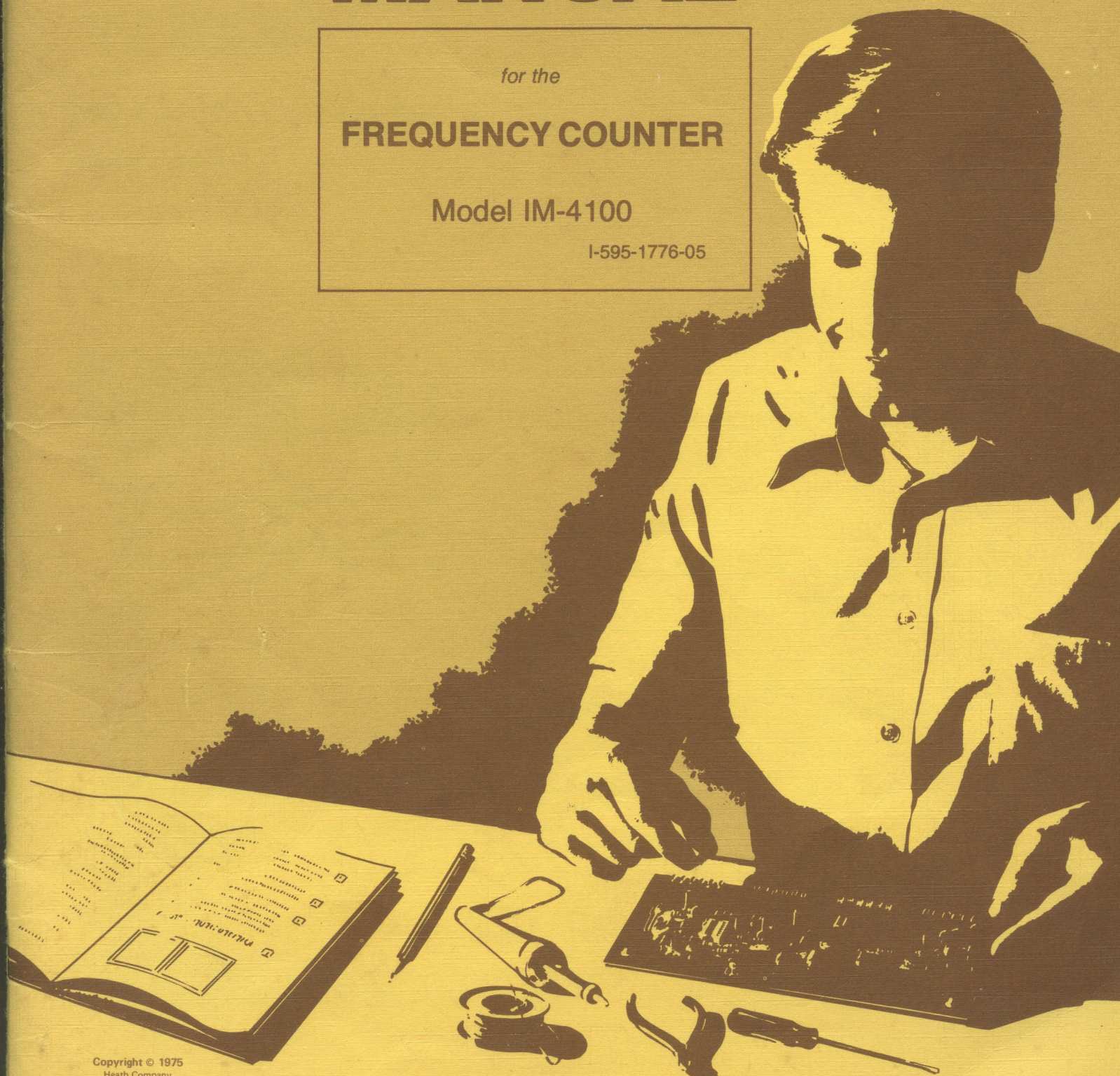
HEATHKIT® MANUAL

for the

FREQUENCY COUNTER

Model IM-4100

I-595-1776-05



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®

FREQUENCY COUNTER

MODEL IM-4100

TABLE OF CONTENTS

INTRODUCTION	2
PARTS LIST	2
ASSEMBLY NOTES	11
STEP-BY-STEP ASSEMBLY	
Circuit Board Assembly	12
Circuit Board Checkout	22
Chassis Assembly	28
INITIAL TESTS	38
FINAL ASSEMBLY	39
CALIBRATION	
Without Instruments	40
With Instruments	41
OPERATION	42
IN CASE OF DIFFICULTY	44
Troubleshooting Chart	45
SPECIFICATIONS	47
CIRCUIT DESCRIPTION	50
CIRCUIT BOARD X-RAY VIEWS	51
SEMICONDUCTOR IDENTIFICATION CHART	54
SCHEMATIC	(fold-in)
WARRANTY	Inside front cover
CUSTOMER SERVICE	Inside rear cover

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

INTRODUCTION

The Heathkit Model IM-4100 Frequency Counter is a versatile, easy-to-use, solid-state frequency counter which can accurately measure frequencies to over 30 MHz. The Counter also is a period meter and an events counter.

The following features make this Counter very versatile:

- Operates from 120 volts AC, 240 volts AC, or 12 volts DC.
- Combined power switch and time base switch.
- 3-position Mode switch.
- Input Attenuator switch.
- Overrange indicator.
- Reset pushbutton switch.
- External time base switch and connectors.

Excellent accuracy is assured by a modern digital design and a 10 MHz crystal oscillator. Additional features include a rugged and compact cabinet, and a swing-into-position handle to elevate the front panel to a desired viewing angle.

Exceptional accuracy, compact design, and the simplified operating controls combine to make this Counter an invaluable tool for the engineer, technician, or hobbyist.

Refer to the "Kit Builders Guide" for information on unpacking, parts identification, tools, wiring, soldering, and step-by-step assembly procedures.

PARTS LIST

Check each part against the following list. Make a check (✓) in the space provided as you identify each part. The parts may vary slightly from the illustration. Any part that is individually packaged with a part number on it should be kept in its package after it is identified until you use it. Some parts are marked with a "171-" or a "172-" packaging number. These numbers are used for packaging only and do not appear in the Manual "Parts List." Save all packaging material until all parts have been located.

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. For pricing information, refer to the separate "Heath Parts Price List."

Each circuit part in this kit has its own circuit 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 when a part has to be replaced, appear:

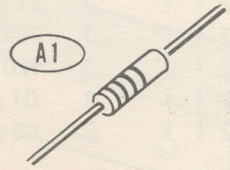
- In the Parts List,
- At the beginning of each step where a component is installed,
- In some illustrations,
- In the Schematic,
- In the sections at the rear of the Manual.

KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.

RESISTORS

NOTE: The following resistors are 1/2-watt, 5% (gold fourth band). Open all the resistor envelopes before you check them against the following list.

A1 ( )	1	39 Ω (orange-white-black)	1-156	R17
A1 ( )	1	100 Ω (brown-black-brown)	1-123	R7
A1 ( )	3	150 Ω (brown-green-brown)	1-111	R5, R16, R23
A1 ( )	3	180 Ω (brown-gray-brown)	1-112	R101, R102, R103
A1 ( )	1	220 Ω (red-red-brown)	1-147	R6
A1 ( )	1	270 Ω (red-violet-brown)	1-170	R33
A1 ( )	3	470 Ω (yellow-violet-brown)	1-157	R8, R27, R29
A1 ( )	4	510 Ω (green-brown-brown)	1-63	R12, R13, R14 R15
A1 ( )	2	680 Ω (blue-gray-(brown)	1-52	R21, R22
A1 ( )	5	1000 Ω (brown-black-red)	1-172	R9, R11, R26, R32, R34
A1 ( )	1	9100 Ω (white-brown-red)	1-180	R3
A1 ( )	5	10 kΩ (brown-black-orange)	1-105	R18, R19, R24, R25, R31
A1 ( )	1	47 kΩ (yellow-violet-orange)	1-115	R28
A1 ( )	1	91 kΩ (white-brown-orange)	1-127	R2
A1 ( )	1	910 kΩ (white-brown-yellow)	1-176	R1
A1 ( )	1	1 MΩ (brown-black-green)	1-101	R4



KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.

CAPACITORS

Disc

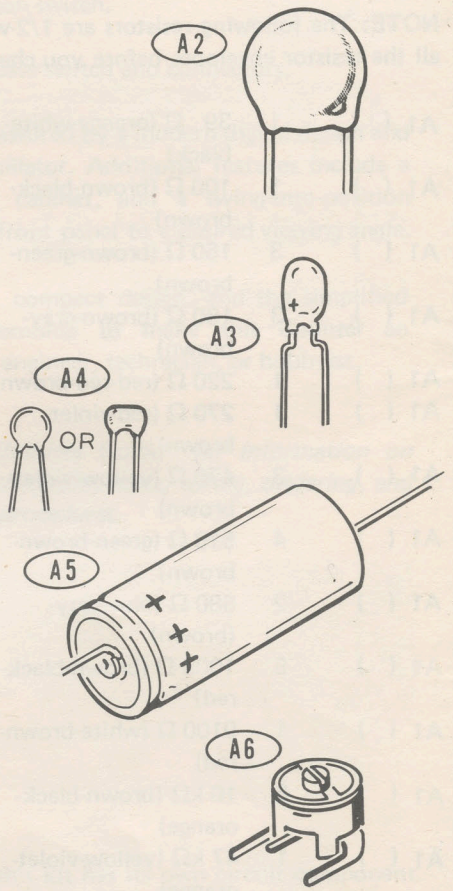
A2 ( )	1	4.7 pF	21-168	C1
A2 ( )	2	10 pF	21-3	C4, C8
A2 ( )	1	27 pF	21-6	C2
A2 ( )	1	200 pF	21-21	C9
A2 ( )	1	420 pF	21-23	C3
A2 ( )	1	.01 μF	21-70	C15
A2 ( )	3	.05 μF	21-143	C11, C13, C17

Tantalum

A3 ( )	3	10 μF	25-220	C5, C21, C22
A3 ( )	1	15 μF	25-252	C12
A3 ( )	1	33 μF	25-253	C18
A3 ( )	2	47 μF	25-223	C6, C14

Other

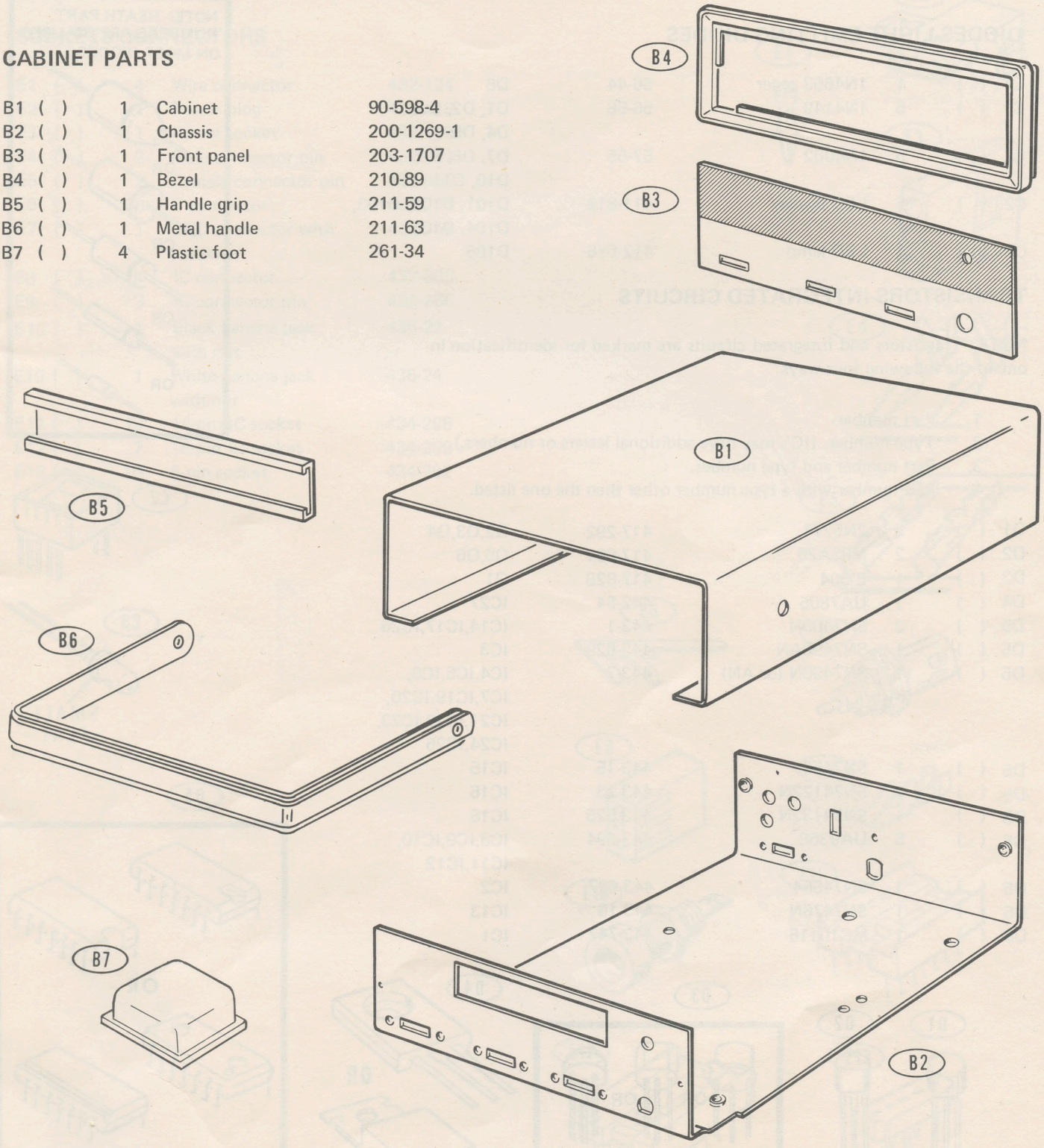
A4 ( )	1	.047 μF ceramic	21-182	C10
A5 ( )	1	6000 μF electrolytic	25-272	C16
A6 ( )	1	7-25 pF trimmer	31-67	C7



KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.

CABINET PARTS

B1	( )	1	Cabinet	90-598-4
B2	( )	1	Chassis	200-1269-1
B3	( )	1	Front panel	203-1707
B4	( )	1	Bezel	210-89
B5	( )	1	Handle grip	211-59
B6	( )	1	Metal handle	211-63
B7	( )	4	Plastic foot	261-34



KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.

DIODES-LIGHT EMITTING DIODES

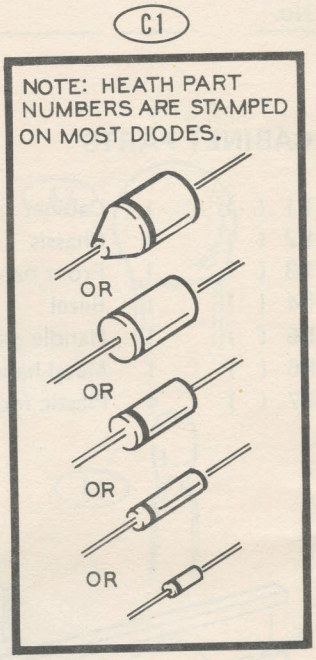
C1 ( )	1	1N4653 zener	56-44	D6
C1 ( )	5	1N4149	56-56	D1, D2, D3, D4, D5
C1 ( )	5	1N4002	57-65	D7, D8, D9, D10, D11
C2 ( )	5	LED display	411-819	D101, D102, D103, D104, D105
C3 ( )	1	LED lamp	412-616	D106

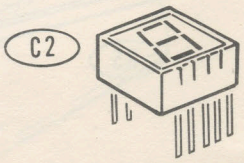
TRANSISTORS-INTEGRATED CIRCUITS

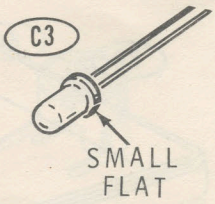
NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways:

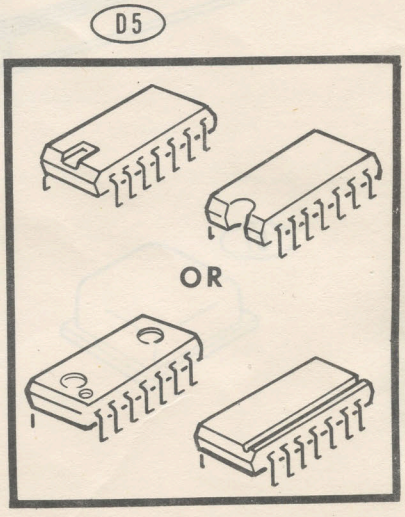
1. Part number.
2. Type number. (IC's may have additional letters or numbers.)
3. Part number and type number.
4. Part number with a type number other than the one listed.

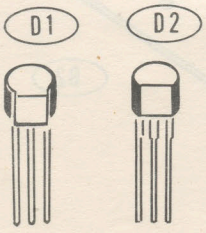
D1 ( )	3	2N5771	417-292	Q2,Q3,Q4
D2 ( )	2	MPSA20	417-801	Q5,Q6
D3 ( )	1	E-304	417-828	Q1
D4 ( )	1	UA7805	442-54	IC27
D5 ( )	3	SN7400N	443-1	IC14,IC17,IC26
D5 ( )	1	SN7490AN	443-629	IC3
D5 ( )	11	SN7490N (or AN)	443-7	IC4,IC5,IC6, IC7,IC19,IC20, IC21,IC22,IC23, IC24,IC25
D5 ( )	1	SN7450	443-15	IC15
D5 ( )	1	SN74122N	443-23	IC16
D5 ( )	1	SN74132N	443-625	IC18
D5 ( )	5	UA9368	443-694	IC8,IC9,IC10, IC11,IC12
D5 ( )	1	SN74S64	443-697	IC2
D5 ( )	1	SN7476N	443-16	IC13
D5 ( )	1	MC10116	443-747	IC1

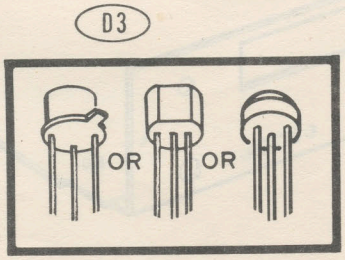


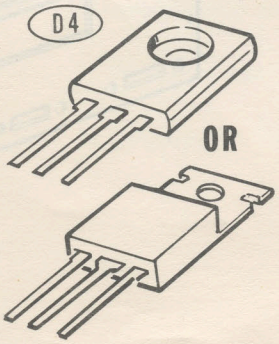








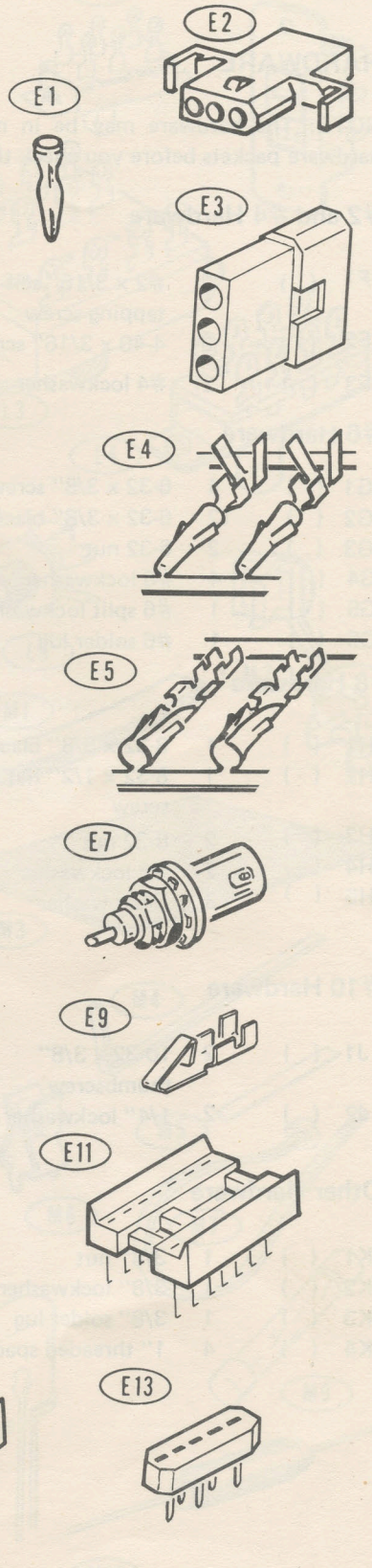




KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.

SOCKETS-CONNECTORS

E1 ( )	4	Wire connector	432-134
E2 ( )	1	Power plug	432-148
E3 ( )	1	Power socket	432-149
E4 ( )	2	Male connector pin	432-854
E5 ( )	2	Female connector pin	432-855
E6 ( )	30	F connector	432-734
E7 ( )	1	BNC connector with hardware	432-758
E8 ( )	1	IC connector	432-865
E9 ( )	3	IC connector pin	432-866
E10 ( )	1	Black banana jack with nut	436-22
E10 ( )	1	White banana jack with nut	436-24
E11 ( )	19	14-pin IC socket	434-298
E12 ( )	7	16-pin IC socket	434-299
E13 ( )	10	5-pin socket	434-292



KEY No.		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 following list.

#2 and #4 Hardware

F1	( )	2	#2 x 3/16" self-tapping screw	250-212
F2	( )	6	4-40 x 3/16" screw	250-366
F3	( )	2	#4 lockwasher	254-9

#6 Hardware

G1	( )	4	6-32 x 3/8" screw	250-233
G2	( )	12	6-32 x 3/8" black screw	250-538
G3	( )	2	6-32 nut	252-77
G4	( )	4	#6 lockwasher	254-25
G5	( )	1	#6 split lockwasher	254-8
G6	( )	1	#6 solder lug	259-1

#8 Hardware

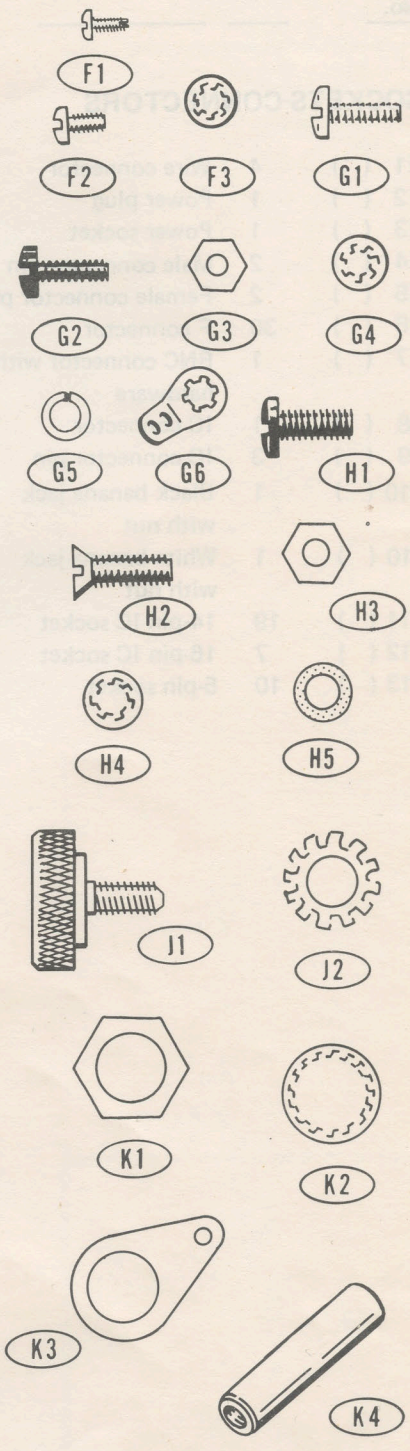
H1	( )	1	8-32 x 3/8" black screw	250-1186
H2	( )	1	8-32 x 1/2" flat head screw	250-571
H3	( )	2	8-32 nut	252-78
H4	( )	2	#8 lockwasher	254-2
H5	( )	3	Fiber washer	253-5

#10 Hardware

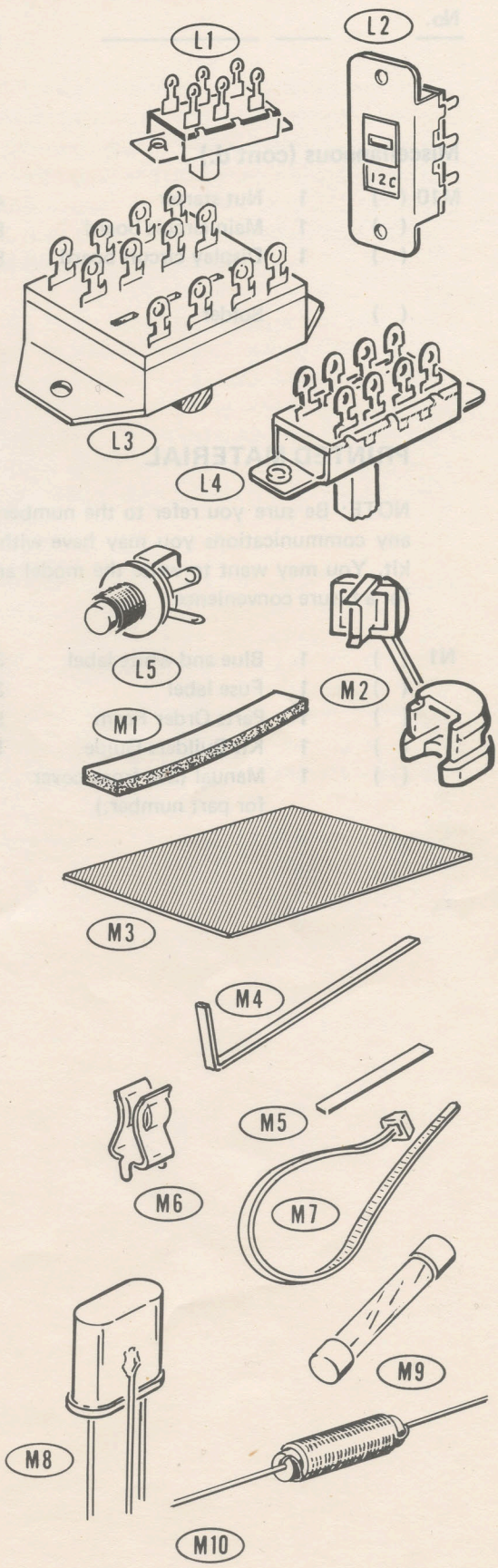
J1	( )	2	10-32 x 3/8" thumbscrew	250-1147
J2	( )	2	1/4" lockwasher	254-12

Other Hardware

K1	( )	1	3/8" nut	252-76
K2	( )	1	3/8" lockwasher	254-5
K3	( )	1	3/8" solder lug	259-27
K4	( )	4	1" threaded spacer	255-11



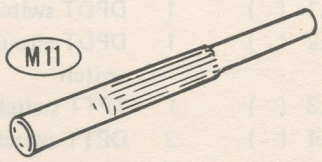
KEY No.	QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.
SWITCHES				
L1 ( )	1	DPDT switch	60-2	SW6
L2 ( )	1	DPDT circuit board switch	60-68	SW1
L3 ( )	1	TPTT switch	60-605	SW2
L4 ( )	2	DPTT switch	60-606	SW3, SW4
L5 ( )	1	Pushbutton switch	64-781	SW5
WIRE				
( )	24"	Large brown wire	344-34	
( )	6"	Large bare wire (used for soldering iron tip only)	340-11	
( )	37"	8-wire cable	347-55	
( )	42"	Small bare wire	340-2	
MISCELLANEOUS				
( )	1	Power transformer	54-899	T1
M1 ( )	1	Foam tape	73-92	
M2 ( )	1	Strain relief	75-71	
M3 ( )	1	Insulation paper	75-108	
( )	1	Line cord	89-23	
M4 ( )	1	IC puller	490-111	
M5 ( )	1	Alignment tool blade	205-778	
M6 ( )	2	Fuse clip	260-65	
M7 ( )	1	Cable tie	354-7	
M8 ( )	1	Crystal	404-426	Y1
M9 ( )	1	1/4-ampere slow-blow fuse	421-33	F1
M9 ( )	1	1/8-ampere slow-blow fuse	421-26	F1
M10 ( )	1	26 μH coil	45-62	L1



KEY No.		QTY.	DESCRIPTION	PART No.	CIRCUIT Component No.

