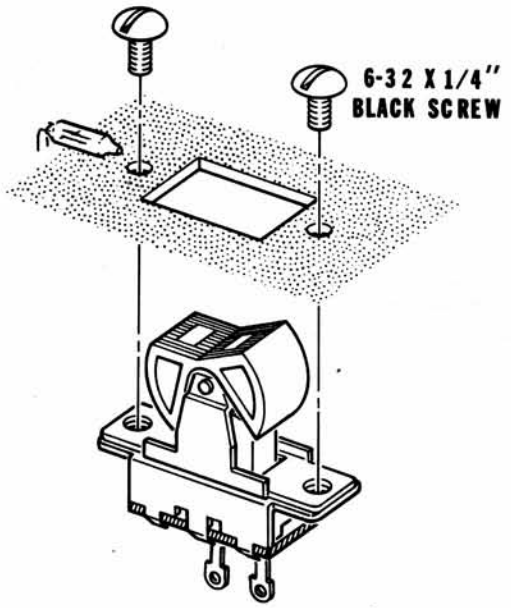


2. Install the B, C, and E leads into the corresponding holes in the circuit board and secure the integrated circuit to the board with a 6-32 x 3/8" screw, a large heat sink, a #6 lockwasher, and a 6-32 nut.

3. Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 1-5



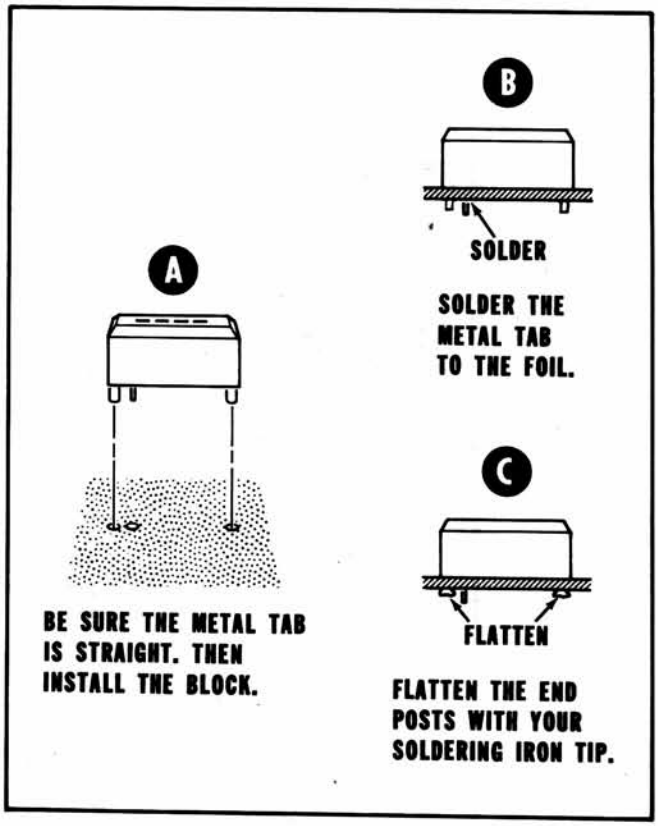
Detail 2-1A

A separate "Illustration Booklet" contains illustrations (Pictorials, Details, etc.) that are too large for the Assembly Manual. The Step-by-Step Assembly instructions will direct you to the proper illustration in the Booklet. The illustrations are arranged in Pictorial number sequence. Place the Booklet in a convenient location and keep it with the Assembly Manual.

Refer to Pictorial 2-1 (in the Illustration Booklet) for the following steps.

( ) Reposition the board as shown.

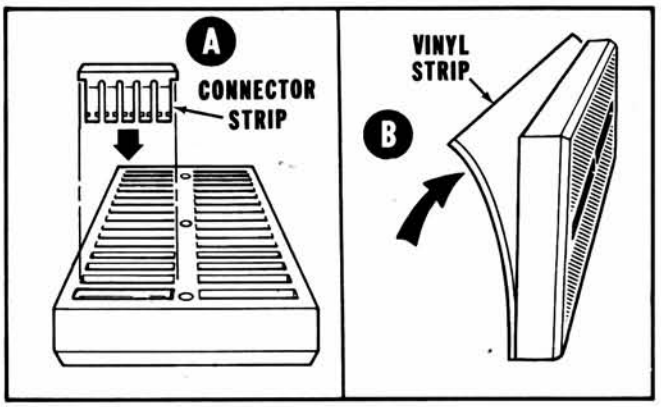
( ) SW101: Refer to Detail 2-1A and mount the SPST rocker switch at SW101 with two 6-32 x 1/4" black screws. Be sure the switch lugs are positioned as shown.



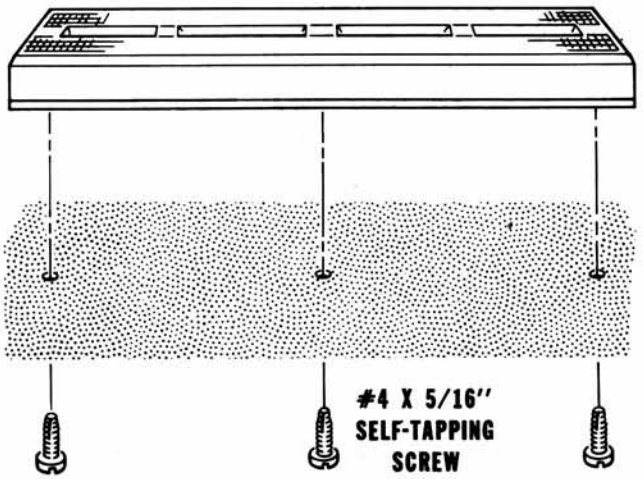
Detail 2-1B

NOTE: In some of the following steps, you will solder to large areas of foil. These connections will require more heat. Hold the soldering iron against the connection until the solder flows smoothly onto the foil.

( ) Refer to Detail 2-1B and install connector blocks at the twenty-one indicated locations.



Detail 2-1C

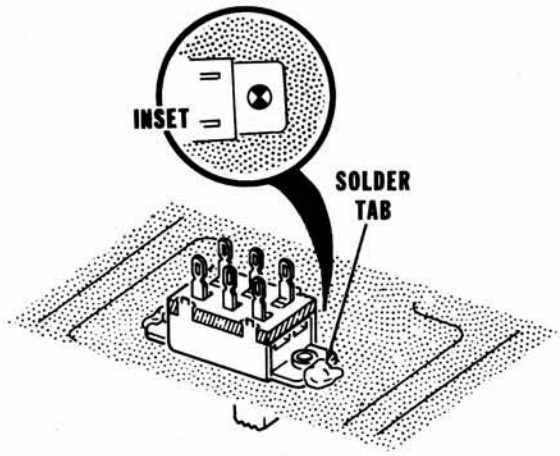


Detail 2-1D

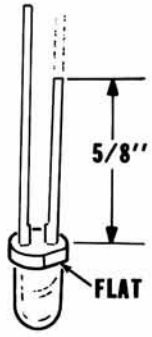
( ) Refer to Part A of Detail 2-1C and install the connector strips, supplied with the breadboarding socket, into the socket. You may have some connector strips left over.

( ) Refer to Part B of Detail 2-1C and remove the paper backing from the vinyl strip supplied with the breadboarding socket. Then line up the long edges of the vinyl strip and socket as shown, and press the sticky side of the vinyl strip against the socket.

( ) Refer to Detail 2-1D, cut three holes through the vinyl strip, and mount the breadboarding socket with three #4 x 5/16" self-tapping screws as shown.



Detail 2-2A



Detail 2-2B

Refer to Pictorial 2-2 (in the Illustration Booklet) for the following steps.

( ) Turn the circuit board foil-side-up and position it as shown in the Pictorial.

( ) SW1: Refer to Detail 2-2A. Then center the foil patterns under the switch tab holes (see the inset drawing) and solder one tab of a DPDT slide switch to the foil at SW1. Use only a small amount of solder at only one spot. Then operate the switch to be sure that it works freely and that the switch knob does not rub against the circuit board. Then finish soldering both switch tabs.

In a similar manner, install DPDT slide switches at:

( ) SW2.

( ) SW3.

( ) SW4.

As before, install SPDT slide switches at:

( ) SW5. Position the switch so the knob is as shown in Pictorial 2-2.

( ) SW6. Position the switch so the knob is as shown.

( ) SW7. As before, install the DPTT slide switch.

( ) Locate the four LED's. Then refer to Detail 2-2B and cut the lead near the flat of each LED to 5/8".

( ) L4. Refer to Detail 2-2C and install an LED as follows:

1. Push the plastic grommet into the hole, from the top side of the circuit board, as far as it will go.

2. Push the LED all the way down into the grommet. Position the shorter lead as shown in Pictorial 2-2.

3. Place the retainer ring over the LED and press the ring down around the grommet as far as it will go.

In a similar manner, install LED's at:

( ) L3.

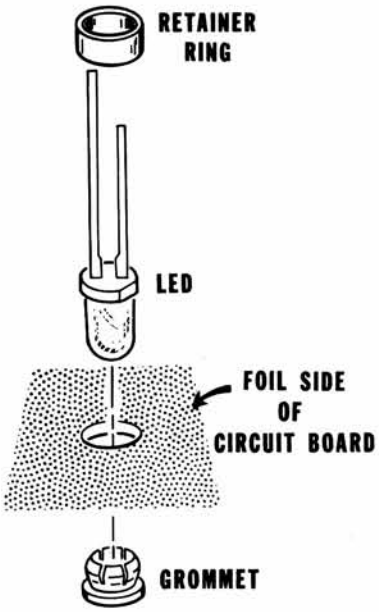
( ) L2.

( ) L1.

NOTES:

1. When you solder a lead or wire to the foil in the following steps, lay the lead end flat on the foil and solder it to the foil. If the lead tries to spring up off the foil, hold it down with the blade of a screwdriver until the solder cools.

2. In the following steps, (NS) means not to solder because other wires will be added later. "S-" with a number, such as (S-3), means to solder the connection. The number following the "S" tells how many wires are at the connection.



Detail 2-2C

Solder the leads of the LED's to the foil as follows:

L4

( ) Shorter lead to foil T (S-1).

( ) Other lead to foil U (S-1).

L3

( ) Shorter lead to foil V (S-1).

( ) Other lead to foil W (S-1).

L2

( ) Shorter lead to foil X (S-1).

( ) Other lead to foil Y (S-1).

L1

( ) Shorter lead to foil Z (S-1).

( ) Other lead to foil AA (S-1).

( ) Cut four 2" yellow wires. Then remove 1/4" of insulation from one end of each wire and 1/2" of insulation from the other end.

( ) Insert the longer bare end of a 2" yellow wire through switch SW4 lugs 2 and 5, and solder the connections. Then solder the free end of the wire to foil K.

Similarly install the other three 2" yellow wires as follows:

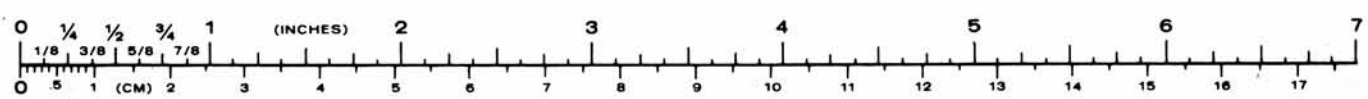
( ) 2" yellow wire between switch SW3 lugs 2 and 5, and foil L. Solder the connections.

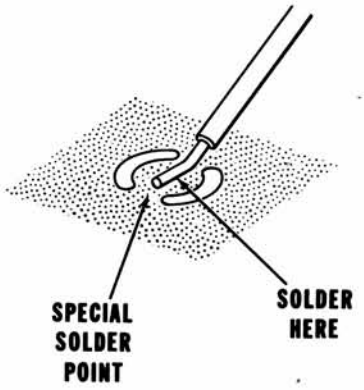
( ) 2" yellow wire between switch SW2 lugs 2 and 5, and foil M. Solder the connections.

( ) 2" yellow wire between switch SW1 lugs 2 and 5, and foil N. Solder the connections.

NOTE: When a bare wire is called for, first remove the indicated length of insulation from the yellow wire. Then cut off and use the bare wire.

( ) Prepare a 3-3/4" bare wire.





Detail 2-2D

NOTE: On some large areas of the foil, special solder points have been prepared to make soldering easier. Portions of foil have been etched away so solder connections will not require as much heat. When you are instructed to, use these special solder points as shown in Detail 2-2D.

( ) Insert the bare wire through switches SW4, SW3, SW2, and SW1 – lugs 4 and 1 of each switch. Then solder the wire to the switch lugs and solder the free end to special solder point J as shown.

( ) Prepare a 4-1/4" yellow wire. Then remove an additional 2-3/4" of insulation from one end.

( ) Insert the long bare wire end through switches SW4, SW3, SW2, and SW1 – lugs 6 and 3 of each switch. Then solder the wire to the switch lugs and solder the free end to foil E.

