Heathkit®

Heathkit®

for the

PRECISION OSCILLOSCOPE CALIBRATOR

Model IG-4244

595-2889-08

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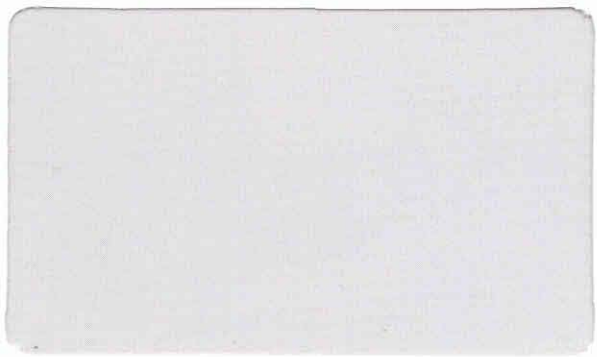
HEATH COMPANY PHONE DIRECTORY

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 Phone Numbers
(8:00 A.M. to 4:30 P.M. Eastern Time, Weekdays Only)

Education Products **616-982-3980**
Amateur Radio **616-982-3296**
Test Equipment, Weather Instruments, Clocks **616-982-3315**
Television **616-982-3307**
Home Products, Stereo, Security, Telephone, Marine, Automotive **616-982-3496**
Computer — Hardware **616-982-3309**



YOUR HEATHKIT 1 YEAR LIMITED WARRANTY

Consumer Protection Plan for Heathkit Consumer Products

Welcome to the Heath family. We believe you will enjoy assembling your kit and will be pleased with its performance. Please read this Consumer Protection Plan carefully. It is a "LIMITED WARRANTY" as defined in the U.S. Consumer Product Warranty and Federal Trade Commission Improvement Act. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Heath's Responsibility

PARTS — Replacements for factory defective parts will be supplied free for 1 year from date of purchase. Replacement parts are warranted for the remaining portion of the original warranty period. You can obtain warranty parts direct from Heath Company by writing or telephoning us at (616) 982-3571. And we will pay shipping charges to get those parts to you . . . anywhere in the world.

SERVICE LABOR — For a period of 1 year from the date of purchase, any malfunction caused by defective parts or materials will be corrected at no charge to you. You must deliver the unit at your expense to the Heath factory, any Heath/Zenith Computers and Electronics center (units of Veritechnology Electronics Corporation), or any of our authorized overseas distributors.

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

NOT COVERED — The correction of assembly errors, adjustments, calibration, and damage due to misuse, abuse, or negligence are not covered by the warranty. Use of corrosive solder and/or the unauthorized modification of the product or of any furnished component will void this warranty in its entirely. This warranty does not include reimbursement for inconvenience, loss of use, customer assembly, set-up time, or unauthorized service.

This warranty covers only Heath products and is not extended to other equipment or components that a customer uses in conjunction with our products.

SUCH REPAIR AND REPLACEMENT SHALL BE THE SOLE REMEDY OF THE CUSTOMER AND THERE SHALL BE NO LIABILITY ON THE PART OF HEATH FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO ANY LOSS OF BUSINESS OR PROFITS, WHETHER OR NOT FORESEEABLE.

Some states do not allow the exlusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

Owner's Responsibility

EFFECTIVE WARRANTY DATE — Warranty begins on the date of first consumer purchase. You must supply a copy of your proof of purchase when you request warranty service or parts.

ASSEMBLY — Before seeking warranty service, you should complete the assembly by carefully following the manual instructions. Heathkit service agencies cannot complete assembly and adjustments that are customer's resonsibility.

ACCESSORY EQUIPMENT — Performance malfunctions involving other non-Heath accessory equipment (antennas, audio components, computer peripherals and software, etc.) are not covered by this warranty and are the owner's responsibility.

SHIPPING UNITS — Follow the packing instructions published in the assembly manuals. Damage due to inadequate packing cannot be repaired under warranty.

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

10-1-87

Heathkit® Manual

for the

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Model IG-4244

595-2889-08

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

Table Of Contents

INTRODUCTION

The Heathkit Model IG-4244 Precision Oscilloscope Calibrator is an accurate, crystal-controlled, fast-rise time square wave generator. It provides you with the accurate time and amplitude signals you need to calibrate Heathkit Oscilloscopes, as well as most other oscilloscopes.

The time (or period) signals (.5 s to 10 ns) are the fast-rise (less than 1 ns) square waves you need to adjust oscilloscope sweep speeds, delay line terminations, and high frequency compensation. A terminated output cable prevents ringing and assures a good frequency response of the time signal.

The accurate voltage signals (1 mV to 100 V) are used for oscilloscope vertical calibration and attenuator compensation. The sine wave signal (approximately 1 V @ 1kHz) is used to adjust trigger circuits.

The Calibrator also serves equally well as a bench standard. It can be used to calibrate other test equipment or as a signal source when you build or test experimental circuits.

UNPACKING

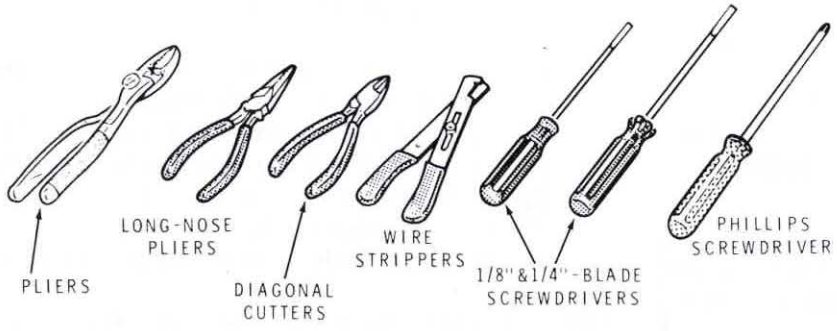
The shipping carton in which your kit was packed contained this Manual and other papers. Set these papers aside. Then refer to the "Pack Index Sheet," locate "Pack #1," and remove it from the shipping carton but do not open it. After you remove this pack, the remaining parts in the shipping carton are Final Pack parts, which consist principally of larger items and parts used in the chassis assembly.

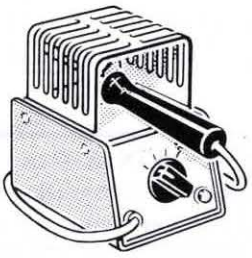
IMPORTANT: To avoid intermixing parts, DO NOT remove anything from a parts pack until you are directed to do so at the beginning of a Parts List. After you identify any part that is packed in an individual envelope with a part number on it, place the part back in its envelope until a step calls for that part.

ASSEMBLY NOTES

TOOLS

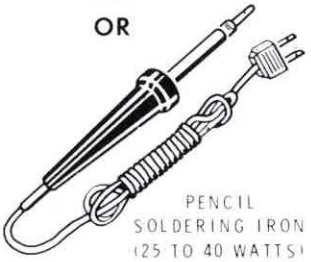
You will need these tools to assemble your kit.



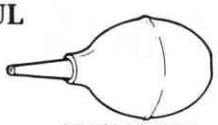


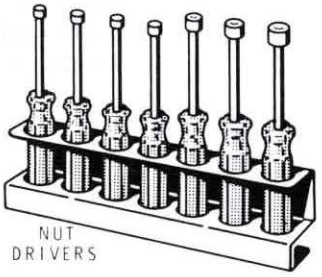
SOLDERING IRON

OR



OTHER HELPFUL TOOLS





*TO REMOVE SOLDER FROM CIRCUIT CONNECTIONS.

ASSEMBLY

1. Follow the instructions carefully. Read the entire step before you perform each operation.

2. The illustrations in the Manual are called Pictorials and Details. Pictorials show the overall operation for a group of assembly steps; Details generally illustrate 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.

3. Most kits use a separate "Illustration Booklet" that contains illustrations (Pictorials, Details, etc.) that are too large for the Assembly Manual. Keep the "Illustration Booklet" with the Assembly Manual. The illustrations in it are arranged in Pictorial number sequence.

4. Position all parts as shown in the Pictorials.

5. Solder a part or a group of parts only when you are instructed to do so.

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

   — In the Parts List,

   — At the beginning of each step where a component is installed,

   — In some illustrations,

   — In the Schematic,

   — In the section at the rear of the Manual.

7. When you are instructed to cut something to a particular length, use the scales (rulers) provided at the bottom of the Manual pages.

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

SOLDERING

Soldering is one of the most important operations you will perform while assembling your kit. A good solder connection will form an electrical connection between two parts, such as a component lead and a circuit board foil. A bad solder connection could prevent an otherwise well-assembled kit from operating properly.

It is easy to make a good solder connection if you follow a few simple rules:

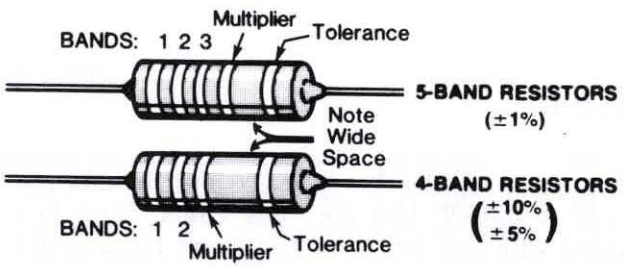
1. Use the right type of soldering iron. A 25 to 40-watt pencil soldering iron with a 1/8" or 3/16" chisel or pyramid tip works best.

2. Keep the soldering iron tip clean. Wipe it often on a wet sponge or cloth; then apply solder to the tip to give the entire tip a wet look. This process is called tinning, and it will protect the tip and enable you to make good connections. When solder tends to "ball" or does not stick to the tip, the tip needs to be cleaned and retinned.

NOTE: Always use rosin core, radio-type solder (60:40 or 50:50 tin-lead content) for all of the soldering in this kit. This is the type we have supplied with the parts. The Warranty will be void and we will not service any kit in which acid core solder or paste has been used.

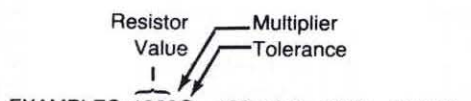
RESISTORS

Resistors are identified in Parts Lists and steps by their resistance value in Ω (ohms), kΩ (kilohms), or MΩ (megohms). They are usually identified by a color code of four or five color bands, where each color represents a number. See the "Resistor Color Code" chart. These colors are given in the steps in their proper order (except for the last band, which indicates a resistor's "tolerance"; see the "Resistor Tolerance Chart"). You do not need to memorize the color codes.



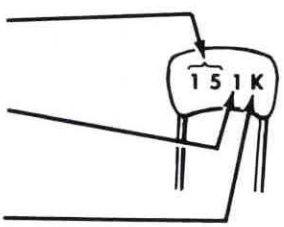
Occasionally, a "precision" or "power" resistor may have the value stamped on it. The letter R, K, or M may also be used at times to signify a decimal point, as in: 2R2 = 2.2 Ω
2K2 = 2.2 kΩ, or 2200 Ω
2M2 = 2.2 MΩ

Precision resistors may also be marked as shown in the following examples. The values of the multipliers are shown in the "Multiplier Chart," and the tolerance values are shown in the "Resistor Tolerance" chart.



CAPACITORS

Capacitors will be called out by their capacitance value in μF (microfarads) or pF (picofarads) and type: ceramic, Mylar®, electrolytic, etc. Some capacitors may have their value printed in the following manner:



First and second digits of capacitor's value: 15

Multiplier: Multiply the first & second digits by the proper value from the "Multiplier Chart."

To find the tolerance of the capacitor, look up this letter in the capacitor Tolerance chart.

RESISTOR COLOR CODE CHART

	Band 1	Band 2	Band 3 (if used)	Multiplier
Color	1st Digit	2nd Digit	3rd Digit	
Black	0	0	0	1
Brown	1	1	1	10
Red	2	2	2	100
Orange	3	3	3	1,000
Yellow	4	4	4	10,000
Green	5	5	5	100,000
Blue	6	6	6	1,000,000
Violet	7	7	7	10,000,000
Gray	8	8	8	100,000,000
White	9	9	9	—
Silver	—	—	—	.01
Gold	—	—	—	.1

RESISTOR TOLERANCE CHART

	COLOR OR LETTER	
±10%	SILVER	
± 5%	GOLD	J
± 2%	RED	G
± 1%	BROWN	F
±0.5%	GREEN	D
±0.25%	BLUE	C
±0.1%	VIOLET	B
±0.05%	GRAY	

MULTIPLIER CHART

FOR THE NUMBER:	MULTIPLY BY:	FOR THE NUMBER:	MULTIPLY BY:
0	1	4	10,000
1	10	5	100,000
2	100	8	0.01
3	1000	9	0.1

CAPACITOR TOLERANCE CHART

LETTER	10 pF OR LESS	OVER 10 pF
B	±0.1 pF	
C	±0.25 pF	
D	±0.5 pF	
F	±1.0 pF	±1%
G	±2.0 pF	±2%
H		±3%
J		±5%
K		±10%
M		±20%

EXAMPLES: 151K = 15 × 10 = 150 pF
759 = 75 × 0.1 = 7.5 pF

NOTE: The letter "R" may be used at times to signify a decimal point, as in: 2R2 = 2.2 (pF or μF).

CIRCUIT BOARD

PARTS LIST

Remove the parts from Pack #1 and check each part against the following list. The key numbers correspond to the numbers on the "Circuit Board Parts Pictorial" (Illustration Booklet, Page 1). After you check any part that is packed in an individual envelope, place the part back in the envelope until that part is called for in a step. Do not throw away any packing material until you account for all the parts.

To order a replacement part, always include the PART NUMBER. Use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover of this Manual.