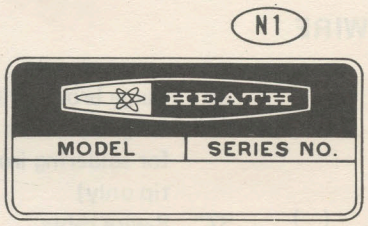
Miscellaneous (cont'd.)

M10	( )	1	Nut starter	490-5
	( )	1	Main circuit board	85-1889-1
	( )	1	Display circuit board	85-1665-1
	( )		Solder	



PRINTED MATERIAL

NOTE: Be sure you refer to the numbers on the blue and white label in any communications you may have with the Heath Company about this kit. You may want to write the model and series numbers in this sample for a future convenience.



N1	( )	1	Blue and white label	391-34
	( )	1	Fuse label	390-1255
	( )	1	Parts Order Form	597-260
	( )	1	Kit Builders Guide	597-308
	( )	1	Manual (See front cover for part number.)	

ASSEMBLY NOTES

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

The illustrations in this Manual are called Pictorials and Details. Pictorials show you the result of performing a group of assembly steps. Details generally show how to perform a single step. When you are directed to refer to a certain Pictorial "for the following steps," continue using that Pictorial until you are referred to another Pictorial for another group of steps.

Read the entire step before you perform the operation; then follow the instructions carefully. Position all parts as shown in the Pictorials.

Install the components on the component (lettered) side of the circuit board in the circuit board Pictorials and then solder the leads to the foil side. Resistors are designated by their resistance value in Ω (ohms), kΩ (kilohms), or MΩ (megohms) and color code. Capacitors will be designated by their capacitance value (in pF and μF) and type (disc, tantalum, or electrolytic). Position electrolytic and tantalum capacitors only as shown.

Due to the small foil area around the circuit board holes and the small areas between foils, 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 40-watt soldering iron with a small tip. Allow it to reach operating temperature, and then apply it only long enough to make a good solder connection.

If a small wattage, small-tip soldering iron is not available, proceed as follows: Be sure your soldering iron is cool. Wrap the large bare wire (supplied) tightly around the soldering iron tip as shown in Figure 1. Allow approximately 1/4" of wire to extend beyond the end of the soldering iron. Cut the wire end to a chisel shape as shown. Occasionally apply solder to the turns of large bare wire to achieve a good heat transfer.

Wipe the soldering iron tip often on a damp cloth or sponge. It is a good habit to wipe the iron each time you solder a group of connections. The soldering iron tip must be clean of oxidation and have a bright thin solder coat.

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

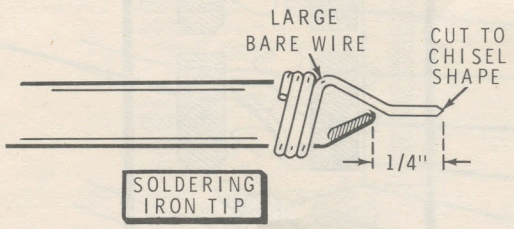


Figure 1

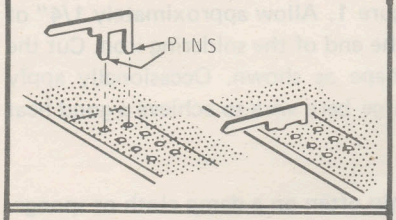
STEP-BY-STEP ASSEMBLY

CIRCUIT BOARD ASSEMBLY

FOR GOOD SOLDER CONNECTIONS, YOU MUST **KEEP THE SOLDERING IRON TIP CLEAN.** WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.

START

NOTE: In the next step you will install the F connectors. First, from the component side, insert the pins into the circuit board holes and press them in until the connector body rests against the circuit board. Then solder the pins to the foil.



( ) Position the display circuit board as shown and install 30 F connectors.

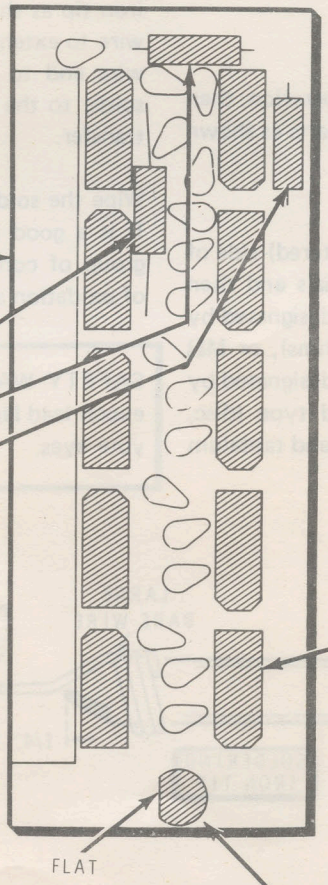
Install three 180 Ω (brown-gray-brown) resistors at:

( ) R101. . . . . .

( ) R102. . . . . .

( ) R103. . . . . .

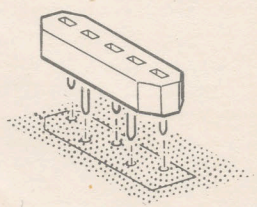
( ) Solder the leads to the foil and cut off the excess lead lengths.



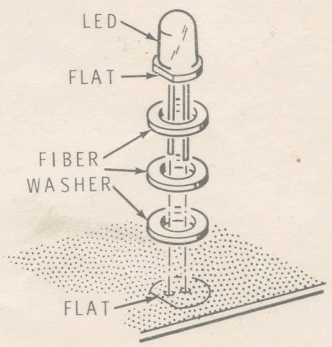
PICTORIAL 1-1

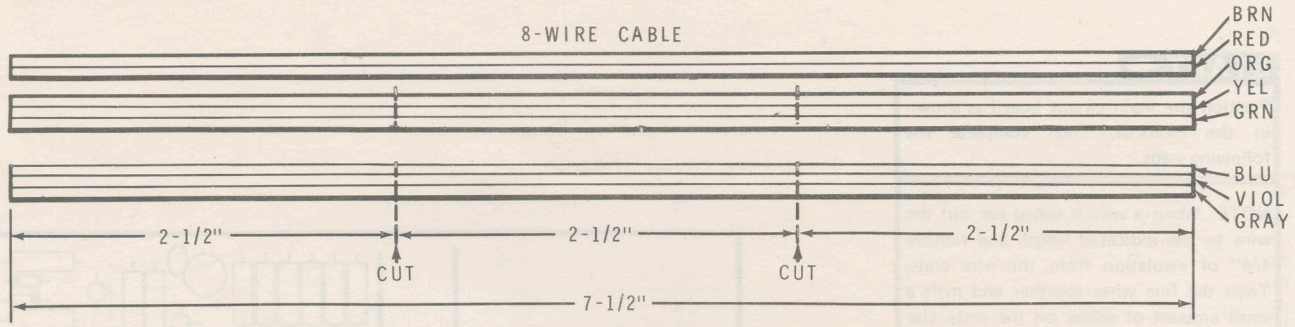
CONTINUE

( ) Mount ten 5-pin sockets as shown and solder the pins as you install them.

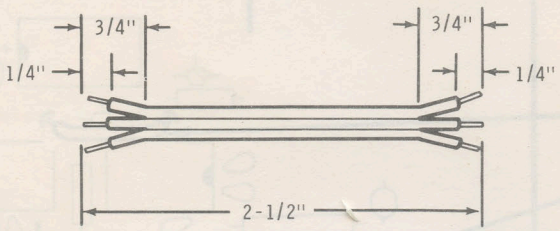


( ) D106: Mount the LED with three fiber washers. Position the flat as shown. Then solder the leads to the foil and cut off the excess lead lengths.





Detail 1-2A

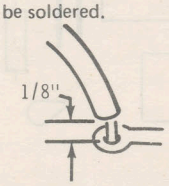


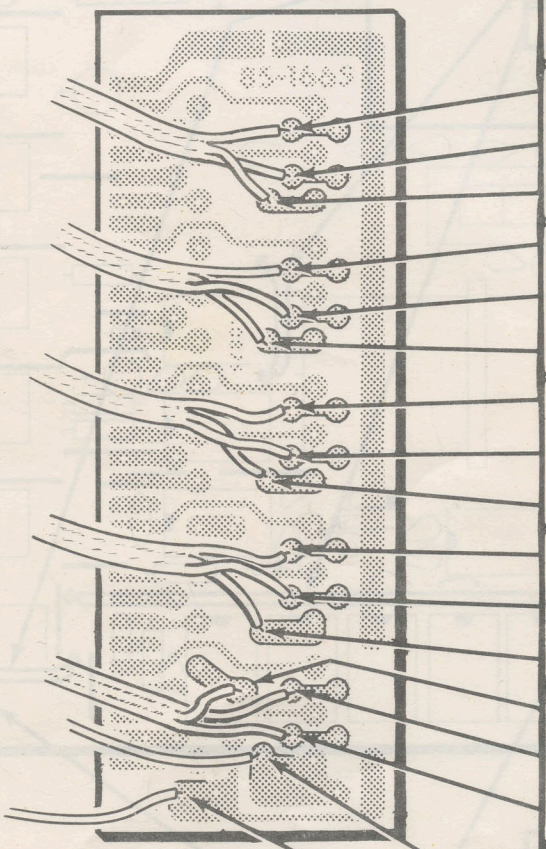
START

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

( ) Refer to Detail 1-2A and cut a 7-1/2" length of 8-wire cable. Then separate and set aside the brown and red wires, and prepare three 2-1/2" lengths of gray-violet-blue cable and three 2-1/2" lengths of orange-yellow-green cable. Twist the fine wires together and melt a small amount of solder on the ends.

NOTE: In the following steps you will install only one end of each wire. Solder each wire as it is connected. Then gently tug on the wire to be sure it is properly soldered. Leave the wire insulation 1/8" from the circuit board so the connection can be soldered.





PICTORIAL 1-2

CONTINUE

Install the 3-wire cables in the following steps as directed, even though some of the wires may seem out of sequence.

( ) T (blue).

( ) S (gray).

( ) R (violet).

( ) P (orange).

( ) N (green).

( ) M (yellow).

( ) L (blue).

( ) K (gray).

( ) J (violet).

( ) H (orange).

( ) G (green).

( ) F (yellow).

( ) E (violet).

( ) D (blue).

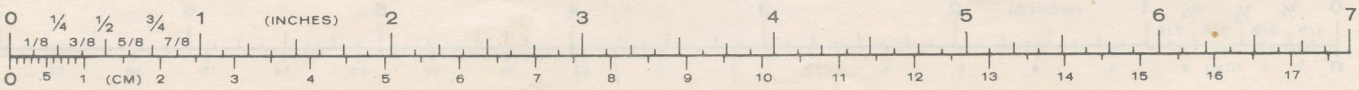
( ) A (gray).

( ) Separate the three wires and set aside the yellow wire.

( ) B (orange).

( ) C (green).

Turn the circuit board over and cut off the excess lead lengths. Check to be sure the bare end of the violet wire you installed at hole E does not touch the resistor lead on the other side of the circuit board. Then set the circuit board aside temporarily.



START

Position the main circuit board as shown in the Pictorial. Then complete the following steps.

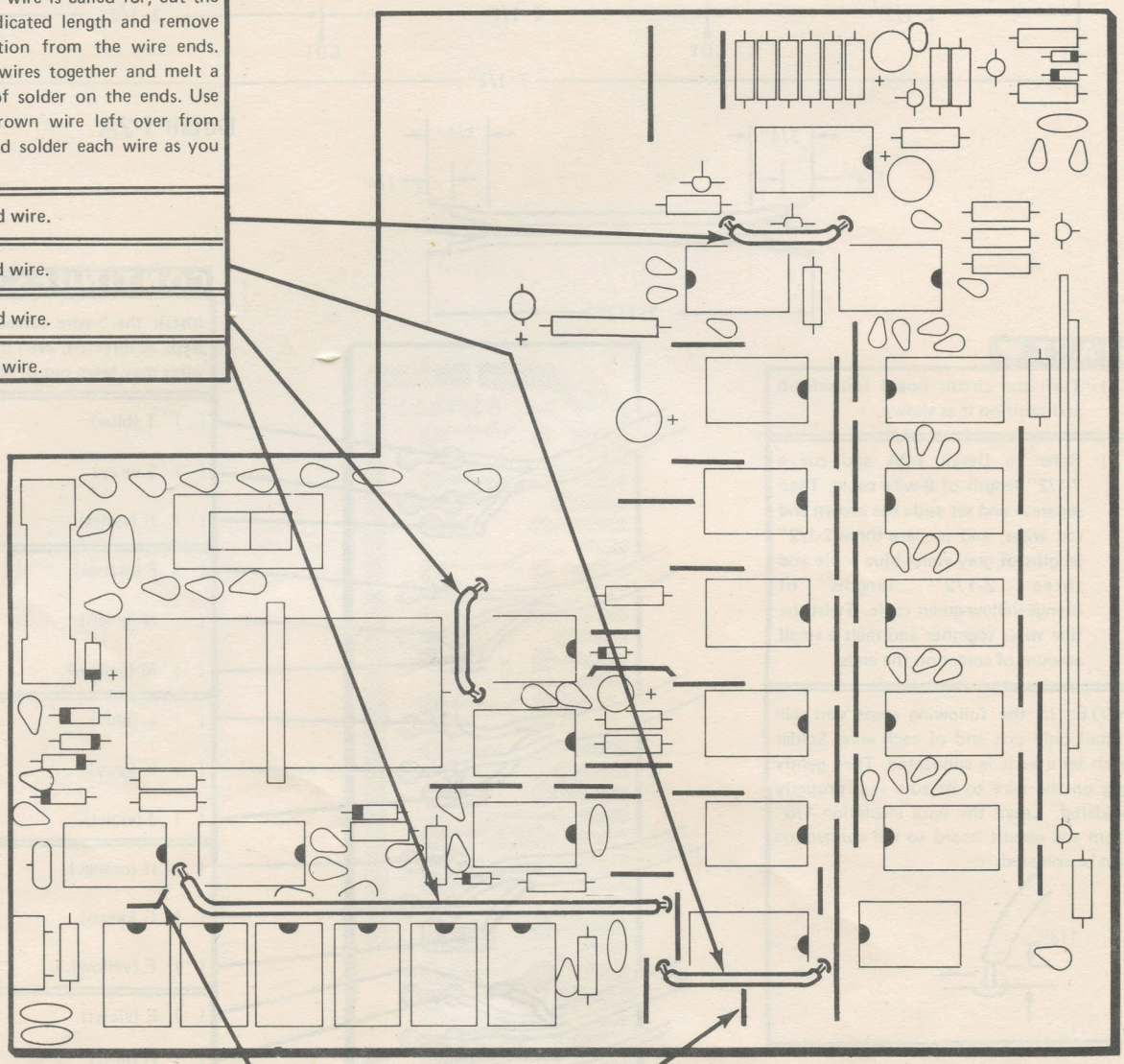
NOTE: When a wire is called for, cut the wire to the indicated length and remove 1/4" of insulation from the wire ends. Twist the fine wires together and melt a small amount of solder on the ends. Use the red and brown wire left over from Pictorial 1-1 and solder each wire as you install it.

( ) 1-1/4" red wire.

( ) 1-1/2" red wire.

( ) 1-1/4" red wire.

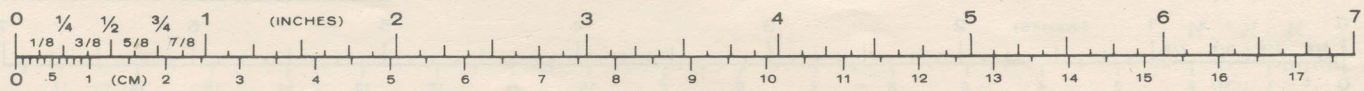
( ) 4" brown wire.



( ) Install bare wires at each of the 36 wire (J) locations as follows:

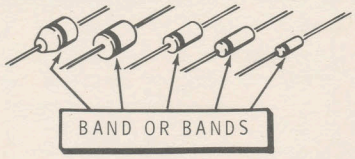
Insert one end of the small bare wire 1/4" into one hole, measure 1/4" past the other indicated hole and cut the wire. Bend this end into the hole, solder both ends to the foil and cut off the excess lead lengths. NOTE: Be sure this wire does not melt the insulation on the nearby insulated wire.

PICTORIAL 2-1

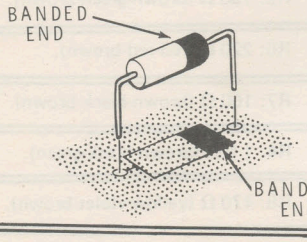


START

NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES.



When you install diodes, always position the banded end as shown on the circuit board.



Install five 1N4149 (#56-56) diodes at:

( ) D2. . . . . .

( ) D1. . . . . .

( ) D4. . . . . .

( ) D3. . . . . .

( ) D5. . . . . .

( ) D6: 1N4653 (#56-44) zener diode.

( ) Install five 1N4002 (#57-65) diodes at D7 through D11.

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

( ) R21: 680 Ω (blue-gray-brown).

( ) R22: 680 Ω (blue-gray-brown).

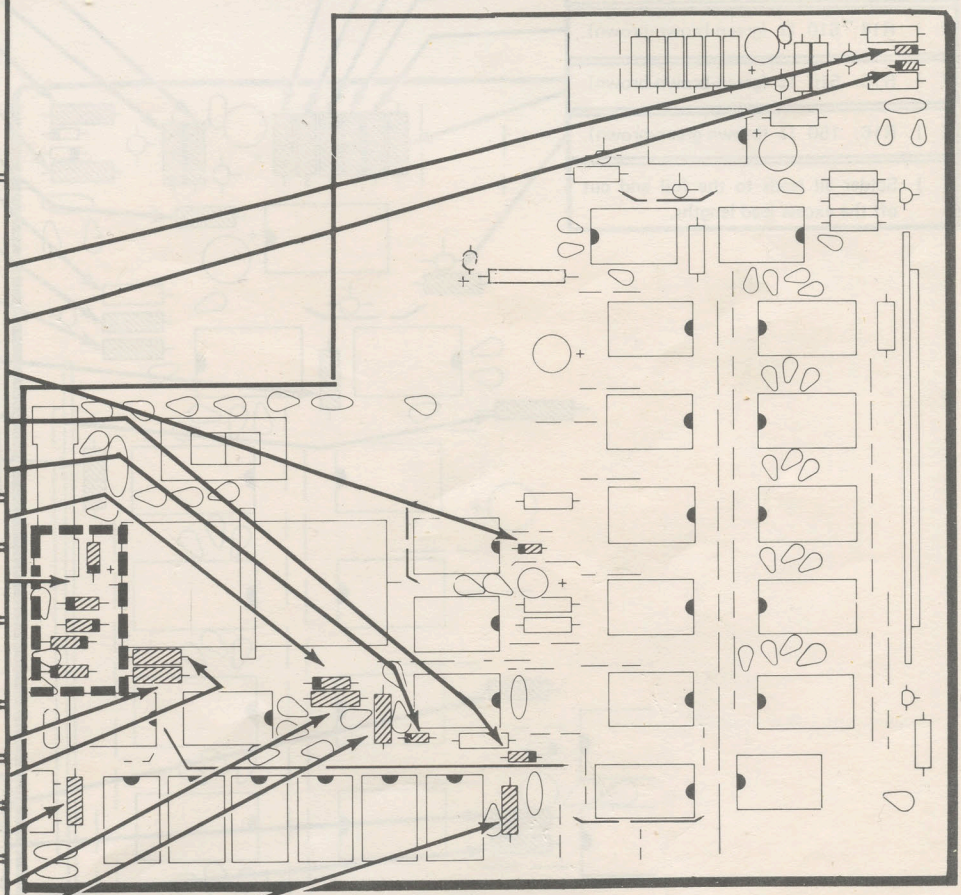
( ) R23: 150 Ω (brown-green-brown).

( ) R33: 270 Ω (red-violet-brown).

( ) R29: 470 Ω (yellow-violet-brown).

( ) R27: 470 Ω (yellow-violet-brown).

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



PICTORIAL 2-2

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

IDENTIFICATION DRAWING

PART NUMBER

START

NOTE: The 510 Ω (green-brown-brown) and 150 Ω (brown-green-brown) resistors have similar color codes. Be sure you install the right resistors at the proper locations in the following steps.

( ) R13: 510 Ω (green-brown-brown).

( ) R12: 510 Ω (green-brown-brown).

( ) R11: 1000 Ω (brown-black-red).

( ) R9: 1000 Ω (brown-black-red).

( ) R14: 510 Ω (green-brown-brown).

( ) R15: 510 Ω (green-brown-brown).

( ) R16: 150 Ω (brown-green-brown).

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

CONTINUE

( ) R5: 150 Ω (brown-green-brown).

( ) R6: 220 Ω (red-red-brown).

( ) R7: 100 Ω (brown-black-brown).

( ) R4: 1 MΩ (brown-black-green).

( ) R8: 470 Ω (yellow-violet-brown).

This resistor will be installed later.

( ) R19: 10 kΩ (brown-black-orange).

( ) R18: 10 kΩ (brown-black-orange).

( ) R17: 39 Ω (orange-white-black).

( ) L1: 26 μH coil.

( ) R34: 1000 Ω (brown-black-red).

( ) R28: 47 kΩ (yellow-violet-orange).

( ) R25: 10 kΩ (brown-black-orange).

( ) R24: 10 kΩ (brown-black-orange).

( ) R31: 10 kΩ (brown-black-orange).

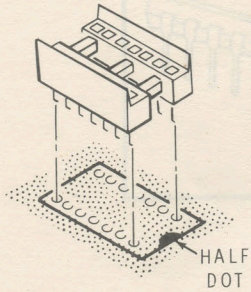
( ) R32: 1000 Ω (brown-black-red).

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

PICTORIAL 2-3

START

NOTE: You will install IC sockets in the following steps. Be sure the leads are straight, insert the leads into the holes, and solder the leads to the foil.



( ) 16-pin IC socket.

( ) Six 16-pin IC sockets.

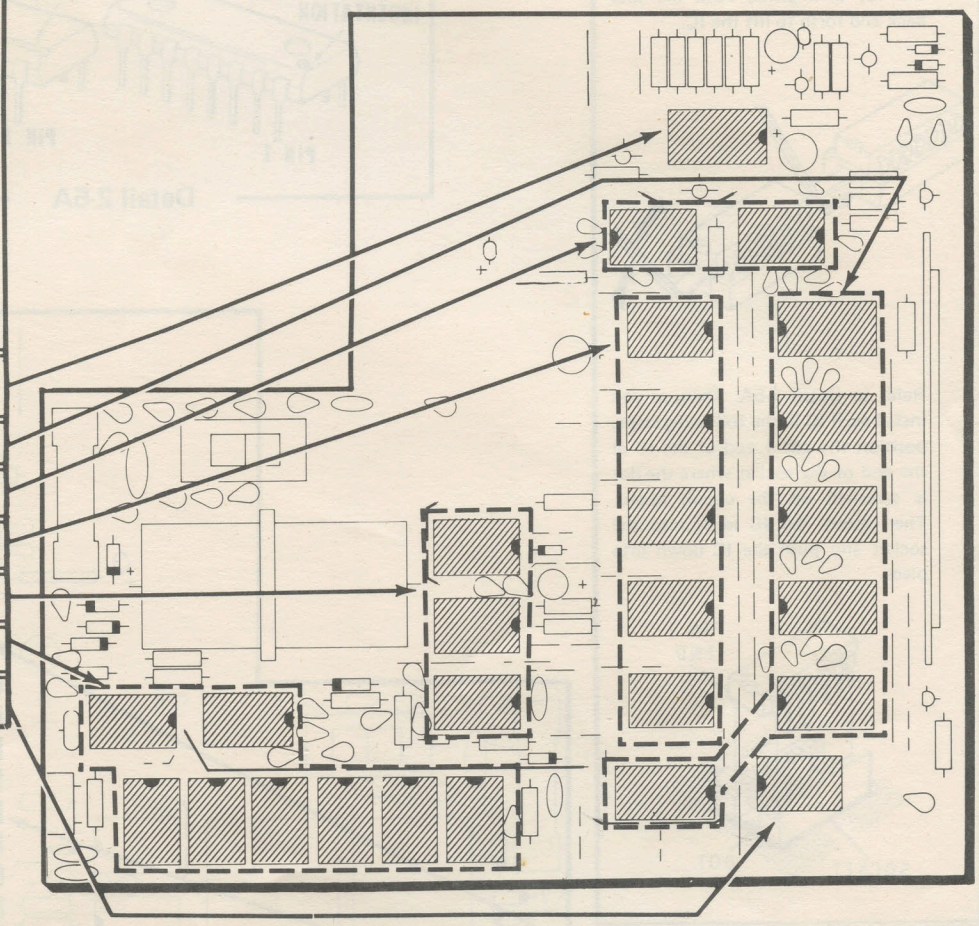
( ) Two 14-pin IC sockets.

( ) Five 14-pin IC sockets.

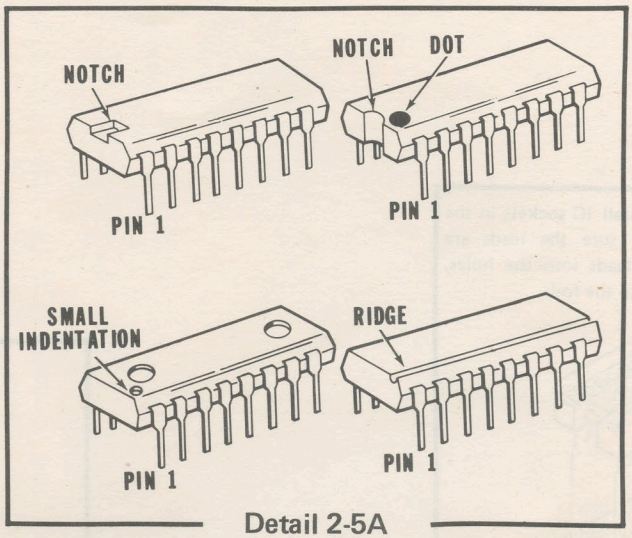
( ) Three 14-pin IC sockets.

( ) Eight 14-pin IC sockets.

( ) 14-pin IC socket.



PICTORIAL 2-4

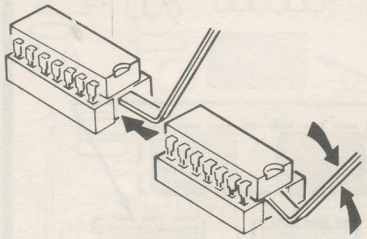


Detail 2-5A

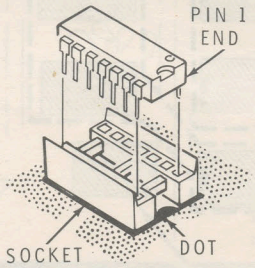
START

NOTES:

1. If it ever becomes necessary to remove an IC from its socket, use the IC puller. Insert its foot beneath the IC; then gently rock the tool back and forth to lift the IC.