( ) Prepare the following yellow wires:

QUANTITY	LENGTH
2	1-3/4"
1	2"
2	2-1/2"
1	2-3/4"
1	3-1/4"

( ) Remove an additional 3/8" of insulation from one end of a 2-1/2" yellow wire. Then insert this wire end through switch SW7 lugs 7 and 3, to lug 2. Solder the wire to the switch lugs and solder the free wire end to foil H.

NOTE: In the following step, be sure you position the positive (+) lead as indicated.

( ) C9: Cut both leads of the 10 μF tantalum capacitor to 1/2". Connect the positive (+) marked lead to foil S (S-1) and connect the other lead to switch SW7 lug 1 (S-1).

( ) C10: Cut one lead of the .01 μF Mylar capacitor to 1/2" and cut the other lead to 3/4". Then cut a 1/2" length of sleeving and slide it onto the 3/4" lead. Connect this lead to switch SW7 lug 6 (S-1) and connect the other lead to foil R (S-1).

( ) C11: Cut both leads of the 62 pF mica capacitor to 1/2". Connect one lead to switch SW7 lug 4 (S-1) and connect the other lead to foil P (S-1).

NOTE: In some of the following steps, you will install wires in circuit board holes. Leave the wire insulation 1/8" from the circuit board so you can solder the connection. Then lightly tug on the wire to be sure it is properly soldered. See the inset drawing on the Pictorial.

Connect the following prepared yellow wires to switch SW5.

( ) 2-1/2" wire from lug 3 (S-1) to hole D (S-1).

( ) 1-3/4" wire from lug 2 (S-1) to foil G (S-1).

( ) 3-1/4" wire from lug 1 (S-1) to hole B (S-1).

Connect the following prepared yellow wires to switch SW6.

( ) 2" wire from lug 3 (S-1) to hole C (S-1).

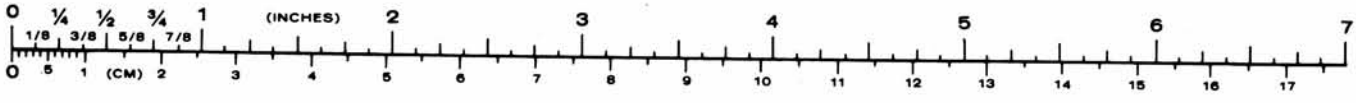
( ) 1-3/4" wire from lug 2 (S-1) to foil F (S-1).

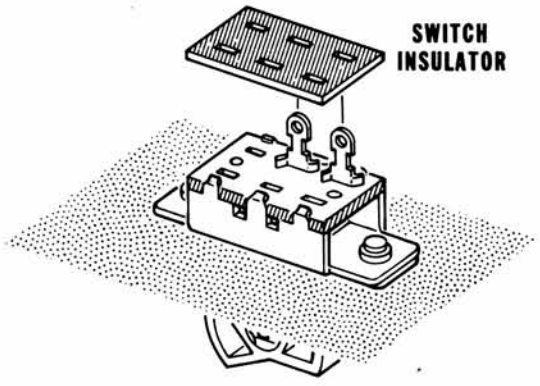
( ) 2-3/4" wire from lug 1 (S-1) to hole A (S-1).

( ) Refer to Detail 2-2E and position the switch insulator down over the lugs of switch SW101.

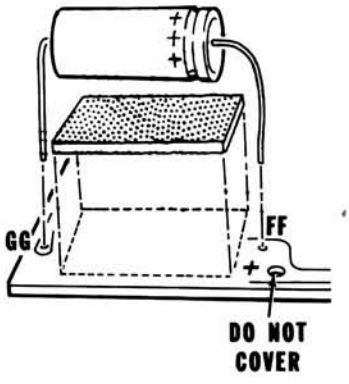
Prepare the following lengths of red stranded wire.

QUANTITY	LENGTH
1	2"
2	8"
1	9"





Detail 2-2E



Detail 2-2F

( ) Connect one end of the 2" red wire to hole HH (S-1). (This hole is labeled on the top side of the circuit board.) Connect the other end of the wire to switch SW101 lug 1 (NS). Wrap the lead securely around the lug.

( ) Connect an 8" red wire to switch SW101 lug 1 (S-2). Wrap the lead securely around the lug. The free end will be connected later.

( ) Connect the other 8" red wire to switch SW101 lug 2 (S-1). Wrap the lead securely around the lug. The free end will be connected later.

( ) Connect the 9" red wire to hole JJ (S-1). (This hole is labeled on the top side of the circuit board.) The free end will be connected later.

( ) Cut three 1-1/2" lengths of foam tape.

NOTE: As you install foam tape in the following steps, first check the circuit board foils to be sure there are no solder bridges. Then press the tape into place.

( ) Refer to Detail 2-2F. Then remove the paper backing from one side of one length of foam tape, and apply the tape between holes GG and FF as shown.

( ) In a similar manner, apply another length of tape between holes EE and DD. Center it between the holes.

( ) In a similar manner, apply another length of tape between holes CC and BB. Center it between the holes.

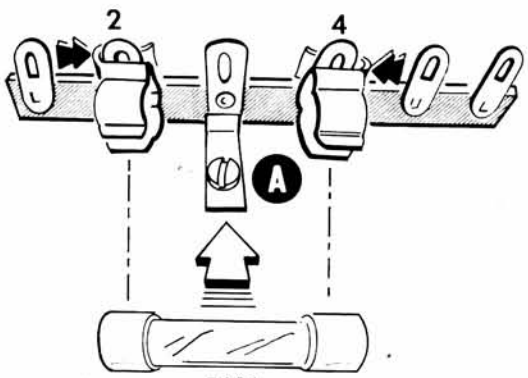
( ) Locate the two 1200 μF electrolytic capacitors and the 2000 μF electrolytic capacitor, and cut each lead to 1".

( ) C1: Refer to Detail 2-2F, remove the protective paper backing from the foam tape, and install the prepared 1200 μF electrolytic capacitor at holes GG (S-1) and FF (S-1) as shown. Be sure to install the lead at the plus (+) marked end of the capacitor in hole FF. Cut off the excess lead lengths on the component side of the circuit board.

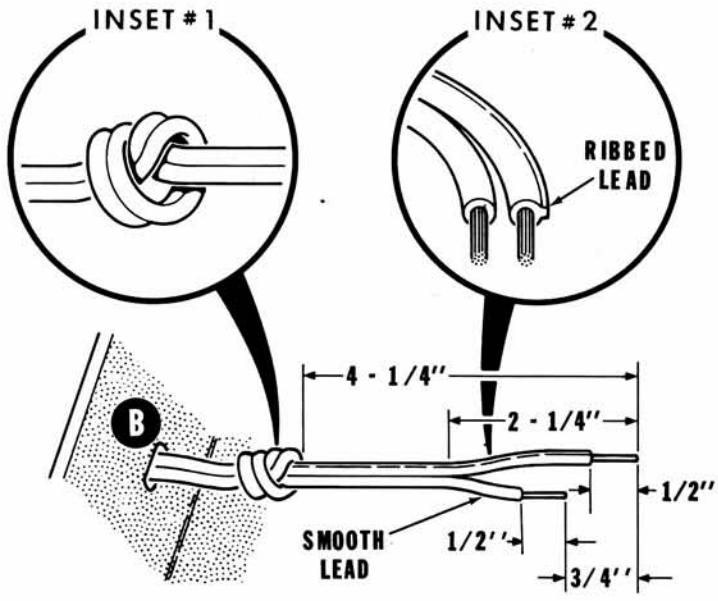
( ) C6: In a similar manner, install another 1200 μF electrolytic capacitor at holes DD (S-1) and EE (S-1). Be sure to install the lead at the plus (+) marked end of the capacitor in hole EE.

( ) C2: In a similar manner, install the 2000 μF electrolytic capacitor at holes BB (S-1) and CC (S-1). Be sure to install the lead at the plus (+) marked end of the capacitor in hole CC.

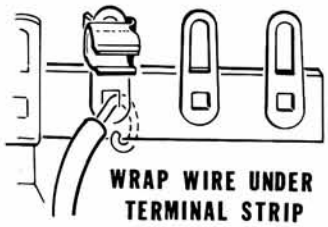
( ) Set the circuit board aside temporarily.



Detail 3-1A



Detail 3-1B



Detail 3-1C

Refer to Pictorial 3-1 (in the Illustration Booklet) for the following steps.

( ) Temporarily mount a 6-lug terminal strip on cabinet post A with a #6 x 3/8" self-tapping screw as shown.

( ) F101: Refer to Detail 3-1A and install two fuse clips and the 3/16-ampere slow-blow fuse at terminal strip A lugs 2 and 4. Then solder the two clips to their lugs. Do not use excessive heat; you may damage the fuse.

( ) Refer to inset drawing #1 on Detail 3-1B, insert the end of the line cord through hole B (from the outside of the cabinet bottom), and tie a knot in the line cord 4-1/4" from the end as shown.

( ) Refer to inset drawing #2 on Detail 3-1B and identify the smooth lead and the ribbed lead of the line cord. Then prepare the end of the line cord as shown.

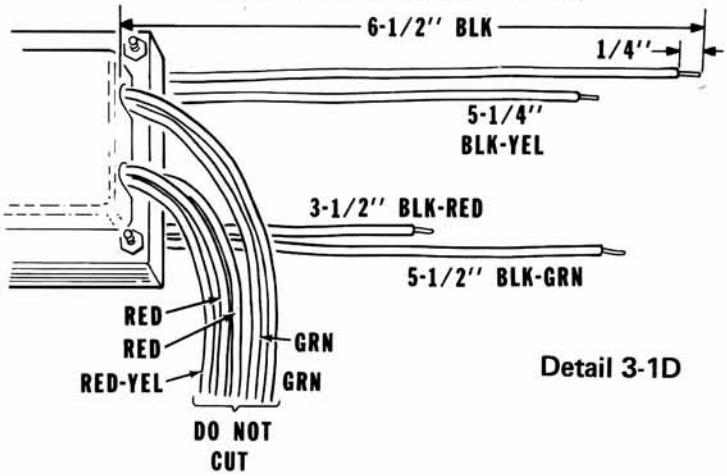
( ) Tightly twist the bare wire ends and apply a small amount of solder to hold the small strands together.

Connect the line cord leads to terminal strip A as follows. Be sure to make a mechanically secure connection; wrap the lead ends securely under the terminal strip as shown in Detail 3-1C.

( ) Smooth lead to the eyelet below lug 4 (S-1).

( ) Ribbed lead to the eyelet below lug 6 (S-1).

( ) Refer to Detail 3-1D and prepare the transformer leads as shown. Measure the leads from where they come out of the transformer. Twist the bare ends and apply a small amount of solder to them, if necessary.



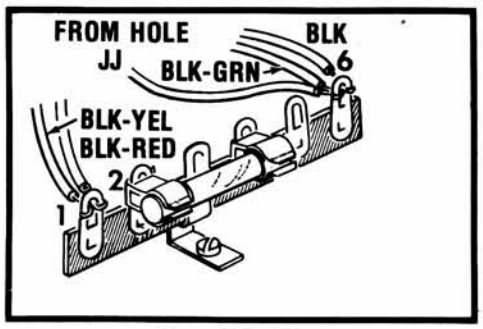
Detail 3-1D

( ) T101: Refer to Pictorial 3-1 and install the power transformer (with the red and green leads up) as shown. Use two #6 x 1-1/8" self-tapping screws.

ALTERNATE LINE VOLTAGE WIRING

Two sets of line voltage wiring instructions are given below, one for 120 VAC and the other for 240 VAC. In the United States 120 VAC is most common. USE ONLY THE INSTRUCTIONS THAT AGREE WITH THE LINE VOLTAGE IN YOUR AREA.

FOR 120 VAC



Detail 3-1E

Refer to Detail 3-1E for the following steps. In these steps, make connections to terminal strip BA. Wrap the lead ends tightly at the connections. Connect four of the power transformer leads as follows:

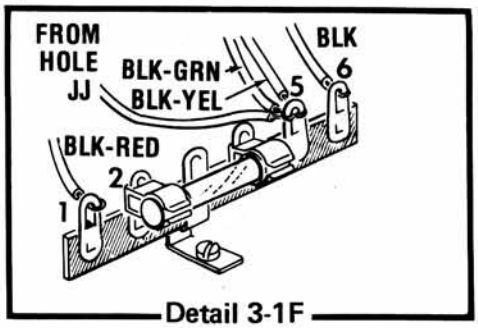
( ) Black-red and black-yellow leads to lug 1 (NS).

( ) Black-green and black leads to lug 6 (NS).

( ) Connect the wire coming from hole JJ to lug 6 (S-3).

Proceed to "Final Wiring."