RESISTORS

All 5% and 10% resistors have four color bands (last band gold for 5% and silver for 10%). The last band (gold or silver) will not be called out.

All **color banded 1% resistors** have five color bands (last band brown). This brown band is set apart from the other bands. The last band (brown) will not be called out.

Refer directly to the enclosed resistor/diode sheet and follow the instructions at the top of that sheet to check your resistors and diodes.

1/4-Watt

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
A1	6-479-12	1	4.7 Ω (yel-viol-gld)	R163
A1	6-100-12	1	10 Ω (brn-blk-blk)	R162
A1	6-150-12	1	15 Ω (brn-grn-blk)	R164
A1	6-560-12	1	56 Ω (grn-blu-blk)	R153
A1	6-750-12	2	75 Ω (viol-grn-blk)	R147, R148
A1	6-820-12	1	82 Ω (gry-red-blk)	R165
A1	6-151-12	3	150 Ω (brn-grn-brn)	R141, R155, R158
A1	6-181-12	1	180 Ω (brn-gry-brn)	R157
A1	6-201-12	2	200 Ω (red-blk-brn)	R149, R159
A1	6-2490-12	1	249 Ω, 1% (red-yel-wht-blk)	R169
A1	6-301-12	3	300 Ω (org-blk-brn)	R151, R152, R203
A1	6-331-12	1	330 Ω (org-org-brn)	R208
A1	6-391-12	1	390 Ω (org-wht-brn)	R142

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KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Resistors (cont'd.)				
A1	6-471-12	9	470 Ω (yel-viol-brn)	R122, R125, R128, R137, R138, R139, R156, R167, R183
A1	6-511-12	18	510 Ω (grn-brn-brn)	R101, R102, R103, R104, R105, R106, R108, R109, R111, R112, R113, R114, R115, R132, R143, R144, R145, R146
A1	6-102-12	4	1000 Ω (brn-blk-red)	R161, R174, R187, R207
A1	6-1101-12	3	1100 Ω, 1% (brn-brn-blk-brn)	R134, R136, R168
A1	6-152-12	6	1500 Ω (brn-grn-red)	R116, R117, R118, R119, R121, R154
A1	6-1501-12	1	1500 Ω, 1% (brn-grn-blk-brn)	R204
A1	6-3011-12	2	3010 Ω, 1% (org-blk-brn-brn)	R175, R176
A1	6-332-12	4	3300 Ω (org-org-red)	R123, R124, R127, R131
A1	6-3741-12	1	3740 Ω, 1% (org-viol-yel-brn)	R171
A1	6-472-12	3	4700 Ω (yel-viol-red)	R126, R129, R133
A1	6-562-12	1	5600 Ω (grn-blu-red)	R184
A1	6-622-12	2	6200 Ω (blu-red-red)	R189, R191
A1	6-7321-12	1	7320 Ω, 1% (viol-org-red-brn)	R205
A1	6-1002-12	1	10 kΩ, 1% (brn-blk-blk-red)	R206
A1	6-3012-12	1	30.1 kΩ, 1% (org-blk-brn-red)	R185
A1	6-4022-12	2	40.2 kΩ, 1% (yel-blk-red-red)	R135, R177
A1	6-6812-12	1	68.1 kΩ, 1% (blu-gry-brn-red)	R186
A1	6-224-12	1	220 kΩ (red-red-yel)	R188

OTHER RESISTORS

NOTE: The following resistors are not on the resistor strip. They are found inside a coin envelope marked "Resistors."

.1% precision resistors can have their value marked on the resistor body, although some may have color bands.

A1	2-763-12	1	70 Ω, (viol-blk-blk-gld-viol) .1% precision	R202
A1	2-762-12	3	77.8 Ω, (viol-viol-gry-gld-viol) .1% precision	R195, R197, R199
A1	2-761-12	4	630 Ω, (blu-org-blk-blk-viol) .1% precision	R194, R196, R198, R201
A2	6-271-1	1	270 Ω, 1-watt (red-viol-brn)	R166
A3	3-48-5	2	6000 Ω (6k), 5-watt, wirewound	R172, R173
A4	3-25-2	1	6300 Ω (6.3k), 2-watt, .1% wirewound	R193
A2	6-183-1	1	18 kΩ, 1-watt (brn-gry-org)	R182

CONTROLS – SWITCH

B1	10-1137	2	2000 Ω (2k) control	R179, R181
B1	10-1138	1	10 kΩ control	R178
B1	10-1184	1	15 kΩ control	R192
B2	63-1394	1	Rotary switch	SW101

CAPACITORS

Ceramic

C1	21-149	1	2.7 pF	C151
C1	21-701	2	3.3 pF	C104, C106
C1	21-111	1	15 pF	C115
C1	21-5	3	20 pF	C116, C117, C118
C1	21-147	1	47 pF	C101
C1	21-75	1	100 pF	C123
C1	21-27	1	.005 µF, 500 V	C121
C1	21-72	2	4700 pF (472)	C142, C143
C1	21-16	4	.01 µF	C144, C145, C146, C147
C2	21-769	15	.01 µF (103) glass	C102, C103, C105, C107, C111, C113, C114, C126, C127, C129, C131, C132, C133, C148, C149
C2	21-786	1	.1 µF (104) glass	C128

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Electrolytic				
C3	25-880	5	10 µF, 35 V	C112, C135, C137, C139, C152
C3	25-911	2	22 µF	C108, C109
C3	25-919	2	150 µF	C134, C153
C3	25-895	2	2200 µF	C136, C138
C4	25-147	1	10 µF, 150 V	C122
C4	25-852	1	100 µF	C119
C4	25-876	1	1000 µF	C141
Mylar				
C5	27-147	1	.0056 µF	C124
C5	27-210	1	.056 µF	C125
DIODES				
D1	56-56	3	1N4149	D113, D116, D119
D1	56-688	1	1N825A	D115
D1	56-99	1	1N5223B	D114
D1	57-27	12	1N2071	D101–D112
D1	56-602	1		D120

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
TRANSISTORS – INTEGRATED CIRCUITS (ICs)				

NOTE: Transistors and intergrated circuits may be marked for identification in any one of the following four ways:

1. Part number.
2. Type number. (On integrated circuits, use **only** those numbers and letters that appear below in **BOLD** print. Disregard any other numbers or letters on the integrated circuits.)
3. Part number and type number.
4. Part number with a type number other than the one shown.

D2	417-91	1	2N5232A transistor	Q112
D2	417-292	1	2N5771 transistor	Q104
D2	417-293	1	2N5770 transistor	Q103
D2	417-885	1	MPSA65 transistor	Q107
D3	417-154	1	2N2369 transistor	Q113
D4	417-979	4	2N6304 transistor	Q101, Q102, Q105, Q106
D5	417-245	3	D40N1 transistor	Q108, Q109, Q111
D5	417-948	1	MDS60 transistor	Q110
D6	442-54	1	UA**7805** integrated circuit	U118
D6	442-709	1	LM**337** integrated circuit	U120
D6	442-630	1	MC**7905** or UA7952C integrated circuit	U119
D7	442-22	1	N5**741** integrated circuit	U116
D7	442-53	1	NE**555** integrated circuit	U117
D7	443-25	1	SN**74151**AN integrated circuit	U114
D7	443-628	1	SN**74196** integrated circuit	U107
D7	443-636	2	MC**10116** integrated circuit	U101, U105
D7	443-679	1	MC**10131** integrated circuit	U102
D7	443-683	2	MC**10102** integrated circuit	U103, U104
D7	443-1121	1	**74F00** integrated circuit	U106
D7	443-731	6	**74LS290** integrated circuit	U108, U109, U110, U111, U112, U113
D7	443-829	1	**74LS76** integrated circuit	U115

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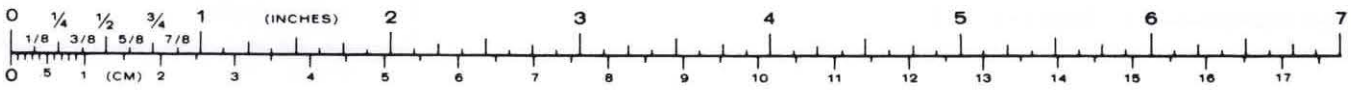
KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
SOCKETS – PLUG				
E1	434-230	2	8-pin IC socket	
E1	434-298	8	14-pin IC socket	
E1	434-299	7	16-pin IC socket	
E2	432-1129	1	4-pin plug	P101
HARDWARE				
F1	250-1414	2	4-40 × ¼" phillips screw	
F2	252-2	2	4-40 nut	
F3	254-9	2	#4 lockwasher	
F4	250-1428	2	6-32 × ¼" phillips screw	
WIRE – SLEEVING – CABLE				
	344-34	24"	Brown wire	
	344-54	15"	Yellow wire	
	346-1	3"	Small black sleeving	
	346-2	5"	Small clear sleeving	
	346-60	1-½"	Large clear sleeving	
	346-35	1-¼"	Small heat-shrinkable sleeving	
	346-46	6"	Large heat-shrinkable sleeving	
	343-15	6"	Coaxial cable	

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
MISCELLANEOUS				
G1	45-605	1	.1 µH (sil-blk-brn-gld-sil) choke	L101
G2	45-617	1	3.3 µH (sil-org-gld-org-sil) or (org-org-gld-sil) choke	L102
G3	73-147	1	Double-stick foam tape	
	85-2810-3	1	Circuit board	
G4	215-94	4	Heat sink	
G5	255-42	1	¾" fiber spacer	
G6	260-65	2	Fuse clip	
G7	404-651	1	20 MHZ crystal	Y102
G7	404-652	1	100 MHZ crystal	Y101
G8	412-637	1	LED	D118
G9	421-31	1	3/16-ampere slow-blow fuse	F101
G10	490-5	1	Nut starter	
G11	490-111	1	IC puller	
G12	490-185	1	Desoldering braid	
G13	390-1255	1	Fuse replacement label*	
G14		1	Blue and white label*	
	597-3097	1	Resistor–diode sheet*	
	597-260	1	Parts Order Form*	
		1	Assembly Manual (see Page 1 for part number)	
			Solder	

*Located inside the Manual.



STEP-BY-STEP ASSEMBLY

CIRCUIT BOARD

START

In the following steps, you will be given detailed instructions on how to install and solder the first part of the circuit board. Read and perform each step carefully. Then use the same procedure whenever you install parts on a circuit board.

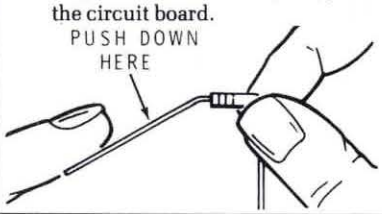
The shaded area in the Identification Drawing at the top of each page indicates what portion of the circuit board you will be working with in each Pictorial. Always refer to the drawing before you begin the assembly.

( ) Position the circuit board as shown with the lettered side up.

NOTE: You will install resistors with four and five color bands. These colors can easily be confused, so take your time. Use a magnifying glass to identify the color bands. Carefully compare the color code in each step with the color bands on the resistor body before you install it in the step. Resistors are 5% (four bands) unless otherwise stated in the step.

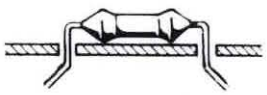
Refer to the Resistor–Diode Sheet to install the following parts.

( ) R102: Hold a 510 Ω (grn-brn-brn) resistor as shown and bend the leads straight down with your finger to fit the hole spacing on the circuit board.

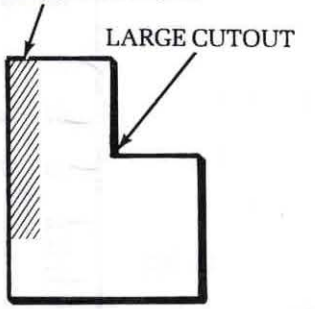


( ) Push the leads through the holes at the indicated location on the circuit board. The end with color bands may be positioned either way.

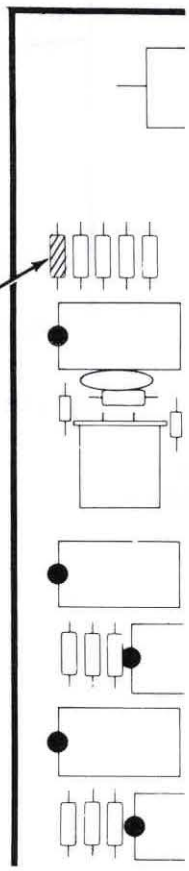
( ) Press the resistor against the circuit board. Then bend the leads outward slightly to hold the resistor in place.



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



IDENTIFICATION DRAWING

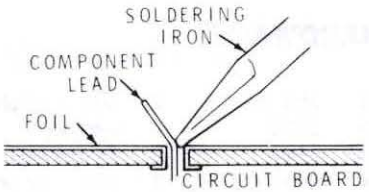


PICTORIAL 1-1

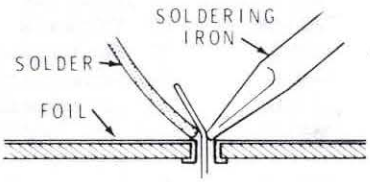
CONTINUE

( ) Solder the resistor leads to the circuit board as follows:

1. Push the soldering iron tip against both the lead and the circuit board foil. Heat **both** for two or three seconds.

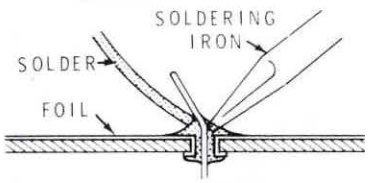


2. Then apply solder to the other side of the connection. IMPORTANT: Let the heated lead and the circuit board foil melt the solder.