2. Refer to Detail 2-5A. Then, as you install each IC in the following steps, position the pin 1 end of the IC at the end of the socket where the dot is screened on the circuit board. Then insert the IC leads into the socket and push the IC down into place.

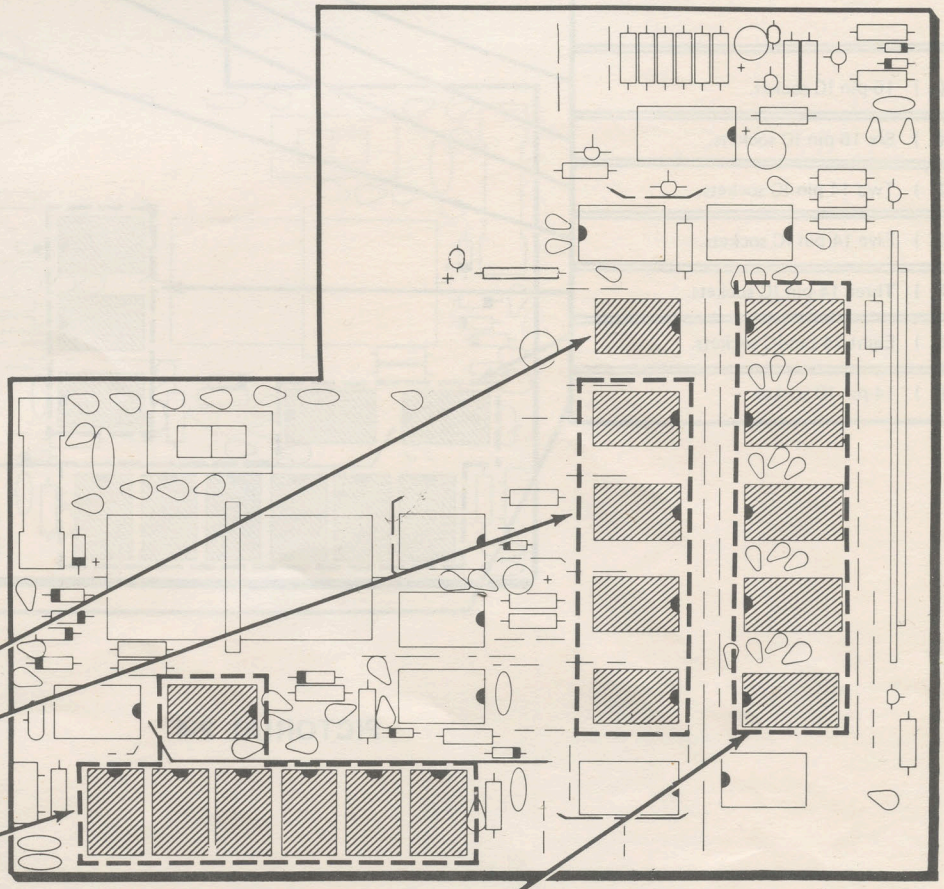


(✓) IC3: SN7490AN (#443-629).

(✓) Install four SN7490N (#443-7) IC's at: IC4, IC5, IC6, and IC7. (These IC's may be marked SN7490AN.)

(✓) Install seven SN7490N (#443-7) IC's at: IC19, IC20, IC21, IC22, IC23, IC24, and IC25.

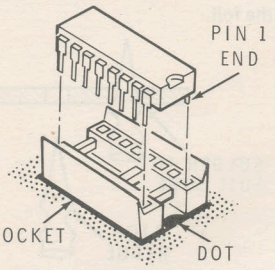
(✓) Install five 9368 (#443-694) IC's at IC8, IC9, IC10, IC11, and IC12.



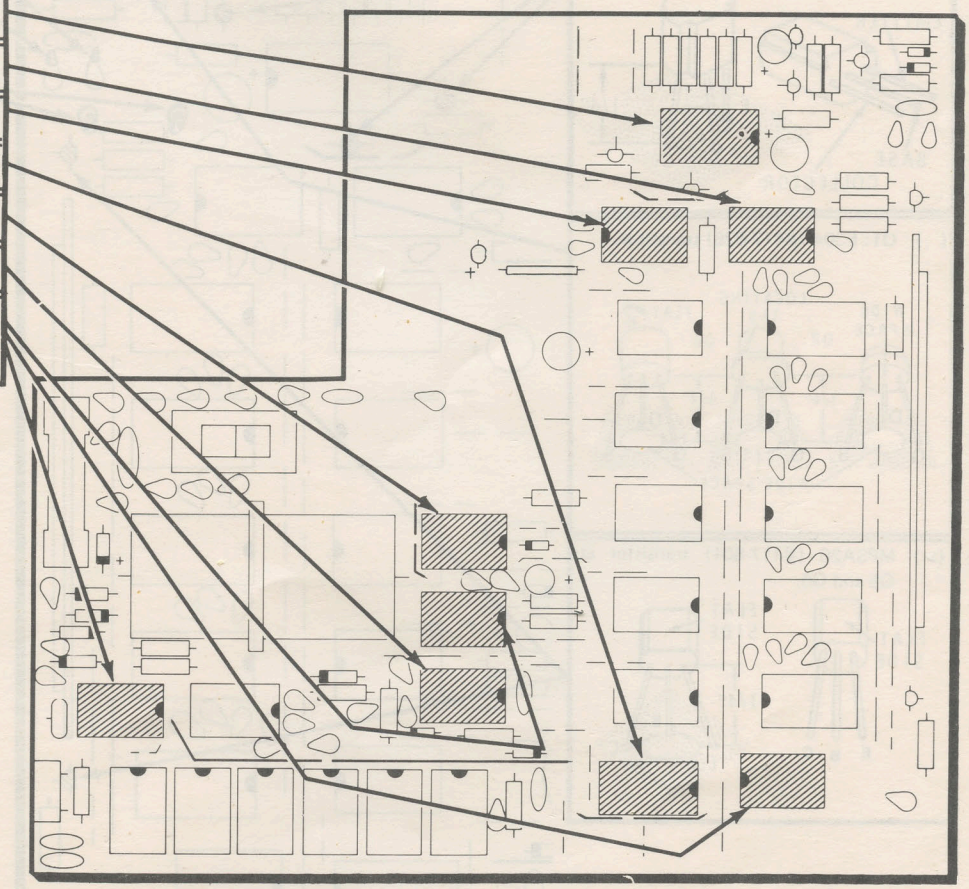
PICTORIAL 2-5

START

NOTE: As you install each IC in the following steps, position the pin 1 end of the IC at the end of the socket where the dot is screened on the circuit board. Then insert the IC leads into the socket and push the IC down into place.



- [ ] IC1: MC10116 (#443-747).
- [ ] IC2: SN74S64 (#443-697).
- [ ] IC15: SN7450 (#443-15).
- [ ] IC13: SN7476N (#443-16).
- [ ] IC16: SN74122N (#443-23).
- [ ] IC18: SN74132N (#443-625).
- [ ] Install three SN7400 (#443-1) IC's at: IC14, IC17, and IC26.



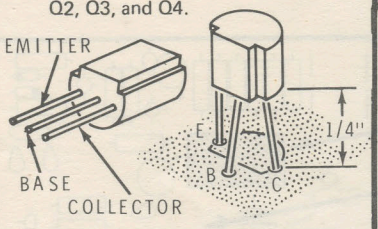
PICTORIAL 2-6

START

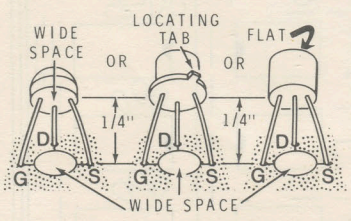
NOTE: In the following steps, install each of the transistors as follows:

1. Refer to the illustrations below and identify the E, C, and B leads of the transistor.
2. Bend the center lead of the transistor as shown below.
3. Insert the transistor leads into the corresponding E, B, and C holes in the circuit board.
4. Position the transistor 1/4" above the circuit board.
5. Turn the circuit board over, solder the leads to the foil, and cut off the excess lead lengths.

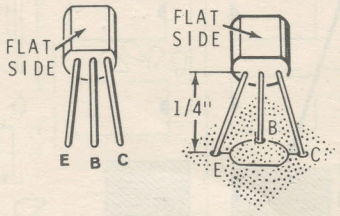
( ) 2N5771 (#417-292) transistors at Q2, Q3, and Q4.



( ) Q1: E304 (#417-828) transistor.

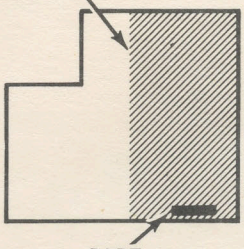


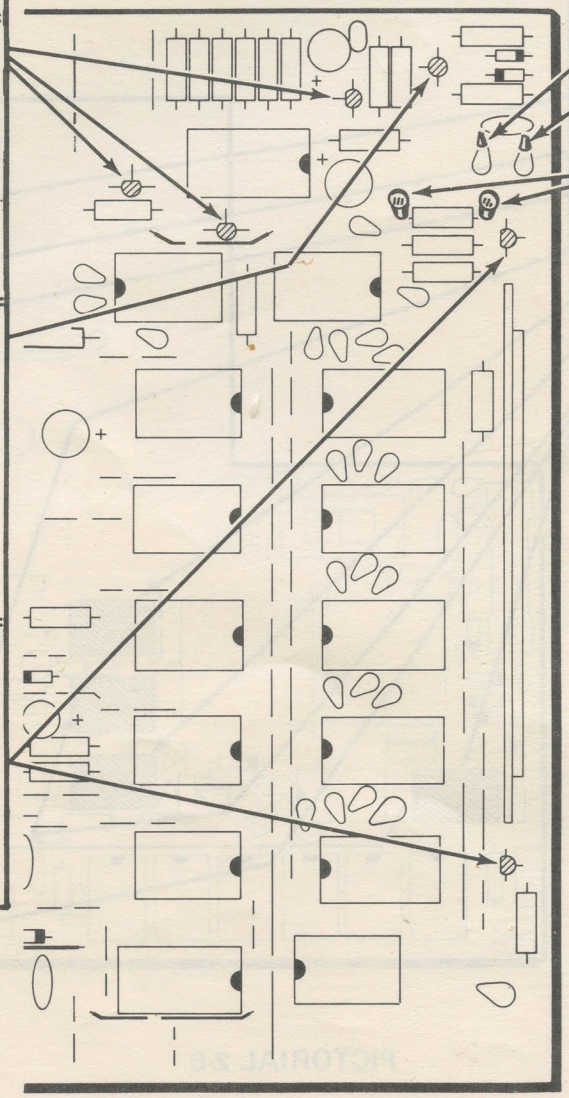
(✓) MPSA20 (#417-801) transistor at Q5 and Q6.



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

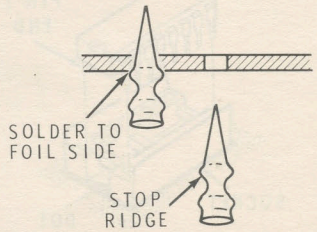
IDENTIFICATION DRAWING





CONTINUE

NOTE: In the following two steps, install wire connectors in the holes from the foil side of the circuit board as shown. Push the connectors into the holes until the stop ridge is down firmly against the circuit board. Then solder the connectors to the foil.



( ) Wire connector at B.

( ) Wire connector at A.

( ) Two wire connectors at 1000. Insert the pins from the component side of the board. Solder them to the foil.

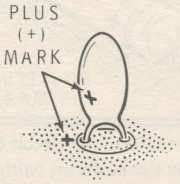
NOTE: A resistor will be connected here later.

PICTORIAL 2-7

START

( ) C10: .047 μF ceramic.

NOTE: When you install tantalum capacitors, be sure to position the plus (+) marked lead in the plus marked hole in the circuit board.



( ) C5: 10 μF tantalum.

( ) C6: 47 μF tantalum.

( ) C4: 10 pF disc.

( ) C14: 47 μF tantalum.

( ) C18: 33 μF tantalum.

( ) C17: .05 μF disc.

( ) C15: .01 μF disc.

( ) C12: 15 μF tantalum.

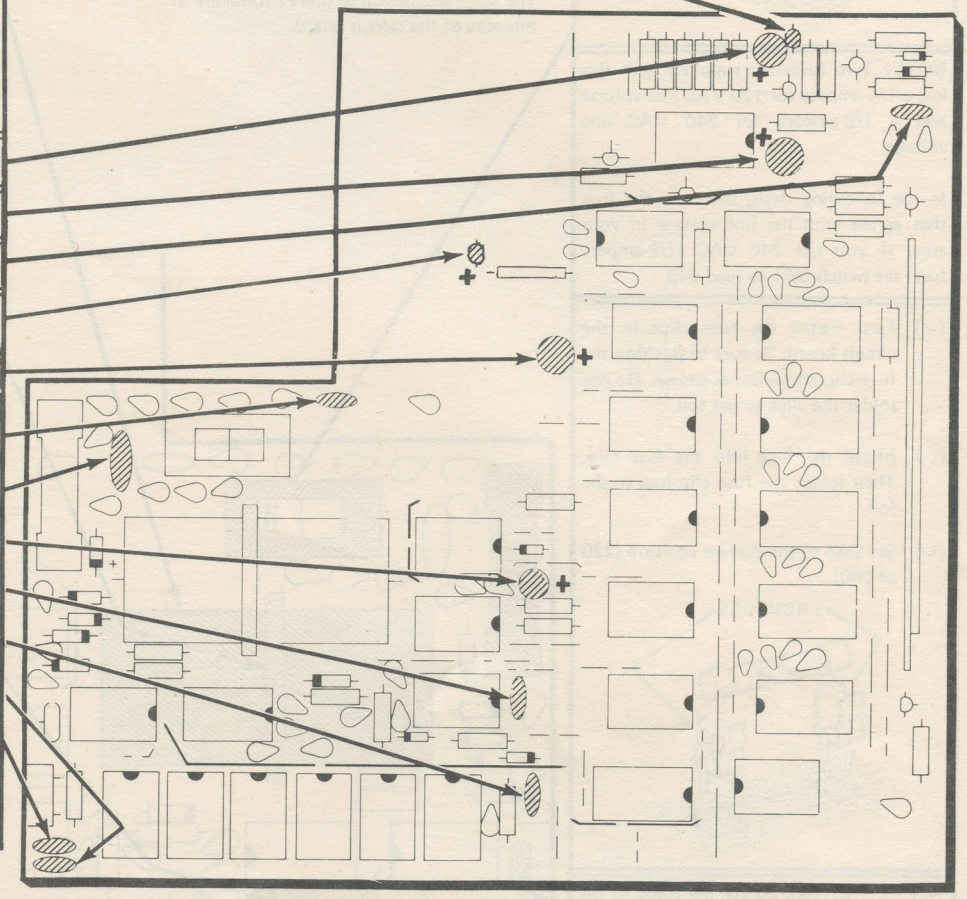
( ) C13: .05 μF disc.

( ) C11: .05 μF disc.

( ) C9: 200 pF disc.

( ) C8: 10 pF disc.

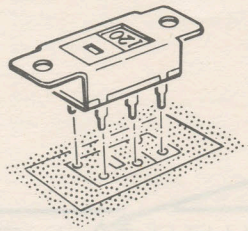
( ) Solder all leads to the foil and cut off the excess lead lengths.



PICTORIAL 2-8

START

(✓) SW1: DPDT circuit board switch. Operate the switch so the "120" reads as shown. Insert the switch lugs into the holes in the circuit board and solder them to the foil.



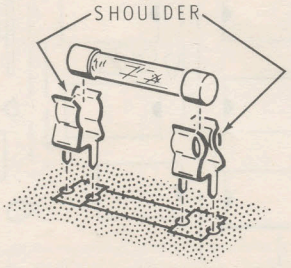
NOTE: Two fuses are supplied with this kit, a 1/4-ampere for 120 VAC line voltage and a 1/8-ampere for 240 VAC line voltage.

In the following steps, use only the fuse that agrees with the line voltage in your area. If you use 240 VAC (1/8-ampere fuse) set switch SW1 to read 240.

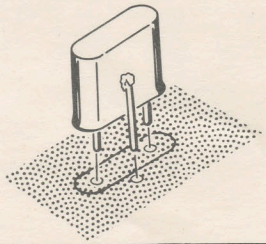
(✓) First install the fuse clips in the circuit board. Be sure to position the fuse clip shoulders as shown. Do not solder the clips to the foil.

(✓) Install the fuse into the fuse clip. Then solder the fuse clip lugs to the foil.

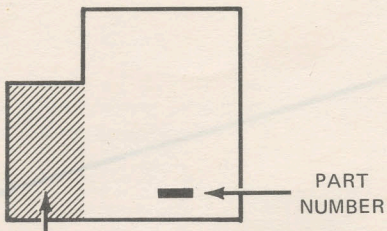
(✓) Set SW1 to the correct position (120 or 240).



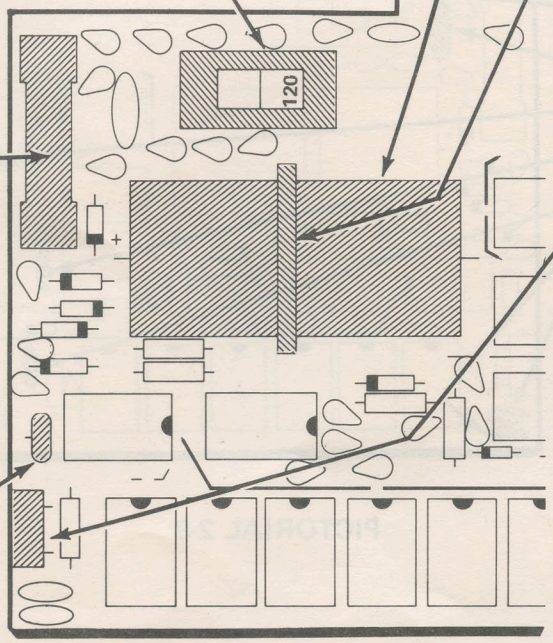
(✓) Y1: Crystal. Solder the leads to the foil and cut off the excess lead lengths.



IDENTIFICATION DRAWING

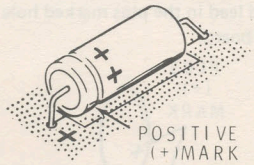


The steps performed in this Pictorial are in this area of the circuit board.

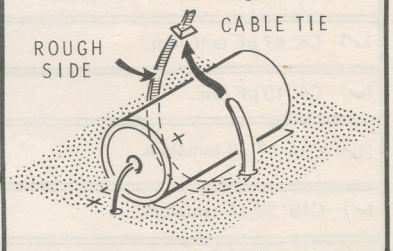


CONTINUE

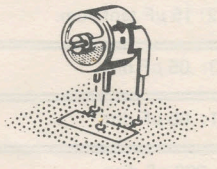
(✓) C16: 6000 µF electrolytic. When you install electrolytic capacitors, always match the positive (+) mark on the capacitor with the positive (+) mark on the circuit board. Solder the leads to the foil and cut off the excess lead lengths.



(✓) Secure C16 to the circuit board with a cable ties as shown (with the rough side of the cable tie on the inside). Cut off the excess length.



(✓) C7: 7-25 pF trimmer. Solder the lugs to the foil.



CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions.

(✓) Unsoldered connections.

(✓) "Cold" solder connections.

(✓) Solder bridges between foil patterns.

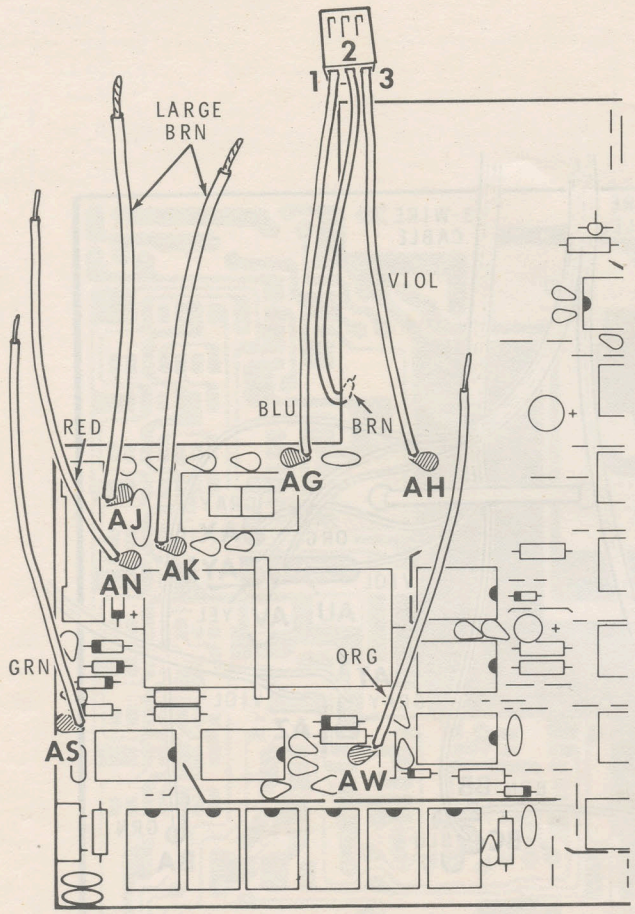
(✓) Protruding leads which could touch together.

(✓) Integrated circuits for the proper type and installation.

(✓) Electrolytic capacitors for the correct position of the positive (+) end.

(✓) Diodes for the correct position of the banded end.

PICTORIAL 2-9



PICTORIAL 2-10

Refer to Pictorial 2-10 for the following steps.

(✓) Cut a 4" length of 8-wire cable, separate the eight wires, and prepare both ends of each wire.

Connect one end of the wires as follows. Solder each wire to the foil as you install it.

(✓) Violet wire to hole AH.

(✓) Brown wire to the indicated large foil area on the bottom of the circuit board.

(✓) Blue wire to hole AG.

(✓) Red wire to hole AN.

(✓) Green wire to hole AS.

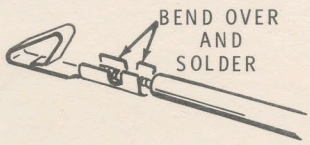
(✓) Orange wire to hole AW.

The other wires will be used later.

(✓) Prepare two 11" large brown wires.

(✓) Connect one large brown wire to hole AJ. Solder it to the foil.

(✓) Connect the other large brown wire to hole AK. Solder it to the foil.



Detail 2-10A

(✓) Refer to Detail 2-10A and install a connector pin on the free end of the blue wire.

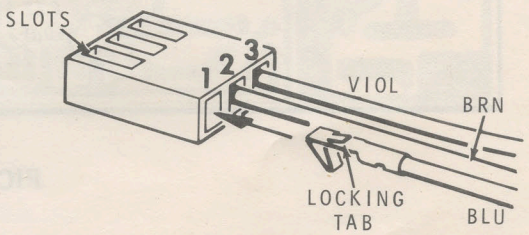
(✓) In a similar manner, install a connector pin on the free end of the violet wire.

(✓) In a similar manner, install a connector pin on the free end of the brown wire.

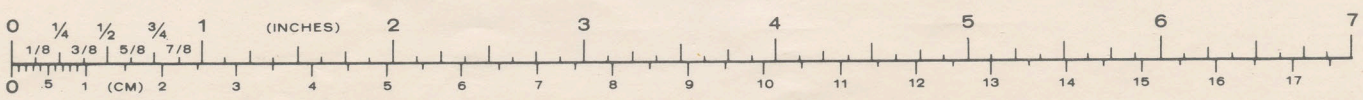
(✓) Refer to Detail 2-10B and position the IC connector so its slots are as shown. Then position the IC connector pin on the blue wire so its locking tab is up as shown. Push the connector pin into opening #1 of the connector until the pin locks in place.

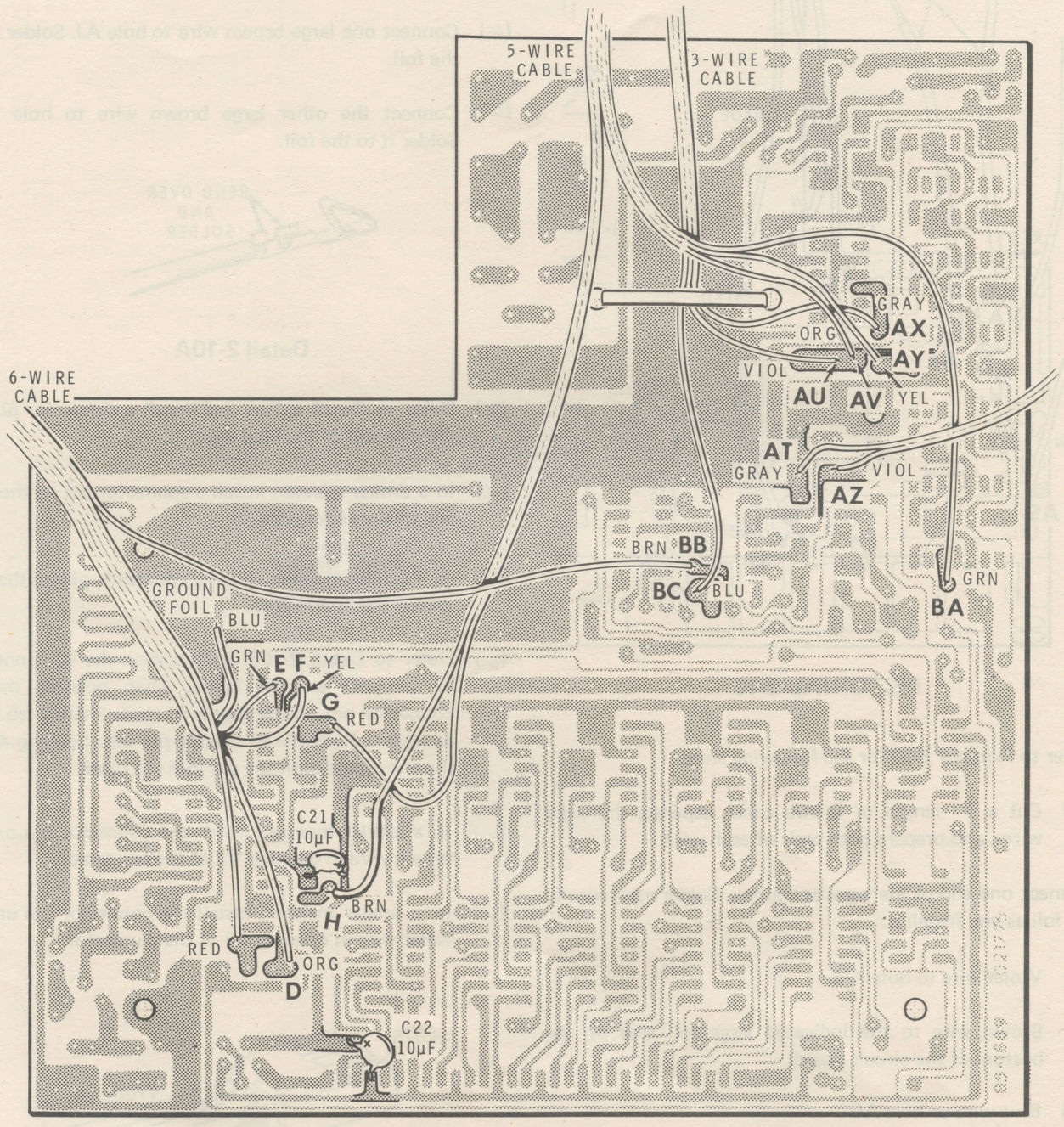
(✓) In a similar manner, install the connector pin on the brown wire in opening #2 of the connector.

(✓) In a similar manner, install the connector pin on the violet wire in opening #3 of the connector.