FOR 240 VAC



Detail 3-1F

Refer to Detail 3-1F for the following steps. In these steps, make connections to terminal strip BA. Wrap the lead ends tightly at the connection. Connect four of the power transformer leads as follows:

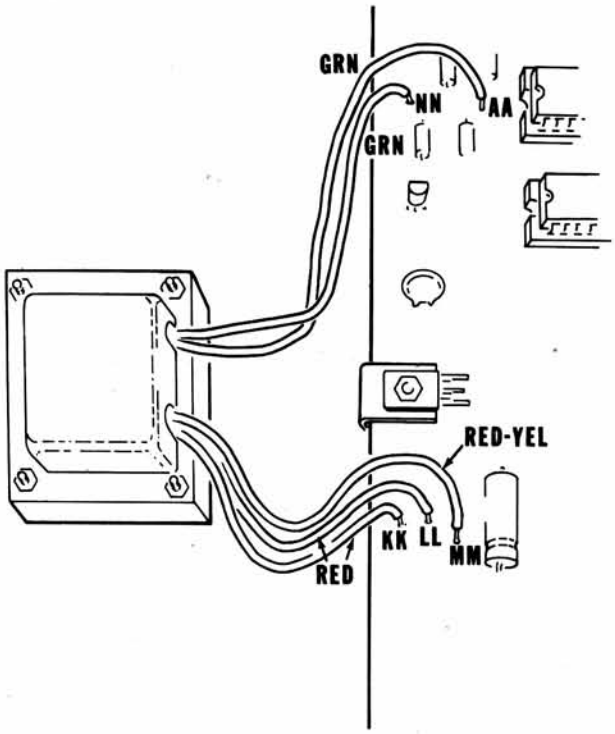
( ) Black-red lead to lug 1 (NS).

( ) Black-yellow and black-green leads to lug 5 (NS).

( ) Black lead to lug 6 (S-1).

( ) Connect the wire coming from hole JJ to lug 5 (S-3).

Proceed to "Final Wiring."



Detail 3-1G

FINAL WIRING

Refer to Detail 3-1G and connect the remaining transformer leads to the component side of the circuit board as follows:

( ) Either red lead to hole KK (S-1).

( ) Other red lead to hole LL (S-1).

( ) Red-yellow lead to hole MM (S-1).

( ) Either green lead to hole AA (S-1).

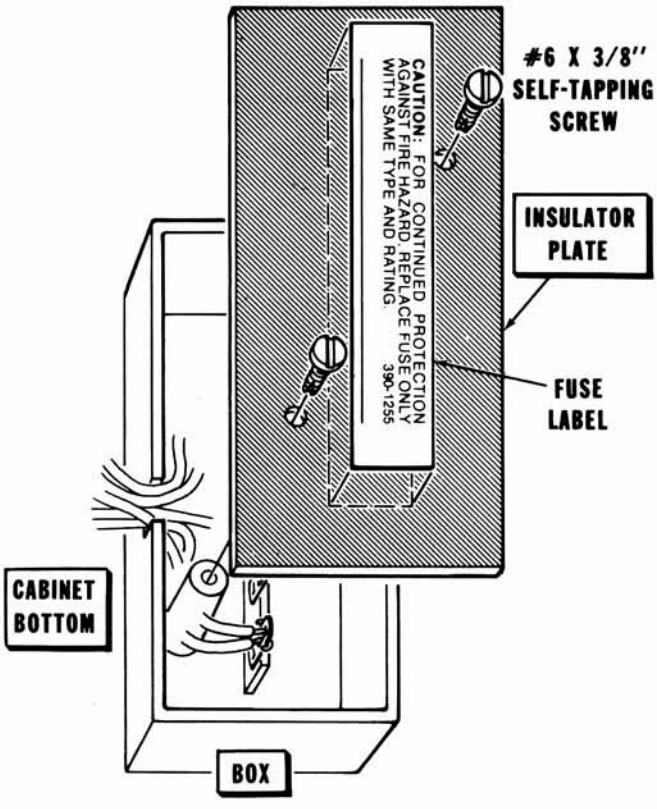
( ) Other green lead to hole NN (S-1).

( ) Turn the circuit board over.

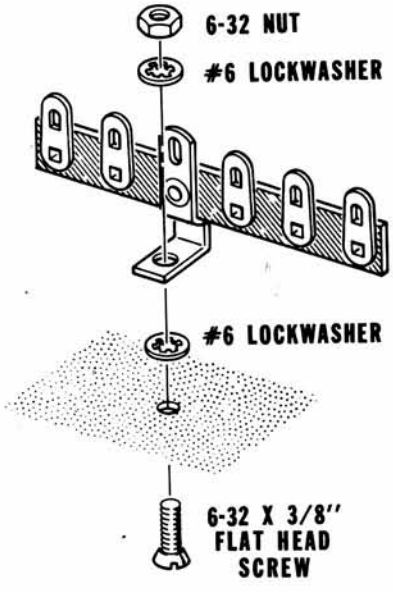
In the following steps, refer to the Pictorial and connect the free ends of the remaining red wires to terminal strip A as follows. Wrap the lead ends tightly around the lugs to form mechanically secure connections.

( ) Connect the wire coming from switch SW101 lug 2 to the eyelet below lug 2 (S-1). Route the wire as shown.

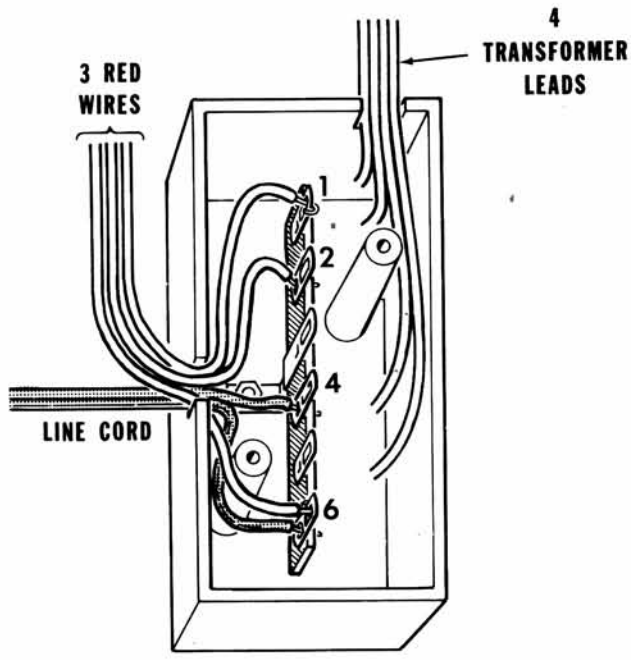
( ) Connect the wire coming from switch SW101 lug 1 to lug 1 (S-3). [This is (S-2) if you wired your kit to operate on 240 volts.]



PICTORIAL 3-2



Detail 3-2A



Detail 3-2B

Refer to Pictorial 3-2 for the following steps.

( ) Remove the fuse. Then remove and save the screw you used to secure terminal strip A to the cabinet.

( ) Refer to Detail 3-2A and mount the terminal strip in the box formed in the cabinet bottom as shown. Use a 6-32 x 3/8" flat head screw, two #6 lockwashers, and a 6-32 nut. Then reinstall the fuse.

( ) Refer to Detail 3-2B and route the leads and wires as shown.

( ) Mount the insulator plate to the terminal strip box with two #6 x 3/8" self-tapping screws. Do not pinch any wires between the plate and box.

( ) Remove the paper backing from the fuse label and press the label onto the insulator plate. Then write the fuse information on the label (3/16-A, slow blow).

This completes the "Step-by-Step Assembly" section. Check the unit over carefully at this time to be sure there are no poor solder connections, solder bridges, loose wire ends, solder splashes, etc. Then proceed to "Test and Adjustment."

TEST AND ADJUSTMENTS

The purpose of this section of the Manual is to make sure your kit operates properly.

Refer to Pictorial 4-1 (in the Illustration Booklet) for the following steps.

( ) Position the circuit board and cabinet bottom as shown.

( ) Place an insulator (piece of cardboard, etc.) under switch SW101 so the switch lugs cannot touch your work surface.

CAUTION: In the following steps, do not touch the area marked high-voltage area. High voltage is present here when the line cord is plugged in.

NOTE: If you do not get the proper results in the following steps, unplug the line cord and proceed to "In Case of Difficulty" on Page 39.

( ) Plug in the line cord plug. Lamp PL101 should be lit. (If lamp PL101 does not light, push switch SW101 to the other position.)

Use a voltmeter to perform the following steps.

( ) Adjust your voltmeter to measure 15 volts DC. Then connect the common lead to the GND small connector block and the probe meter lead to the +12 small connector block. Use short lengths of #22 wire or cutoff component leads to go into the blocks. See inset drawing #1.

( ) Adjust VOLTAGE ADJUST control R6 until the voltmeter indicates 12 volts.

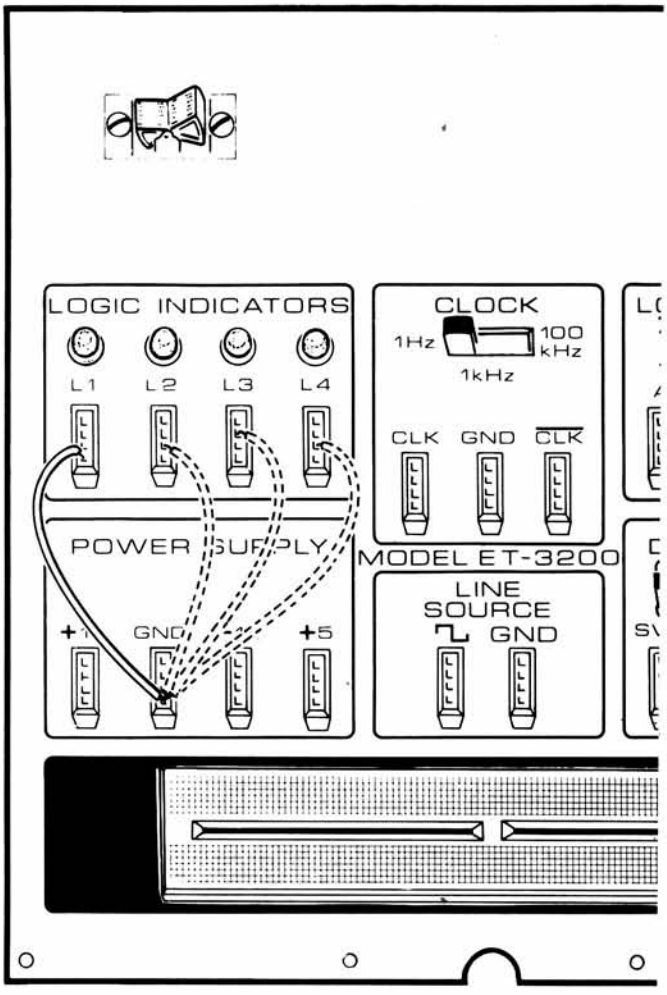
( ) Connect the probe lead to the +5 small connector block. The meter should indicate 5 volts.

( ) Disconnect the voltmeter leads.

( ) Connect the common voltmeter lead to the −12 small connector block.

( ) Connect the other voltmeter lead to the GND small connector block. The meter should indicate 12 volts.

( ) Disconnect the voltmeter leads and set the meter aside.



Detail 4-1A

NOTE: The LOGIC indicators (L1 through L4) should all be off.

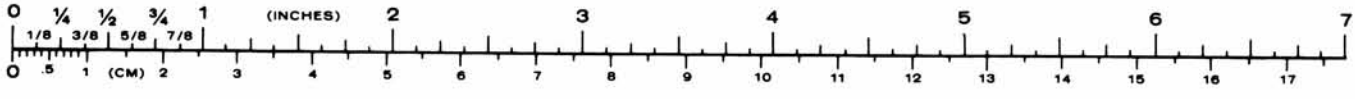
( ) Prepare two 10" black wires.

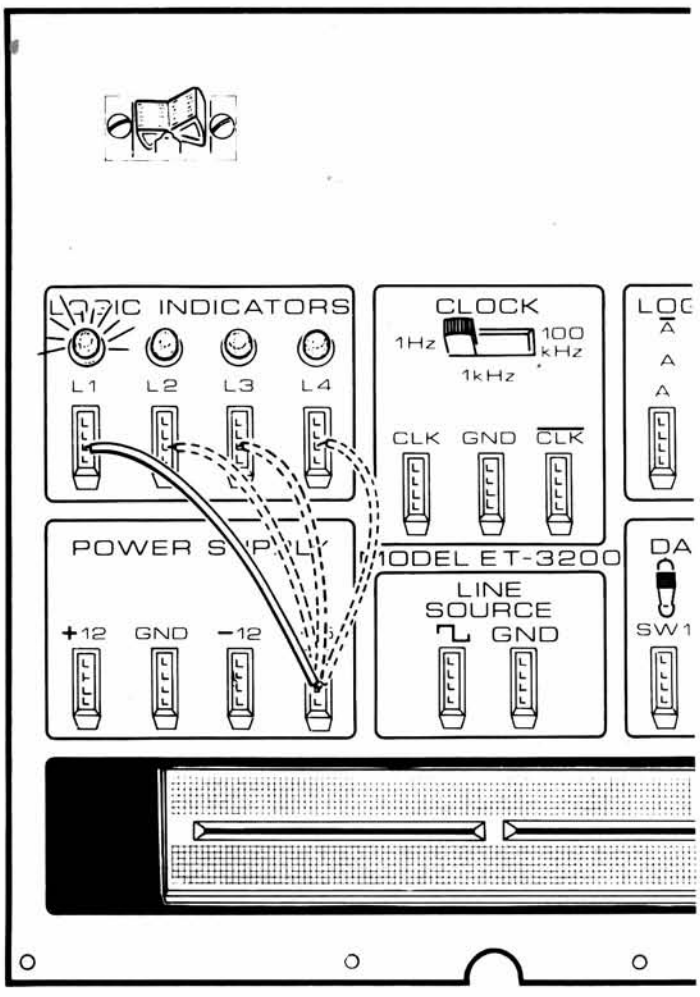
NOTE: In the following steps, connect the prepared wires to the indicated small connector blocks.