3. As the solder begins to melt, allow it to flow around the connection. Then remove the solder and the iron and let the connection cool.

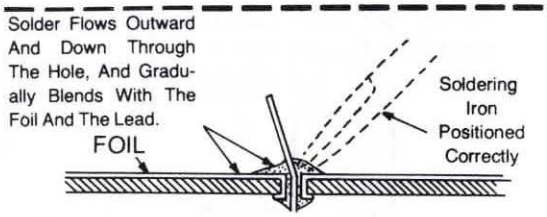
NOTE: Do not use too much solder. All the holes on this board are "plated through" holes and solder will flow onto the other side of the board. Use a minimum of solder and be careful not to fill nearby holes with solder.



( ) Cut off the excess lead lengths close to the connection. WARNING: Clip the leads so the ends will not fly toward your eyes.

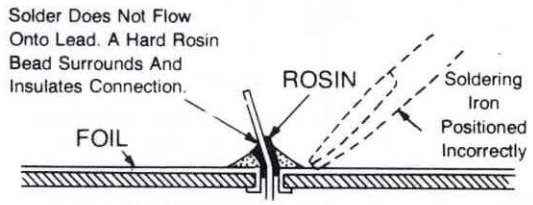
( ) Check the connection. Compare it to the illustrations on Page 13. After you have checked the solder connections, proceed with the assembly on Page 14. Use the same soldering procedure for each connection.

A GOOD SOLDER CONNECTION

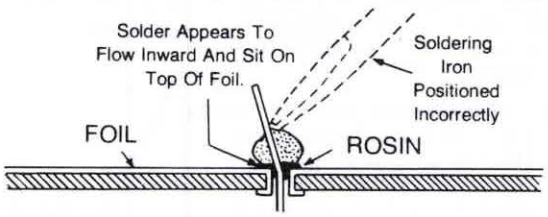


When you heat the lead and the circuit board foil at the same time, the solder will flow evenly onto the lead and the foil. The solder will make a good electrical connection between the lead and the foil.

POOR SOLDER CONNECTIONS



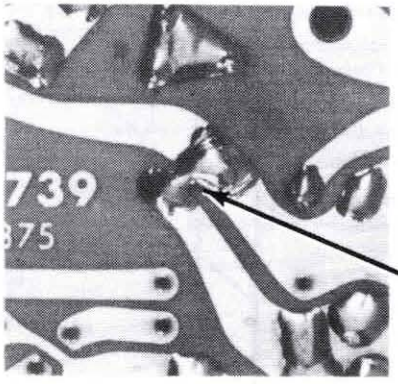
When the lead is not heated sufficiently, the solder will not flow onto the lead as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.



When the foil is not heated sufficiently the solder will blob on the circuit board as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.

SOLDER BRIDGES

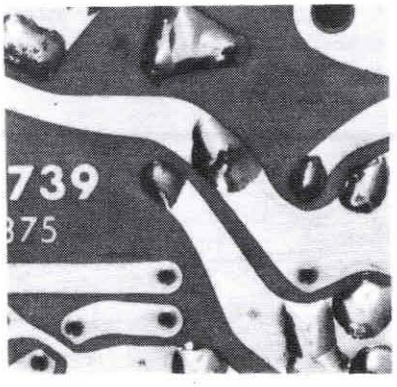
A solder bridge between two adjacent foils is shown in photograph **A**. Photograph **B** shows how the connection should appear. A solder bridge may occur if you accidentally touch an adjacent previously soldered connection, if you use too much solder, or if you "drag" the soldering iron across other foils as you remove it from the connection. A good rule to follow is: always take a good look at the foil area around each lead before you solder it. Then, when you solder the connection, make sure the solder remains in this area and does not bridge to another foil. This is especially important when the foils are small and close together. NOTE: It is alright for solder to bridge two connections on the same foil.



A

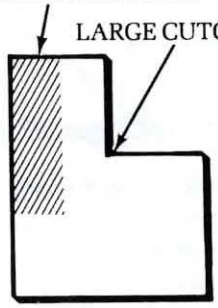
SOLDER BRIDGE

B



Use only enough solder to make a good connection, and lift the soldering iron straight up from the circuit board. If a solder bridge should develop, turn the circuit board foil-side-down and heat the solder between connections. The excess solder will run onto the tip of the soldering iron, and this will remove the solder bridge. NOTE: The foil side of most circuit boards has a coating on it called "solder resist." This is a protective insulation to help prevent solder bridges.

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



IDENTIFICATION DRAWING

START

NOTE: Make sure you installed the first resistor at R102 on Page 12 before you proceed.

Install six 510 Ω (grn-brn-brn) resistors at the following locations:

( ) R105 .....
( ) R111 .....
( ) R112 .....
( ) R101 .....
( ) R104 .....
( ) R103 .....

( ) L101: .1 μH (sil-blk-brn-gld-sil) choke (#45-605).

( ) C102: .01 μF (103) glass ceramic.

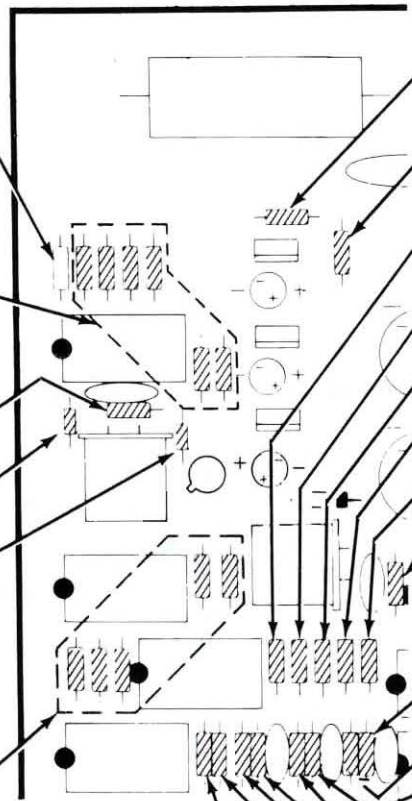
( ) C148: .01 μF (103) glass ceramic.

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

Install five 510 Ω (grn-brn-brn) resistors at the following locations:

( ) R106 .....
( ) R114 .....
( ) R108 .....
( ) R109 .....
( ) R132 .....

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



CONTINUE

( ) R169: 249 Ω, 1% (red-yel-wht-blk).

( ) R171: 3740 Ω, 1% (org-viol-yel-brn).

( ) R115: 510 Ω (grn-brn-brn).

( ) R125: 470 Ω (yel-viol-brn).

( ) R128: 470 Ω (yel-viol-brn).

( ) R122: 470 Ω (yel-viol-brn).

( ) C114: .01 μF (103) glass ceramic.

( ) R134: 1100 Ω, 1% (brn-brn-blk-brn).

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

( ) R124: 3300 Ω (org-org-red).

( ) R123: 3300 Ω (org-org-red).

( ) R131: 3300 Ω (org-org-red).

( ) R129: 4700 Ω (yel-viol-red).

( ) R127: 3300 Ω (org-org-red).

( ) R126: 4700 Ω (yel-viol-red).

( ) R141: 150 Ω (brn-grn-brn).

( ) R142: 390 Ω (org-wht-brn).

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

PICTORIAL 1-2

START

Install three 510 Ω (grn-brn-brn) resistors at the following locations:

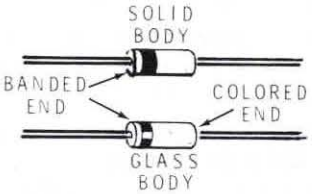
( ) R113 .....
( ) R143 .....
( ) R144 .....

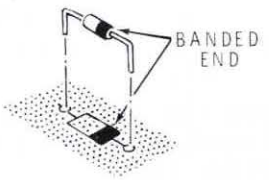
( ) R148: 75 Ω (viol-grn-blk).

( ) R161: 1000 Ω (brn-blk-red).

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

NOTE: When you install a diode, always match the band on the diode with the band mark on the circuit board. THE CIRCUIT WILL NOT WORK IF A DIODE IS INSTALLED BACKWARDS. See Detail 1-3A.





If your diode has a solid body, the band is clearly defined. If your diode has a glass body, do not mistake the colored end inside the diode for the banded end. Look for a band painted on the outside of the glass.

( ) D119: 1N4149 diode (#56-56).

( ) D113: 1N4149 diode (#56-56).

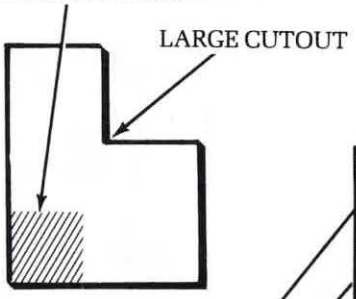
( ) C103: .01 µF (103) glass ceramic.

( ) R155: 150 Ω (brn-grn-brn).

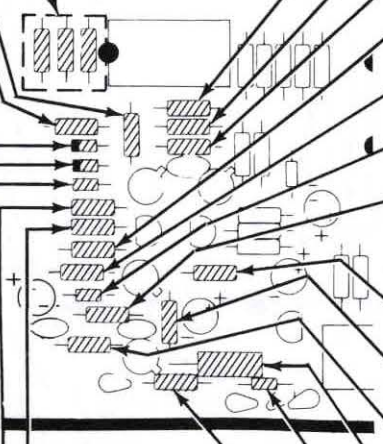
( ) R157: 180 Ω (brn-gry-brn).

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

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



IDENTIFICATION DRAWING



CONTINUE

( ) R151: 300 Ω (org-blk-brn).

( ) R152: 300 Ω (org-blk-brn).

( ) R153: 56 Ω (grn-blu-blk).

( ) R159: 200 Ω (red-blk-brn).

( ) R162: 10 Ω (brn-blk-blk).

( ) C105: .01 µF (103) glass ceramic.

( ) R164: 15 Ω (brn-grn-blk).

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

( ) R168: 1100 Ω, 1% (brn-brn-blk-brn).

( ) R163: 4.7 Ω (yel-viol-gld).

( ) R165: 82 Ω (gry-red-blk).

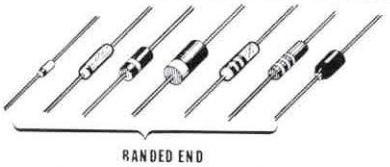
( ) R166: 270 Ω, **1-watt** (red-viol-brn).

( ) C107: .01 µF (103) glass ceramic.

( ) R167: 470 Ω (yel-viol-brn).

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

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



Detail 1-3A

PICTORIAL 1-3

START

( ) R121: 1500 Ω (brn-grn-red).

( ) R119: 1500 Ω (brn-grn-red).

( ) R118: 1500 Ω (brn-grn-red).

( ) R145: 510 Ω (grn-brn-brn).

( ) R146: 510 Ω (grn-brn-brn).

( ) R149: 200 Ω (red-blk-brn).

( ) R147: 75 Ω (viol-grn-blk).

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

( ) C111: .01 µF (103) glass ceramic.

( ) R154: 1500 Ω (brn-grn-red).

( ) R156: 470 Ω (yel-viol-brn).

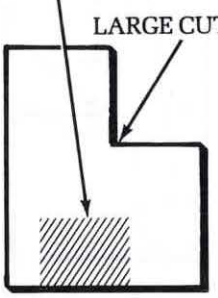
( ) R158: 150 Ω (brn-grn-brn).

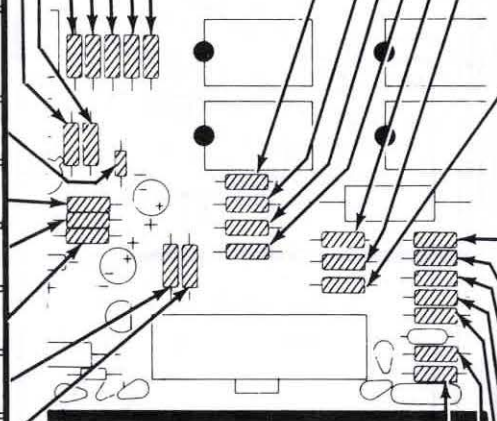
( ) R117: 1500 Ω (brn-grn-red).

( ) R116: 1500 Ω (brn-grn-red).

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

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





PICTORIAL 1-4

CONTINUE

( ) R139: 470 Ω (yel-viol-brn).

( ) R138: 470 Ω (yel-viol-brn).

( ) R137: 470 Ω (yel-viol-brn).

( ) L102: 3.3 µH choke (sil-org-gld-org-sil or org-org-gld-sil) (#45-617).

( ) R205: 7320 Ω, 1% (viol-org-red-brn).

( ) R204: 1500 Ω, 1% (brn-grn-blk-brn).

NOTE: When you install a .1% precision resistor, with a value printed on it, position it so you can read the value printed on the body after you install it on the circuit board.

( ) R194: 630 Ω, .1% precision (blu-org-blk-blk-viol).

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

( ) R195: 77.8 Ω, .1% precision (viol-viol-gry-gld-viol).

( ) R196: 630 Ω, .1% precision (blu-org-blk-blk-viol).

( ) R197: 77.8 Ω, .1% precision (viol-viol-gry-gld-viol).

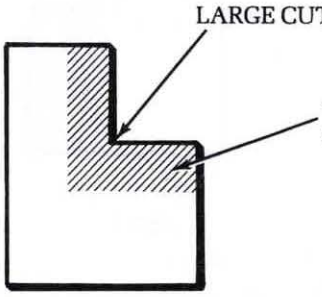
( ) R198: 630 Ω, .1% precision (blu-org-blk-blk-viol).

( ) R199: 77.8 Ω, .1% precision (viol-viol-gry-gld-viol).

( ) R201: 630 Ω, .1% precision (blu-org-blk-blk-viol).