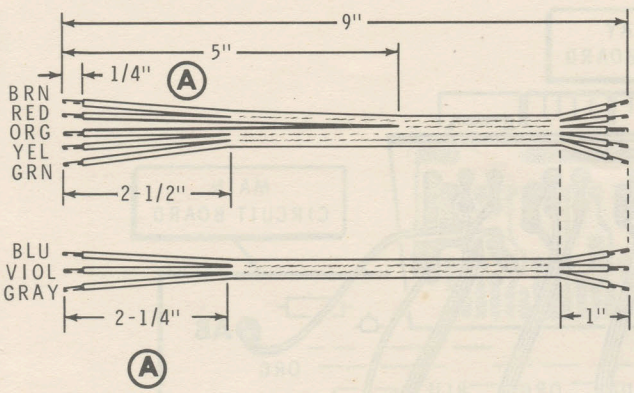


Detail 2-10B

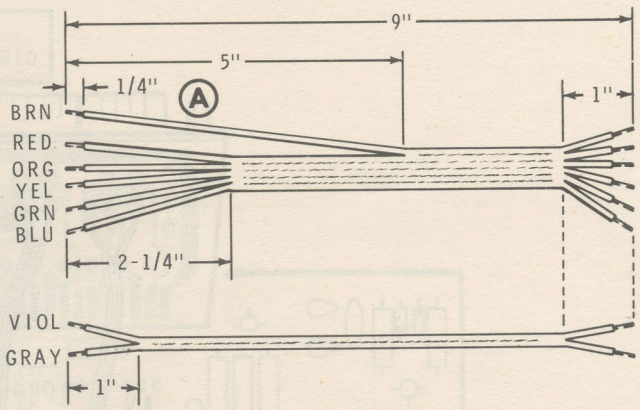




PICTORIAL 2-11



Detail 2-11A



Detail 2-11B

Refer to Pictorial 2-11 for the following steps.

(✓) Refer to Detail 2-11A and separate a 9" length of 8-wire cable into two cables and prepare them as shown.

(✓) Turn the circuit board foil-side-up.

Connect end A of the 3-wire cable to the indicated circuit board holes. Leave 1/8" of bare wire exposed for soldering and solder the wires to the foil as you install them.

(✓) Blue wire to hole BC.

(✓) Violet wire to hole AU.

(✓) Gray wire to hole AX.

(✓) Route this cable under the cable tie as shown.

Connect end A of the 5-wire cable as follows:

(✓) Green wire to hole BA.

(✓) Orange wire to hole AV.

(✓) Yellow wire to hole AY.

(✓) Red wire to hole G.

(✓) Brown wire to hole H.

( ) Refer to Detail 2-11B and separate a 9" length of 8-wire cable into two cables and prepare them as shown.

Connect either end of the 2-wire cable to the indicated circuit board holes as follows:

(✓) Gray wire to hole AT.

(✓) Violet wire to hole AZ.

Connect end A of the 6-wire cable as follows:

(✓) Blue wire to the indicated ground foil (no hole).

(✓) Green wire to hole E.

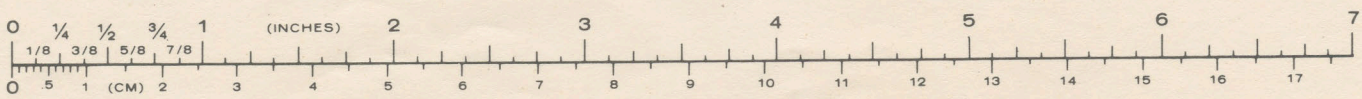
(✓) Yellow wire to hole F.

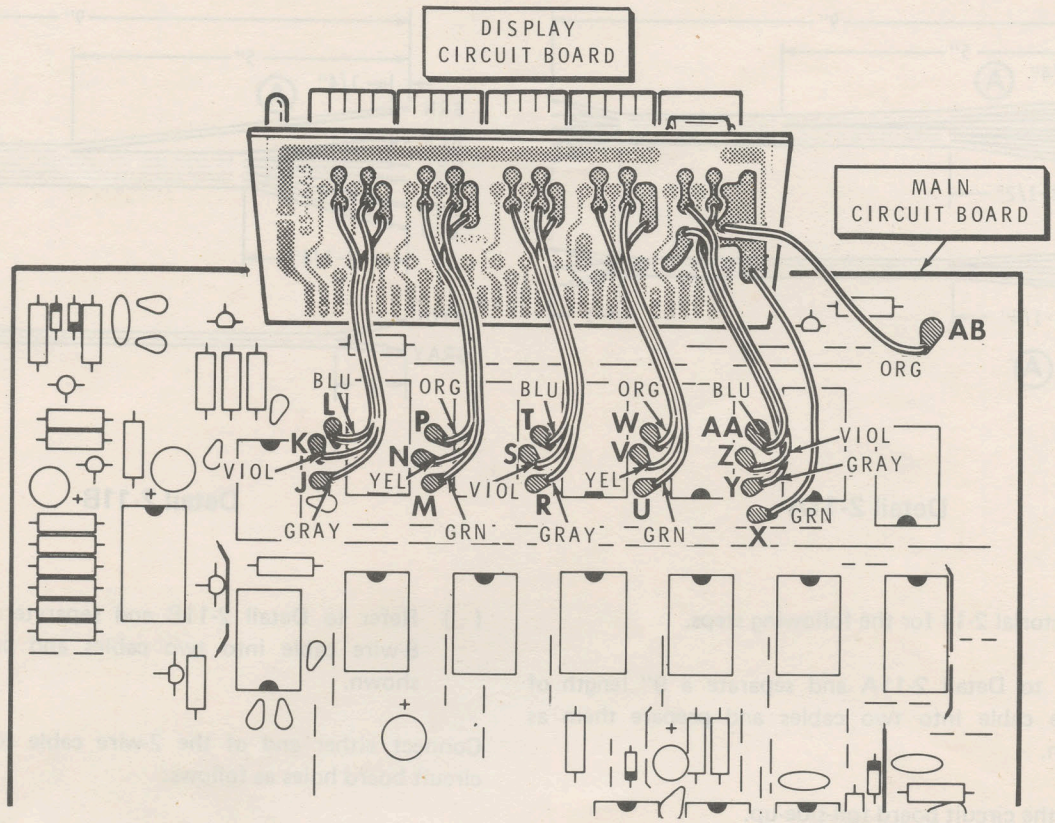
(✓) Orange wire to hole D.

(✓) Red wire to hole C.

(✓) Brown wire to hole BB.

(✓) C21, C22: 10 μF tantalum. Solder the leads directly to the foil. Be sure to connect the plus (+) marked leads as shown. Keep the leads as short as possible.





PICTORIAL 3-1

Refer to Pictorial 3-1 for the following steps.

( ) Turn the main circuit board component-side-up.

( ) Refer to Detail 3-1A and mount the display circuit board to the main circuit board. Be sure the F connector pins are straight; then insert them into the row of holes until the display circuit board sits flush with the main circuit board. Be sure the display board is perpendicular to the main board. Solder the pins to the foil and cut off the excess pin lengths.

( ) Individual green wire to hole X.

( ) Individual orange wire to hole AB.

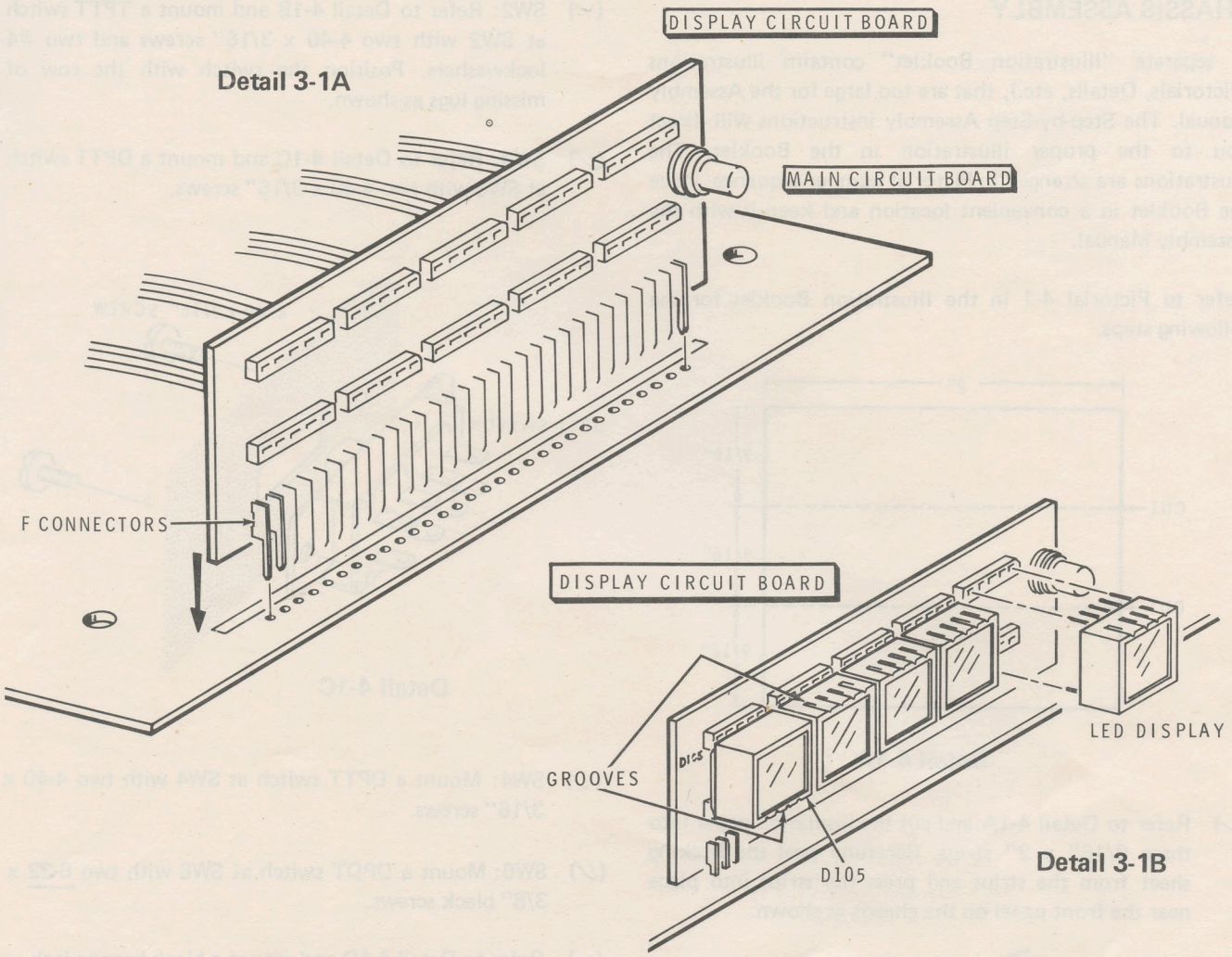
( ) Gray wire to hole Y.

( ) Violet wire to hole Z.

( ) Blue wire to hole AA.

( ) Green wire to hole U.

( ) Yellow wire to hole V.



Detail 3-1A

Detail 3-1B

( ) Orange wire to hole W.

( ) Gray wire to hole R.

( ) Violet wire to hole S.

( ) Blue wire to hole T.

( ) Green wire to hole M.

( ) Yellow wire to hole N.

( ) Orange wire to hole P.

( ) Gray wire to hole J.

( ) Violet wire to hole K.

( ) Blue wire to hole L.

( ) D105: Refer to Detail 3-1B and notice the grooved side of the LED displays. Position the grooves down and install an LED display in the sockets at D105. Be sure the pins are straight and each pin goes into a socket hole.

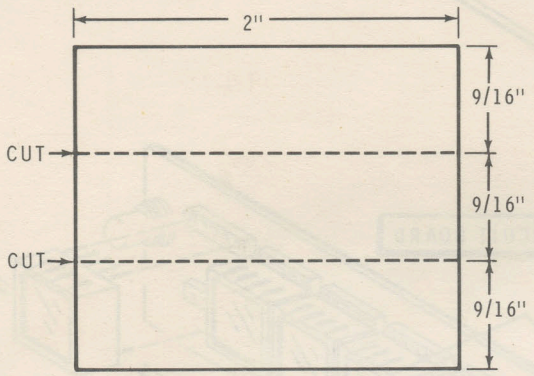
( ) D104, D103, D102, D101: Position the grooves up and mount the remaining four LED displays in the remaining sockets.

Temporarily set the circuit boards aside.

CHASSIS ASSEMBLY

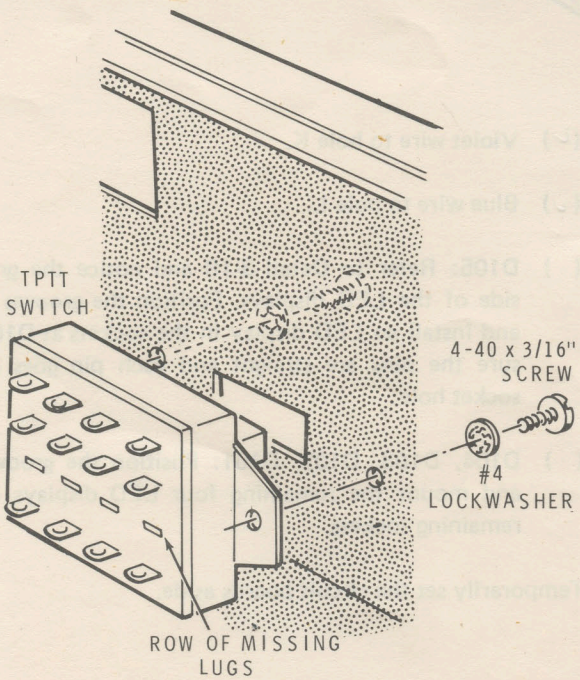
A separate "Illustration Booklet" contains illustrations (Pictorials, Details, etc.), that are too large for the Assembly Manual. The Step-by-Step Assembly instructions will direct you to the proper illustration in the Booklet. The illustrations are arranged in Pictorial number sequence. Place the Booklet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

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



Detail 4-1A

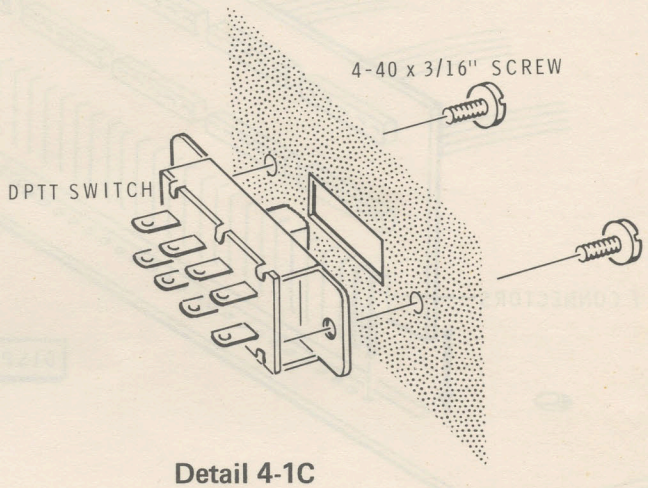
( ) Refer to Detail 4-1A and cut the insulation paper into three 9/16" x 2" strips. Carefully peel the backing sheet from the strips and press the strips into place near the front panel on the chassis as shown.



Detail 4-1B

( ) SW2: Refer to Detail 4-1B and mount a TPTT switch at SW2 with two 4-40 x 3/16" screws and two #4 lockwashers. Position the switch with the row of missing lugs as shown.

( ) SW3: Refer to Detail 4-1C and mount a DPTT switch at SW3 with two 4-40 x 3/16" screws.



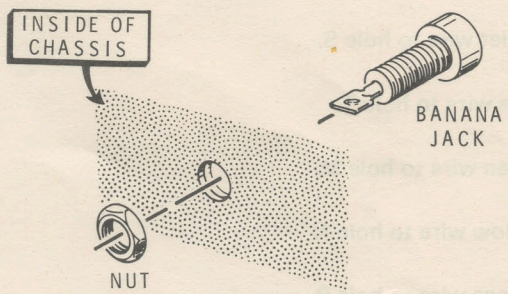
Detail 4-1C

( ) SW4: Mount a DPTT switch at SW4 with two 4-40 x 3/16" screws.

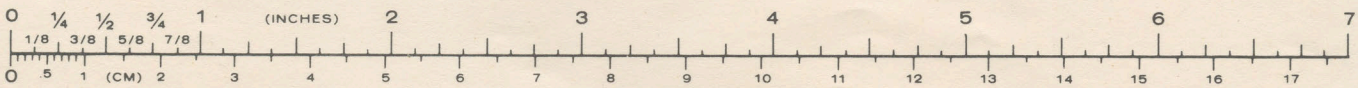
( ) SW6: Mount a DPDT switch at SW6 with two 6-32 x 3/8" black screws.

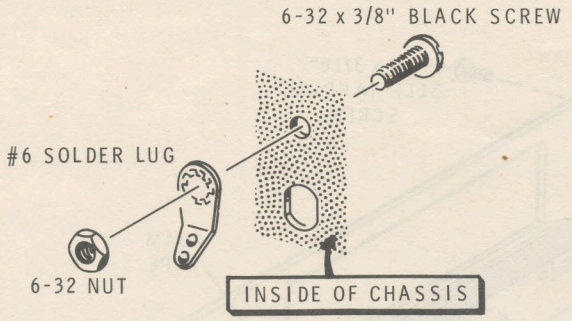
( ) Refer to Detail 4-1D and mount a black banana jack at AS with the attached nut. Do not overtighten the nut.

( ) In the same manner, mount a white banana jack at AW.

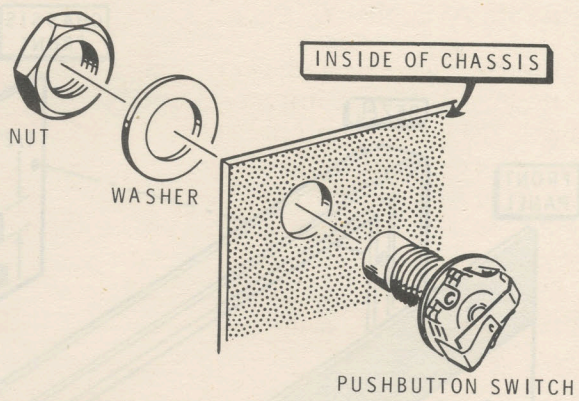


Detail 4-1D





Detail 4-1E

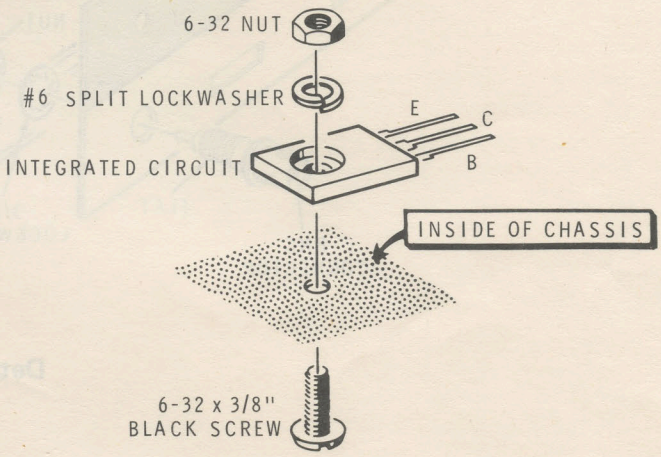


Detail 4-1F

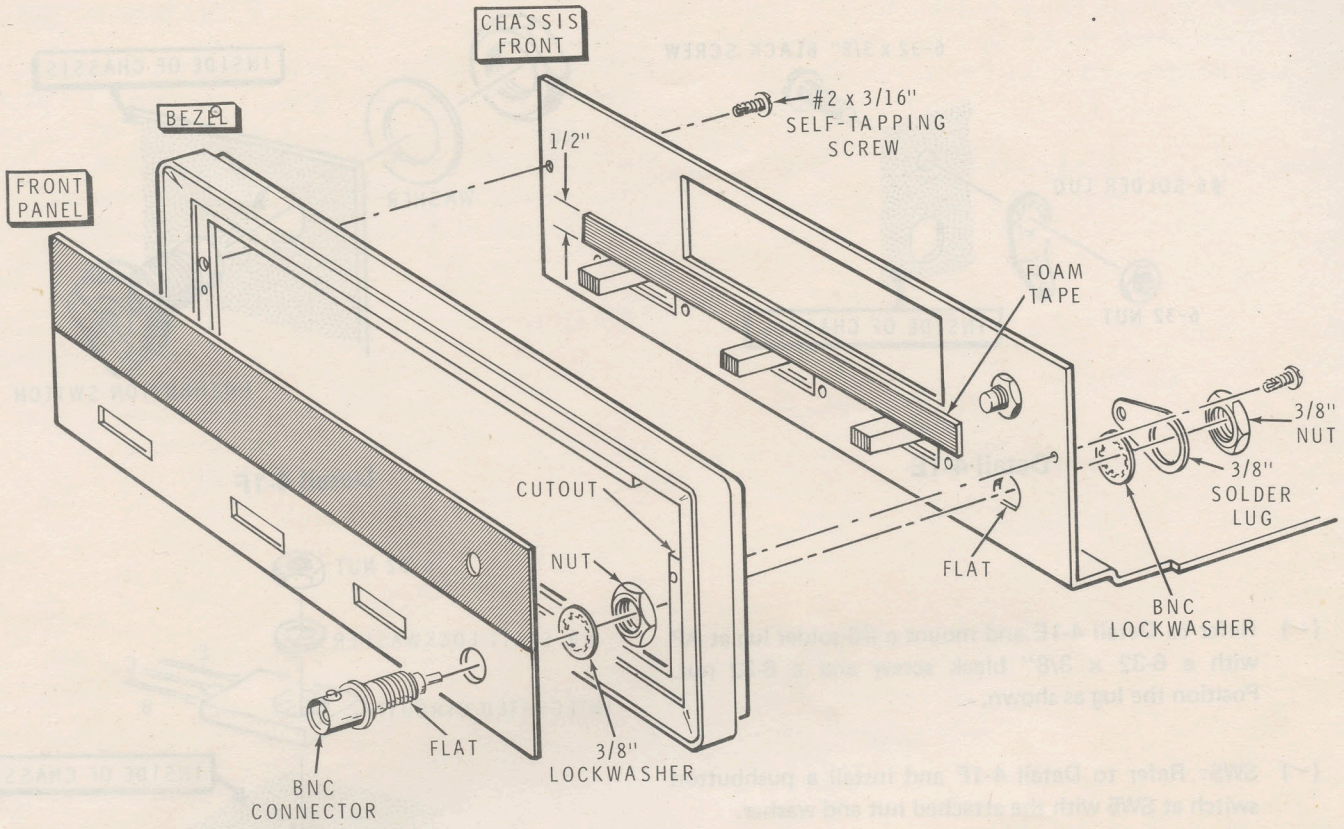
(✓) Refer to Detail 4-1E and mount a #6 solder lug at AP with a 6-32 x 3/8" black screw and a 6-32 nut. Position the lug as shown.

(✓) SW5: Refer to Detail 4-1F and install a pushbutton switch at SW5 with the attached nut and washer.

(✓) IC27: Refer to Detail 4-1G and mount UA7805 (#442-54) integrated circuit at IC27 with a 6-32 x 3/8" black screw, a #6 split lockwasher, and a 6-32 nut. Be sure the bare metal side of the integrated circuit is against the chassis, and position the integrated circuit as shown.



Detail 4-1G



Detail 4-1H

(✓) Refer to Detail 4-1H and mount the bezel to the chassis front with two #2 x 3/16" self-tapping screws. Position the cutout as shown.

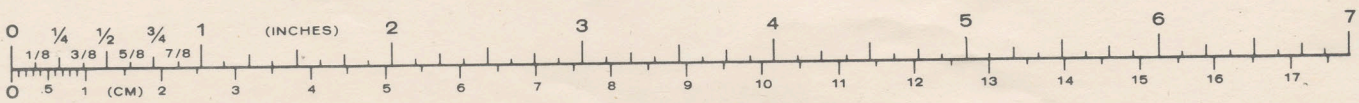
(✓) Cut the foam tape so it is 1/2" wide. Remove the protective paper from one side and press the foam tape to the chassis front as shown.

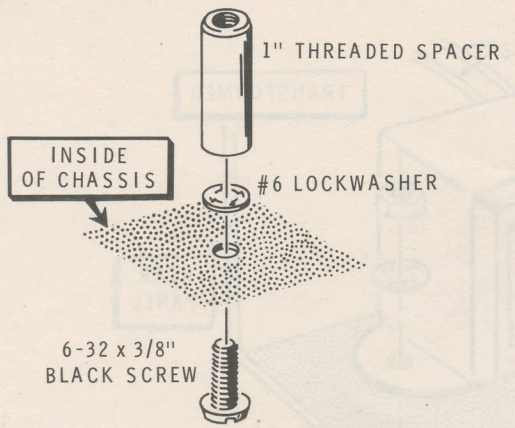
( ) Remove the protective paper backing from the front panel. (There may be tape on both sides.)

( ) Mount the BNC connector to the front panel with a 3/8" lockwasher and nut. (Do not use the lockwasher supplied with the BNC connector. It will be used later.) Position the flat down as shown. Also, be sure the flat on the nut closest to the bottom edge of the front panel is positioned down so it clears the bezel in the next step. This nut does not have to be real tight. fest/straff

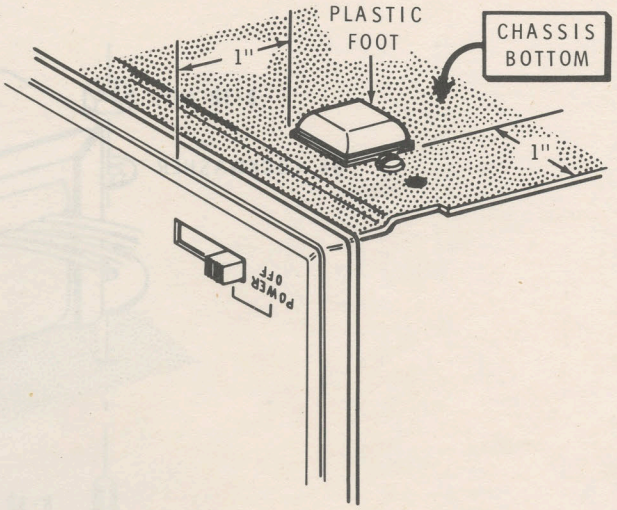
wirklich/tatsächlich

( ) Read the following step. Then position the front panel into place to make sure the parts fit properly before you actually perform the step.





Detail 4-1J



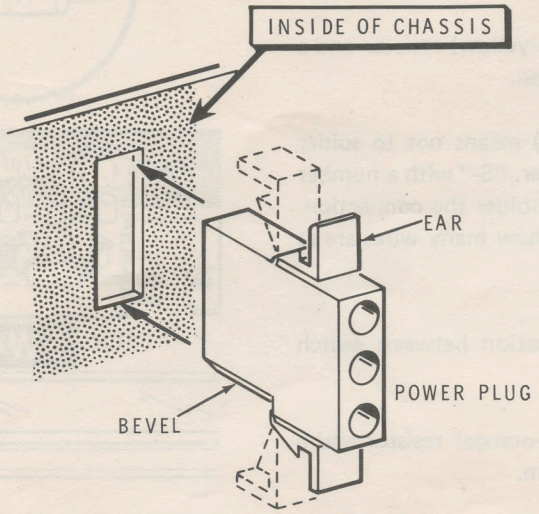
Detail 4-1K

(✓) Mount the front panel to the chassis as follows: Remove the protective paper from the foam tape. Position the BNC connector in the mounting hole and center the front panel in the bezel. Then press the front panel in place. Place the BNC lockwasher, a 3/8" solder lug, and a 3/8" nut on the BNC connector. Position the solder lug as shown. Then tighten the hardware.