( ) Refer to Detail 4-1A and connect a black wire from GND to L1. Indicator L1 should remain off.

( ) Leave the one wire end connected to GND. Then momentarily connect the other end of the wire to L2, then L3, and then L4. These indicators should remain off.

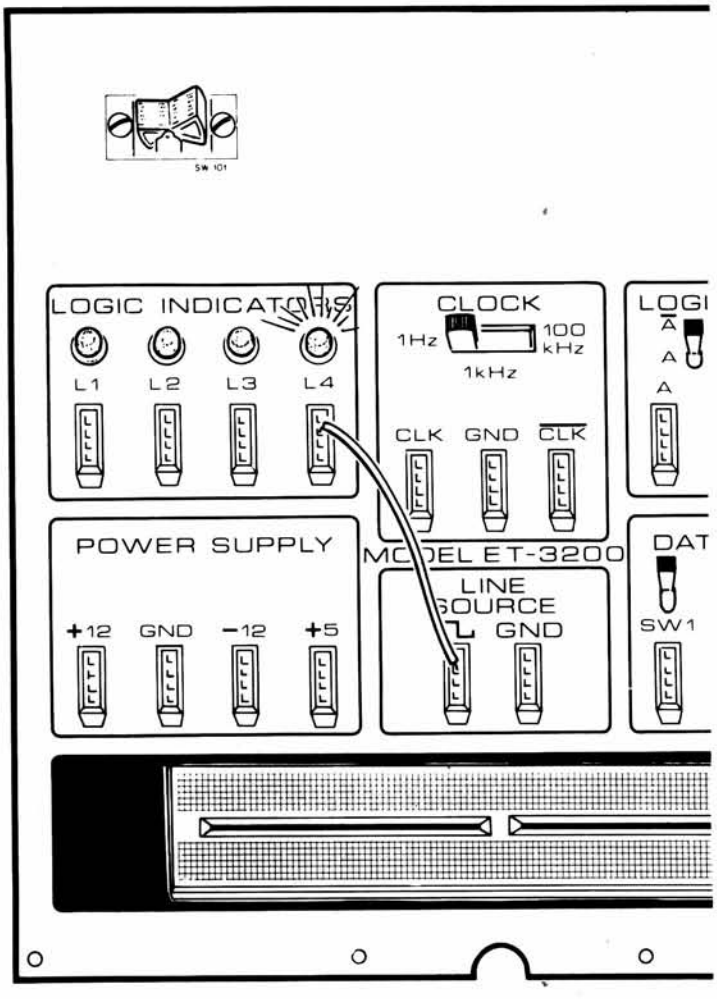
( ) Disconnect the wire.





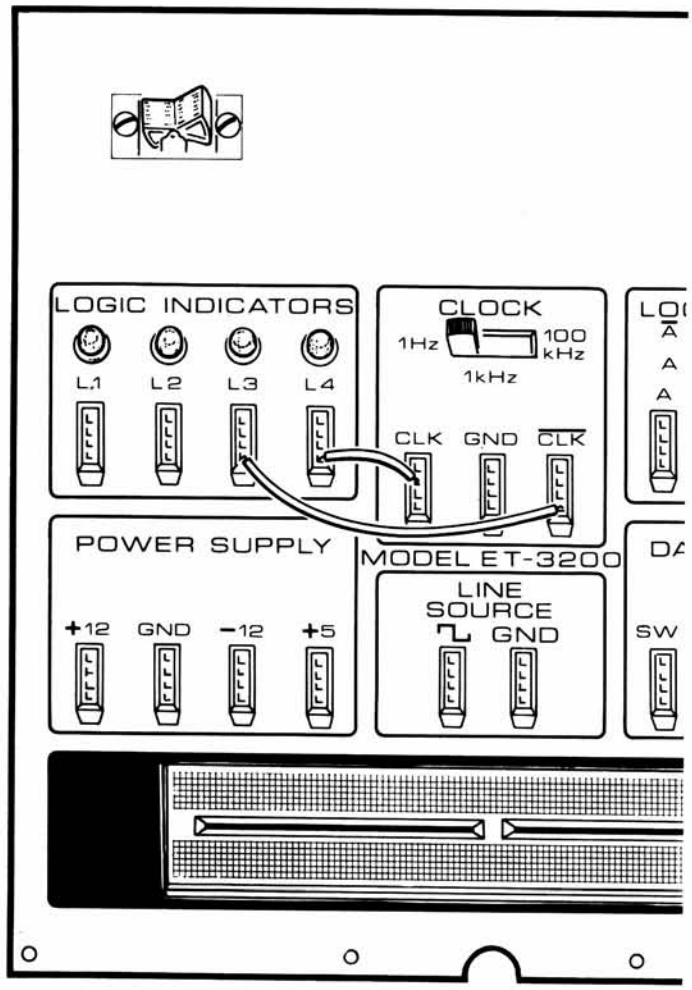
Detail 4-1B

( ) Refer to Detail 4-1B and connect one end of the wire to +5. Then again connect the other end of the wire to L1, then L2, then L3, and then L4. Each indicator should light when you connect the wire to it.



Detail 4-1C

( ) Refer to Detail 4-1C and connect the wire between L4 and LINE SOURCE ⊓⊔ . The indicator should light.



Detail 4-1D

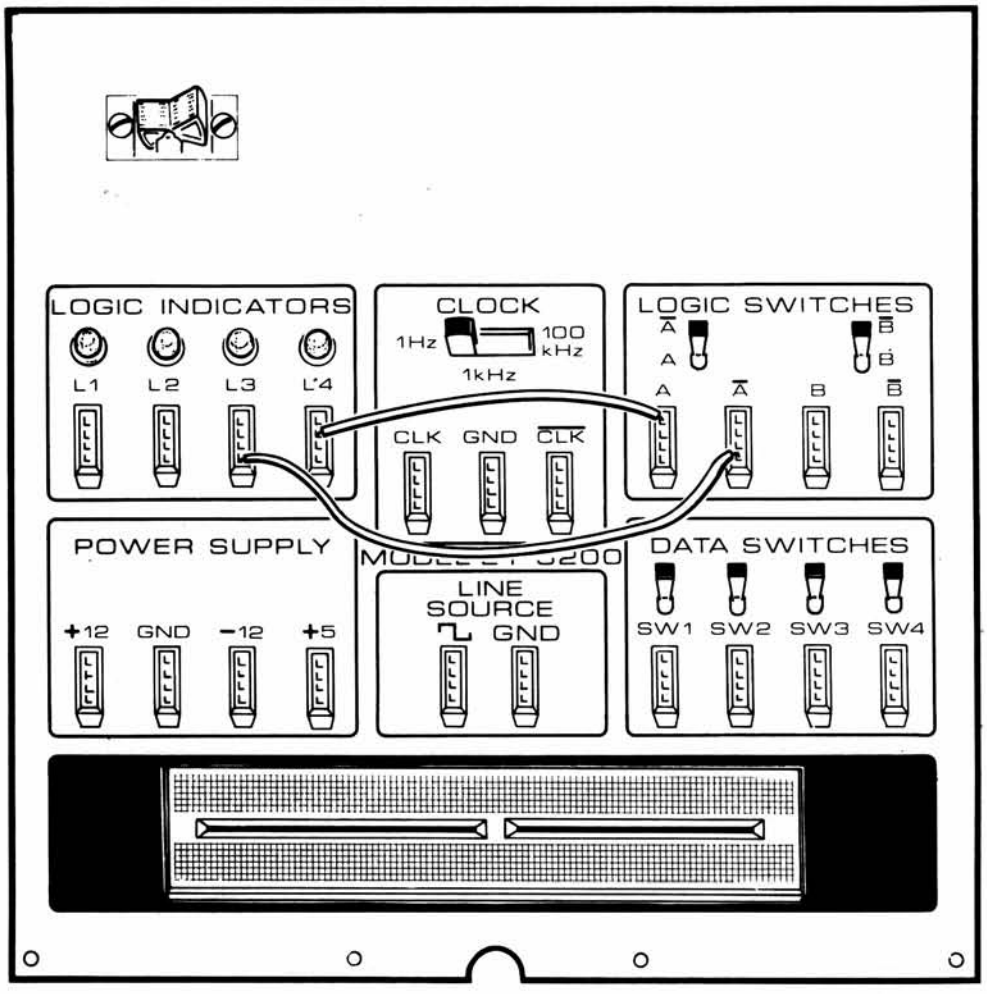
( ) Refer to Detail 4-1D and position the CLOCK switch to the 1 Hz position.

( ) Connect a wire from L4 to CLK.

( ) Connect another wire from L3 to $\overline{\text{CLK}}$. The indicators should blink on and off once each second. When L3 is on, L4 is off; and when L3 is off, L4 is on.

( ) Position the CLOCK switch to the 1 kHz position. The indicators should appear to be on continuously.

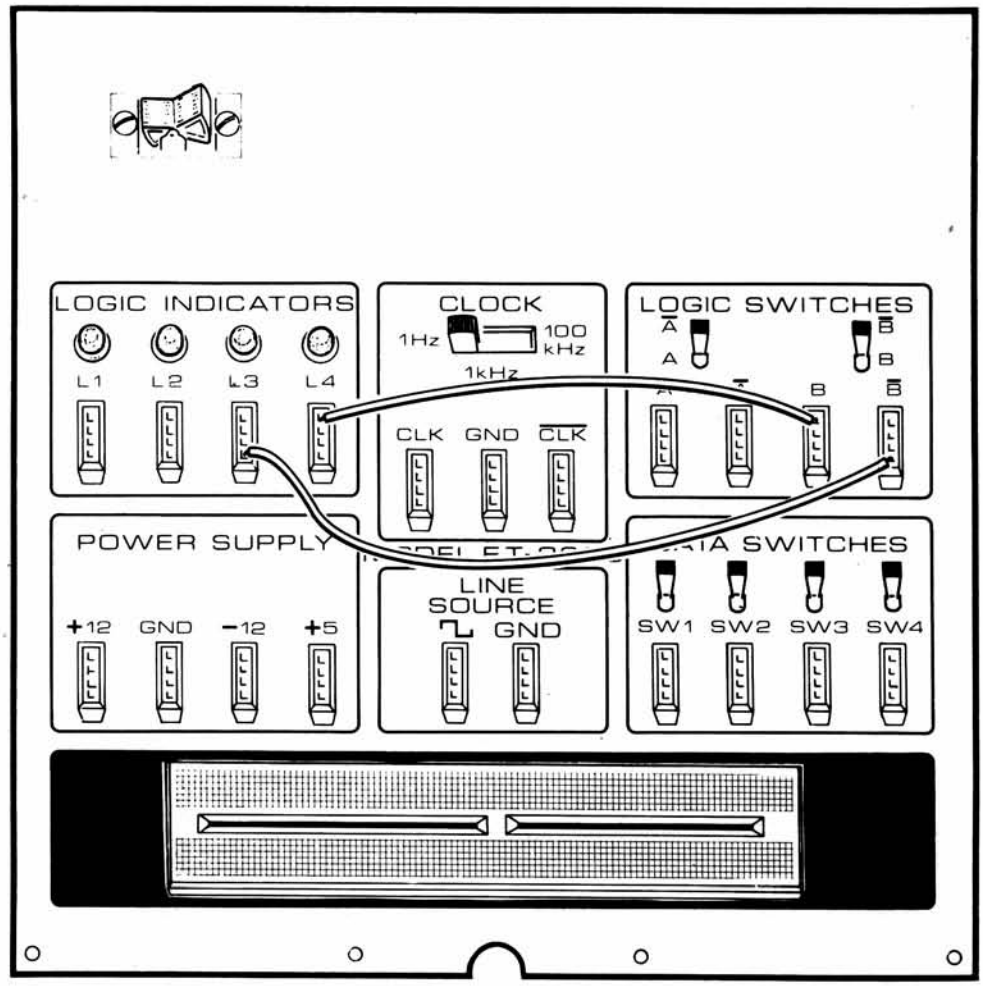
( ) Position the CLOCK switch to 100 kHz. The indicators should again be on, but brighter than before.



Detail 4-1E

( ) Refer to Detail 4-1E and reconnect one wire from L4 to LOGIC switch A.

( ) Reconnect the other wire from L3 to LOGIC switch $\overline{A}$. Then operate switch A-$\overline{A}$. When the switch is in the $\overline{A}$ (normal) position, indicator L3 should be on and L4 should be off. When the switch is in the A position, L3 should be off and L4 should be on.