( ) R202: 70 Ω, .1% precision (viol-blk-blk-gld-viol).

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



IDENTIFICATION DRAWING

START

Install eight 1N2071 (#57-27) diodes at the following locations. Position the banded ends as shown.

( ) D101 .....
( ) D102 .....
( ) D103 .....
( ) D104 .....
( ) D105 .....
( ) D106 .....
( ) D107 .....
( ) D108 .....

( ) R133: 4700 Ω (yel-viol-red).

( ) C113: .01 µF (103) glass ceramic.

( ) D120: (#56-602) diode.

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

( ) R136: 1100 Ω, 1% (brn-brn-blk-brn).

( ) C149: .01 µF (103) glass ceramic.

Install four 1N2071 (#57-27) diodes at the following locations:

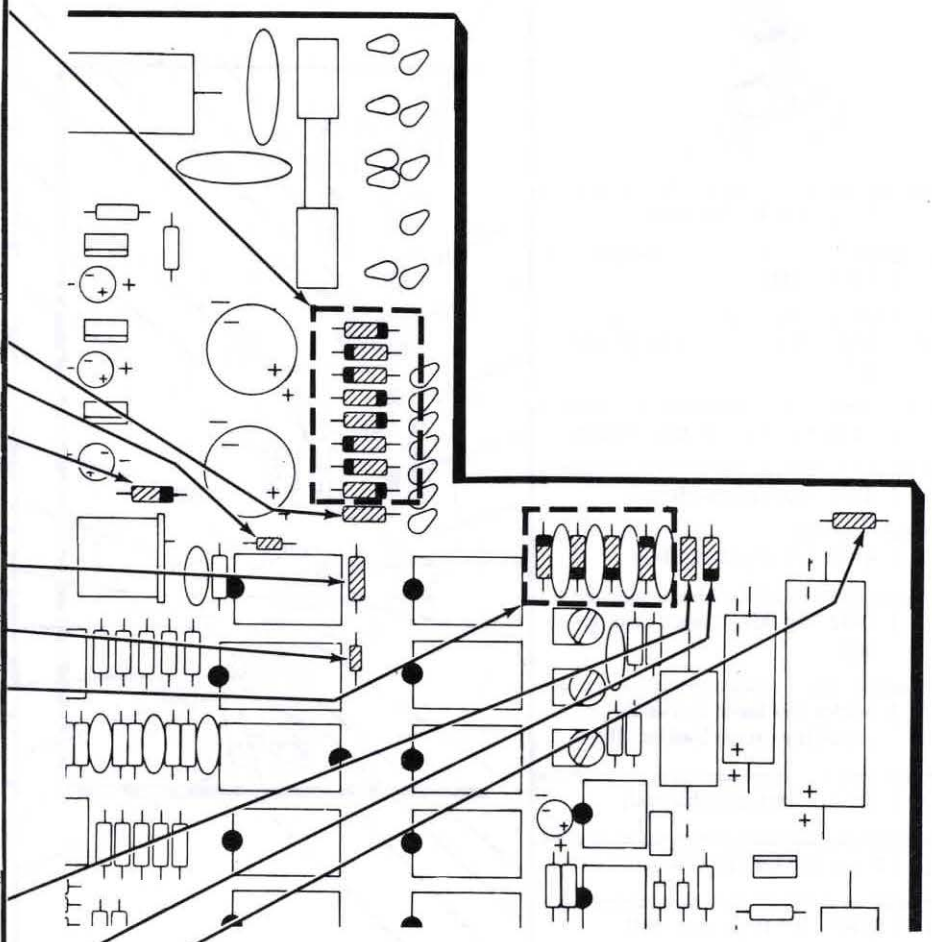
( ) D109 .....
( ) D110 .....
( ) D111 .....
( ) D112 .....

( ) R176: 3010 Ω, 1% (org-blk-brn-brn).

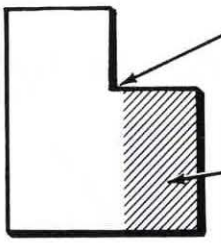
( ) D115: 1N825A diode (#56-688).

( ) R203: 300 Ω (org-blk-brn).

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



PICTORIAL 1-5



IDENTIFICATION DRAWING

START

( ) R181: 2000 Ω (2k) control. Insert the control pins into the circuit board holes and press the control flat against the circuit board. Solder the pins to the foil and cut off the excess pin lengths.

( ) R179: 2000 Ω (2k) contol.

( ) R178: 10 kΩ control.

( ) R186: 68.1 kΩ, 1% (blu-gry-brn-red).

( ) C133: .01 μF (103) glass ceramic.

( ) R207: 1000 Ω (brn-blk-red).

( ) R183: 470 Ω (yel-viol-brn).

( ) R182: 18 kΩ, **1-watt** (brn-gry-org).

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

( ) R184: 5600 Ω (grn-blu-red).

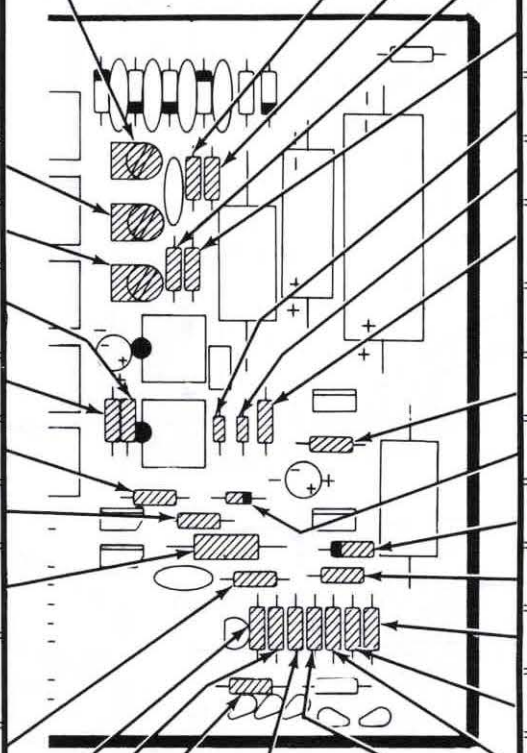
( ) R188: 220 kΩ (red-red-yel).

( ) R187: 1000 Ω (brn-blk-red).

( ) C128: **.1 μF (104)** glass ceramic.

( ) C129: .01 μF (103) glass ceramic.

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



PICTORIAL 1-6

CONTINUE

( ) R177: 40.2 kΩ, 1% (yel-blk-red-red).

( ) R175: 3010 Ω, 1% (org-blk-brn-brn).

( ) R206: 10 kΩ, 1% (brn-blk-blk-red).

( ) R135: 40.2 kΩ, 1% (yel-blk-red-red).

( ) C126: .01 μF (103) glass ceramic.

( ) C127: .01 μF (103) glass ceramic.

( ) R185: 30.1 kΩ, 1% (org-blk-brn-red).

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

( ) R174: 1000 Ω (brn-blk-red).

( ) D116: 1N4149 diode (#56-56).

( ) D114: 1N5223B diode (#56-99).

( ) R208: 330 Ω (org-org-brn).

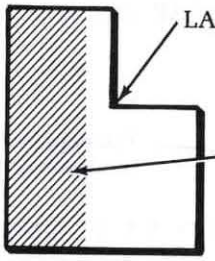
( ) C132: .01 μF (103) glass ceramic.

( ) R191: 6200 Ω (blu-red-red).

( ) C131: .01 μF (103) glass ceramic.

( ) R189: 6200 Ω (blu-red-red).

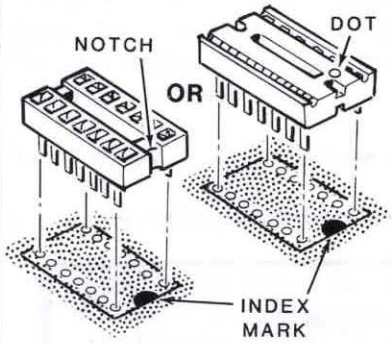
( ) Solder the leads to the foil and cut off the excess lead lengths.



IDENTIFICATION DRAWING

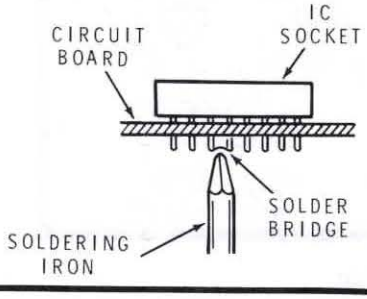
START

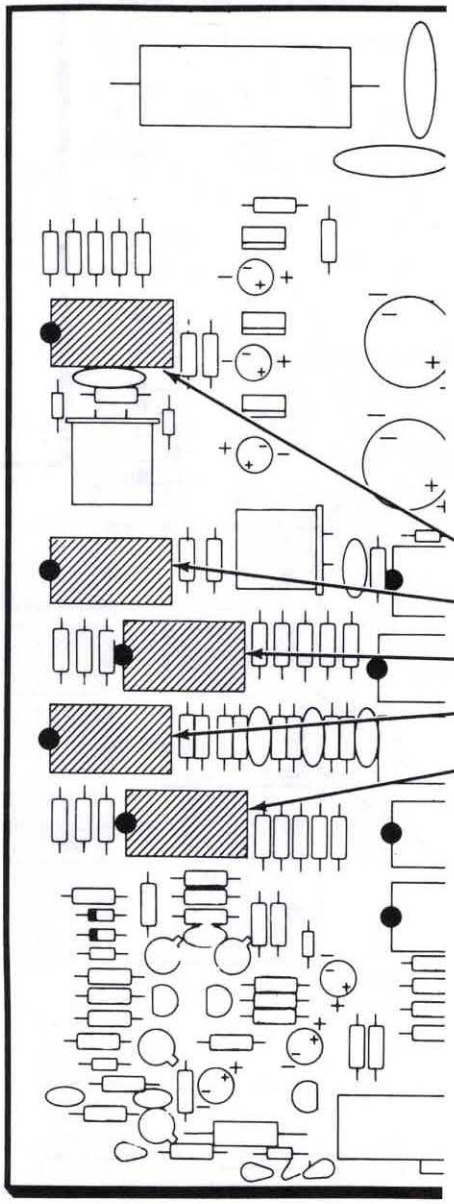
NOTE: Before you install an IC socket, make sure the pins are straight. If there is any kind of identification mark (notch, dot, arrowhead, etc.) at or near one end of the socket, place this marked end toward the index mark on the circuit board (this index mark should still be visible after you install the socket). Then start the pins into the circuit board holes and solder them to the foil.



NOTE: It is very easy to form a solder bridge between foils on the circuit board. After each solder step, carefully inspect the foil for solder bridges and remove any that have formed.

If a solder bridge has occurred, hold the circuit board foil-side-down as shown, and hold the soldering iron tip between the two points that are bridged. The solder will flow down the soldering iron tip.





CONTINUE

Install 16-pin IC sockets at the following locations.

( ) U101 .....

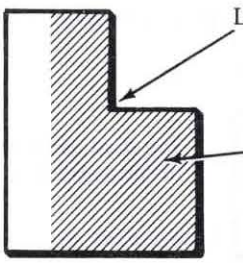
( ) U102 .....

( ) U103 .....

( ) U104 .....

( ) U105 .....

PICTORIAL 1-7



IDENTIFICATION DRAWING

START

Install eight 14-pin IC sockets at the following locations:

( ) U106 .....

( ) U107 .....

( ) U108 .....

( ) U109 .....

( ) U110 .....

( ) U111 .....

( ) U112 .....

( ) U113 .....

Install two 16-pin IC sockets at the following locations:

( ) U115 .....

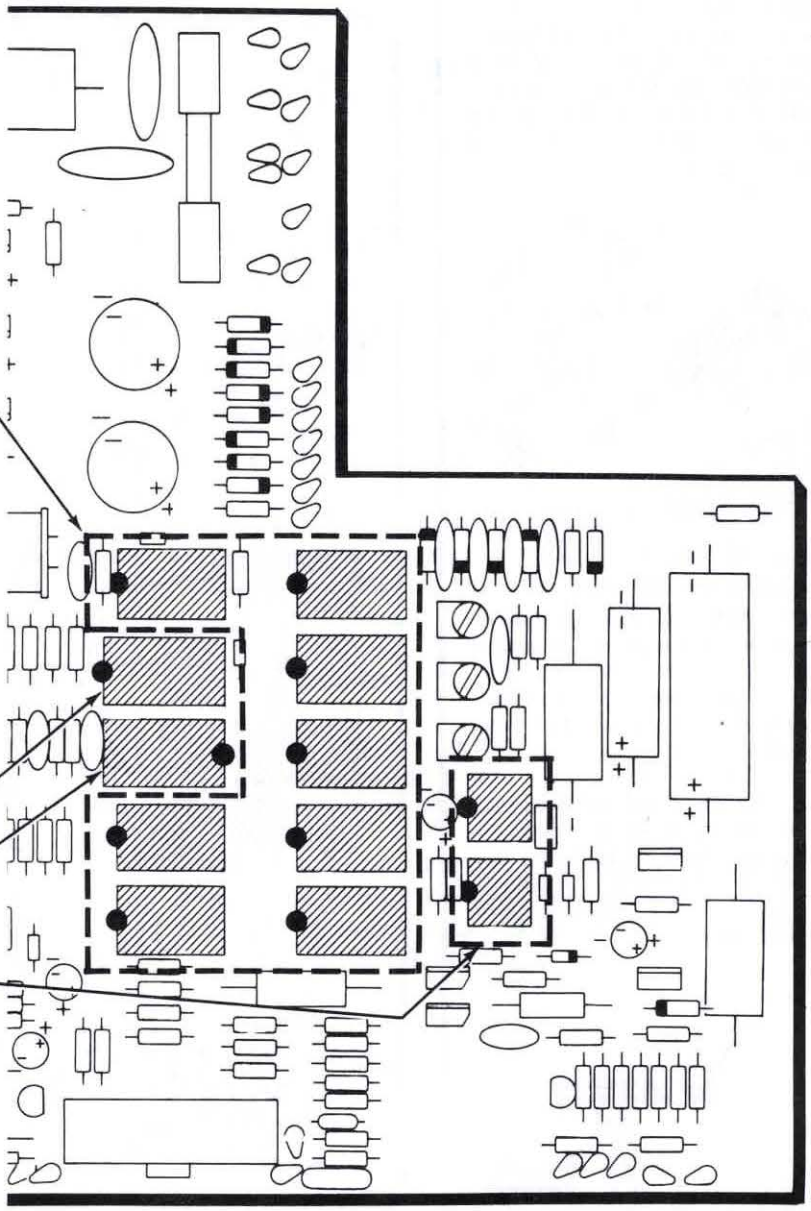
( ) U114 .....