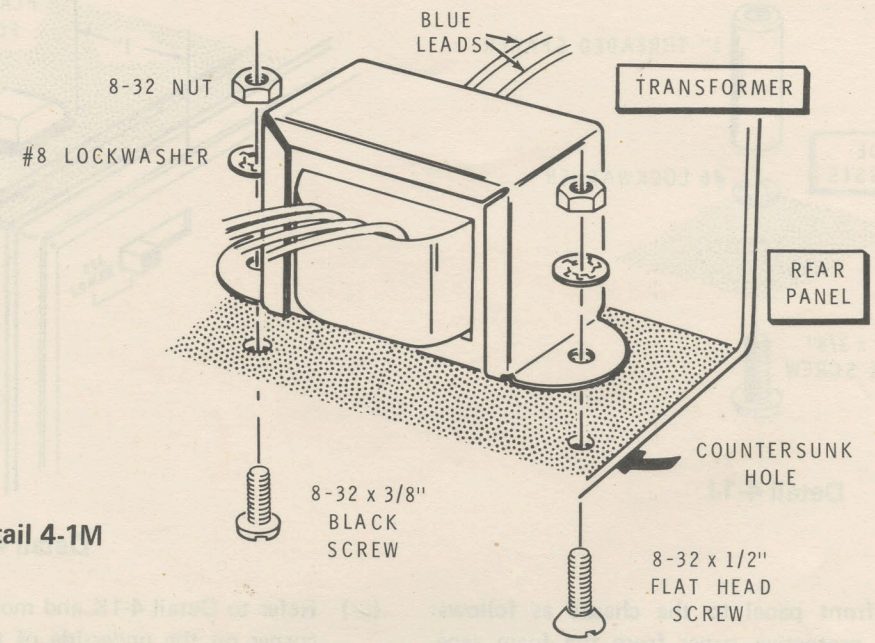
(✓) Refer to Detail 4-1J and mount the threaded spacers at AJ, AK, AG, and AH. Use a 6-32 x 3/8" black screw and #6 lockwasher to mount each spacer as shown.

(✓) Refer to Detail 4-1K and mount a plastic foot at each corner on the underside of the chassis as shown. To mount the feet, remove the protective backing and press each foot into place. Be sure to observe the 1" dimensions so the feet will not interfere with the cabinet later.

(✓) Refer to Detail 4-1L and mount a power plug at AR on the rear chassis panel. Position the plug so the beveled edge of the plug is shown.



Detail 4-1L



Detail 4-1M

(✓) T1: Refer to Detail 4-1M and mount the power transformer at T1 with one 8-32 x 3/8" black screw, one 8-32 x 1/2" flat head screw at the countersunk hole, two #8 lockwashers, and two 8-32 nuts as shown. Be sure to position the transformer with the blue leads toward the rear panel.

Refer to Pictorial 4-2 for the following steps.

NOTE: In the following steps, connect the capacitor leads as closely as possible to the resistor body as shown in the inset drawing. Solder the capacitor leads to the resistor leads and cut off the excess capacitor leads.

( ) Prepare a 910 kΩ (white-brown-yellow) resistor and a 4.7 pF disc capacitor combination.

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

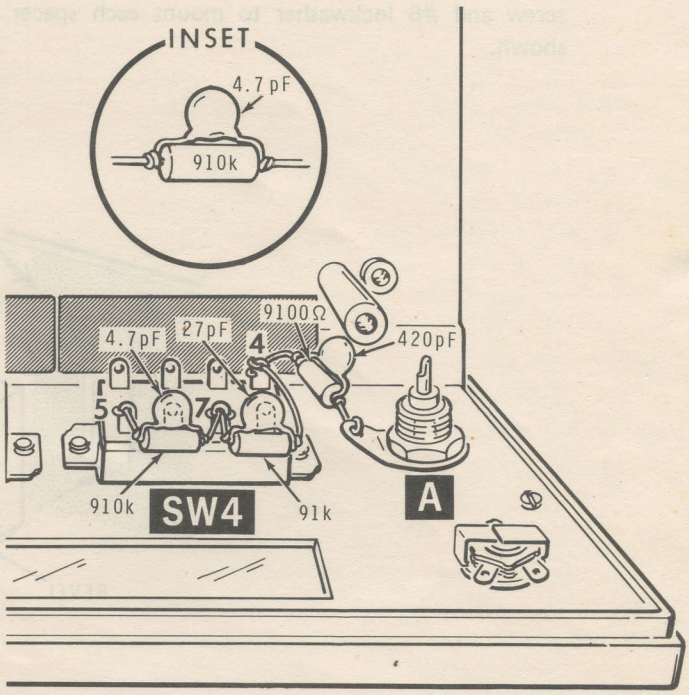
( ) R1, C1: Connect this combination between switch SW4 lugs 5 (NS) and 7 (NS).

( ) Prepare a 91 kΩ (white-brown-orange) resistor and a 27 pF disc capacitor combination.

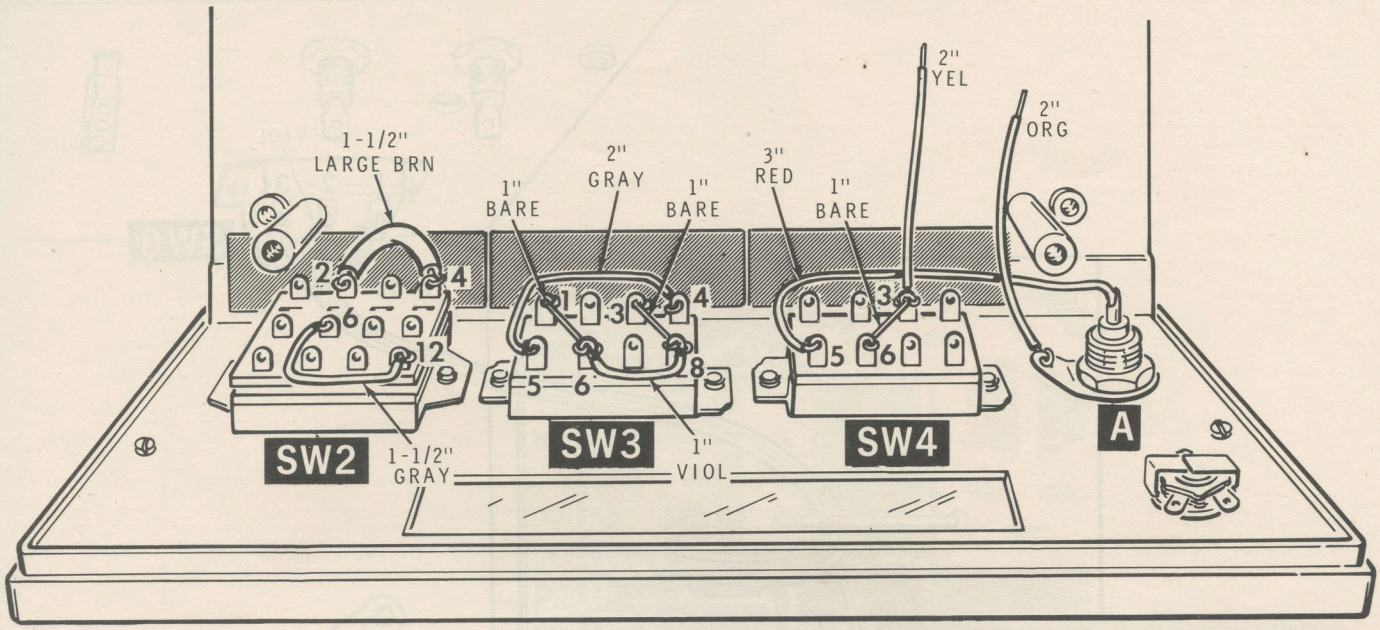
( ) R2, C2: Connect this combination between switch SW4 lugs 7 (S-2) and 4 (NS).

( ) Prepare a 9100 Ω (white-brown-red) resistor and a 420 pF disc capacitor combination.

( ) R3, C3: Connect this combination from switch SW4 lug 4 (S-2) to solder lug A (NS).



PICTORIAL 4-2



PICTORIAL 4-3

Refer to Pictorial 4-3 for the following steps.

( ) Connect a bare wire between switch SW4 lugs 3 (NS) and 6 (S-1).

NOTE: To prepare a wire, cut the wire to the length indicated and remove 1/4" of insulation from each end. Then twist the fine wire strands at the ends of the wire and apply only enough solder to the bare ends to hold the fine wire strands together.

( ) Prepare the following wires:

LENGTH	COLOR
2"	Yellow
3"	Red
2"	Orange
1"	Bare
1"	Bare
2"	Gray
1"	Violet
1-1/2"	Gray
1-1/2"	Large brown

( ) Connect one end of the 2" yellow wire to switch SW4 lug 3 (S-2). The other end will be connected later.

( ) Connect one end of the 3" red wire to switch SW4 lug 5 (S-2). Connect the other end to the BNC connector center lug (S-1).

( ) Connect one end of the 2" orange wire to solder lug A (S-2). The other end will be connected later.

( ) Connect a 1" bare wire between switch SW3 lugs 1 (S-1) and 6 (NS).

( ) Connect a 1" bare wire between switch SW3 lugs 3 (S-1) and 8 (NS).

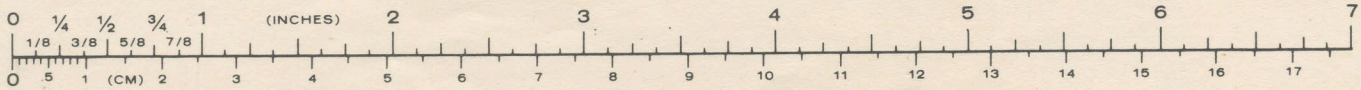
( ) Connect the 2" gray wire between switch SW3 lugs 4 (S-1) and 5 (NS).

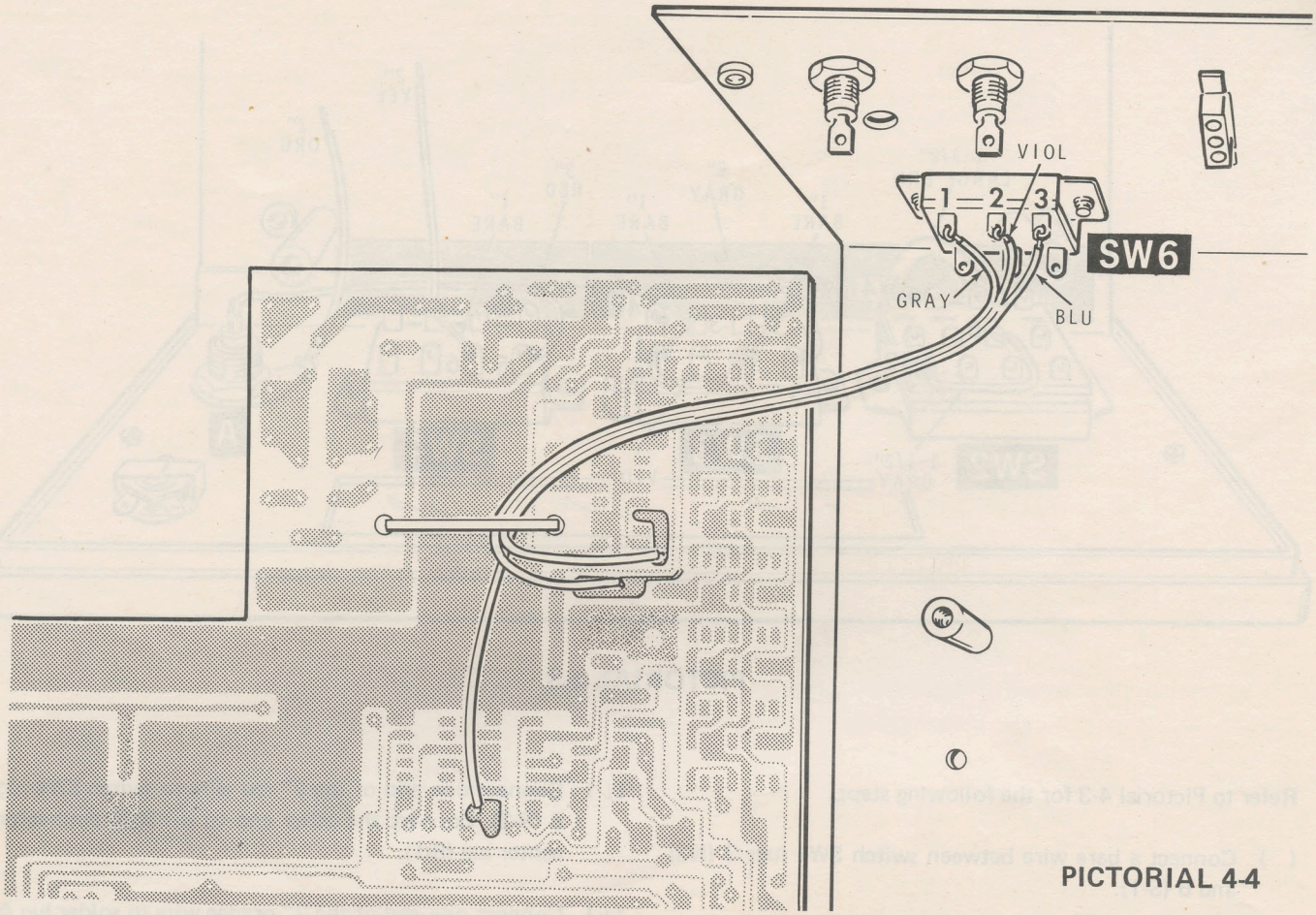
( ) Connect the 1" violet wire between switch SW3 lugs 6 (NS) and 8 (S-2).

NOTE: For the following steps, you may want to temporarily remove the spacer near switch SW2.

( ) Connect the 1-1/2" gray wire between switch SW2 lugs 6 (S-1) and 12 (NS).

( ) Connect the large brown wire between switch SW2 lugs 2 (S-1) and 4 (NS). Make both connections mechanically secure.





PICTORIAL 4-4

Refer to Pictorial 4-4 for the following steps.

(✓) Position the main circuit board near the chassis as shown.

Locate the 3-wire cable coming from the main circuit board and connect the free wire ends to switch SW6 as follows:

(✓) Gray to lug 1 (S-1).

(✓) Violet to lug 2 (S-1).

(✓) Blue to lug 3 (S-1).

Refer to Pictorial 4-5 for the following steps.

Position the circuit board as shown and then connect the transformer leads to the main circuit board as follows:

(✓) Either blue to hole AP (S-1). beide

(✓) Other blue to hole AR (S-1).

( ) Black/red to hole AE (S-1).

( ) Black/yellow to hole AF (S-1).

( ) Black to hole AL (S-1).

( ) Black/green to hole AM (S-1).

( ) Locate the line cord and pass the free end through hole AN in the chassis rear panel. Fläche

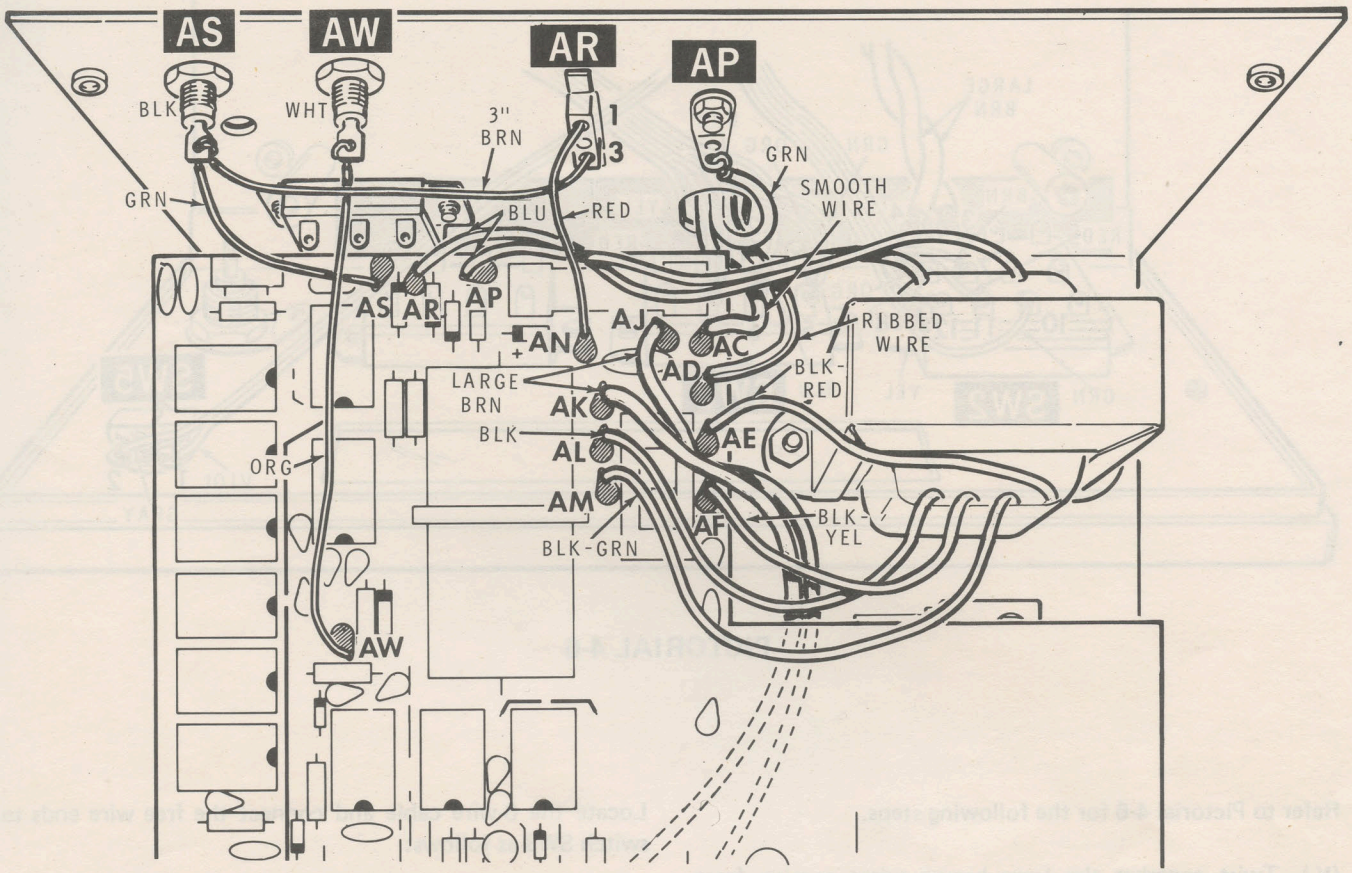
( ) Cut the bare wire ends off the line cord.

( ) Separate the line cord wires for 2", prepare the ends, and connect them in the following steps.

NOTES:

1. One of the outer line cord wires has a rib along the Rand edge of its insulation. The other wire is smooth. It is important that you connect the smooth wire as indicated. glatt / gleichmäßig

2. In the following steps, be sure all the wire strands go into the holes.



PICTORIAL 4-5

(✓) Smooth wire to circuit board hole AC (S-1).

(✓) Ribbed wire to circuit board hole AD (S-1).

(✓) Green wire to solder lug AP (S-1).

(✓) Prepare a 3" length of brown wire.

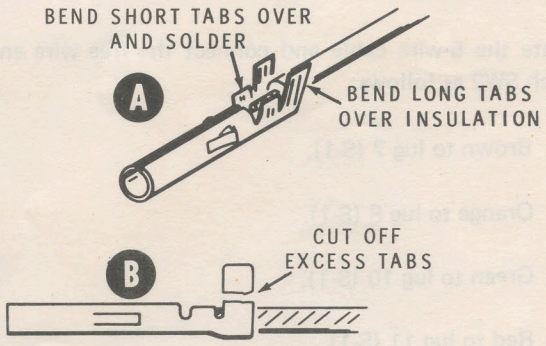
(✓) Refer to Detail 4-5A and install a female connector pin on one end of the brown wire.

(✓) Insert the connector into power plug AR hole 3.

(✓) In the same manner, install a female connector pin on the red wire coming from hole AN on the main circuit board.

(✓) Insert this connector into power plug AR hole 1.

(✓) Connect the free end of the brown wire coming from the power plug to black banana jack AS (NS).

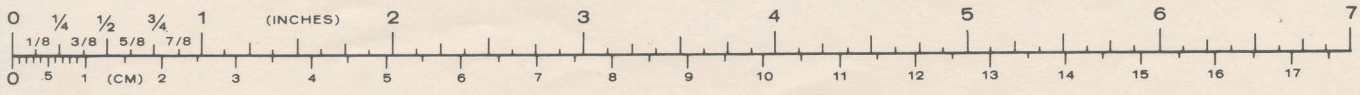


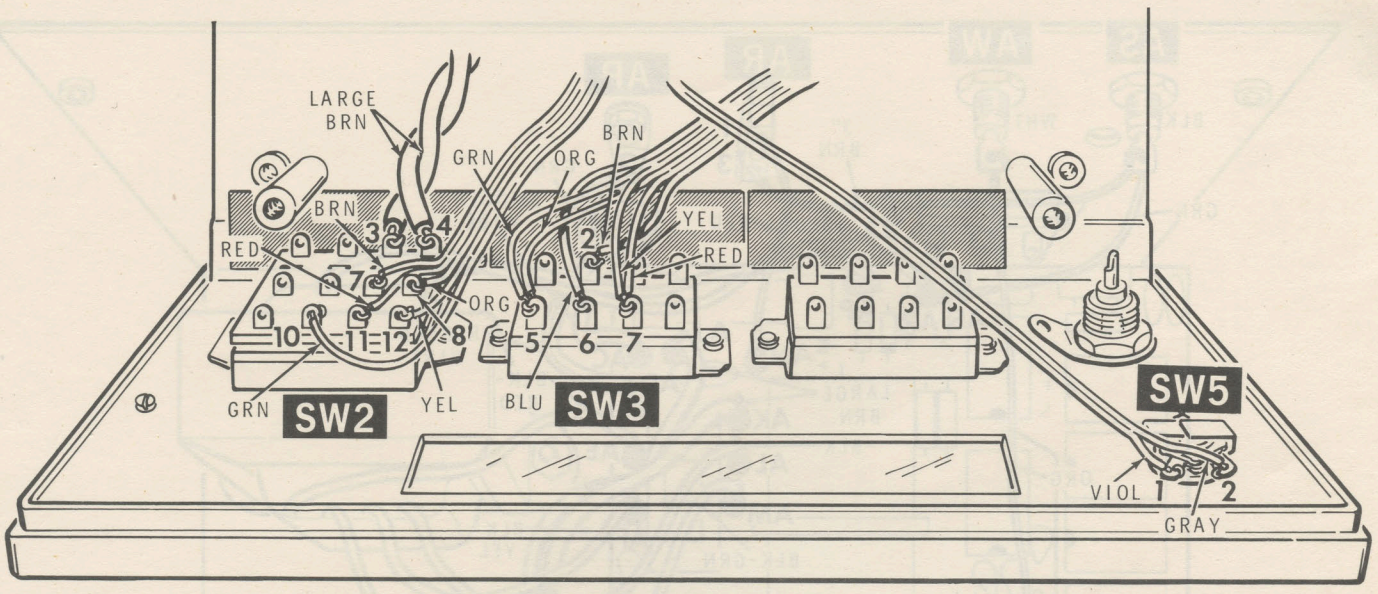
Detail 4-5A

(✓) Connect the green wire coming from hole AS on the circuit board to black banana jack AS (S-2).

(✓) Connect the orange wire coming from hole AW on the circuit board to white banana jack AW (S-1).

( ) Route the two large brown wires coming from holes AJ and AK under the circuit board as shown.





PICTORIAL 4-6

Refer to Pictorial 4-6 for the following steps.

(✓) Twist together the large brown wires coming from holes AJ and AK. Then connect the free end of either wire to switch SW2 lug 3 (S-1) and the other wire to lug 4 (S-2). Make mechanically secure connections.

Locate the 5-wire cable and connect the free wire ends to switch SW2 as follows:

(✓) Brown to lug 7 (S-1).

(✓) Orange to lug 8 (S-1).

(✓) Green to lug 10 (S-1).

(✓) Red to lug 11 (S-1).

(✓) Yellow to lug 12 (S-2).

Locate the 6-wire cable and connect the free wire ends to switch SW3 as follows:

(✓) Brown to lug 2 (S-1).

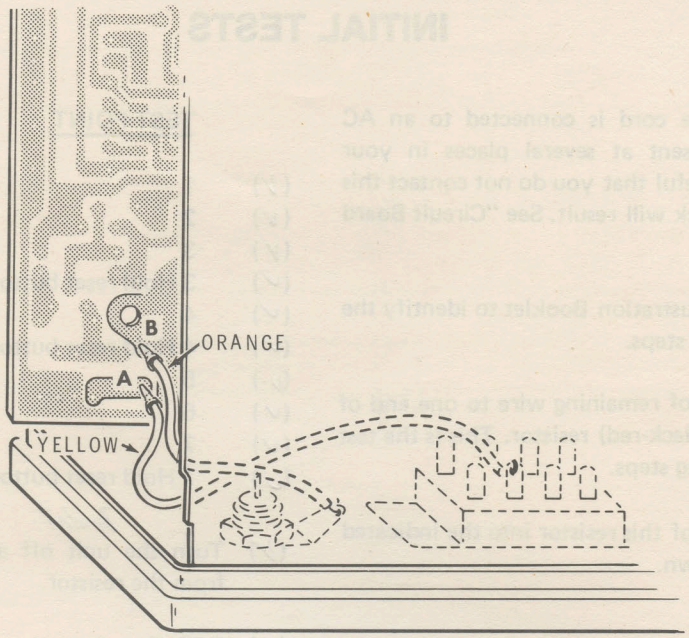
(✓) Orange and green to lug 5 (S-3).

(✓) Blue to lug 6 (S-3).

(✓) Red and yellow to lug 7 (S-2).

(✓) Locate the 2-wire cable and connect the violet wire to SW5 lug 1 (S-1).

(✓) Connect the gray wire to SW5 lug 2 (S-1).



Detail 4-7A

Refer to Pictorial 4-7 in the Illustration Booklet for the following steps.

(✓) Push the IC connector onto the integrated circuit leads (IC27). Be sure the connector slots are positioned up as shown.

(✓) Position the circuit board in place on the spacers.

(✓) Refer to Detail 4-7A and insert the free end of the orange wire into the wire connector at B.

(✓) Insert the free end of the yellow wire into the wire connector at A.

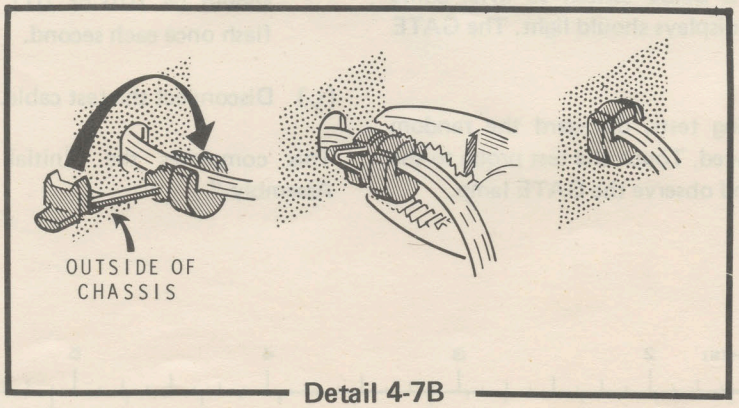
(✓) Check the parts mounted to the front panel switches and be sure they are out of the way of the circuit board. Then mount the circuit board on the spacers with four 6-32 x 3/8" screws.