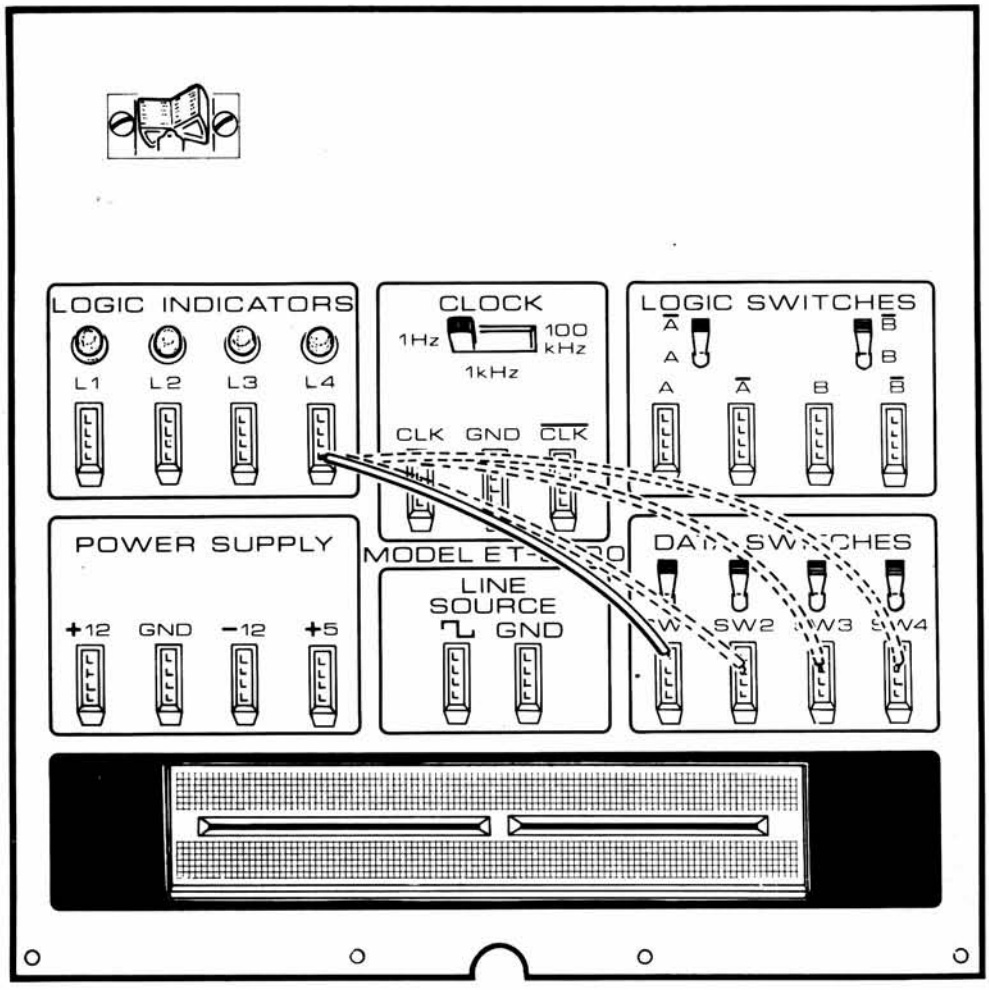


Detail 4-1F

( ) Refer to Detail 4-1F and reconnect one wire from L4 to LOGIC switch B.

( ) Reconnect the other wire from L3 to LOGIC switch $\overline{B}$. Then operate switch B-$\overline{B}$. Again, when the switch is in the $\overline{B}$ position, L3 should be on and L4 should be off. When the switch is in the B position, L3 should be off and L4 should be on.

( ) Remove and set aside one of the two wires.



Detail 4-1G

( ) Refer to Detail 4-1G and reconnect the other wire from L4 to DATA switch SW1. Operate the switch. In the up position, L4 should be on. In the down position, L4 should be off.

( ) Perform the above test at DATA switches SW2, SW3, and SW4. Then remove the wire and set it aside.

FINAL ASSEMBLY

Refer to Pictorial 4-1 (in the Illustration Booklet) for the following steps.

( ) Disconnect the line cord plug.

( ) Remove the protective backing from the Warning label and apply the label to the cabinet bottom as shown. Install it so the printing is upside down.

( ) In a similar manner, install the blue and white identification label. Be sure to refer to the numbers on this label in any communication you have with the Heath Company about this kit.

( ) Install a plastic foot in the smooth areas at each of the four corners of the cabinet bottom as shown. First remove the protective backing; then press the foot into place.

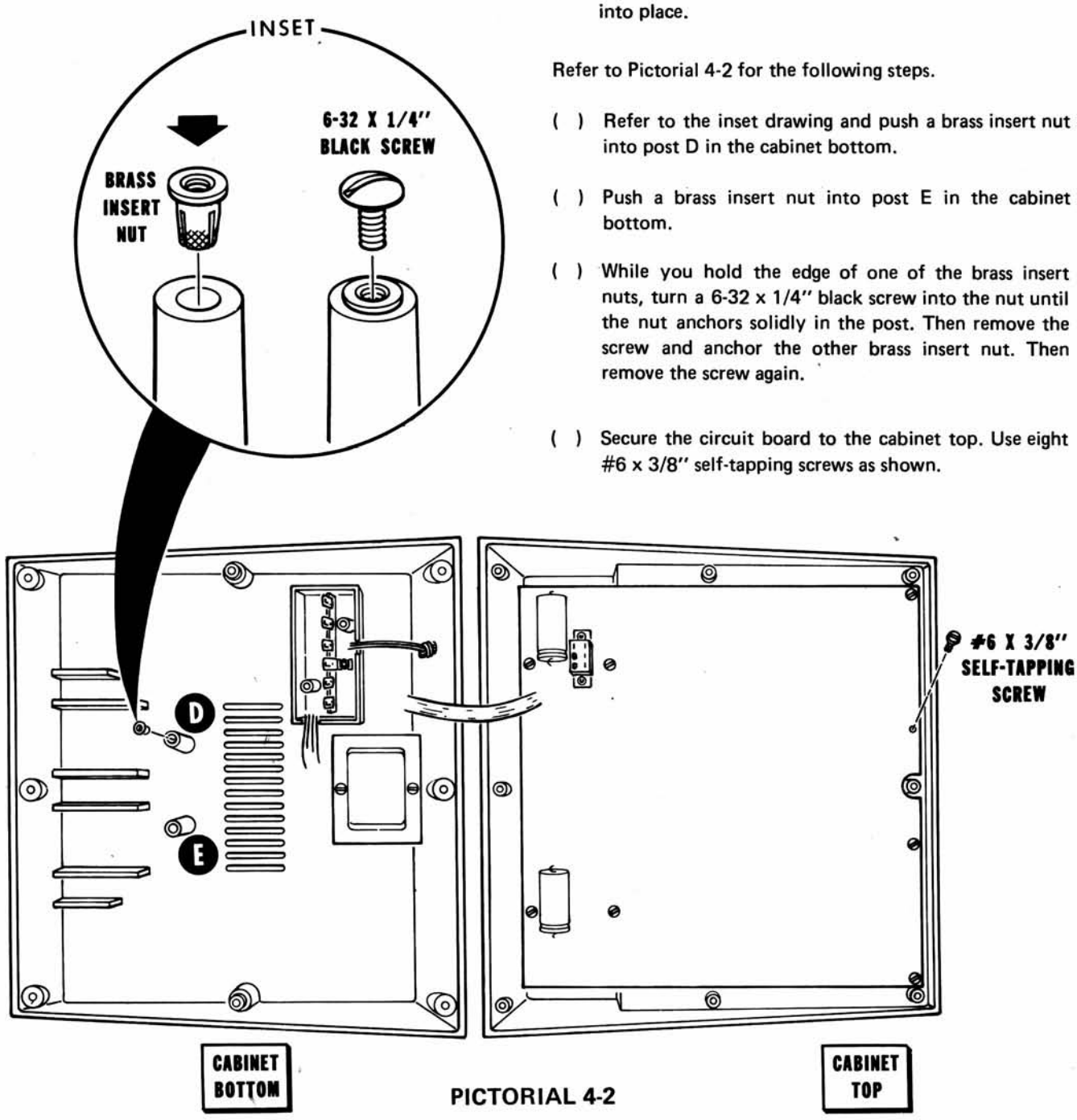
Refer to Pictorial 4-2 for the following steps.

( ) Refer to the inset drawing and push a brass insert nut into post D in the cabinet bottom.

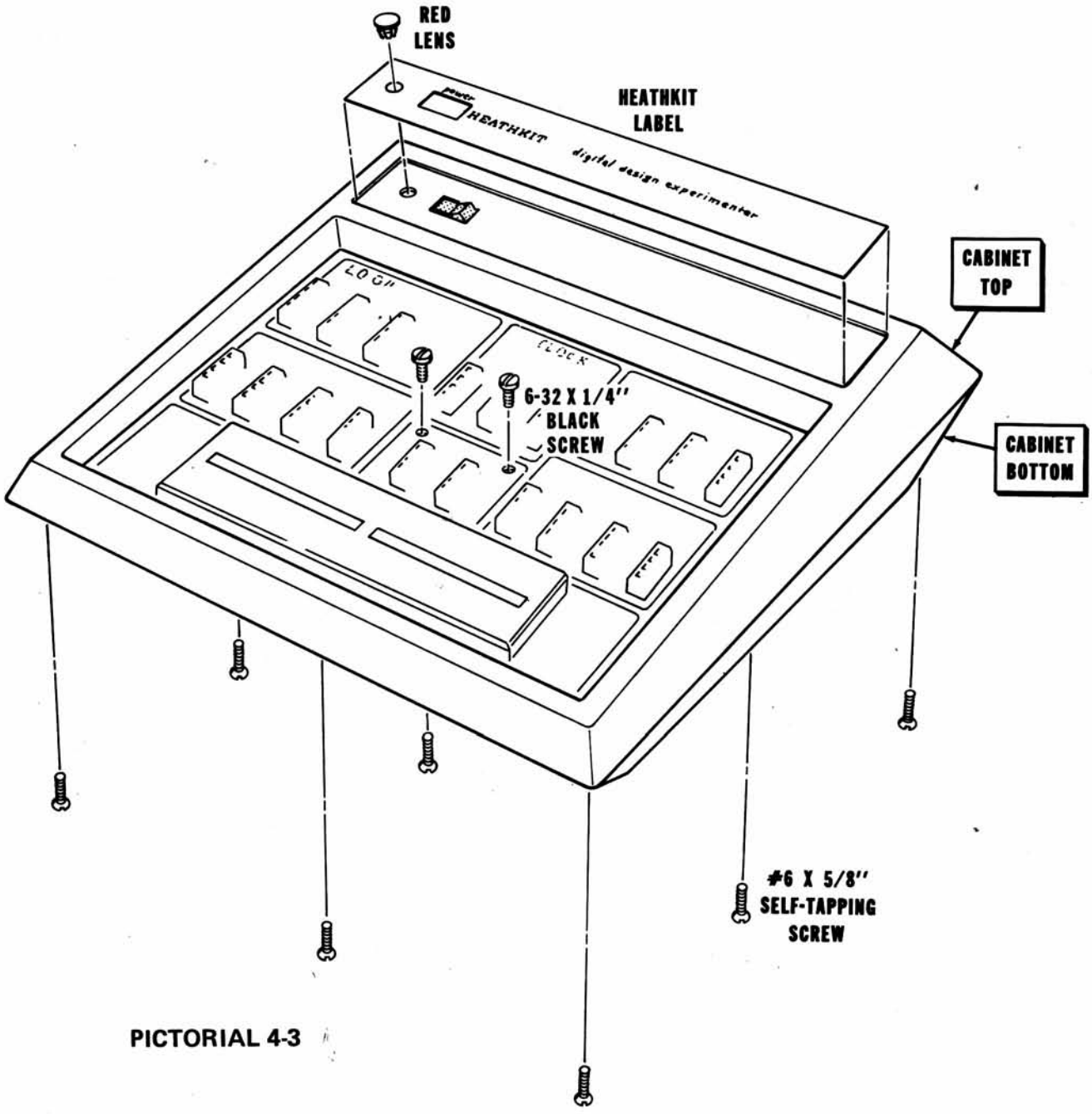
( ) Push a brass insert nut into post E in the cabinet bottom.

( ) While you hold the edge of one of the brass insert nuts, turn a 6-32 x 1/4" black screw into the nut until the nut anchors solidly in the post. Then remove the screw and anchor the other brass insert nut. Then remove the screw again.

( ) Secure the circuit board to the cabinet top. Use eight #6 x 3/8" self-tapping screws as shown.



PICTORIAL 4-2



PICTORIAL 4-3

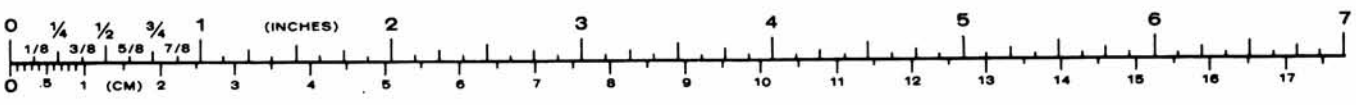
Refer to Pictorial 4-3 for the following steps.