Note the index mark at U114.

Install two 8-pin IC sockets at the following locations:

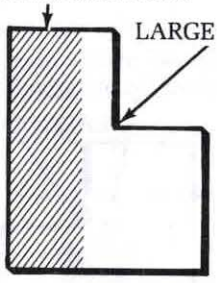
( ) U116 .....

( ) U117 .....



PICTORIAL 1-8

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

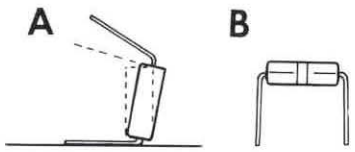


IDENTIFICATION DRAWING

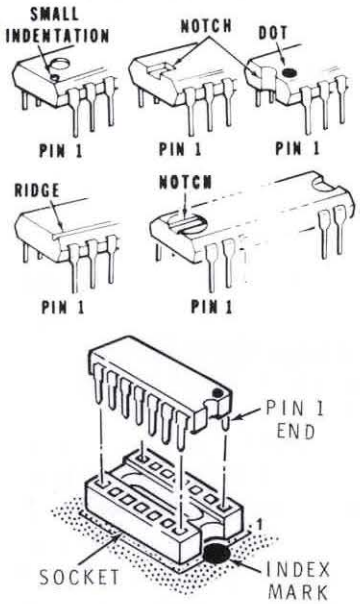
START

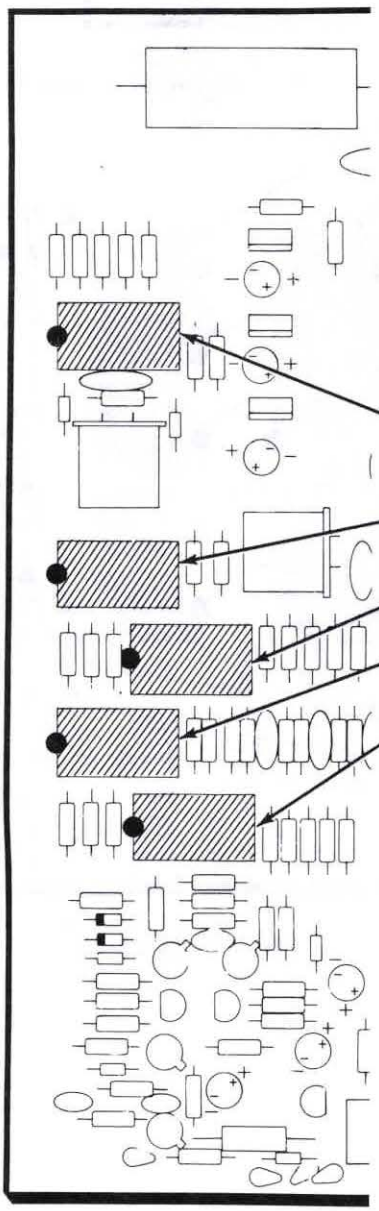
To install an IC:

1. Be sure the pins are straight. Then lay it down on one of its rows of pins, as shown below at A, and roll it over until the pins are at right angles or bent in slightly as shown at B. Repeat this process for the other row of pins.



2. Position the pin 1 end of the IC over the index mark on the circuit board.

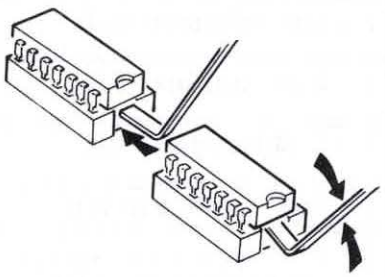




CONTINUE

3. Be sure each IC pin is properly started into the socket. Then push the IC down. NOTE: An IC pin that is bent under the IC will look as though it is correctly installed in the socket.

4. Should it ever become necessary to remove an IC, use the IC puller. Insert the short end beneath the IC; then gently rock the longer end up and down to lift the IC.



( ) U101: MC10116 (#443-636).

( ) U102: MC10131 (#443-679).

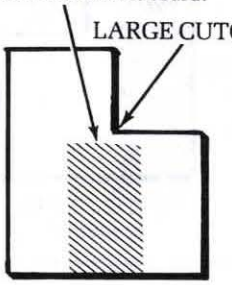
( ) U103: MC10102 (#443-683).

( ) U104: MC10102 (#443-683).

( ) U105: MC10116 (#443-636).

PICTORIAL 1-9

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



IDENTIFICATION DRAWING

START

( ) U107: SN74196 (#443-628).

( ) U106: 74F00 (#443-1121).

( ) U108: 74LS290 (#443-731).

( ) U115: 74LS76 (#443-829).

( ) U109: 74LS290 (#443-731).

( ) U114: SN74151AN (#443-25). Note the index mark at U114.

( ) U110: 74LS290 (#443-731).

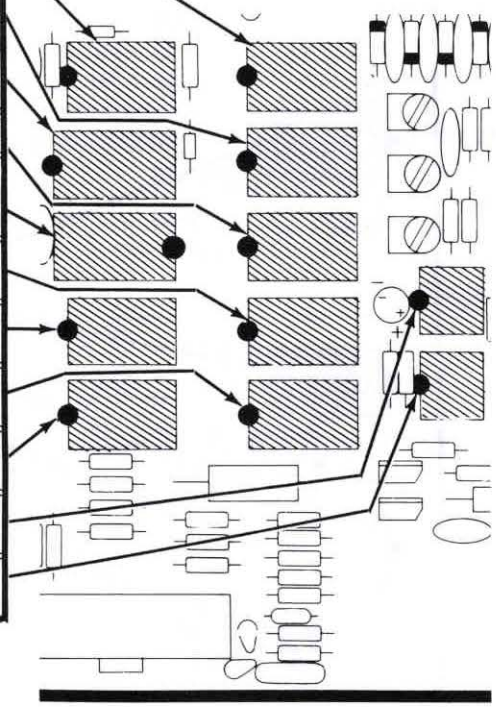
( ) U113: 74LS290 (#443-731).

( ) U111: 74LS290 (#443-731).

( ) U112: 74LS290 (#443-731).

( ) U116: N5741 (#442-22).

( ) U117: NE555 (#442-53).

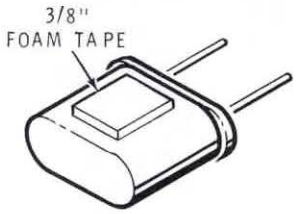


PICTORIAL 1-10

START

( ) Cut two 3/8" pieces of double-stick foam tape.

( ) Locate the 100 MHz crystal (#404-652). Remove one side of the protective backing from a 3/8" piece of double-stick foam tape and press the tape against the side of the crystal without the frequency printed on it.

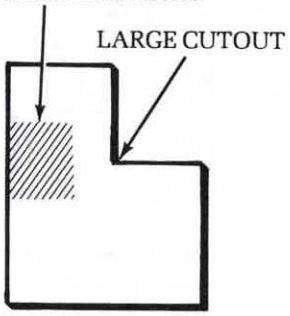


( ) Bend the leads down in the direction of the foam tape. Then remove the remaining backing from the other side of the double-stick foam tape.

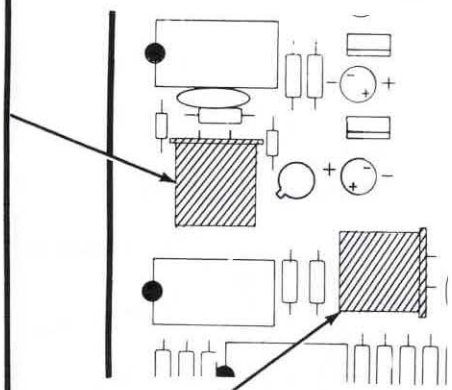
( ) Y101: Install the prepared 100 MHz crystal at Y101. Insert the leads into the circuit board holes and position the crystal body over the circuit board outline. Then press the crystal firmly against the circuit board, solder the leads to the foil, and cut off the excess lead lengths.

( ) Y102: Similarly, use the remaining 3/8" piece of double-stick foam tape and mount the 20 MHz crystal (#404-651) at Y102. Solder the leads to the foil and cut off the excess lead lengths.

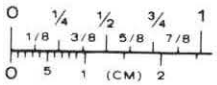
The steps performed in this Pictorial are in this area of the circuit board.



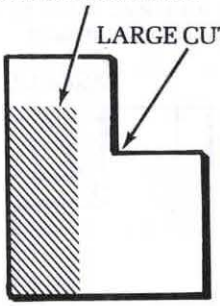
IDENTIFICATION DRAWING



PICTORIAL 1-11



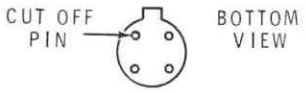
The steps performed in this Pictorial are in this area of the circuit board.



IDENTIFICATION DRAWING

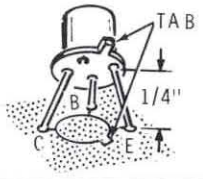
START

( ) Locate two 2N6304 (#417-979) transistors. Facing the bottom of the transistors, cut off the indicated lead from each one as shown.



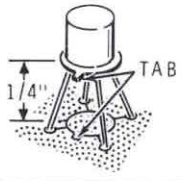
Install the two transistors with the cutoff leads in the next two steps.

( ) Q101: 2N6304 transistor (#417-979). Line up the tab on this transistor with the outline of the tab on the circuit board. Then insert the three leads into the corresponding holes. Solder the leads to the foil and cut off the excess lead lengths.

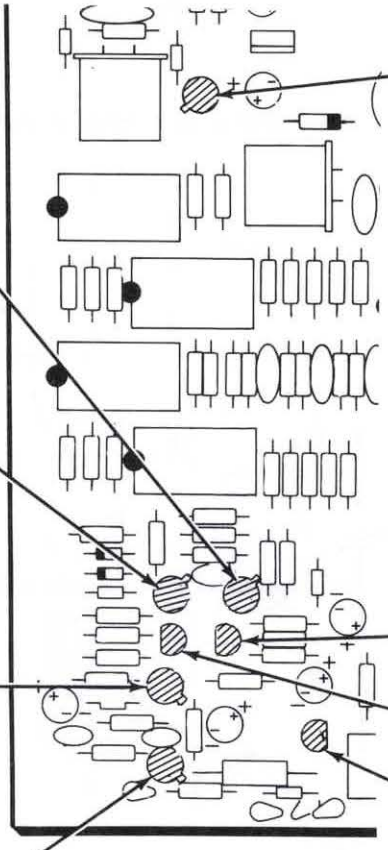


( ) Q102: 2N6304 transistor (#417-979).

( ) Q105: 2N6304 transistor (#417-979). Line up the tab on the transistor with the outline on the circuit board. Then insert the **four** leads into the corresponding circuit board holes. Solder the leads to the foil and cut off the excess lead lengths.

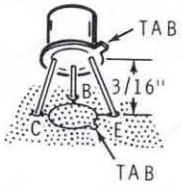


( ) Q106: 2N6304 transistor (#417-979).

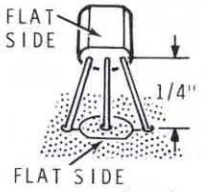


CONTINUE

( ) Q113: 2N2369 transistor (#417-154).



NOTE: Install the following transistors in the manner shown. First line up the flat on the transistor with the outline of the flat on the circuit board. Insert the transistor leads into the corresponding holes. Solder each lead to the foil and cut off the excess lead lengths.



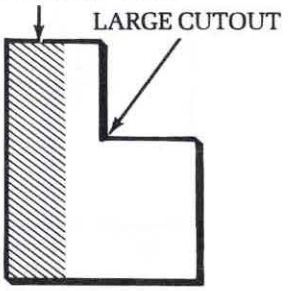
( ) Q103: 2N5770 transistor (#417-293).

( ) Q104: 2N5771 transistor (#417-292).

( ) Q107: MPSA55 transistor (#417-885).

PICTORIAL 1-12

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



IDENTIFICATION DRAWING

START

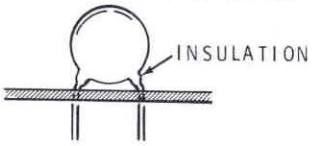
NOTE: Before you install an electrolytic capacitor, look at it and identify the leads. One lead will have either a negative (−) mark or a positive (+) mark near it on the side of the capacitor. See Detail 1-13A. (The marking for a negative lead may look like an oblong bar, sometimes with a circle around it, inside an arrow.) . . . Be sure to install the negative lead in the negative-marked hole, and the positive lead in the positive-marked hole.

( ) C139: 10 µF, 35V electrolytic.

( ) C135: 10 µF, 35V electrolytic.