( ) Refer to Detail 4-7B and, from outside the chassis, install a strain relief on the line cord as shown.

( ) Write the fuse rating on the fuse replacement label (1/4-A slow-blow for 120 VAC, or 1/8-A slow-blow for 240 VAC).

( ) Remove the backing paper from the fuse label and press the label into place as shown.

This completes the "Step-by-Step Assembly" of your Heathkit Frequency Counter. The cabinet will be mounted later. Carefully inspect all connections for loose wires or unsoldered connections. Remove any wire clippings or solder splashes. Then proceed to "Initial Tests."



Detail 4-7B

INITIAL TESTS

WARNING: When the line cord is connected to an AC outlet, line voltage is present at several places in your Frequency Counter. Be careful that you do not contact this voltage or an electrical shock will result. See "Circuit Board X-Ray Views" on Page 51.

Refer to Figure 2 in the Illustration Booklet to identify the test points for the following steps.

( ) Solder a 10" length of remaining wire to one end of the 1000 Ω (brown-black-red) resistor. This is the test probe for the following steps.

( ) Insert the other lead of this resistor into the indicated wire connector as shown.

NOTE: If you do not obtain the proper results in any of the following steps, unplug the line cord and proceed to the "Initial Test Difficulties." If you cannot solve the problem, proceed to "In Case of Difficulty" on Page 44.

( ) Set the four switches as follows:

OSCILLATOR	INT
POWER/TIME BASE	POWER OFF
MODE	FREQ
INPUT ATTEN	10

( ) Plug the line cord into the AC outlet.

( ) Set the POWER/TIME BASE switch to kHz. Some segments of the LED displays should light. The GATE lamp should be off.

NOTE: During the following tests, disregard the random numbers that may be displayed. Touch the test probe to the following test points (TP) and observe the GATE lamp.

	TEST POINT	GATE LAMP
( )	1	on
( )	2	blinks
( )	3	on
( )	3 Hold reset button in.	off
( )	4	on
( )	4 Hold reset button in.	off
( )	5	blinks
( )	6	blinks
( )	7	off
( )	7 Hold reset button in.	on

( ) Turn the unit off and unsolder the test probe wire from the resistor.

( ) R26: Cut the resistor leads to 3/8", bend the leads as necessary, and insert the ends into the wire connectors as shown in the inset drawing.

( ) Connect a test cable to the INPUT connector. If you do not have a test cable, proceed to "Final Assembly."

( ) Position the MODE switch to FREQ, and the POWER/TIME BASE switch to kHz.

( ) Connect the signal lead of the test cable to test point 8. Leave the other test cable lead disconnected. Notice that the OVERRANGE indicator is lit. The GATE lamp is flashing.

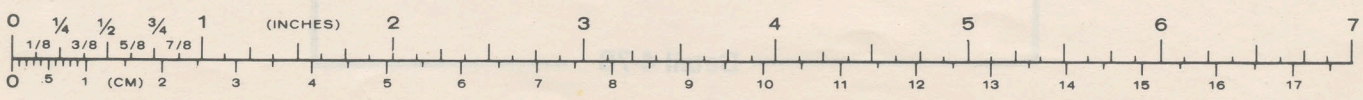
( ) Position the MODE switch to TOL.

( ) Connect the test cable signal lead to test point 9. Then push and release the RESET button. The Counter should start at zero and add up the incoming pulses at the rate of 10 pulses per second.

( ) Position the MODE switch to FREQ. The display should be .010 or .011 and the GATE lamp should flash once each second.

( ) Disconnect the test cable.

This completes the "Initial Tests." Proceed to "Final Assembly."



INITIAL TEST DIFFICULTIES

TEST POINT	TROUBLE	CAUSE
1	GATE lamp does not light.	No +5 volt supply.
2	Lamp does not blink.	1. OSCILLATOR switch not in INT. 2. IC's 19-26.
3	Lamp not on.	D5, IC17, or IC18.
3 (Button in)	Lamp not off.	RESET button.
4	Lamp not on.	IC18.
4 (Button in)	Lamp not off.	D5.
5	Lamp does not blink.	1. IC13, IC15. 2. MODE and TIME BASE switches.
6	Lamp does not blink.	IC16, IC18, IC17.
7	Lamp not off.	IC17, IC18, IC14.
7 (Button in)	Lamp not on.	D5.

FINAL ASSEMBLY

Refer to Pictorial 4-8 in the Illustration Booklet for the following steps.

( ) Mount the cabinet to the chassis with four 6-32 x 3/8" black screws.

( ) Refer to the inset drawing and mount the plastic handle grip on the handle.

( ) Mount the handle to the cabinet with two 10-32 x 3/8" thumbscrews and two 1/4" lockwashers as shown.

( ) Carefully peel away the backing paper from the blue and white identification label. Then press the label onto the chassis bottom. Be sure to refer to the numbers on this label in any communications you have with the Heath Company about this kit.

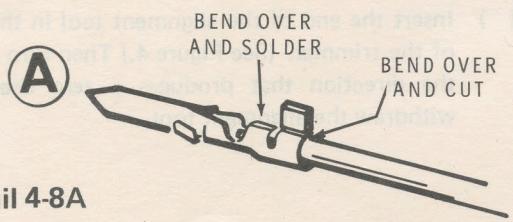
NOTE: If you intend to operate your Counter from a DC power supply, perform the following steps. Otherwise, proceed directly to "Calibration."

( ) Refer to Part A of Detail 4-8A and install male connector pins on the positive and negative leads of your DC power supply as shown.

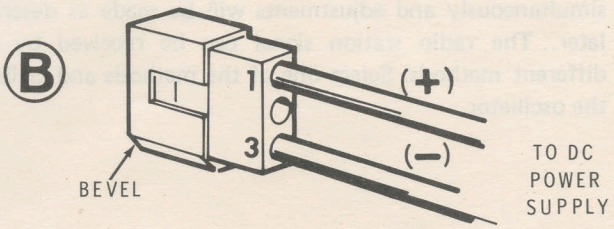
( ) Refer to Part B of the Detail and position the connector plug with its beveled edges as shown. Then insert the pin attached to the positive lead of the power supply into hole 1. Insert the other pin into hole 3.

( ) Refer to the Pictorial and push the connector plug onto connector socket AR.

This completes the assembly of your kit. Proceed to "Calibration."



Detail 4-8A



CALIBRATION

(✓) Refer to Figure 3 and push the alignment tool blade into the small end of the nut starter as shown. this will be used as an alignment tool in the following steps.

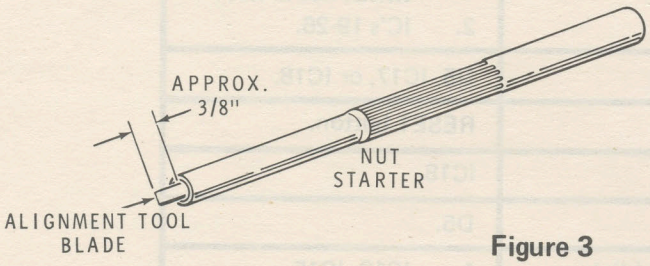


Figure 3

The accuracy of your Counter depends to a great extent upon the care and accuracy with which you perform the following steps. If at any time you do not obtain the results called for in a step, refer to the "In Case of Difficulty" section on Page 44 to correct the problem.

This section of the Manual contains two calibration procedures. If you have access to a reliable frequency counter and/or an accurate frequency generator, proceed to the "With Instruments" procedures on Page 41. If these instruments are not available, proceed to the following "Without Instruments" procedure.

Without Instruments

IMPORTANT: Most communications receivers and standard (AM) broadcast receivers, especially those with a built-in antenna coil, have sufficient sensitivity to produce the audible difference frequency called for in the following steps. However, if you are unable to hear the difference frequency, try another receiver and/or remove the cabinet shell from your Counter before you assume there is a difficulty.

( ) Turn the Counter on and allow it to warm up for 30 minutes. This is MOST IMPORTANT for an accurate calibration.

( ) Push the POWER/TIME BASE switch to the kHz position.

( ) Push the MODE switch to TOL.

CLOCK OSCILLATOR

You will calibrate your Counter by using a radio receiver to compare the frequency of the Counter's 10 MHz clock oscillator with an accurate radio frequency. Signals from a radio station and from your Counter will be received simultaneously and adjustments will be made as described later. The radio station signal can be received by two different methods. Select one of the methods and calibrate the oscillator.

1. If you have a general coverage communications receiver, use its AM mode. For best accuracy, tune it to the highest WWV station frequency (25, 20, 15, 10, or 5 MHz) that you can receive at a satisfactorv volume level in your area. Temporarily connect an insulated, unshielded wire to the receiver antenna connection (leave the outside antenna connected to the receiver) and lay the wire over the oscillator section of your Counter in the area shown in Figure 4 in the Illustration Booklet.

You should hear a tone. If you do not hear the tone, remove the cabinet shell from your Counter and place the insulated wire near IC26. This should make the signal easier to hear.

2. You can use a broadcast AM radio, by tuning in a station of medium volume and connecting a temporary additional antenna and laying it over the oscillator section of the Counter at the location shown in Figure 4 in Illustration Booklet. If you do not hear the tone of the Counter oscillator, remove the Counter cabinet shell and place the temporary antenna wire close to IC26. You can also use a portable AM Broadcast radio by holding it so its antenna is close to the Counter oscillator section.

( ) Insert the end of the alignment tool in the screw slot of the trimmer. (See Figure 4.) Then turn the screw in the direction that produces a zero beat. Carefully withdraw the alignment tool.

With Instruments

NOTE: In the following steps, keep the cabinet shell on the Counter.

( ) Turn the Counter on and allow it to warm up for 30 minutes. This is MOST IMPORTANT for an accurate calibration.

You will need precision equipment to calibrate the clock and the input sensitivity of your Counter in the following steps.

This calibration can be performed with either a frequency counter and a signal generator (capable of a 1-30 MHz, 250 mV output) or with a known, stable, laboratory standard frequency. Determine which of these methods you will use. Then complete the steps under the appropriate heading. If at any time you do not obtain the results called for in a step, refer to the "In Case of Difficulty" section on Page 44 to correct the problem.

CALIBRATION WITH A FREQUENCY COUNTER AND SIGNAL GENERATOR

Refer to Figure 5 in the Illustration Booklet for the following steps.

NOTE: The accuracy of your Counter, for this type of calibration, depends on the accuracy of the test frequency counter.

( ) Connect the test leads of the test frequency counter to the output terminals of the signal generator.

( ) Also connect the test leads of your Counter to the output terminals of the signal generator.

( ) Press the POWER/TIME BASE switch to the kHz position for maximum resolution.

( ) Set the signal generator to any convenient frequency between 1 MHz and 30 MHz at 250 mV to 500 mV output.

( ) Use the alignment tool and adjust the OSC ADJ capacitor (see the inset drawing on Figure 5) until your Counter indicates exactly the same frequency as the test frequency counter.

( ) Disconnect the test leads.

This completes the calibration of your Frequency Counter. Proceed to the "Operation" section.

CALIBRATION WITH A KNOWN LABORATORY STANDARD FREQUENCY

NOTE: It is essential that the known frequency source (frequency of your choice between 1-30 MHz) be absolutely stable. The accuracy of this type of calibration depends entirely on the accuracy of this known frequency.

( ) Connect the known frequency to the test cable of the Counter.

( ) Push the POWER/TIME BASE switch to the kHz position for maximum resolution. NOTE: If the frequency is 100 kHz or higher, the overrange lamp will be lighted.

( ) Use the alignment tool and adjust the OSC ADJ capacitor until the known frequency is exactly indicated on your Counter.

This completes the calibration of your Frequency Counter. Proceed to the "Operation" section.

OPERATION

Refer to Figure 6 in the Illustration Booklet for a description of the display, control, and adjustment.

CAUTION: Use ONLY the center conductor of the input lead of your Counter to check the frequency of an AC line voltage. Connecting the ground input lead to the "hot" (ungrounded) side of an AC line may result in a blown fuse and/or damage to your Counter.

INPUT PROBES AND CABLES

Any standard 10 megohm oscilloscope probe can be used with this Counter. Refer to the Maximum Input Voltage for the maximum AC voltage that can be applied to the INPUT of the Counter at various frequencies.

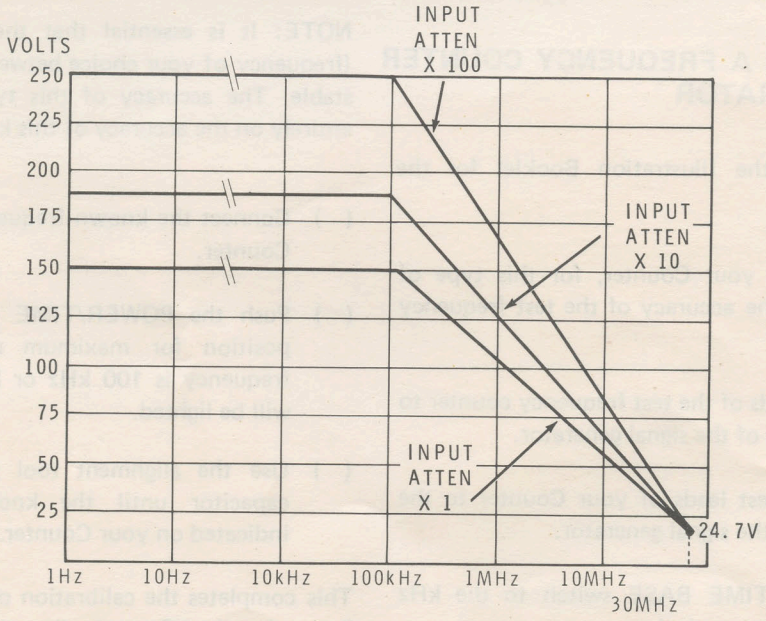
When you connect your Counter to a transmission line, make sure that the line is properly terminated (low standing wave ratio) to avoid possible damage to the equipment under test and incorrect readings.

READING THE COUNTER

CAUTION: Avoid any excessive voltages that could damage your Counter. Refer to the "Maximum Input Voltage" for maximum safe input voltages at various frequencies.

Maximum Input Voltage

Up to a frequency of 100 kHz, the maximum permissible input voltage is 250 volts rms. At frequencies above 100 kHz, the maximum input voltage must be derated according to the following graph.



MAXIMUM INPUT VOLTAGE DERATING CURVE

Unknown Frequencies

To measure an unknown frequency, push the POWER/TIME BASE switch to kHz. Then apply the unknown frequency to the counter input. If the OVERRANGE indicator lights up, the frequency is higher than 99.999 kHz and the POWER/TIME BASE switch should be pushed to MHz. If the display then constantly changes in a random manner, the frequency is higher than the Counter's capability, or the input level is too low.

The Display

Frequencies lower than 100 kHz can be read directly to a resolution of ±1 Hz in the kHz position of the POWER/TIME BASE switch. Frequencies of 100 kHz and higher (within the range of the Counter) can be read to ±1 Hz by using both time base positions. A frequency of 12,345,678 Hz would be displayed as follows:

POWER/TIME BASE Switch	Display	Overrange Indicator
MHz	12.345	Off
kHz	45.678	On

ACCURATE LOW FREQUENCY MEASUREMENTS

Your Frequency Counter counts and displays low frequency signals. However, the display error will be ±1 count because the clock in the Counter is not synchronized with the incoming signal. To measure a low frequency signal more accurately, position the POWER/TIME BASE switch to mS and the MODE switch to PER. Then solve for the equation f = 1/period.

Example: Accurately count a 10 Hz signal from a signal generator.
The period display is 99.991 mS.
Solve for f = 1/period = 1/.099991 =10.0009 Hz.

NOTES:

1. Noise on the input signal can cause large errors in this type of measurement as noise will make the Schmitt trigger switch either early or late.

2. When possible, use fast rise-time signals (square waves instead of sine waves). Noise on square wave signals has less time to influence the Schmitt trigger and thus error is substantially reduced.

TOTALIZE MEASUREMENTS

In the TOL mode, the Counter adds up (totalizes) the input pulses until the:

1. Input pulses stop.
2. RESET button is pushed. (This clears the count to zero so the count will be 1 with the next input pulse.)
3. Count is stopped by a logic 0 at the rear panel INPUT/OUTPUT connectors when the OSCILLATOR switch is in the EXT position.

12-VOLT OPERATION

The Counter will operate normally on DC power except the POWER/TIME BASE switch does not turn the Counter off. The Counter will remain on as long as the DC power is applied.

IN CASE OF DIFFICULTY

This three-part section gives suggestions for locating and resolving difficulties.

The first part, "General Troubleshooting Information," deals with problems that exist when you have just completed the assembly of your kit. This information primarily covers soldering and assembly problems.

The second part consists of a "Troubleshooting Chart," which gives difficulties and likely causes.

The third part, "Important Wave Shapes," contains significant waveforms.

If the checks under these three headings do not help you locate the problem, the difficulty may be a component. Read the "Circuit Description" (Pages 50 and 51) and refer to the Schematic Diagram in the Illustration Booklet to help you determine where the trouble is.

NOTE: 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.

GENERAL TROUBLESHOOTING INFORMATION

1. Make sure you have power at the transformer primary.

2. Make sure switch SW1 (120-240) is properly set.

3. Recheck the wiring. Trace each wire 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 consistently overlooked by the kit builder.

4. Most problems result from poor connections and soldering. Use a magnifying glass and check all solder connections to be sure they are soldered as described in the "Soldering" section of the "Kit Builders Guide." Also check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring. Look for solder bridges between circuit board foils. Compare your foil pattern with the "X-Ray Views" on Page 51 and 52. Many troubles can be eliminated by reheating all connections to make sure they are soldered as described in the "Soldering" section of the "Kit Builders Guide."

5. Make sure that the proper transistor has been installed at each location and that each lead is in the proper hole.

6. Press each integrated circuit into its socket so that each pin will make a secure connection. Be sure that each IC pin is properly installed in its socket and not bent out or under the IC.

7. Check each IC to make sure its index mark matches the half-circle on the circuit board.

8. Check the values of the parts. Make sure the proper part has been wired into the circuit at each location. For example, a 150 Ω (brown-green-brown) resistor could easily be installed in place of a 510 Ω (green-brown-brown) resistor.

9. Check the continuity of the circuit board foils. If you find an open foil, bridge it through the circuit board with a jumper wire.

10. A review of the "Circuit Description" may help you to determine where the trouble is.

Substitution

Corresponding components of the circuitry for each display can be interchanged with the components of another, IC's 3 through 7 can be interchanged, for example.

If one display unit shows a digit incorrectly, interchange it with one of the other units to determine if the display or the circuit is faulty. If the circuit is faulty and there are no solder bridges on the associated foil, interchange the decoder/driver IC with one of the others. This method can be used with other single digit problems and can be extended to interchanging the decade counter integrated circuits.

Clock Circuit

Verify that the clock oscillator and divider circuits are operating properly by checking the voltage at pin 12 of IC19. The meter should alternately indicate less than 0.4 volt for one-half second and then greater than 2.4 volts for one-half second.

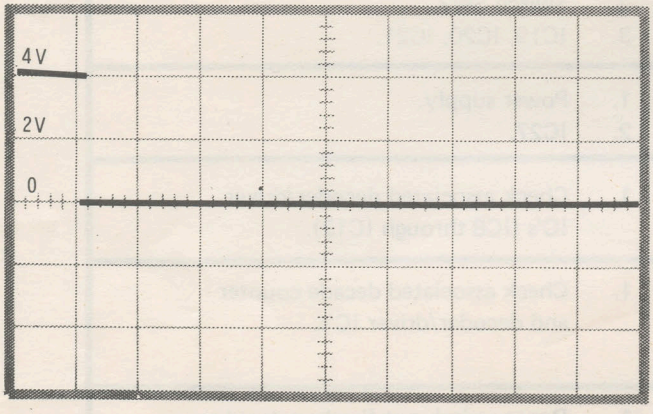
Troubleshooting Chart

CONDITION	POSSIBLE CAUSE
One readout does not reset to zero with the input shorted.	1. Check associated decade counter and decoder/driver IC's.
Readouts will not reset to zero in the kHz or MHz range.	1. Q6. 2. IC18. 3. IC22, IC23, IC24. 4. IC17.
Counter functions normal in MHz range but not in kHz range.	1. IC13. 2. Switch SW2. 3. IC19, IC20, IC21.
Display will not light.	1. Power supply. 2. IC27.
One or more display tubes will not light.	1. Check associated decoder/driver IC's (IC8 through IC12).
One display tube does not indicate correct numeral from known frequency source.	1. Check associated decade counter and decoder/driver IC's.
Counter resets to zero but will not count.	1. Range switch not firmly pressed to correct position. 2. Insufficient amplitude of input signal. 3. Transistors Q1 through Q4, IC1, IC2, IC15.
OVER (overrange) lamp does not function or is on continuously.	1. IC14. 2. IC13.
Counting sequence is displayed during gating.	1. Memory transfer line, Q6. 2. IC18.
Decimal point does not light.	1. Resistor R102. 2. Interchange D104 with another display.
Random count with input cable disconnected.	1. Scrape paint under BNC connector on back of panel.
+5 volt supply too high.	1. IC27.

IMPORTANT WAVE SHAPES

This section shows wave shapes that should be present at various points in your Frequency Counter. The wave shapes are line drawings of photographs of the graticule on an oscilloscope. A low capacitance X10 probe was used and the oscilloscope was set for .1 volt-per-division. The time base is indicated for each drawing. Use the MHz position of the POWER/TIME BASE switch. All wave shapes are approximately 3.5 to 4.5 volts. The bottom horizontal lines of the wave shapes represent approximately 0 to .4 volt.

IC3, 4, 5, 6, 7; Pin 2

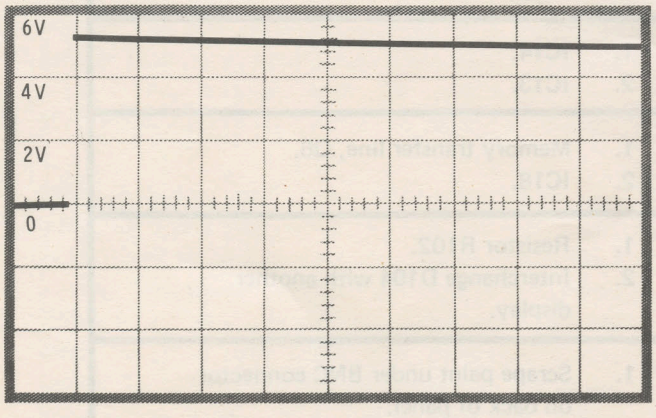


50 µSEC/DIV
RESET PULSE

IC25; Pin 12

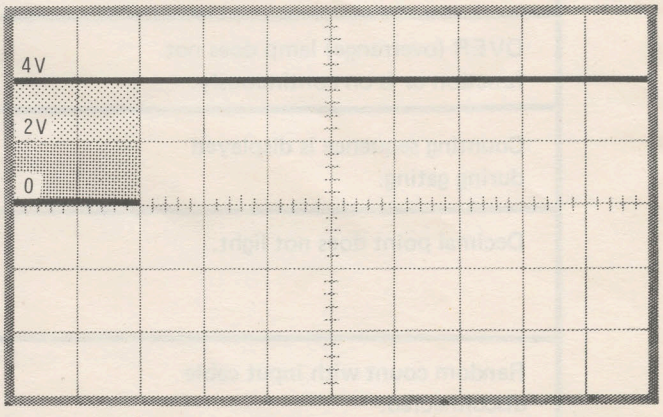
.5 µSEC/DIV
OSCILLATOR

Q6; Collector



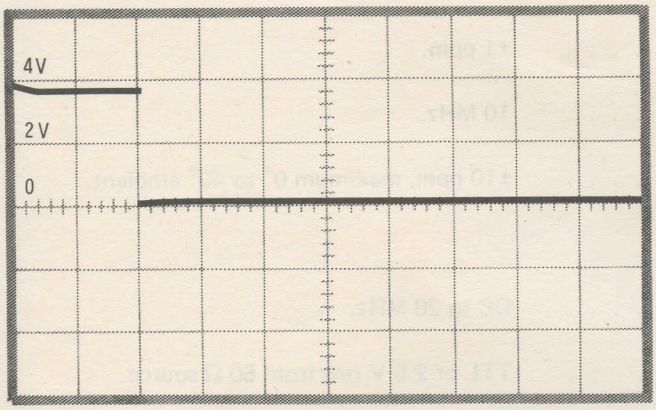
50 µSEC/DIV
TRANSFER PULSE

IC2; Pin 8



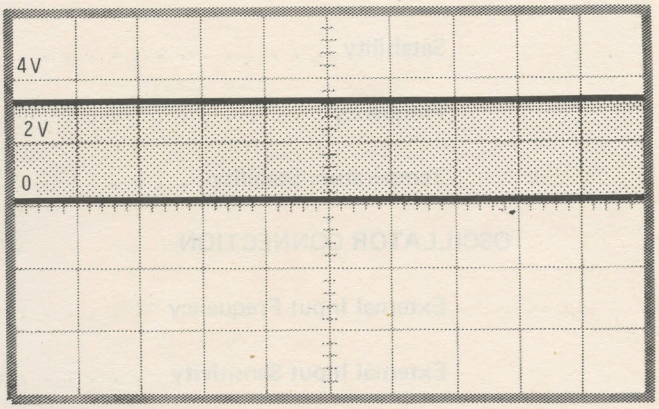
PIN 8
.5 mSEC/DIV
GATED SIGNAL

IC2; Pin 6



.5 mSEC/DIV
GATE

IC2; Pin 4



.5 mSEC/DIV
INPUT SIGNAL

SPECIFICATIONS

FUNCTIONS

Frequency	5 Hz to 30 MHz.
Period	1 μsec resolution to 99.999 sec.
Totalize	1 - 99,999 events.

INPUT

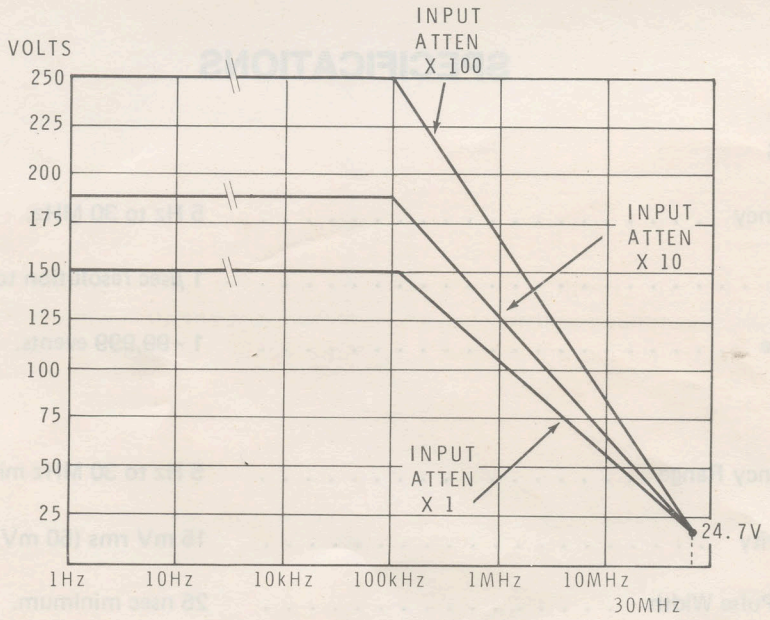
Frequency Range	5 Hz to 30 MHz minimum.
Sensitivity	15 mV rms (50 mV, 5 Hz to 50 Hz).
Period Pulse Width	25 nsec minimum.
Low Frequency Signal Risetime	1 msec for signals less than 10 Hz.
Input Impedance	1 MΩ shunted by less than 35 pF.
Protection	240 volts rms at 60 Hz. See the Input Derating curve.
Attenuator	X1, X10, X100 fixed compensation.