( ) Mount the cabinet top to the cabinet bottom. Use two 6-32 x 1/4" black screws and eight #6 x 5/8" self-tapping screws.

( ) Remove the protective backing from the Heathkit label and apply the label to the cabinet top as shown.

( ) Push the red lens into the indicated hole as shown.

This completes the assembly of your kit. Use the remaining wire for your experiments. (Cut the wire to the desired lengths and remove 1/4" of insulation from the ends.) Proceed to "Operation and Applications."



OPERATION AND APPLICATIONS

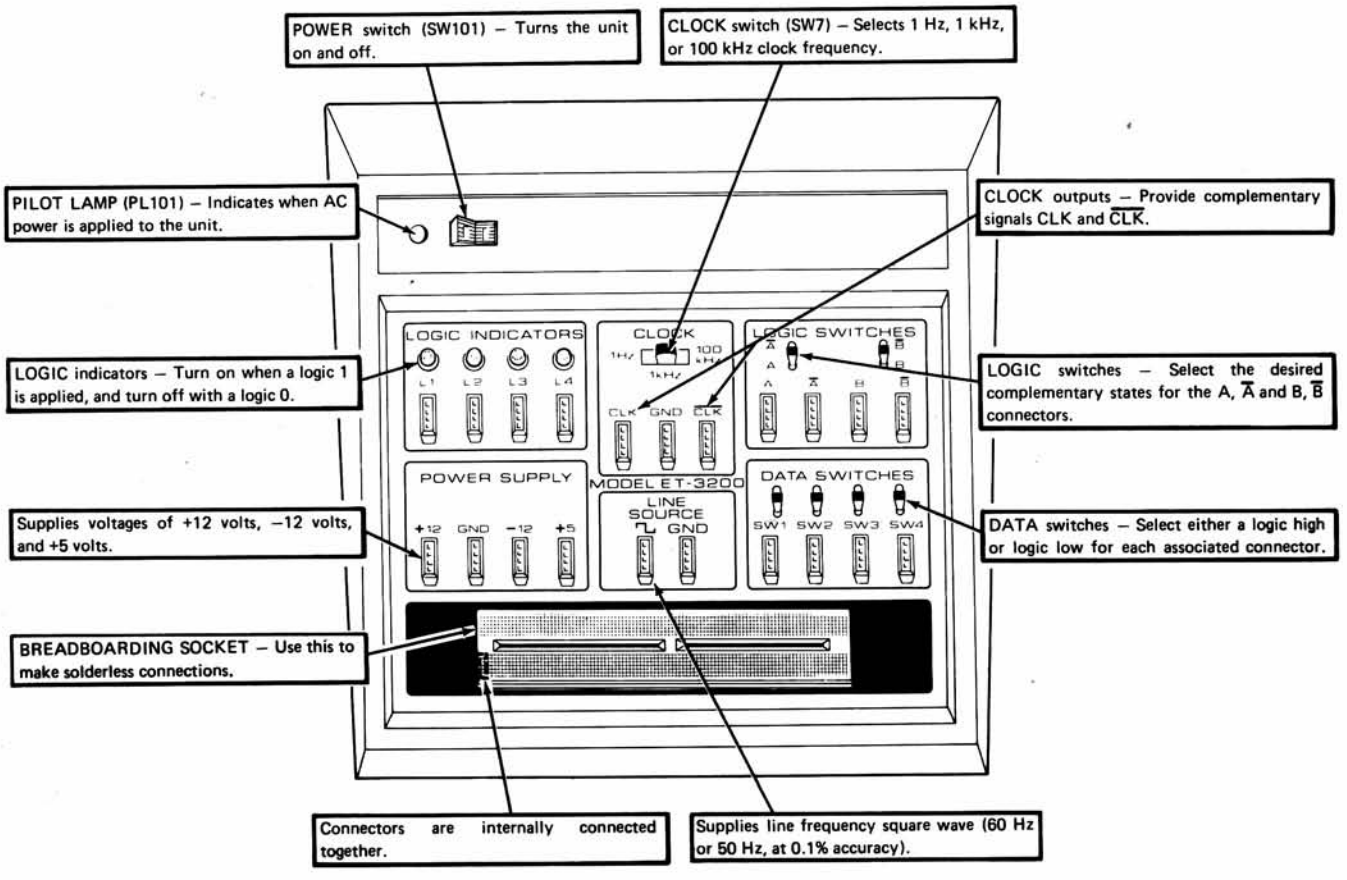


Figure 1

The Experimenter not only supplies the common DC voltages used in digital electronics, but it also supplies: a line frequency square wave (60 or 50 Hz); complementary clock signals of 1 Hz, 1 kHz and 100 kHz; logic and data switches to control input levels; and logic indicators to visually monitor logic states and transitions.

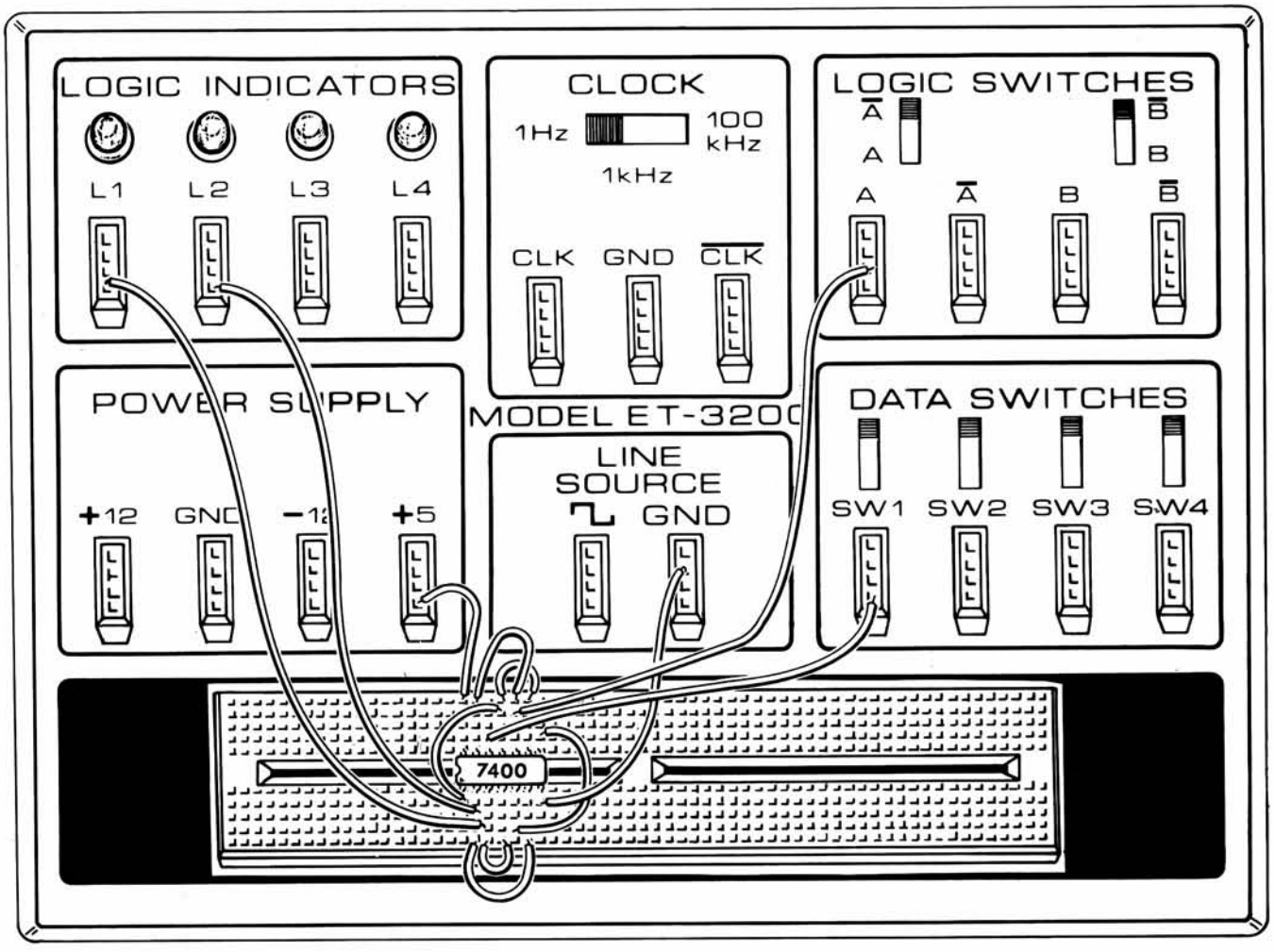
Figure 1 gives a brief description of each control function.

CONNECTOR BLOCK

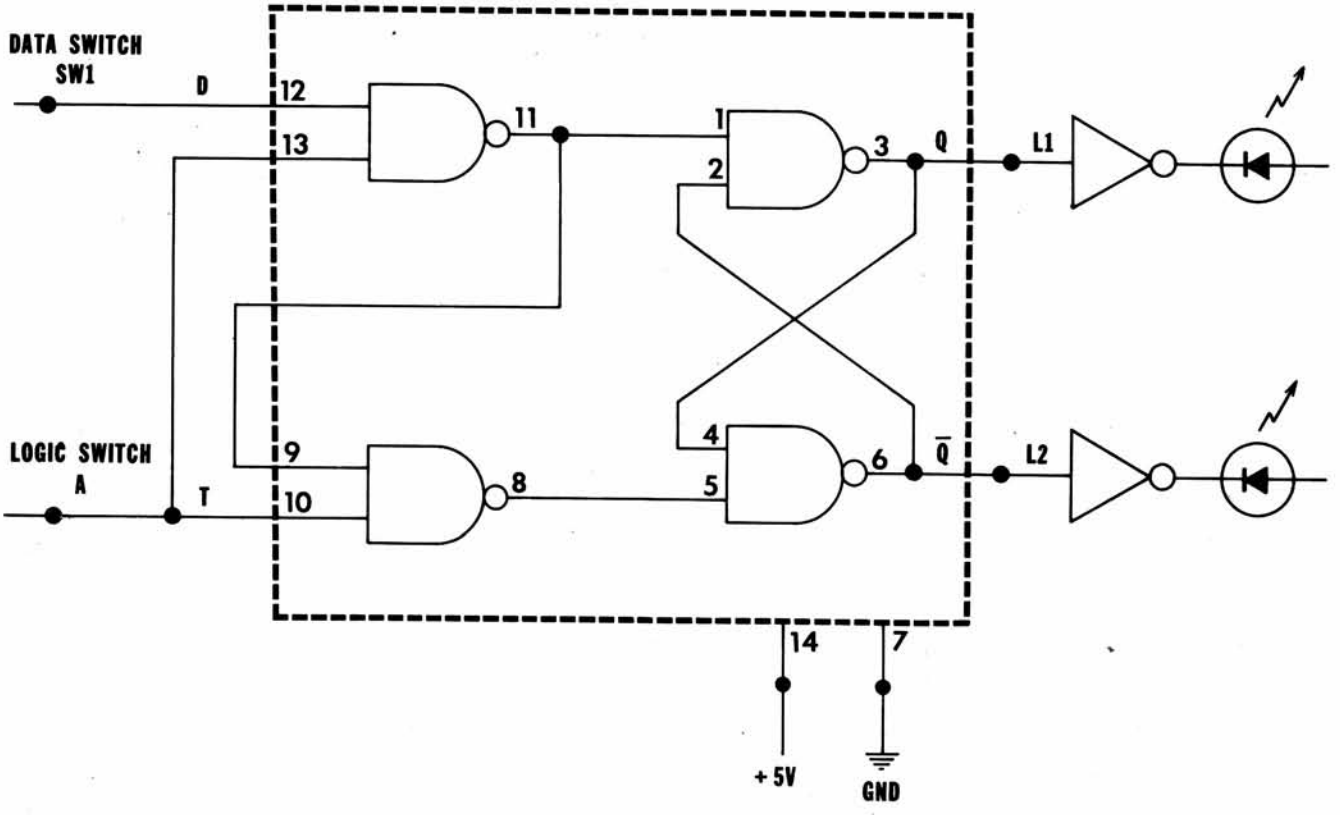
The connector blocks are designed to accept up to #20 (.032") solid wire and most common-component leads. The four connectors in a small connector block are internally connected together. Also, each vertical row of five connectors in the breadboarding socket are connected together as shown in the Figure. Thus, you can build simple or complex circuits without making solder connections.

Page 35 shows an example of a typical experiment. The breadboarding socket is designed to accommodate integrated circuits and the IC puller supplied in your kit fits down into the center channel of the breadboarding socket to gently and easily lift the IC out.