( ) C137: 10 µF, 35V electrolytic.

NOTE: When you install ceramic capacitors, do not push the insulated portion of the leads into the circuit board holes. This could make it difficult to solder the leads to the foil.



( ) C101: 47 pF ceramic.

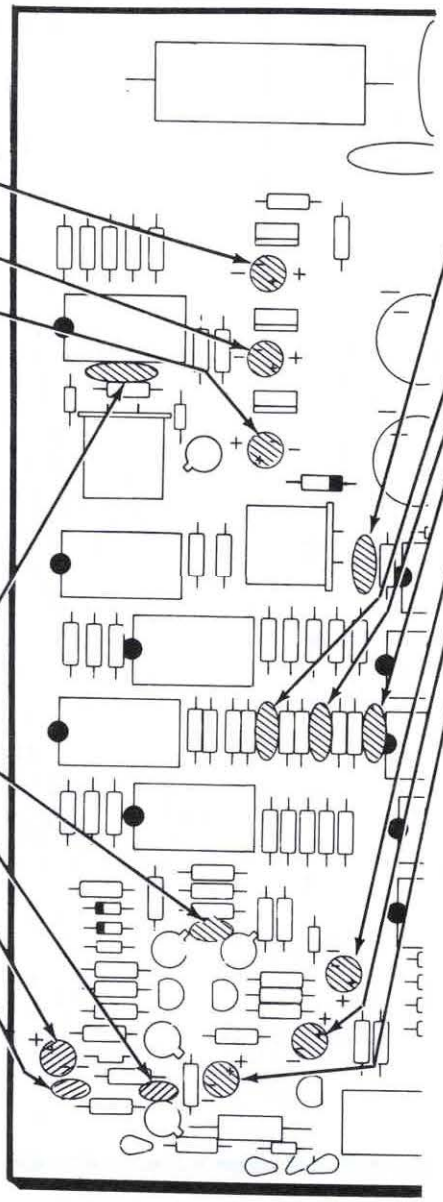
( ) C151: 2.7 pF ceramic.

( ) C104: 3.3 pF ceramic.

( ) C152: 10 µF, 35 V electrolytic.

( ) C106: 3.3 pF ceramic.

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



PICTORIAL 1-13

CONTINUE

( ) C115: 15 pF ceramic.

Install three 20 pF ceramic capacitors at the following locations:

( ) C117.

( ) C118.

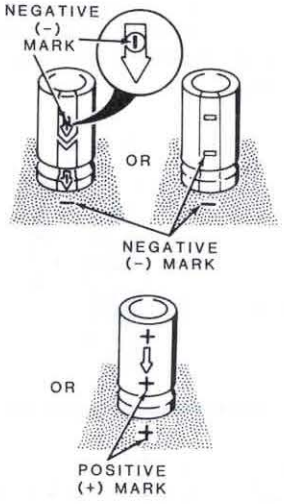
( ) C116.

( ) C112: 10 µF, 35V electrolytic.

( ) C109: 22 µF electrolytic.

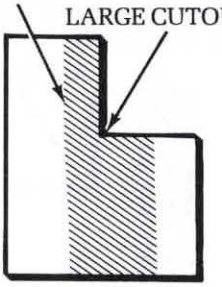
( ) C108: 22 µF electrolytic.

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



Detail 1-13A

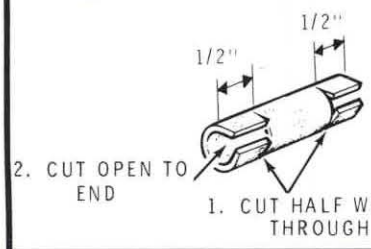
The steps performed in this Pictorial are in this area of the circuit board.



IDENTIFICATION DRAWING

START

( ) Cut the 1-1/2" large clear sleeving to the dimensions shown.

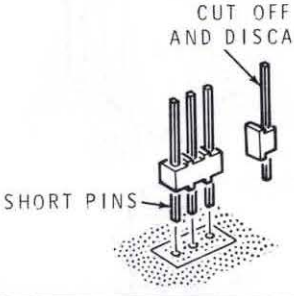


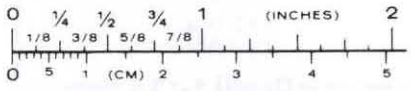
( ) Slide the prepared 1-1/2" clear sleeving over a 3/16-ampere slow-blow fuse.

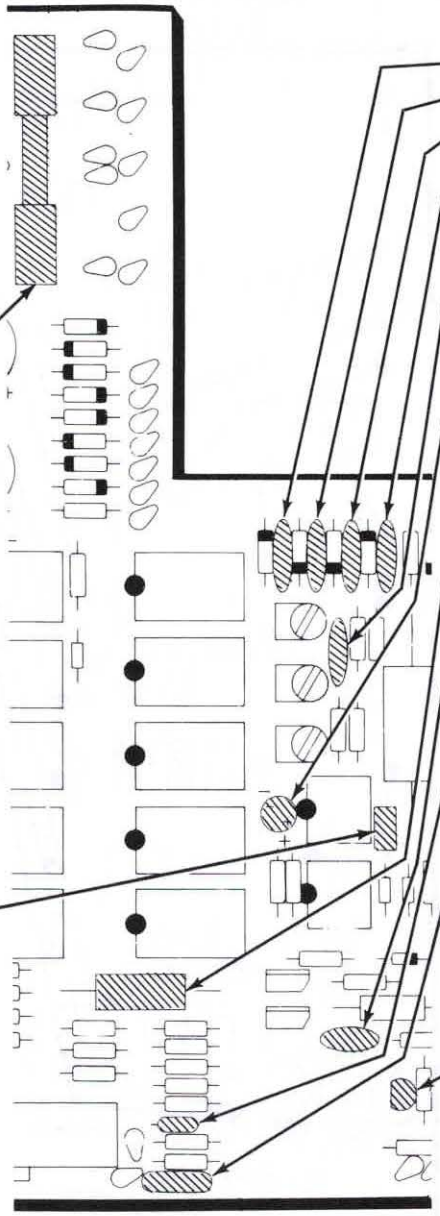
NOTE: To install fuse clips in the following steps, place a fuse clip into the circuit board at each end of the fuse outline. Be sure the shoulders of the clips are at the outer end as shown.

( ) F101: Install two fuse clips and the 3/16"-ampere slow-blow fuse with the clear sleeving at F101. Position the sleeving cutouts as shown. Solder the clip lugs to the foil.

( ) Locate the 4-pin plug and cut one of the pins from it to make a 3-pin plug. Then mount the 3-pin plug at P101. Solder the short pins to the circuit board foils. Discard the remaining plug pin.







PICTORIAL 1-14

CONTINUE

Install four .01 µF ceramic capacitors at the following locations:

( ) C144.
( ) C145.
( ) C146.
( ) C147.

( ) C121: .005 µF, 500V ceramic. Use the smaller .005 µF capacitor.

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

( ) C134: 150 µF electrolytic.

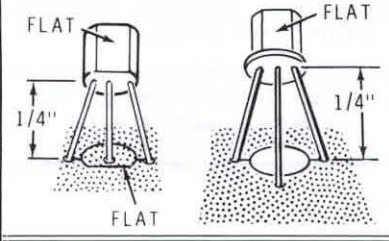
( ) R193: 6300 Ω (6.3k), .1%, 2-watt resistor. Position the resistor body slightly above the circuit board.

( ) C123: 100 pF ceramic.

( ) C124: .0056 µF Mylar.

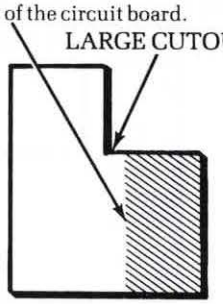
( ) C125: .056 µF Mylar. NOTE: Keep this capacitor to the right of hole Z, near the switch outline so it does not interfere with the switch mounting later on.

( ) Q112: 2N5232A transistor (#417-91).



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

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

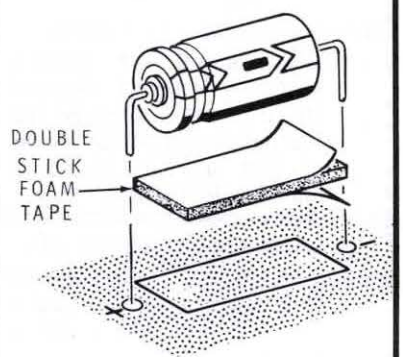


IDENTIFICATION DRAWING

START

( ) Cut a 1-1/4" piece of double-stick foam tape. Set the remaining foam tape aside.

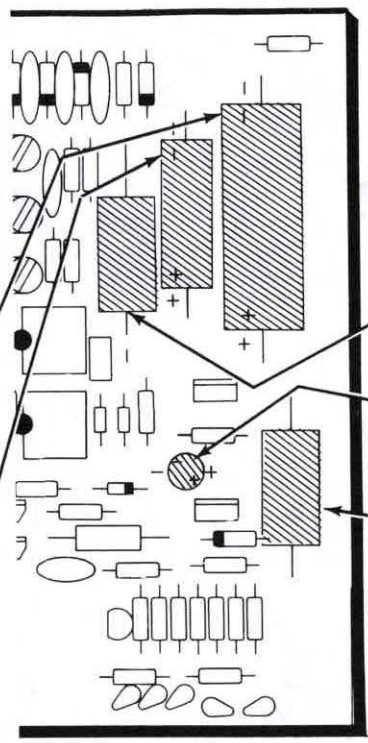
( ) Remove the protective backing from one side of the 1-1/4" double-stick foam tape and press the tape along the body of a 100 µF, 150 V electrolytic capacitor. Do not cover the polarity markings on the capacitor.



( ) Remove the remaining backing from the double-stick foam tape on the 100 µF, 150V electrolytic capacitor. Then install the capacitor at C119. One lead will have a positive (+) mark or a negative (−) mark near it. **Be sure** to install the positive lead in the positive-marked hole. Be careful; only the negative lead may be marked.

( ) C122: 10 µF, 150V electrolytic.

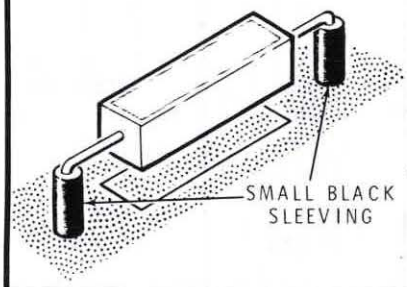
( ) Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE

( ) Cut two 5/8" and two 1/4" pieces of small black sleeving.

NOTE: When you install the following resistors, mount them above the circuit board as shown. Use the small black sleeving on each lead to provide the proper spacing.



( ) Slide the 5/8" pieces of small black sleeving over the leads of a 6000 Ω (6k), 5-watt, wire-wound resistor. Form the leads to fit the circuit board hole spacing and install the resistor at R173.

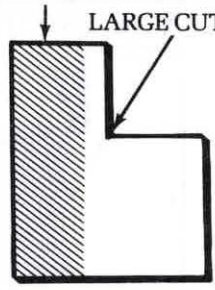
( ) C153: 150 µF electrolytic.

( ) Slide the 1/4" pieces of small black sleeving over the leads of the remaining 6000 Ω (6k), 5-watt, wire-would resistor. Install the resistor at R172.

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

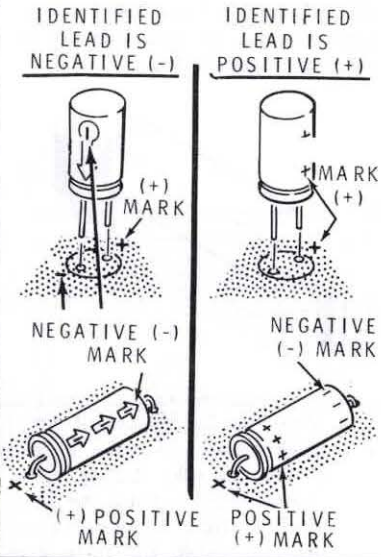
PICTORIAL 1-15

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



START

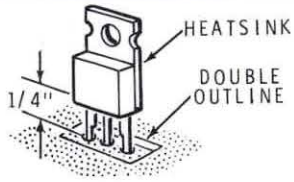
( ) C141: 1000 µF electrolytic. Position the positive (+) mark on the capacitor toward the (+) mark on the circuit board. If the capacitor only has a negative (−) mark on it, position this **away** from the positive mark and toward the negative mark on the circuit board.



( ) C142: 4700 pF (472) ceramic (#21-821).

( ) C143: 4700 pF (472) ceramic (#21-821).

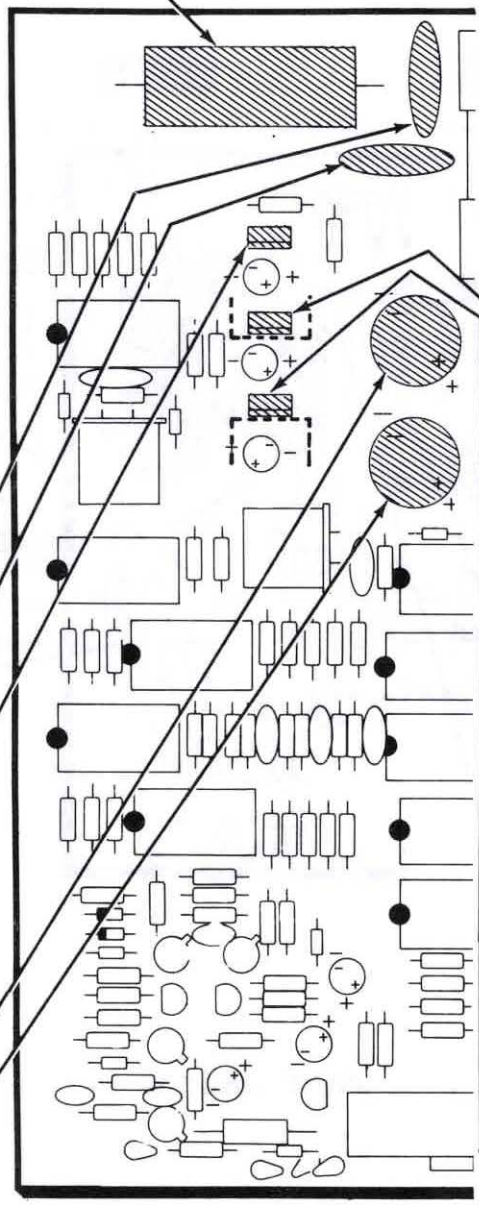
( ) U120: LM337 integrated circuit (#442-709). Position the bare metal side over the double outline on the circuit board. Solder the leads to the foil and cut off the excess lead lengths.