TIME BASE

Setability	±1 ppm.
Frequency	10 MHz.
Temperature Stability	±10 ppm, maximum 0° to 40° ambient.

OSCILLATOR CONNECTION

External Input Frequency	DC to 20 MHz.
External Input Sensitivity	TTL or 2.5 V rms from 50 Ω source.
Internal Output	TTL signal at 1 MHz.



MAXIMUM INPUT VOLTAGE DERATING CURVE

GENERAL

Gate Interval	kHz - 1 sec, MHz - 1 msec (indicated by gate light).
Manual Gate	DC control in events mode using external OSC input connector.
Display Time	200 msec plus gate interval.
Power Requirements	105 - 130 or 210 - 260 VAC (switch selected), 50 - 60 Hz, (at 25 watts.); or 9 - 14 VDC at 1.25 amperes.
Dimensions	7-1/4" wide, 10-1/2" deep, 2-3/4" high (less handle).
Weight	5 lbs.

The Heath Company reserves the right to discontinue products and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.

CIRCUIT DESCRIPTION

Refer to the Schematic Diagram and the Block Diagram while you read this "Circuit Description."

The following "Theory of Operation" contains a general description of the circuits. The remaining sections describe each circuit in detail.

THEORY OF OPERATION

The signal to be counted is applied, through the input attenuator and impedance converter to the Schmitt trigger. There the signal is "squared" and applied to the GATE. During the time the pulse from the time base scaler (GATE pulse) is also present at the GATE, the GATE is open and the frequency is counted by the following decade counters. After the GATE is closed, at the end of the GATE pulse, the "count" in the decade counters is transferred to the memories by the transfer pulse. At this time, proper segments of the display units turn on and the frequency is displayed. The reset pulse then clears the decade counters so they are ready for the next time the GATE is open. The duration of the GATE pulse is determined by the position of the POWER/TIME BASE switch. The pulse is of one-second duration in the kHz position and of one millisecond duration in the MHz position.

The input to IC13 converts either the time base or the input period to a GATE "ON" time, depending on the position of the Mode switch. By counting the input signal gated by the time base signal, frequency is displayed. By counting the time base signal gated by the input signal, period is displayed. In the totalize mode, the Counter simply counts the input signal without any gating.

INPUT CIRCUIT AND SCHMITT TRIGGER

The input signal is applied to an input circuit that consists of a switchable voltage divider (R1, R2, R3) that is frequency compensated by C1, C2, and C3. The signal is then coupled through C4 and R4 to D1 and D2, which provide over-voltage protection for Q1.

Transistors Q1 and Q2 are direct coupled with 100% negative feedback. These transistors provide wide bandwidth, high input impedance, low output impedance, and gain of one. IC1C and IC1A then amplify the signal to the input limits of IC1B, which is wired as a Schmitt trigger. IC1B drives Q3 and Q4, which translates the signal to TTL (Transistor-Transistor-Logic) levels and makes the signal compatible with the remaining logic circuitry.

10 MHz CLOCK AND SCALER

A 10 MHz crystal and gates B and C of IC26 form a TTL-compatible clock. Capacitors C7, C8, and C9 provide the proper capacitive load for the crystal, and C7 is variable to allow you to precisely calibrate the oscillator. Resistors R21, R22, and R23 assure efficient starting of the oscillator. Gate A of IC26 provides buffering action between the oscillator and the first decade divider (IC25) of the time base scaler. The 10 MHz clock signal is then further divided by IC's 19 through 24 to provide appropriate GATE times for the frequency mode and time pulses for the period mode.

GATING, MEMORY, RESET

Frequency Mode

The input signal at IC2B pin 4 is coupled through gates B and E of IC2 to the counters (IC3 through IC7) by the GATE pulse (one second or one millisecond) from pin 11 of IC13B. During this count time, Q5 and D106 (the GATE lamp) are turned on. At the end of the GATE pulse, pin 10 of IC13B goes high. This causes pin 11 of IC18D to pulse low, and pin 8 of IC18C to pulse high and turn on Q6 for an instant. During this instant, IC's 8 through 12 accept the count from the five decade counters and begin to display. The frequency is displayed until the end of the next GATE pulse when the display is updated.

If the display was in overrange, IC13A pin 15 would be high and this overrange condition would be entered in data latch IC14. The high at the output of IC14 would allow the overrange indicator to light. Under non-overrange conditions, IC14 keeps the indicator off.

The trailing edge of the pulse from pin 11 of IC18D triggers IC16 and produces a 200 millisecond output pulse. This pulse first turns on IC17D and clears IC13B. The pulse from pin 6 of IC16 also gates IC18A and IC18B, and resets the decade counters (IC3 through IC7) to zero. IC17C then changes state and clears IC13A. Any overrange information has already been entered into data latch IC14.

Period Mode

The input signal at IC15E pin 9 is coupled through IC15 gates E and F to IC13B, the GATE control flip-flop. The selected time base signal is applied to IC2 pin 11 and counted by the decade counters during the time IC2 is GATED on (which is the time of one period of the input signal).

Totalize Mode

IC2D pin 1 and IC15E pin 10 are held low by Mode switch SW3. This inhibits the GATE function of the Counter and the input signal at IC2A pin 3 is coupled through gates A and E to the counters.

Switch SW5 resets the Counter in all modes by grounding IC18B pin 5. If you reset the Counter with an external GATE pulse, the pulse is coupled through R33 and SW6 to IC17A pin 1. This creates a low at pin 6 of IC17B which turns off GATE IC2A so no signal can propagate through IC2 to the counters.

OVERRANGE DETECTION

If the count passes from 99.999 to 100.000, a pulse is produced at the D output (pin 11) of IC7. This spillover toggles IC13A, which is a standard JK flip-flop. The J input of this IC is tied to logic 1 (+5 volts). This causes the Q output to latch to a logic 1 condition whenever the CK input is toggled. The Q output remains in this condition until a logic 0 is applied to the C (clear) input.

IC14 is quadruple 2-input NAND gate package used as a data latch. The logic level at pin 1 of IC14 will be transferred to pin 6 when pin 2 and pin 13 are both at a logic 1. A logic 0 at these inputs will inhibit the transfer. The output of this latch is used to short out the overrange LED when no spillover has occurred. The overrange indicator lights whenever IC13 pin 15 is at a logic 1.

POWER SUPPLY

Transformer T1 steps down the line voltage to the proper value of AC. Diodes D7 through D10 rectify the AC and capacitors C16 and C17 filter out the pulsations. IC27 regulates the DC to a constant five volts.

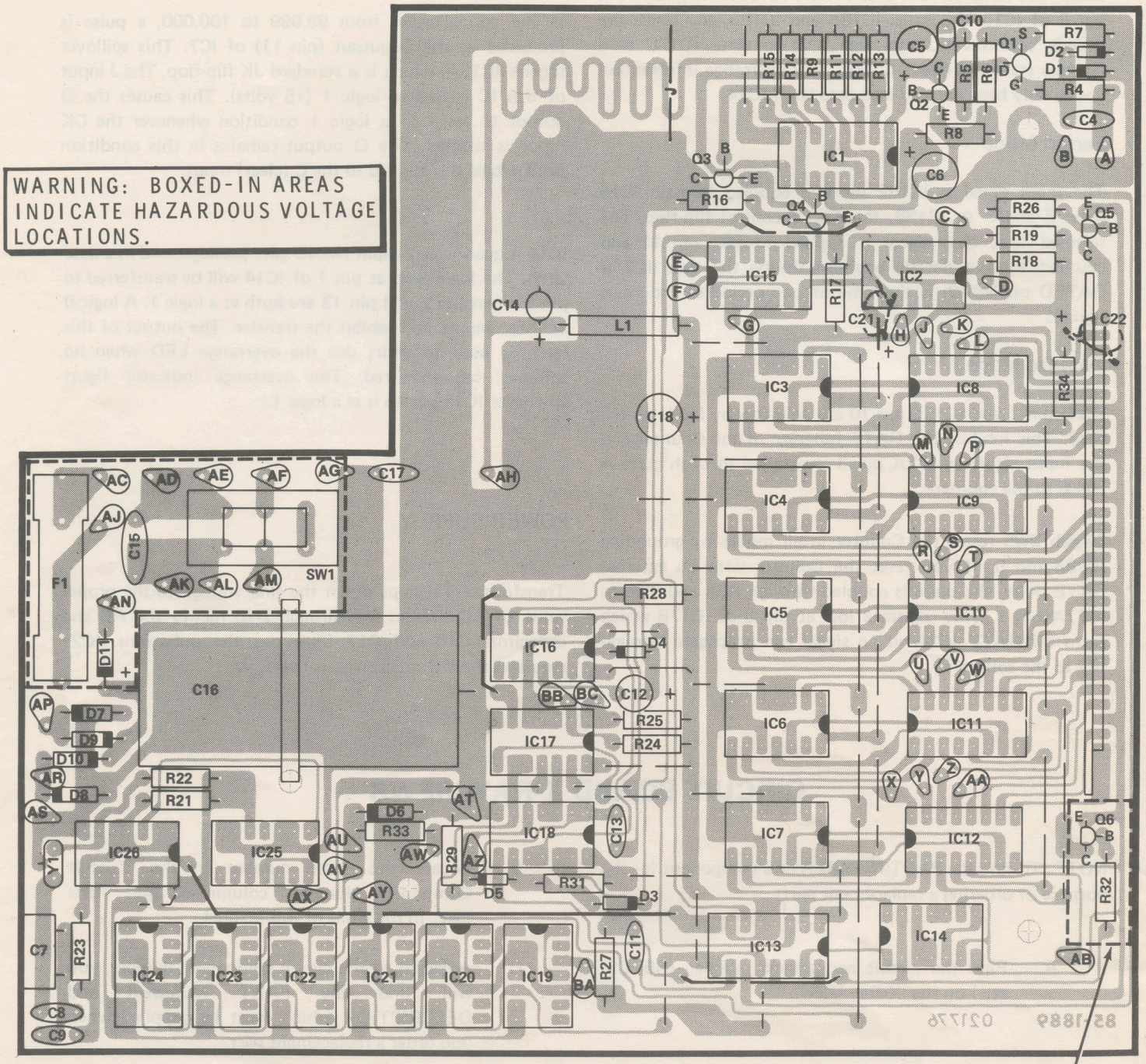
CIRCUIT BOARD X-RAY VIEWS

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.

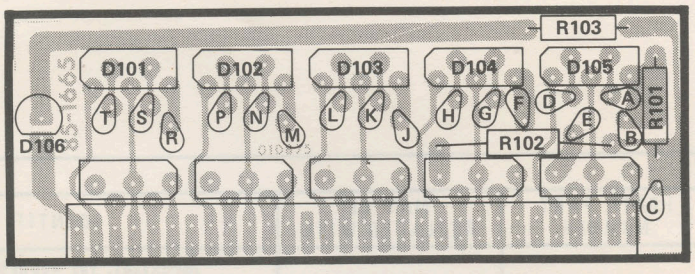
C. Adjacent to the circuit component number, you will find the PART NUMBER and DESCRIPTION which must be supplied when you order a replacement part.



MAIN CIRCUIT BOARD
(VIEWED FROM COMPONENT SIDE)

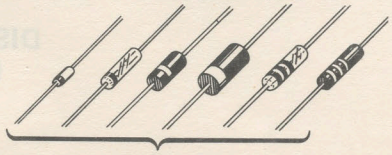
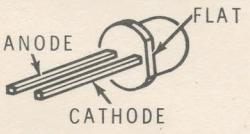
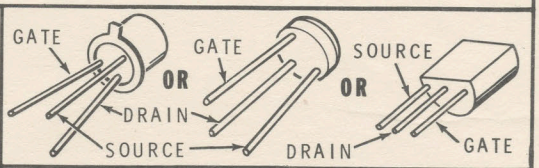
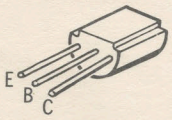
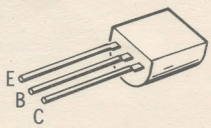
POWER SWITCH UNDER CIRCUIT BOARD

MAIN CIRCUIT BOARD
(Viewed from component side)



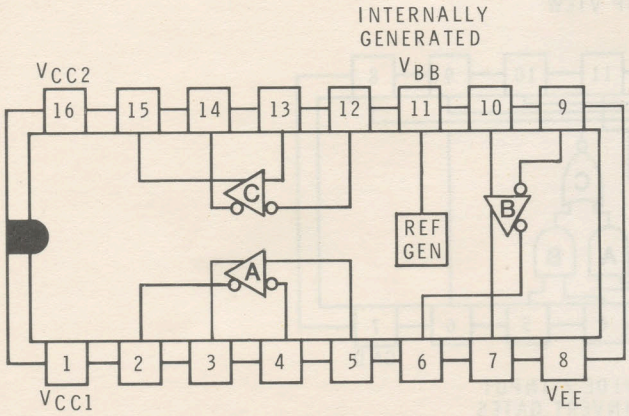
DISPLAY CIRCUIT BOARD
(Viewed from foil side)

SEMICONDUCTOR IDENTIFICATION CHART

COMPONENT	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION
DIODES			
D1, D2, D3, D4, D5	56-56	IN4149	**IMPORTANT: THE BANDED END OF DIODES CAN BE MARKED IN A NUMBER OF WAYS.**  **BANDED END**
D6	56-44	IN4653	
D7, D8, D9, D10, D11	57-65	IN4002	
D106	412-616	FLV117	
TRANSISTORS			
Q1	417-828	E-304	
Q2, Q3, Q4	417-292	2N5771	
Q5, Q6	417-801	MPSA20	

INTEGRATED CIRCUITS

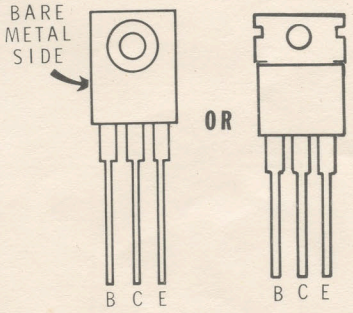
TOP VIEW



TRIPLE LINE RECEIVER
#443-747
MC10116P

(SELECTED)

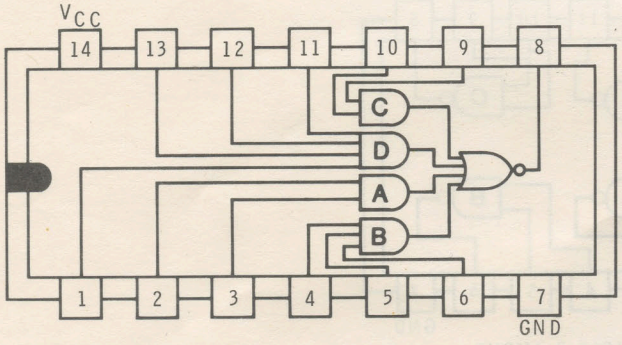
IC1



5-VOLT REGULATOR
#442-54
μA7805

IC27

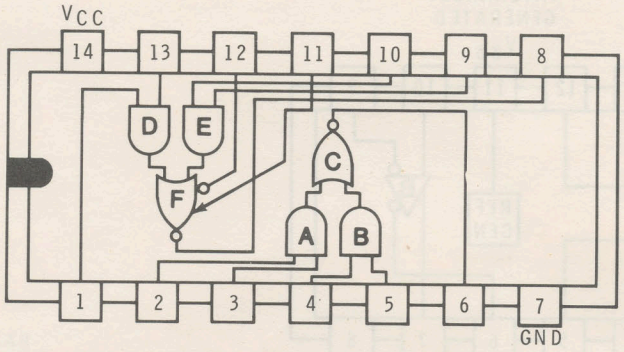
TOP VIEW



4-2-3-2-INPUT
AND-OR-INVERT GATES
#443-697
SN74S64

IC2

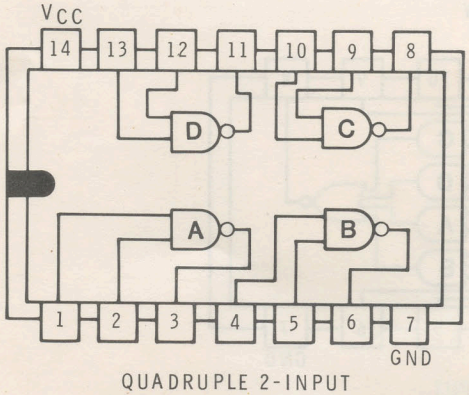
TOP VIEW



DUAL 2-WIDE 2-INPUT
AND-OR-INVERT GATES
(ONE GATE EXPANDABLE)
#443-15
SN7450N

IC15

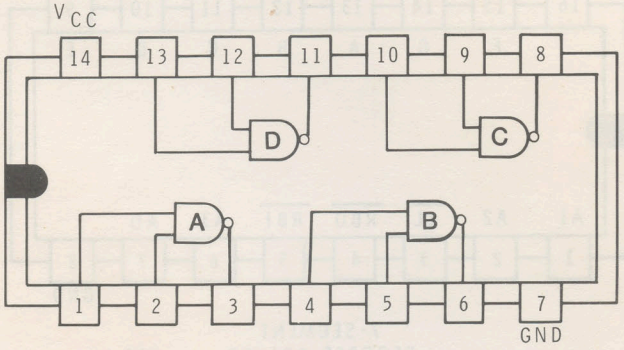
TOP VIEW



QUADRUPLE 2-INPUT
POSITIVE-NAND GATES
#443-1
SN7400N

IC14
IC17
IC26

TOP VIEW

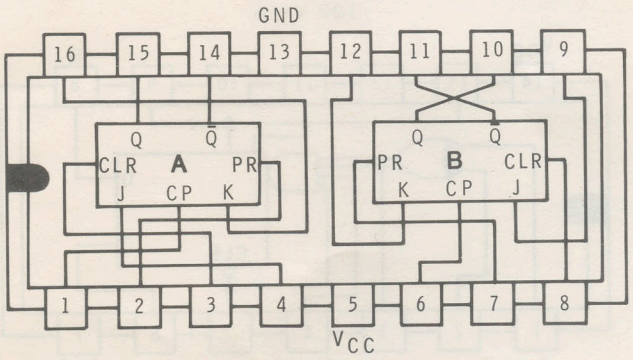


QUADRUPLE 2-INPUT
POSITIVE-NAND
SCHMITT TRIGGERS

IC18

#443-625
SN74132N

TOP VIEW

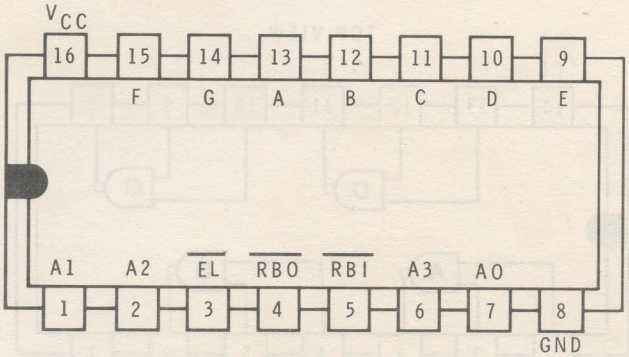


DUAL J-K FLIP-FLOP

IC13

#443-16
SN7476N

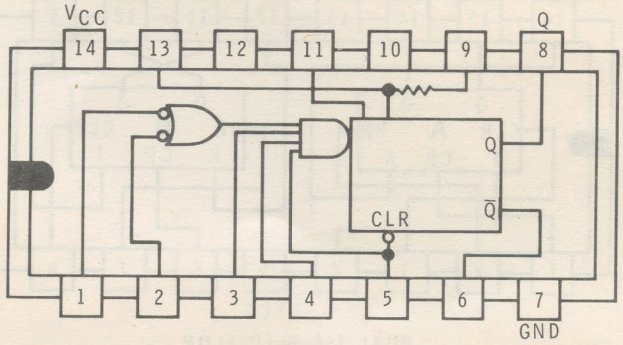
TOP VIEW



7-SEGMENT
DECODER DRIVER
#443-694
9368

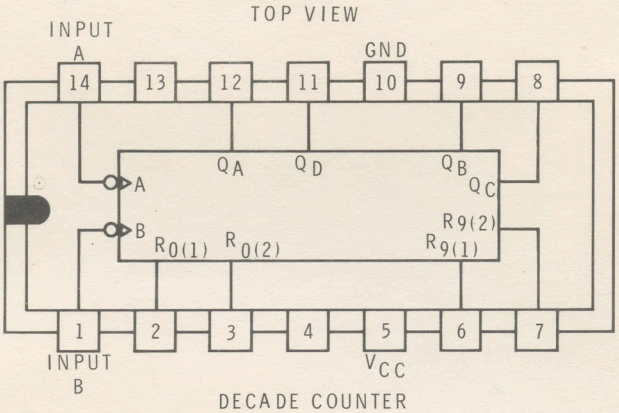
IC8
IC9
IC10
IC11
IC12

TOP VIEW



RETRIGGERABLE MONOSTABLE
MULTIVIBRATOR WITH CLEAR
#443-23
SN74122N

IC16

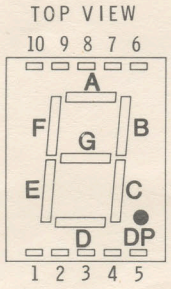


DECADE COUNTER

#443-7 SN7490N AND #443-629 SN7490AN

IC4	IC19	IC3
IC5	IC20	
IC6	IC21	
IC7	IC22	
	IC23	
	IC24	
	IC25	

DISPLAY



#411-819
FND500

D101
D102
D103
D104
D105

PIN

1. . . . . Segment E
2. . . . . Segment D
3. . . . . Common Cathode
4. . . . . Segment C
5. . . . . DP
6. . . . . Segment B
7. . . . . Segment A
8. . . . . Common Cathode
9. . . . . Segment F
10. . . . Segment G

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

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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

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

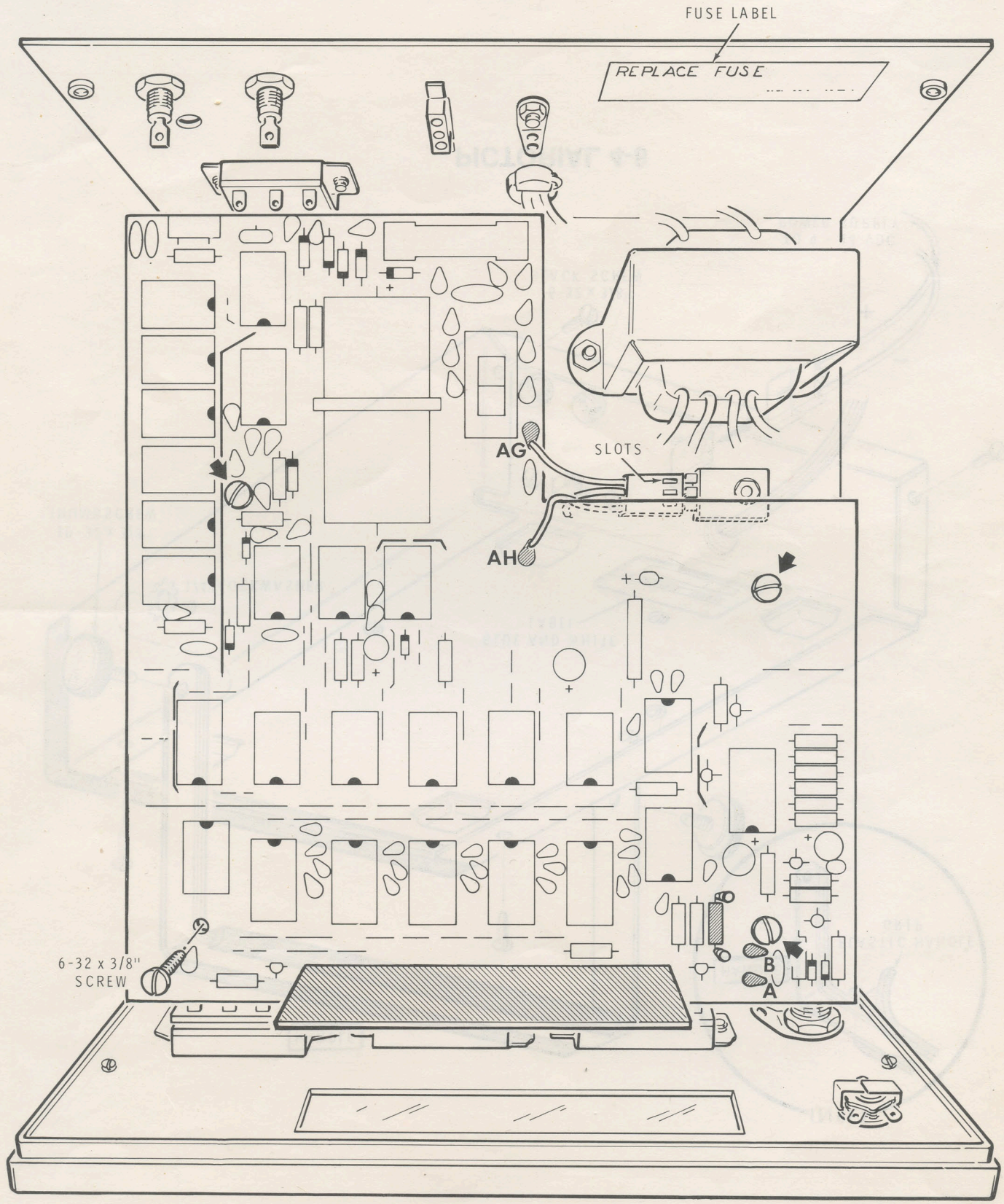
HEATH

Schlumberger

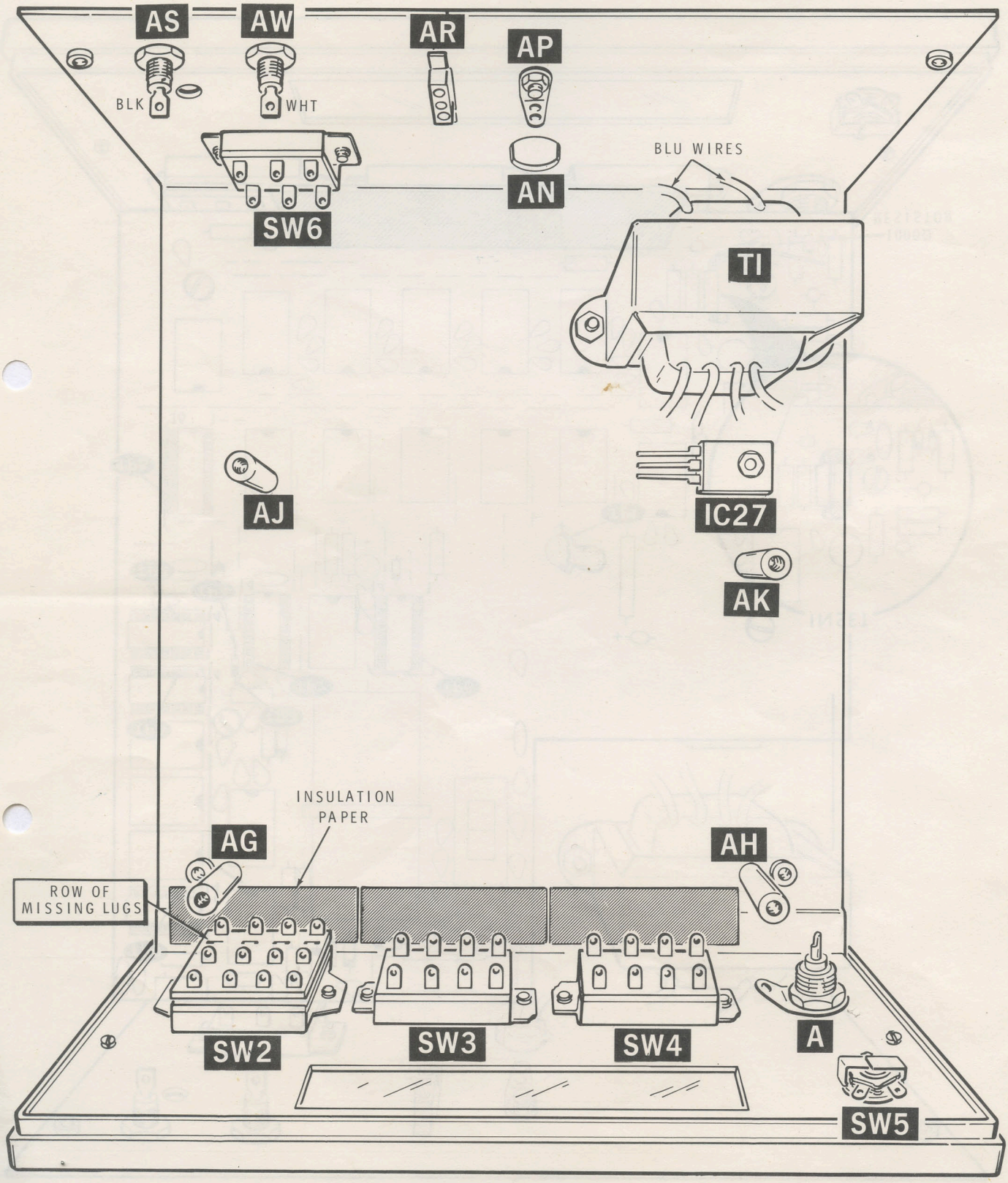
HEATH COMPANY • BENTON HARBOR, MICHIGAN

THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM

LITHO IN U.S.A.