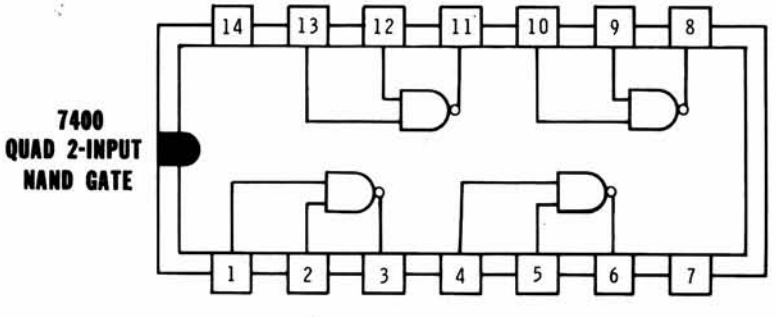
WIRING EXAMPLE



TYPE 7400 QUAD 2-INPUT TTL NAND GATE CONNECTED AS A D-TYPE FLIP-FLOP



TOP VIEW

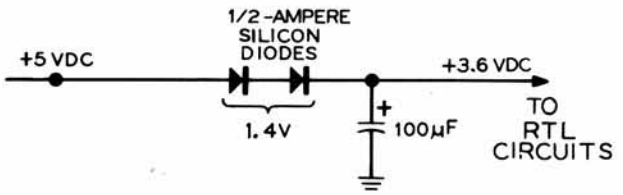


IC Logic Compatibility

As shown in the following "IC Compatibility Chart," the power supplies and other circuitry of your Digital Experimenter are compatible with most of today's commonly used logic families. Figure 2 (on Page 38) shows how the power supply can be adapted for still another logic family, and Figures 3 and 4 show simple interface (connecting) circuitry between some of these families.

IC COMPATIBILITY CHART

TYPE OF IC	TYPICAL SUPPLY VOLTAGE	COMPATIBLE WITH INDICATOR AND SWITCHES	COMMENTS
RTL	+3.6V (See Note 1 on Page 38)	Yes (See Note 2 on Page 38)	
DTL	+5V	Yes	
TTL	+5V	Yes	Applies to open collector, Schottky, and 3-state types also.
CMOS	+5 +12V	Yes (when used with +5V supply)	Recommend +5VDC for indicator and switch compatibility.
ECL	+5.2V (See Note 3 on Page 38)	No (See Note 4 on Page 38)	Check ECL manufacturer's literature before using.
nMOS	+5V	Yes	Not all nMOS uses a +5 volt supply. Check manufacturer's data.
pMOS (See Note 5)	+5V −12V	Yes	TTL compatible, static types only.
Linear	+12V −12V	Not Applicable.	Good for op amps, line drivers and receivers, and other linear circuits.



RECOMMENDED POWER SUPPLY CIRCUIT FOR RTL IC'S.

Figure 2

NOTES:

1. Use circuit shown in Figure 2 to derive the recommended supply voltage for RTL IC's.

2. Outputs of data and logic switches in the binary 1 state are a higher voltage than that required by RTL circuits. But the higher voltage will not damage RTL circuits and they will operate satisfactorily.

3. The recommended ECL supply voltage is –5.2 VDC. However, by reversing the ground and supply voltage connections, +5 volts from the ET-3200 can be used. Connect the IC ground to +5 volts and the normal supply input (VEE) to ground. This will produce satisfactory operation for most applications.

4. Even with a +5-volt supply on the ECL circuits, this type of IC is not compatible with the switches and indicators on the ET-3200. With some simple circuit additions, you can obtain full compatibility. Figure 3 shows two simple circuits to convert standard TTL levels to ECL levels. The second circuit in Figure 3 can also be used to convert the clock, data switch, and logic switch outputs of the ET-3200 to ECL levels.

   Figure 4 shows circuits for converting ECL levels to TTL levels. All of these level translator circuits assume that both ECL and TTL circuits will be operating from the same +5-volts supply.

5. Static type only. Dynamic pMOS requires more sophisticated interfacing. In all cases, check the manufacturer's data sheets.

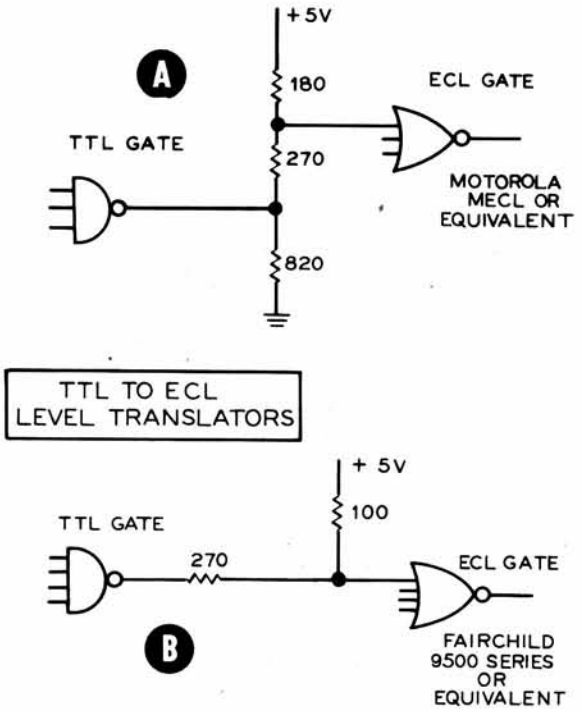


Figure 3

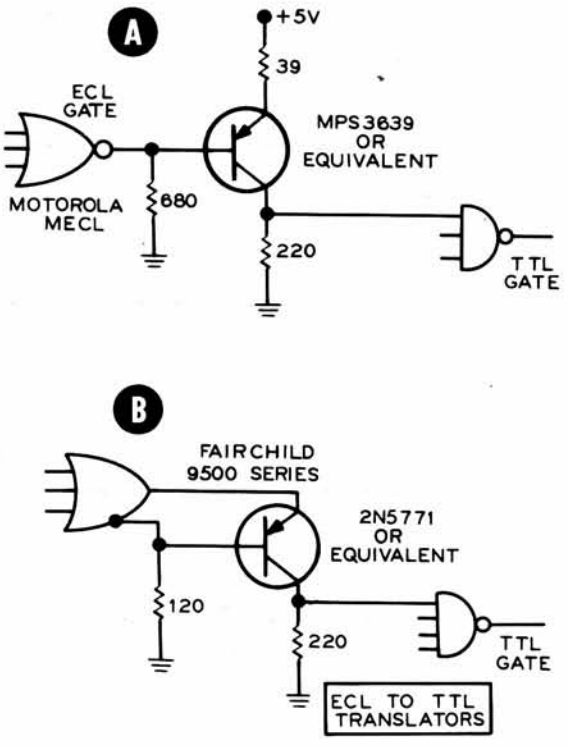


Figure 4

IN CASE OF DIFFICULTY

Use the "Visual Tests" first to find a difficulty that shows up right after your kit is assembled. You can also use the "Troubleshooting Charts" right after your kit is assembled, or at some future time in case your Experimenter should ever malfunction.

If the trouble is still not located after you complete the "Visual Tests," and a voltmeter is available, check voltage readings against those shown on the "Voltage Chart" (in the Illustration Booklet). Read the "Precautions" on this Page before you make any measurements. NOTE: All voltage readings were taken with a high input impedance voltmeter.

In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of the Manual. Your Warranty is located inside the front cover.

NOTE: Refer to the "Circuit Board X-Ray View" (in the Illustration Booklet) for the physical location of parts on the circuit boards.

VISUAL TESTS

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something you consistantly overlook.

2. About 90% of the kits that are returned to the Heath Company for repair do not function properly due to poor connections and soldering. Therefore, you can eliminate many troubles by reheating all connections to make sure they are soldered as described in the "Soldering" section of the "Kit Builders Guide."

3. Check to be sure that all transistors are in their proper locations. Make sure each lead is connected to the proper point.

4. Check to be sure that each of the IC pins are properly installed in their connectors, and not bent or under the IC. Also be sure the IC's are installed in their correct positions.

5. Check the values of the parts. Be sure in each step that the proper part has been wired into the circuit, as shown in the Pictorial diagrams. It would be easy, for example, to install a 680 Ω (blue-gray-brown) resistor where a 6800 Ω (blue-gray-red) resistor should have been installed.

6. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.

7. A review of the "Circuit Description" may also help you determine where the trouble is.

PRECAUTIONS

1. Be cautious when you test IC and transistor circuits. Although they have almost unlimited life when used properly, they are much more vulnerable to damage from excessive voltage or current than tubes.

2. Be sure you do not short any terminals to ground when making voltage measurements. If the probe should slip, for example, and short out a bias or supply point, it is very likely to damage one or more IC's, transistors, or diodes.

Troubleshooting Chart

PROBLEM	POSSIBLE CAUSE
Pilot lamp does not light.	1. Fuse F101.
+12-volt power supply varies with Voltage Adjust control R6 but will not reach +12 volts DC.	1. Zener diode ZD1.
Both plus and minus 12-volt supplies are high and will not adjust.	1. Transistor Q3 open. 2. Transistor Q1 shorted. 3. Transistor Q2 shorted.
−12-volt supply is high; +12-volt supply is OK.	1. Transistor Q7 open. 2. Transistor Q5 shorted. 3. Transistor Q6 shorted.
LED remains lit with no input.	1. L1: Transistor Q9 or Q10. L2: Transistor Q11 or Q12. L3: Transistor Q13 or Q14. L4: Transistor Q15 or Q16.
Clock will not change frequency.	1. Switch SW7.

SPECIFICATIONS

Power Supplies:	
Output Voltages	+12 volts DC at 100 mA. −12 volts DC at 100 mA. +5 volts DC at 500 mA with thermal overload protection.
Load Regulation	+12 volts DC, better than 1%. −12 volts DC, better than 1%. +5 volts DC, better than 2%.
Data Switches:	
States	+5 volts or 0 volts.
Maximum Current	10 mA, each switch.
Outputs	4 terminals, one for each switch.
Logic Switches:	
Type	Momentary contact, spring loaded.
Circuit	Two flip-flop latches for contact bounce buffering.
Output States	Complementary, +5 volts and +0.2 volts.
Clock:	
Frequency Selection	3-position slide switch.
Output Frequency	1 Hz, 1 kHz, 100 kHz; ±20%.
Duty Cycle	45%.
Output Voltage	5 volts peak-to-peak.
Output Terminals	Normal and complement.
Logic Indicators	Red light emitting diode (LED).
General:	
Power Requirements	105-130 volts or 210-260 volts rms, 50-60 Hz, 15 watts maximum.
Fuse	3/16-ampere, slow-blow.
Dimensions	12-1/8" wide x 11-3/4" deep x 3-1/2" high.
Net Weight	4 lbs.

CIRCUIT DESCRIPTION

Refer to the Schematic Diagram (fold-out from Page 41) while you read this "Circuit Description."

DATA SWITCHES

These switches select either ground potential or +5 volts DC. Resistor R39 limits the current.

LOGIC SWITCHES

Switch A-$\overline{A}$ controls a latching flip-flop made up of sections A and B of IC2. When switch SW5 is in the $\overline{A}$ position, pins 1 and 2 are low. This produces a high at pins 3 and 4. Because pin 5 is floating at this time, it is also considered to be high. This makes a low at pin 6. When SW5 is in the A position, a low is at pin 5. This forces pins 6 and 2 high. With highs at pins 1 and 2, pins 3 and 4 go low and the outputs A and $\overline{A}$ have changed state.

Switch B-$\overline{B}$ operates the same as switch A-$\overline{A}$.

LOGIC INDICATORS

With no input to connector L1, transistors Q9 and Q10, and LED L1 are off. When a high is applied to connector L1, transistor Q9 turns on transistor Q10. Current then flows through LED L1, resistor R23, transistor Q10, and the LED turns on. The other indicators operate in the same manner.

CLOCK

The clock is made up of IC3 (a 555 timer), and the RC time frequency control components. These are R46, R47, and C9, C10, or C11. Switch SW7 selects the desired capacitor. The output of IC3 (pin 3) is applied to two NAND gates that operate as inverters to produce the CLK and $\overline{CLK}$ outputs.

LINE FREQUENCY SIGNAL

The line frequency signal is coupled from the secondary of T101, through resistor R41, to the base of transistor Q17. Diode D9 half-wave rectifies the signal. This leaves the positive excursions to turn on transistor Q17. Transistor Q17 then drives section B of IC4, which is a NAND gate connected as an inverter.

+5-VOLT SUPPLY

The secondary voltage of transformer T101 is rectified by diodes D1 through D4, filtered by capacitor C2, and regulated by IC1.

12-VOLT SUPPLIES

The center-tapped secondary of transformer T101 is rectified by diodes D5 through D8 and filtered by capacitors C1 and C6.

Transistor Q1 is a current amplifier for pass transistor Q2. If the current through Q2 becomes excessive, the voltage developed across R4 turns on transistor Q4. The current that was flowing through R2, R3, and Q1 now has another path, through Q4. Therefore, if Q4 turns on harder, less current flows into the base of Q1 and Q2. This in turn allows less current to flow from the collector to emitter of Q2 and the current is limited to a safe value.

If the output voltage changes, this change is sensed by voltage divider R6 and R7, and is applied to the base of Q3. The base voltage of Q3 therefore changes, but the emitter is held constant by ZD1. This causes the current through Q3 to change and again control Q1 and Q2 as before until the output voltage is at the proper value.