( ) C136: 2200 µF electrolytic.

( ) C138: 2200 µF electrolytic.

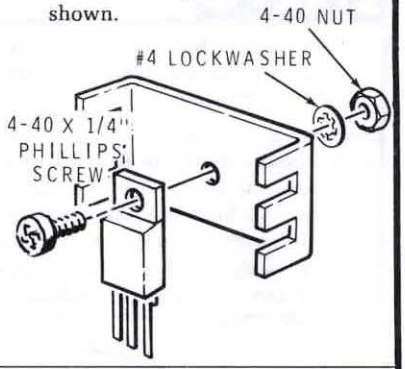
( ) Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 1-16

CONTINUE

( ) Mount a heat sink to an MC7905 or UA7952C (#442-630) integrated circuit with a 4-40 × 1/4" phillips screw, #4 lockwasher, and 4-40 nut. Position the heat sink against the bare metal side of the integrated circuit as shown.

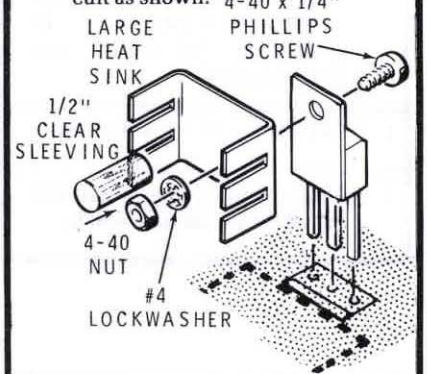


( ) U119: Install the prepared MC7905 (#442-630) integrated circuit at U119. Position the heat sink over the dotted lines. Solder the leads to the foil and cut off the excess lead lengths.

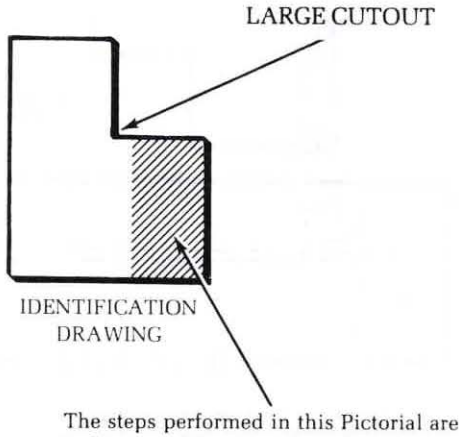
( ) Cut a 1/2" piece of clear sleeving.

( ) Slide the 1/2" clear sleeving over the lower fin on the heat sink as shown.

( ) Mount the heat sink with the sleeving to a UA7805 (#442-54) integrated circuit with a 4-40 × 1/4" phillips screw, #4 lockwasher, and 4-40 nut. Position the heat sink against the bare metal side of the integrated circuit as shown.

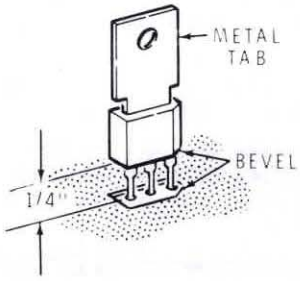


( ) U118: Install the prepared UA7805 (#442-54) integrated circuit at U118. Position the heat sink over the dotted lines. Solder the leads to the foil and cut off the excess lead lengths.



START

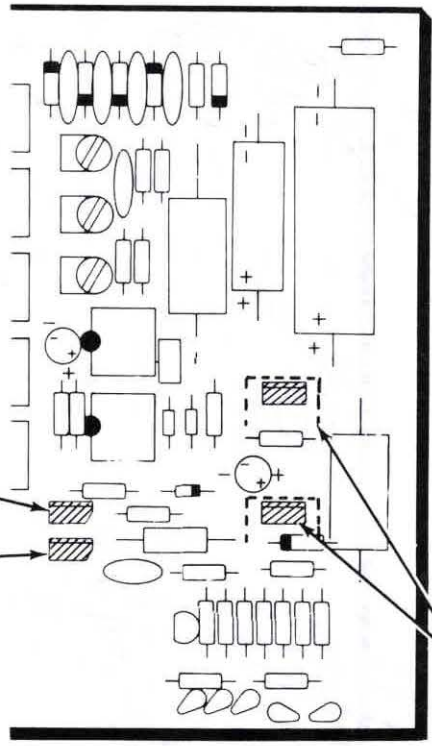
NOTE: When you install the following transistors, position the metal tab over the double outline on the circuit board. Also position the beveled edge over the beveled outline on the circuit board.



( ) Q110: MDS60 transistor (#417-948).

( ) Q111: D40N1 transistor (#417-245).

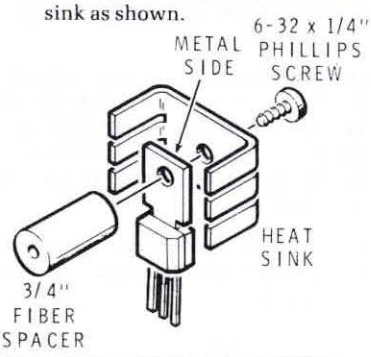
( ) Solder the leads to the foil and cut off the excess lead lengths.



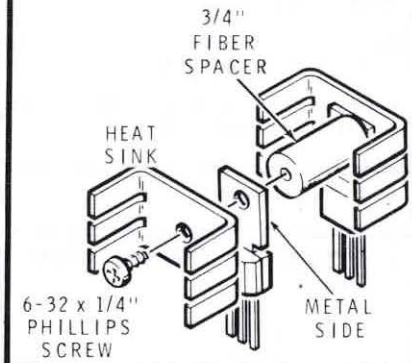
PICTORIAL 1-17

CONTINUE

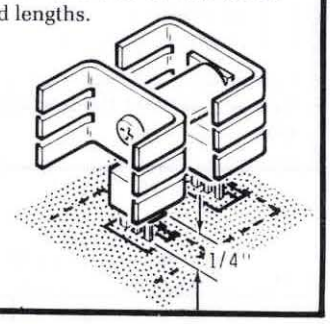
( ) Mount a heat sink to the bare metal side of a D40N1 (#417-245) transistor with a 6-32 × 1/4" phillips screw and a 3/4" fiber spacer. Position the heat sink as shown.



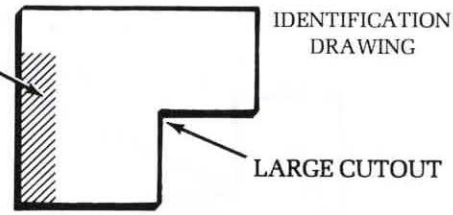
( ) Mount a heat sink and another D40N1 (#417-245) transistor to the other end of the 3/4" fiber spacer with a 6-32 × 1/4" phillips screw. Position the heat sink against the bare metal side of the transistor as shown.



( ) Q108/Q109: Mount the prepared D40N1 (#417-245) transistors on the circuit board at Q108 and Q109. Position the heat sinks over the dotted outlines on the circuit board with the bottom of the transistors 1/4" above the circuit board. Solder the leads to the foil and cut off the excess lead lengths.



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



START

( ) Reposition the circuit board as shown.

NOTE: When you are instructed to prepare a solid wire, as in the following step, cut the wire to the indicated length and remove 1/4" of insulation from both ends.

( ) Prepare the following yellow wires:

1-1/4"
1-5/8"
2"

Connect one end of the prepared yellow wires to the circuit board as follows. Solder each wire to the foil after you connect it and cut off the excess wire lengths.

( ) 1-1/4" wire at hole R.

( ) 1-5/8" wire at hole S.

( ) 2"wire at hole T.

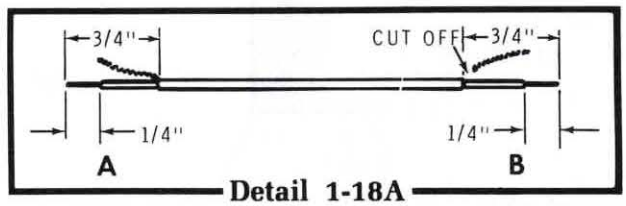
( ) Prepare the following yellow wires:

2"
1-5/8"
2-1/8"

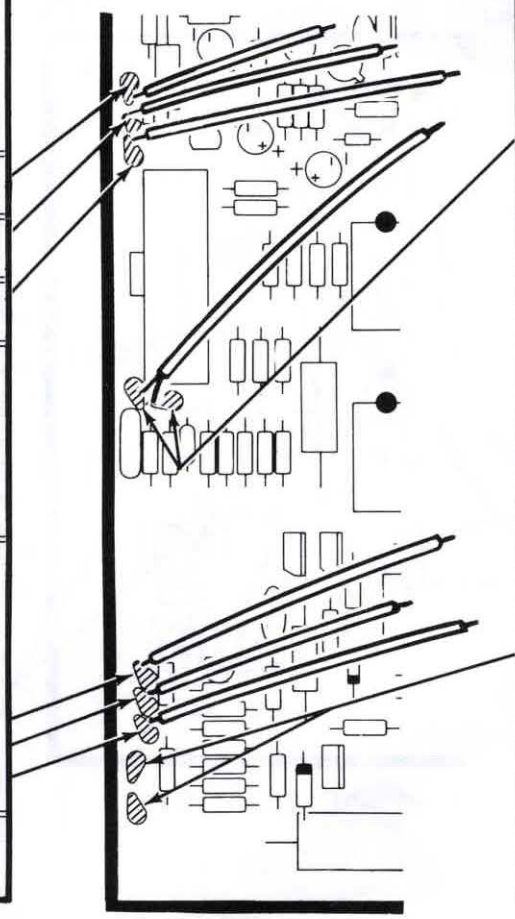
Connect one end of each of the prepared yellow wires to the circuit board as follows. Solder each wire to the foil after you connect it and cut off the excess wire lengths.

( ) 2" wire to hole U.
( ) 1-5/8"wire to hole V.
( ) 2-1/8"wire to hole W.

You will connect the free wire ends later.



Detail 1-18A



PICTORIAL 1-18

CONTINUE

( ) Cut a 2-1/2" piece of coaxial cable.

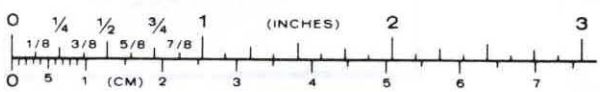
( ) Refer to Detail 1-18A and prepare ends A and B of the 2-1/2" coaxial cable.

( ) Connect the inner lead at end A of the 2-1/2" coaxial cable to circuit board hole Z and the shield lead to hole AA. Solder both leads to the foil and cut off the excess lead lengths. You will connect end B later.

( ) Cut two 3/8" pieces of small black sleeving.

( ) Slide a 3/8" piece of small black sleeving over each lead of the LED.

( ) D118: Insert the shorter LED lead into circuit board hole X and the longer lead into hole Y from the **FOIL SIDE**. Insert the leads into the holes until the sleeving is 1/16" from the circuit board, then bend the LED over against the board and solder the leads to the foil. Cut off the excess lead lengths.



START

( ) SW101: Install the rotary switch at SW101. Straighten any bent pins. Then insert the pins through the circuit board holes with the switch shaft as shown on the outline. Press the switch flat against the circuit board. Solder two opposite corner pins, check to make sure the switch is against the circuit board, and solder the remaining pins to the foil.

( ) Turn the circuit board over and position it with the notch as shown in Detail 1-19B.

( ) Locate the 15 kΩ control (#10-1184).

( ) Refer to Detail 1-19A and bend lug 2 over against lug 1 of the 15 kΩ control and solder lugs together. Cut off the excess at lug 1, but do not cut off lug 2.

( ) Cut a 3/8" length of small sleeving.

( ) Slide the 3/8" small sleeving over control lug 3 and bend the end of the lug down 90° as shown in Detail 1-19A.

( ) R192: Position the 15 kΩ control as shown in Detail 1-19B. Insert lugs 2 and 3 into the circuit board holes at R192 from the foil side and solder them to the foil.

( ) Rotate control R192 fully clockwise.

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions.

( ) Unsoldered connections.

( ) Poor solder connections.

( ) Solder bridges between foil patterns.

( ) Protruding leads which could touch together.

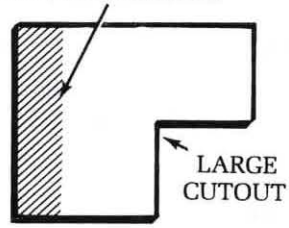
( ) Transistors and IC's for the proper **type** and **installation**.

( ) Diodes for the proper positioning of the banded end.