PICTORIAL 4-7



PICTORIAL 4-1

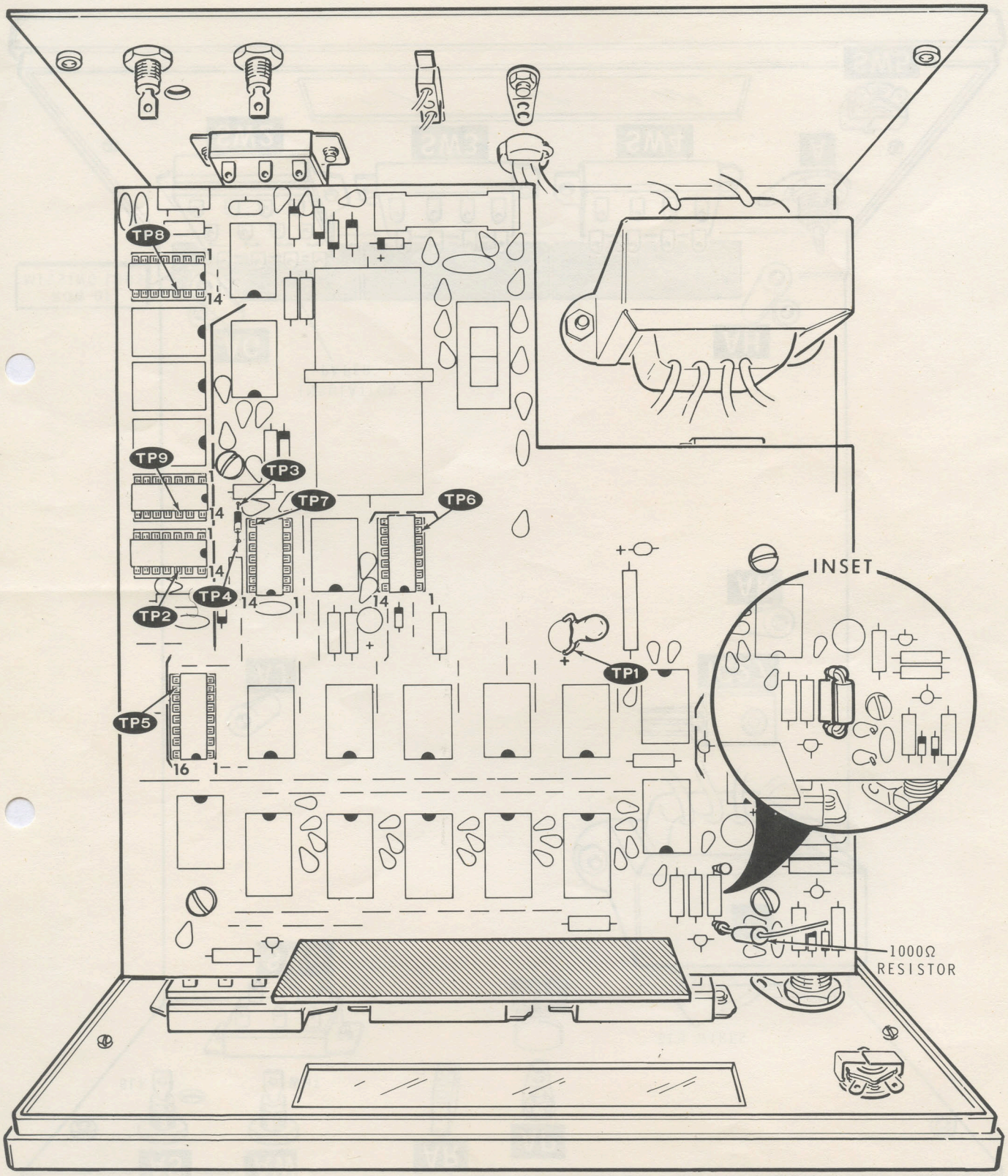
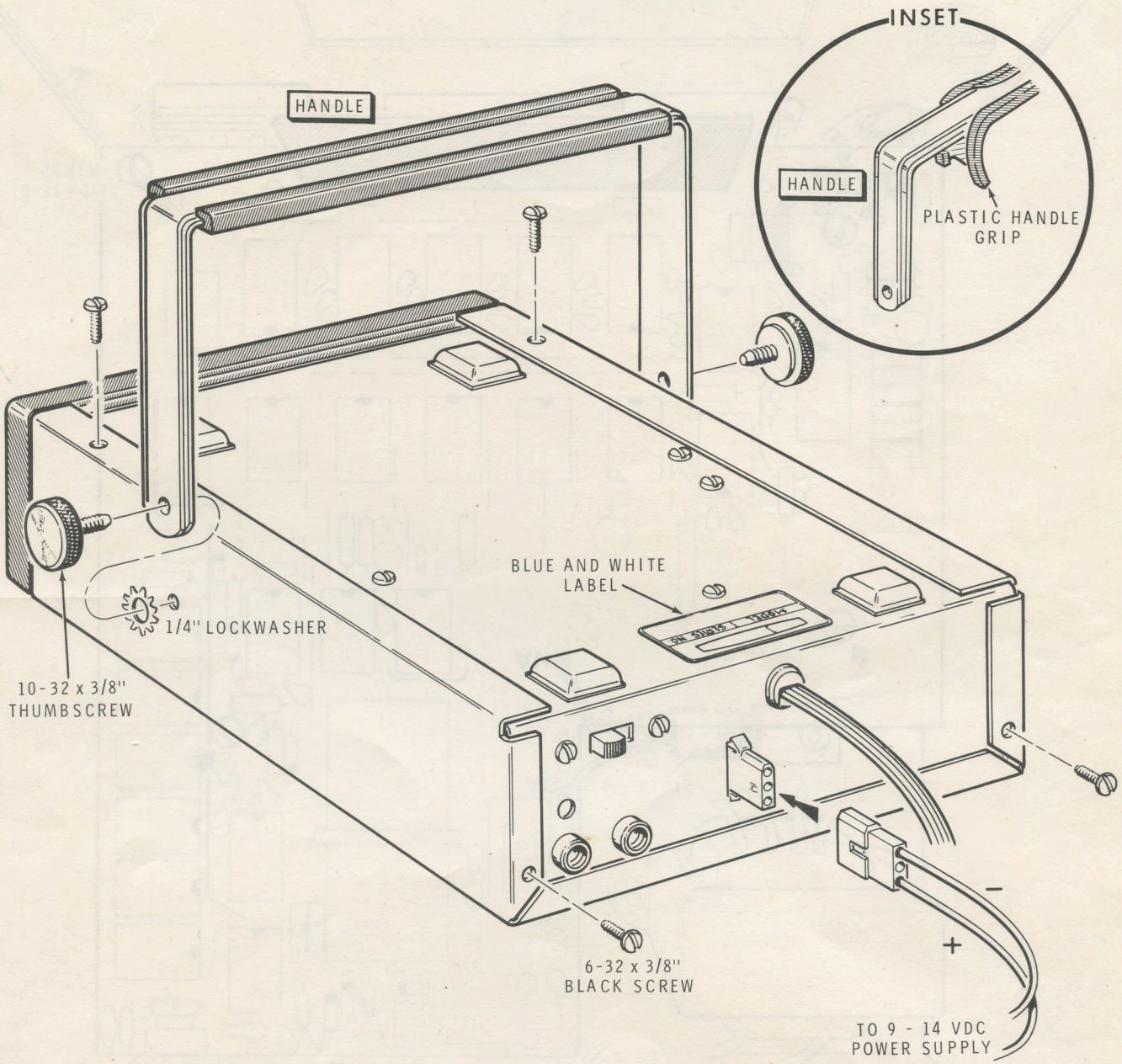


Figure 2



PICTORIAL 4-8

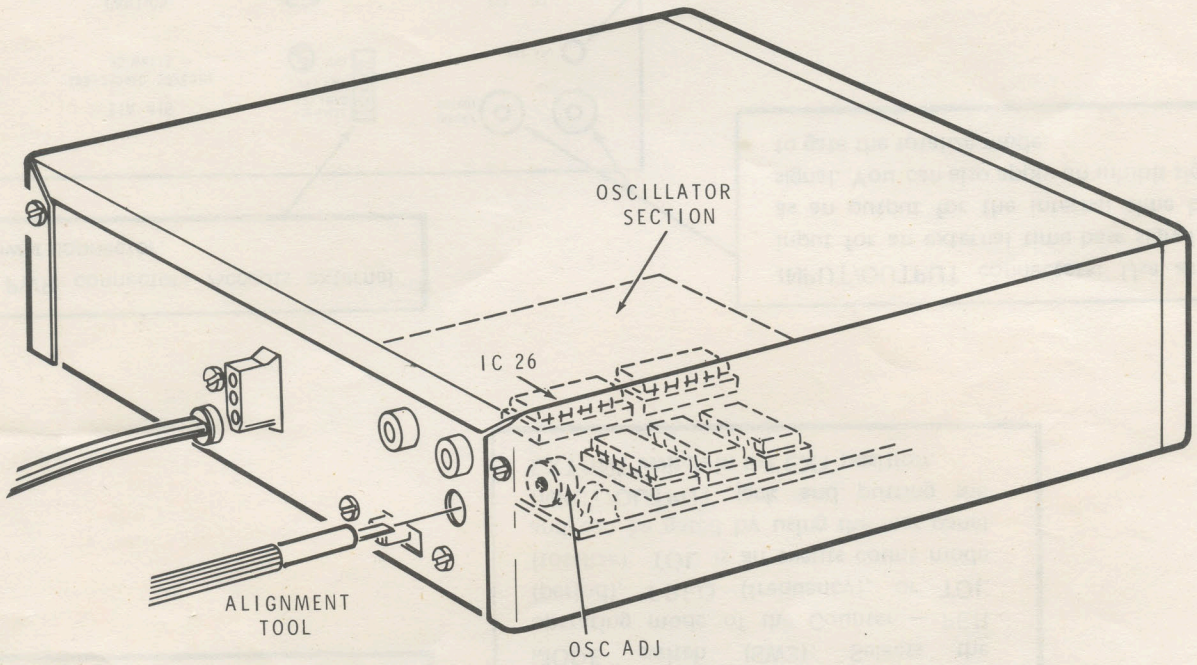


Figure 4

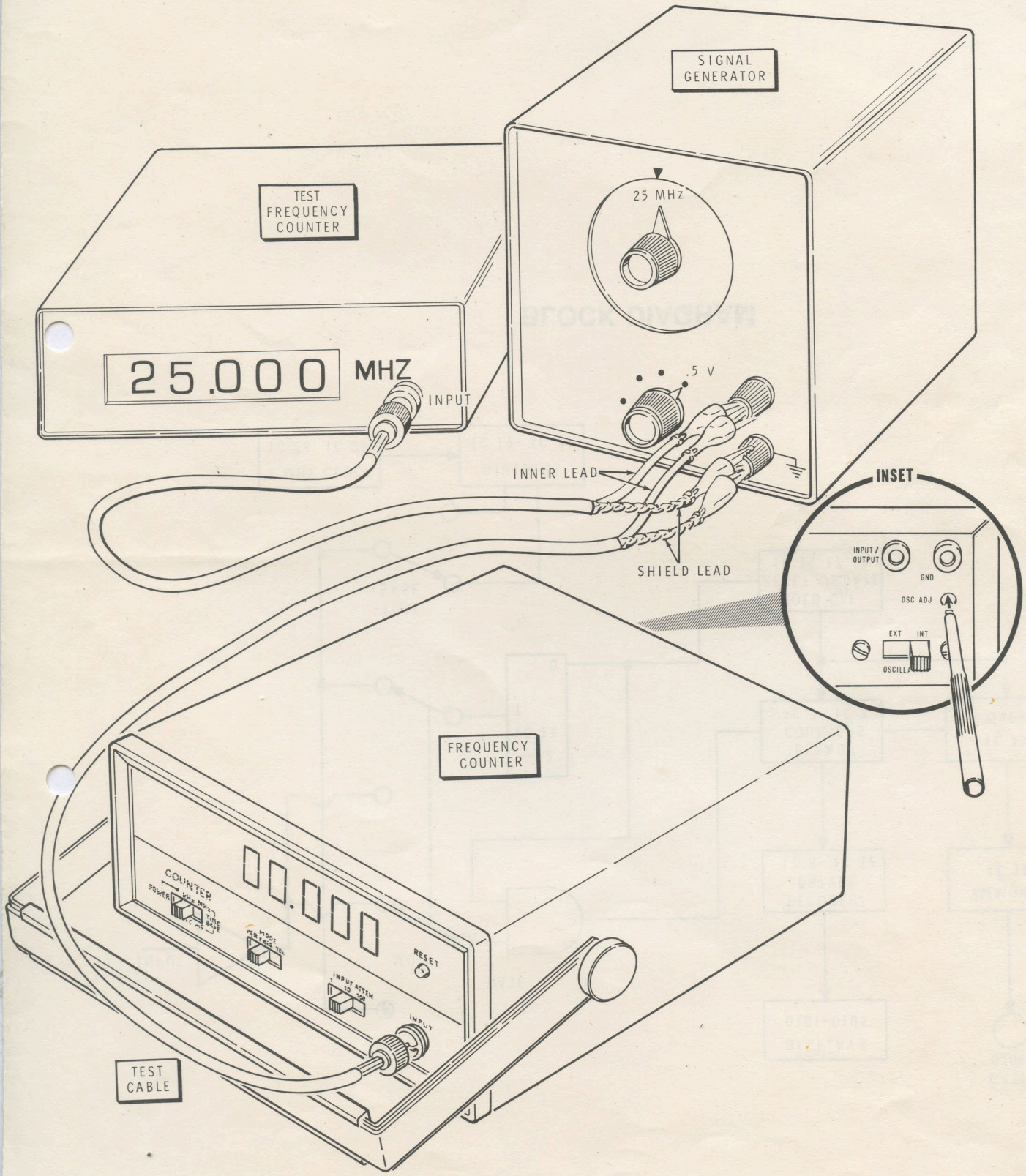
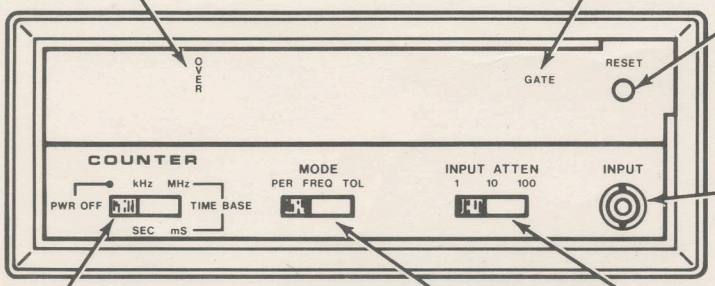

SIGNAL GENERATOR
TEST FREQUENCY COUNTER
25 MHz
25.000 MHZ
INPUT
.5 V
INNER LEAD
SHIELD LEAD
INSET
INPUT / OUTPUT
GND
OSC ADJ
EXT
INT
OSCILL
FREQUENCY COUNTER
00.000
COUNTER
POWER
RESET
INPUT
TEST CABLE

Figure 5

OVERRANGE indicator: Indicates when the number to be displayed is larger than the display can handle.

GATE lamp (D106): Flashes off and back on when the display is updated.

RESET switch (SW5): Resets the display to zero in any mode.



INPUT CONNECTOR

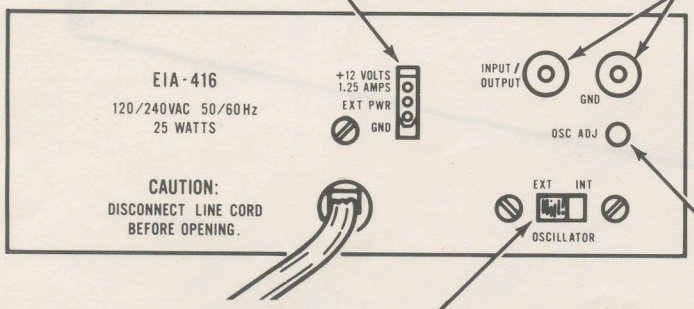
POWER/TIME BASE switch (SW2): Turns the unit on and off, selects between kHz and MHz in the FREQ MODE, and selects between SEC and mS in the PER (period) MODE.

INPUT ATTEN switch (SW4): Divides the amplitude of the incoming signal by 1, 10, or 100.

MODE switch (SW3): Selects the operating mode of the Counter – PER (period), FREQ (frequency), or TOL (totalize). TOL is an events count mode and can be gated by using the rear panel INPUT/OUTPUT jack and putting the EXT/INT switch in the EXT position.

EXT PWR connector: Accepts external DC power connector.

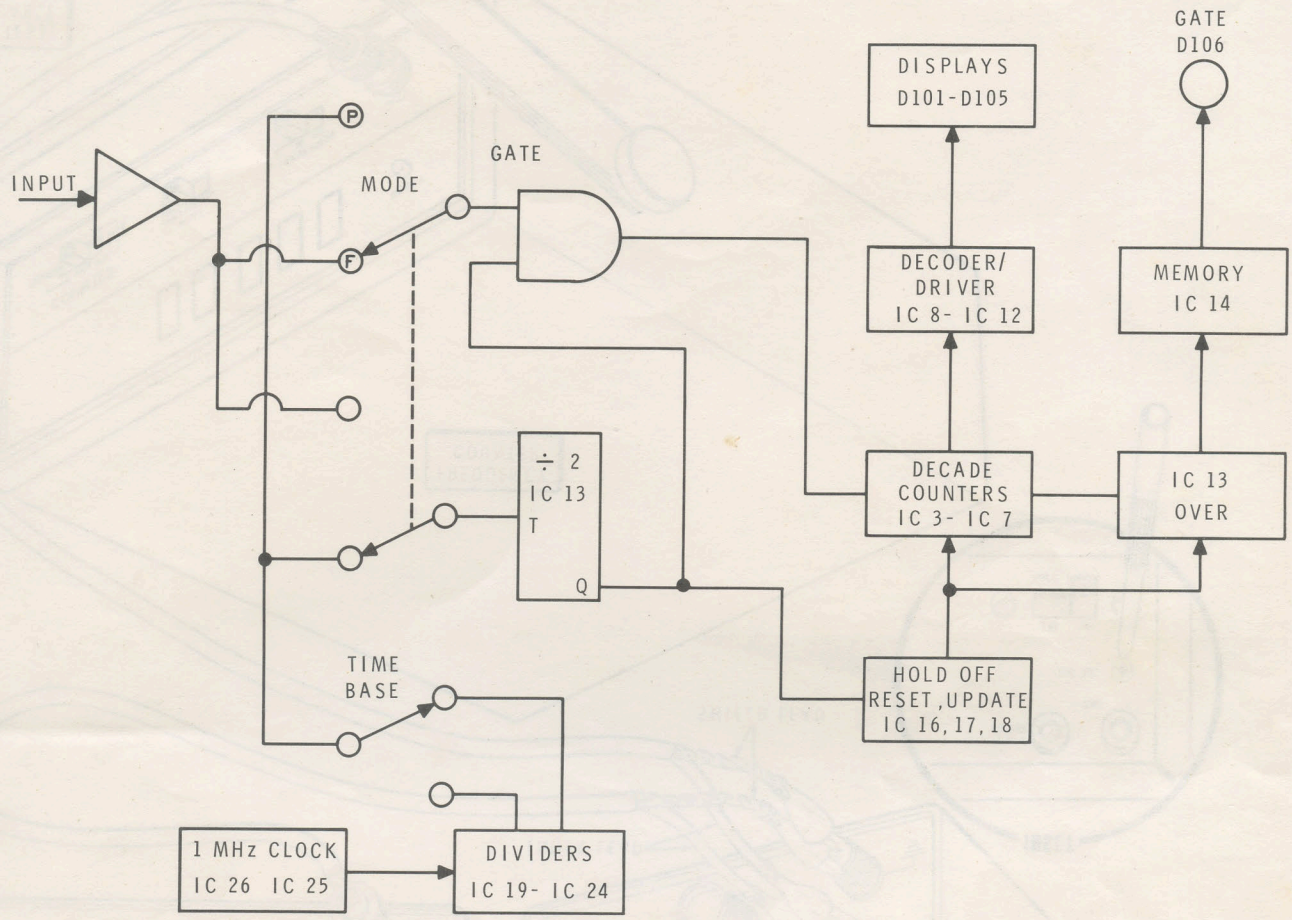
INPUT/OUTPUT connectors: Use as an input for an external time base signal, or as an output for the internal time base signal. You can also apply an inhibit signal to gate the totalize mode.



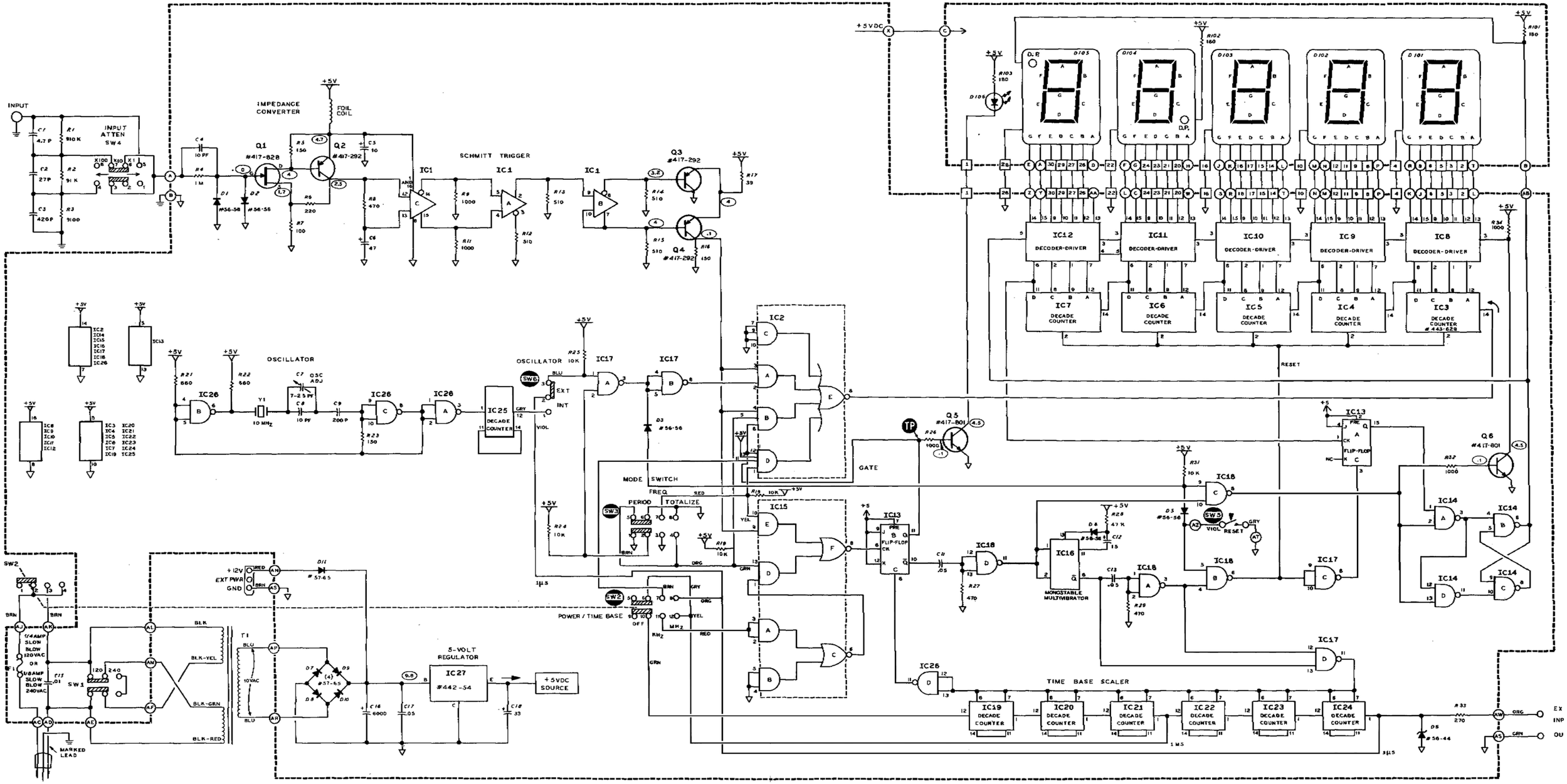
OSCILLATOR EXT INT switch: Selects either the internal time base or an external time base signal.

OSC ADJ capacitor (C7): Calibrates the time base frequency.

Figure 6



BLOCK DIAGRAM



SCHEMATIC OF THE HEATH MODEL IM-4100/SM-4100 FREQUENCY COUNTER

SCHEMATIC OF MOTOROLA MODEL S-1357A FREQUENCY COUNTER

NOTES:

1. COMPONENT NUMBERS ARE IN THE FOLLOWING GROUPS:

   1 - 99 PARTS MOUNTED ON THE CHASSIS AND MAIN CIRCUIT BOARD.
   101 - 199 PARTS MOUNTED ON THE DISPLAY CIRCUIT BOARD.

2. ALL RESISTOR VALUES ARE IN OHMS: K=1,000; M=1,000,000.
3. ALL RESISTORS ARE 1/2 WATT, 5%.
4. ALL CAPACITOR VALUES ARE IN µF UNLESS OTHERWISE NOTED.
5. ⏚ THIS SYMBOL INDICATES CHASSIS GROUND.
6. ▽ THIS SYMBOL INDICATES CIRCUIT BOARD GROUND.
7. ⊖ THIS SYMBOL INDICATES A PART MOUNTED ON THE CHASSIS BUT SHOWN ON THE CIRCUIT BOARD.
8. ⬭ THIS SYMBOL INDICATES A DC VOLTAGE TAKEN WITH A HIGH INPUT IMPEDANCE VOLTMETER BETWEEN THE POINT INDICATED AND GROUND WITH NO INPUT SIGNAL. VOLTAGES MAY VARY ±20%.