The positive 12-volt supply is used as the reference for the negative 12-volt supply. Voltage divider R17 and R18 monitor the outputs of the supplies and control Q7. The negative supply operates similar to the positive supply.

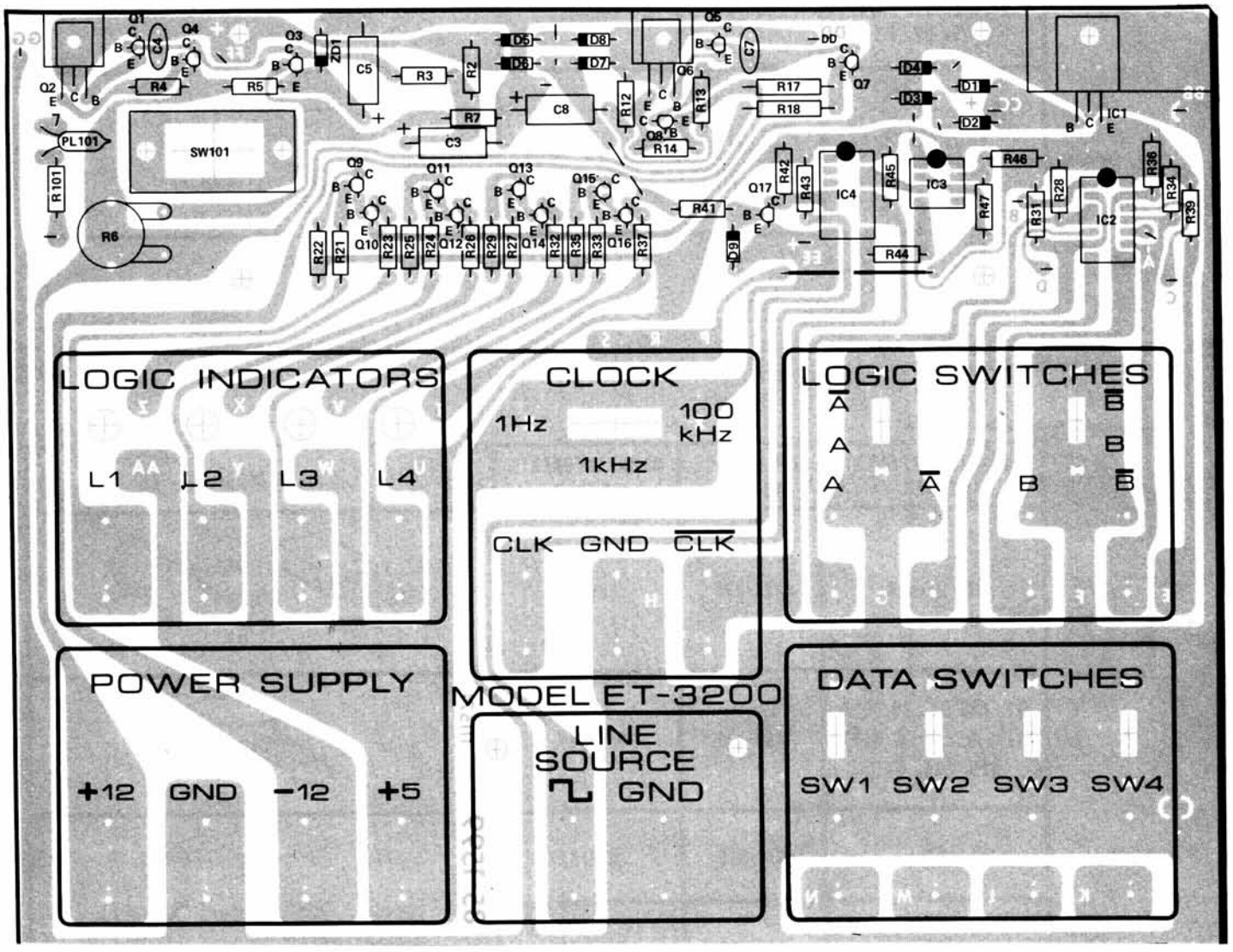
CIRCUIT BOARD X-RAY VIEW

NOTE: To find the PART NUMBER of a component for the purpose of ordering a replacement part:

A. Find the circuit component number (R5, C3, etc.) on the "X-Ray View."

B. Locate this same number in the "Circuit Component Number" column of the "Parts List" in the front of this Manual.

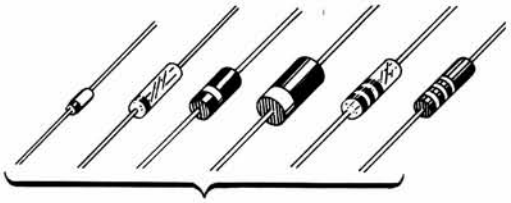
C. Adjacent to the circuit component number, you will find the PART NUMBER and DESCRIPTION which must be supplied when you order a replacement part.



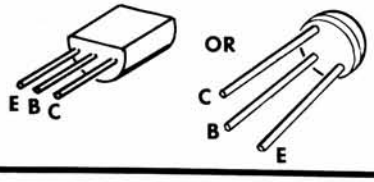
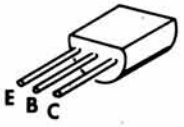
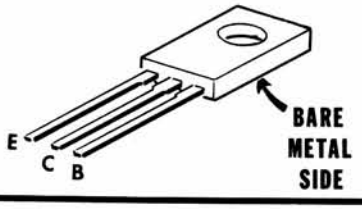
(Shown from component side)

IDENTIFICATION CHARTS

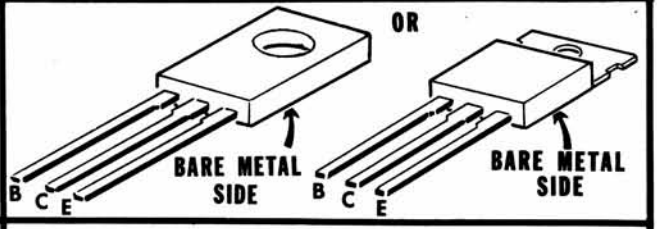
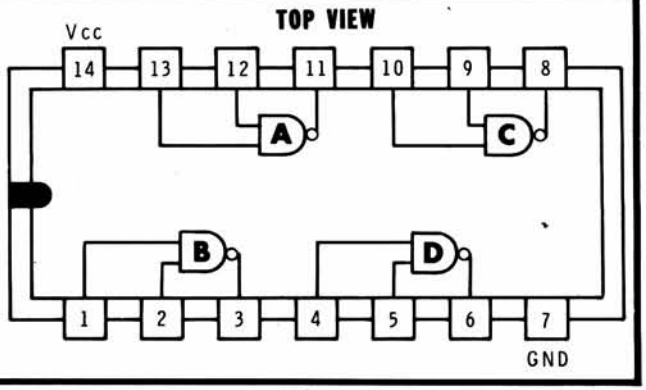
DIODES

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MANUFACTURER'S NUMBER	BASE DIAGRAM
D9	56-56	1N4149	IMPORTANT: THE BANDED END OF DIODES CAN BE MARKED IN A NUMBER OF WAYS.  BANDED END
ZD1	56-97	1N3017	
D1, D2, D3, D4, D5, D6, D7, D8	57-65	1N4002	
LED1, LED2, LED3, LED4	412-611		

TRANSISTORS

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MANUFACTURER'S NUMBER	BASE DIAGRAM
Q5, Q7, Q8	417-235	2N4121	
Q1, Q3, Q4, Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16, Q17	417-801	MPSA20	
Q2	417-818	MJE181	
Q6	417-819	MJE171	

INTEGRATED CIRCUITS

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MANUFACTURER'S NUMBER	BASE DIAGRAM
IC3	442-53	NE555V	
IC1	442-54	UA7805	
IC2, IC4	443-54	SN7403N	

FOR PARTS REQUESTS ONLY

- Be sure to follow instructions carefully.
- Use a separate letter for all correspondence.
- Please allow 10 - 14 days for mail delivery time.

DO NOT WRITE IN THIS SPACE

INSTRUCTIONS

- Please print all information requested.
- Be sure you list the correct **HEATH** part number exactly as it appears in the parts list.
- If you wish to prepay your order, mail this card and your payment in an envelope. Be sure to include 10% (25¢ minimum, $3.50 maximum) for insurance, shipping and handling. Michigan residents add 4% tax.

  Total enclosed $_____
- If you prefer COD shipment, check the COD box and mail this card. COD ☐

NAME _____

ADDRESS _____

CITY _____

STATE _____ ZIP _____

The information requested in the next two lines is not required when purchasing nonwarranty replacement parts, but it can help us provide you with better products in the future.

Model # _____ Invoice # _____

Date Purchased _____ Location Purchased _____

LIST **HEATH** PART NUMBER	QTY.	PRICE EACH	TOTAL PRICE
TOTAL FOR PARTS			
HANDLING AND SHIPPING			
MICHIGAN RESIDENTS ADD 4% TAX			
TOTAL AMOUNT OF ORDER			

SEND TO: **HEATH COMPANY**
BENTON HARBOR
MICHIGAN 49022
ATTN: PARTS REPLACEMENT

Phone (Replacement parts only): 616 982-3571

THIS FORM IS FOR U.S. CUSTOMERS ONLY
OVERSEAS CUSTOMERS SEE YOUR DISTRIBUTOR

CUT ALONG DOTTED LINE

FOR PARTS REQUESTS ONLY

- Be sure to follow instructions carefully.
- Use a separate letter for all correspondence.
- Please allow 10 - 14 days for mail delivery time.

DO NOT WRITE IN THIS SPACE

INSTRUCTIONS

- Please print all information requested.
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MICHIGAN 49022
ATTN: PARTS REPLACEMENT

Phone (Replacement parts only): 616 982-3571

THIS FORM IS FOR U.S. CUSTOMERS ONLY
OVERSEAS CUSTOMERS SEE YOUR DISTRIBUTOR

CUSTOMER SERVICE

REPLACEMENT PARTS

Please provide complete information when you request replacements from either the factory or Heath Electronic Centers. Be certain to include the **HEATH** part number exactly as it appears in the parts list.

Replacement parts are maintained specifically to repair Heath products. Parts sales for other reasons will be declined.

ORDERING FROM THE FACTORY

Print all of the information requested on the parts order form furnished with this product and mail it to Heath. For telephone orders (parts only) dial 616 982-3571. If you are unable to locate an order form, write us a letter or card including:

- Heath part number.
- Model number.
- Date of purchase.
- Location purchased or invoice number.
- Nature of the defect.
- Your payment or authorization for COD shipment of parts not covered by warranty.

Mail letters to: Heath Company
Benton Harbor
MI 49022
Attn: Parts Replacement

Retain original parts until you receive replacements. Parts that should be returned to the factory will be listed on your packing slip.

OBTAINING REPLACEMENTS FROM HEATH ELECTRONIC CENTERS

For your convenience, "over the counter" replacement parts are available from the Heath Electronic Centers listed in your catalog. Be sure to bring in the original part and purchase invoice when you request a warranty replacement from a Heath Electronic Center.

TECHNICAL CONSULTATION

Need help with your kit? — Self-Service? — Construction? — Operation? — Call or write for assistance. you'll find our Technical Consultants eager to help with just about any technical problem except "customizing" for unique applications.

The effectiveness of our consultation service depends on the information you furnish. Be sure to tell us:

- The Model number and Series number from the blue and white label.
- The date of purchase.
- An exact description of the difficulty.
- Everything you have done in attempting to correct the problem.

Also include switch positions, connections to other units, operating procedures, voltage readings, and any other information you think might be helpful.

Please do not send parts for testing, unless this is specifically requested by our Consultants.

Hints: Telephone traffic is lightest at midweek — please be sure your Manual and notes are on hand when you call.

Heathkit Electronic Center facilities are also available for telephone or "walk-in" personal assistance.

REPAIR SERVICE

Service facilities are available, if they are needed, to repair your completed kit. (Kits that have been modified, soldered with paste flux or acid core solder, cannot be accepted for repair.)

If it is convenient, personally deliver your kit to a Heathkit Electronic Center. For warranty parts replacement, supply a copy of the invoice or sales slip.

If you prefer to ship your kit to the factory, attach a letter containing the following information directly to the unit:

- Your name and address.
- Date of purchase and invoice number.
- Copies of all correspondence relevant to the service of the kit.
- A brief description of the difficulty.
- Authorization to return your kit COD for the service and shipping charges. (This will reduce the possibility of delay.)

Check the equipment to see that all screws and parts are secured. (Do not include any wooden cabinets or color television picture tubes, as these are easily damaged in shipment. Do not include the kit Manual.) Place the equipment in a strong carton with at least THREE INCHES of *resilient* packing material (shredded paper, excelsior, etc.) on all sides. Use additional packing material where there are protrusions (control sticks, large knobs, etc.). If the unit weighs over 15 lbs., place this carton in another one with 3/4" of packing material between the two.

Seal the carton with reinforced gummed tape, tie it with a strong cord, and mark it "Fragile" on at least two sides. Remember, the carrier will not accept liability for shipping damage if the unit is insufficiently packed. Ship by prepaid express, United Parcel Service, or insured Parcel Post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

HEATH

Schlumberger

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THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM

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