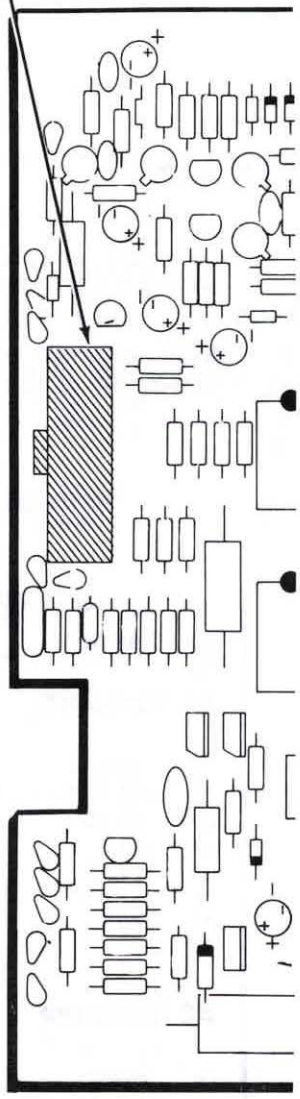
( ) Electrolytic capacitors for the correct position of the positive (+) or negative (−) mark.

Set the circuit board aside until it is called for later. This completes the circuit board assembly.

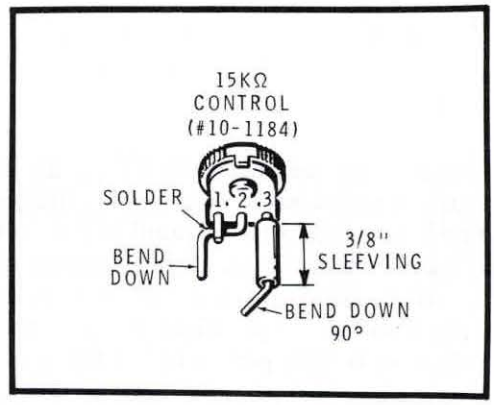
The steps performed in this Pictorial are in this area of the circuit board.



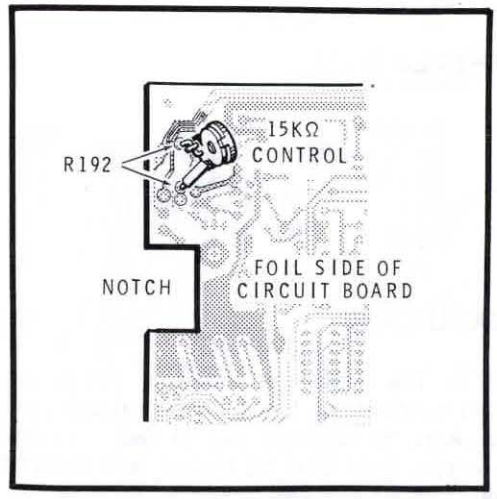
IDENTIFICATION DRAWING



PICTORIAL 1-19



Detail 1-19A



Detail 1-19B

CHASSIS

PARTS LIST

Remove the remaining parts from the shipping carton and check each part against the following list. The key numbers correspond to the numbers on the "Chassis Parts Pictorial" (Illustration Booklet, Page 2). After you check any part that is packed in an individual envelope, place the part back in the envelope until that part is called for in a step. Do not throw away any packing material until you account for all the parts. *SAVE THE SHIPPING CARTON* for use later in the assembly.

To order a replacement part, always include the PART NUMBER. Use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover of this Manual.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION

METAL PARTS

A1	90-1264-1	1	Top cover
A2	200-1540-1	1	Chassis
A3	203-2137	1	Front panel
A4	205-1894	1	Mounting plate
A5	210-89	1	Bezel

HARDWARE

NOTE: The hardware is shown full size so you can place any nut, screw, etc, you are uncertain about over the drawing. Also, the hardware may be packed in more than one envelope. Open all of the envelopes (marked HDW) before you check the hardware against the Parts List.

#2 & #4 Hardware

B1	250-212	2	#2 × 3/16" self-tapping screw
B2	254-26	2	#2 lockwasher
B3	250-1347	1	4-40 × 3/32" black setscrew
B4	250-1414	2	4-40 × 1/4" phillips screw

#6 Hardware

C1	250-1282	1	6-32 × 1/8" black setscrew
C2	250-1325	14	6-32 × 1/4" black phillips screw
C3	250-1428	7	6-32 × 1/4" phillips screw
C4	252-3	1	6-32 nut
C5	254-1	5	#6 lockwasher
C6	255-821	5	6-32 × 5/8" spacer
C7	259-1	1	#6 solder lug

#8 Hardware

D1	250-571	1	8-32 × 1/2" flat head screw
D2	250-1436	1	8-32 × 3/8" black phillips screw
D3	252-78	2	8-32 nut
D4	254-2	2	#8 lockwasher

Heathkit®

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Other Hardware				
E1	252-7	2	½" control nut	
E2	252-39	1	⅜" nut	
E3	253-15	2	⅝" flat fiber washer	
E4	253-16	1	⅝" fiber shoulder washer	
E5	253-196	1	⅝" plastic D-washer	
E6	254-14	1	¼" lockwasher	
E7	259-10	1	Control solder lug	
E8	253-10	1	Control flat washer	
CONNECTORS				
F1	432-758	1	Female BNC	
F2	432-919	2	Male BNC	
F3	432-1041	1	2-hole jumper	
F4	432-1238	1	Female BNC with tabs	
SWITCHES – INSULATORS				
G1	60-91	1	2-position slide switch	SW2
G2	60-606	1	3-position slide switch	SW1
G3	75-52	1	Switch insulator	
G4	75-736	1	Strain relief insulator	

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
KNOBS				
H1	462-1108	1	Small knob	
H2	462-1143	1	Large knob	
MISCELLANEOUS				
J1	6-510-12	1	51 Ω, ¼-watt, 5% (grn-brn-blk) resistor	R3
J2	9-134	1	50 Ω disc resistor	R1
J3	10-1186	1	2000 Ω (2k) control	R2
J4	54-1007	1	Power transformer	T1
J5	56-670	1	MBD101 diode	D1
J6	89-54	1	Line cord	
J7	134-237	2	Shielded cable assembly	
J8	261-34	4	Foot	
J9	490-23	1	#4 allen wrench	
J10	490-14	1	#6 allen wrench	

STEP-BY-STEP ASSEMBLY

CHASSIS PARTS MOUNTING

NOTES:

1. The term "hardware" will be used to refer to the screws, nuts, and lockwashers where parts are being mounted in some of the following steps. The phrase "Use 6-32 × ¼" black phillips hardware," for example, means to use a 6-32 × ¼" black phillips screw, one or more #6 lockwashers, and a 6-32 nut. Refer to the Detail called out in the step for the correct number of lockwashers to use and the correct way to install the hardware.

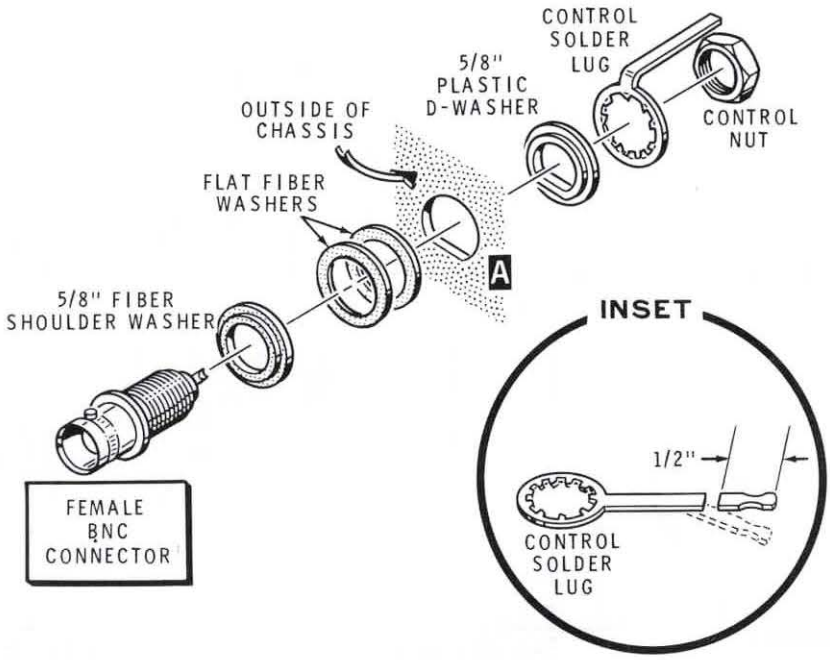
2. Use the nut starter supplied with this kit to hold and start 4-40 and 6-32 nuts on screws.

3. Place a soft cloth on your work area to prevent the painted surfaces from becoming scratched.

( ) Position the chassis as shown in Pictorial 2-1 (Illustration Booklet, Page 3). The parts that you will mount in the following steps are shown in place on the chassis in Pictorial 2-1. The Details you will be referred to are used with this Pictorial and show an exploded view of the part being mounted. Always refer to the Detail for the method of mounting the part, and to the Pictorial for positioning the part.

( ) Refer to the inset drawing of Detail 2-1A and bend the control solder lug as shown. Then cut ½" from the end of the lug.

( ) Refer to Detail 2-1A and mount a female BNC connector at A with a ⅝" fiber shoulder washer, two flat fiber washers, a ⅝" plastic D-washer, the formed control solder lug, and a control nut. Use the control nut supplied with the BNC connector and discard the control lockwasher. Make sure the plastic D-washer seats inside the chassis hole and that the shoulder of the fiber shoulder washer faces toward the BNC connector flange. Position the control solder lug toward the top right side as shown.



Detail 2-1A

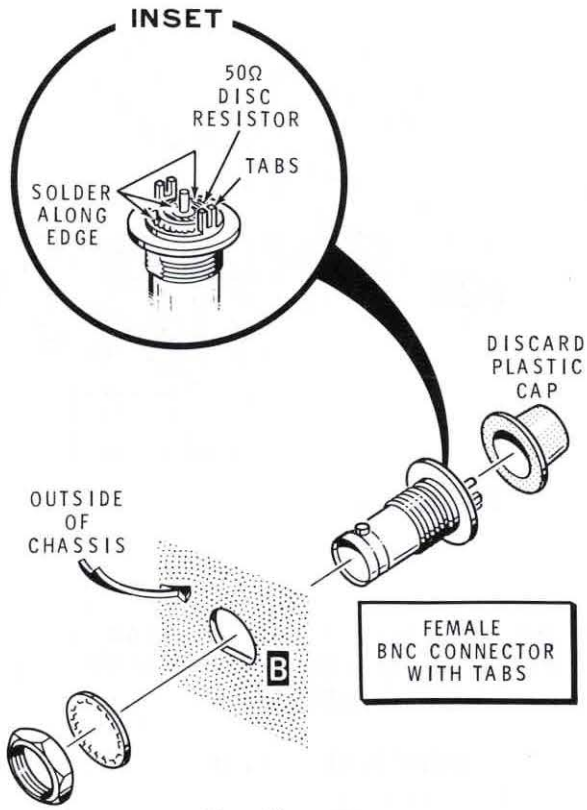
( ) If installed, remove and discard the plastic cap from the female BNC connector with tabs, then refer to the inset drawing on Detail 2-1B and slide the 50 Ω disc resistor over the connector's center pin and solder the center ring of the resistor to the pin. Do not apply too much heat.

( ) Refer to the inset drawing of Detail 2-1B and solder the outside edge of the resistor to the rim of the BNC connector. Do not get any solder between the connector tabs. Use as much heat as necessary to make the solder flow evenly between the disc resistor and the connector rim. NOTE: Since the connector will get quite hot, do not hold it with your fingers. Allow it to cool sufficiently before you handle it in the next step.

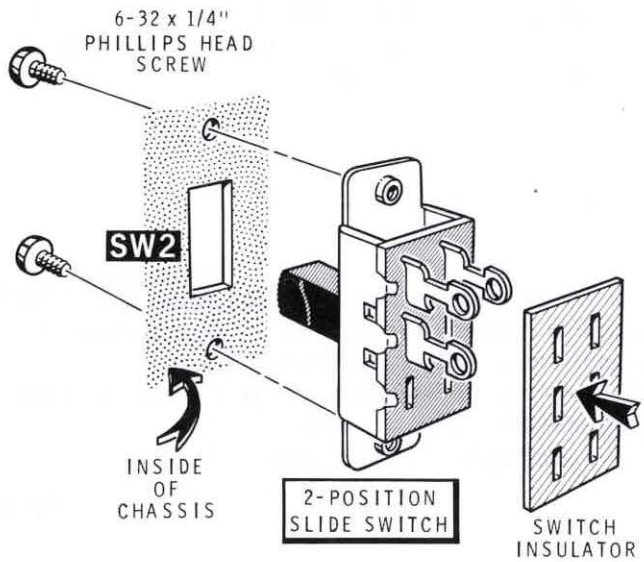
( ) Refer to Detail 2-1B and loosely mount the female BNC connector with tabs at B. Use the hardware supplied with the connector.

( ) SW2: Refer to Detail 2-1C and mount a 2-position slide switch to the chassis at SW2 with two 6-32 × ¼" phillips screws. Position the switch with the lugs as shown.

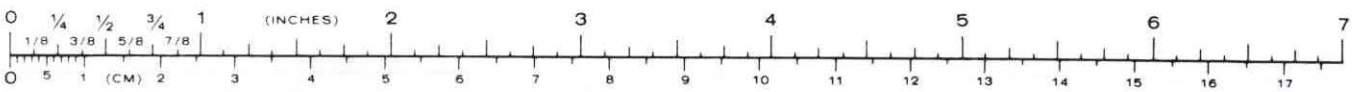
( ) Refer to Detail 2-1C and install a switch insulator over the lugs of switch SW2. Press the insulator against the switch body.

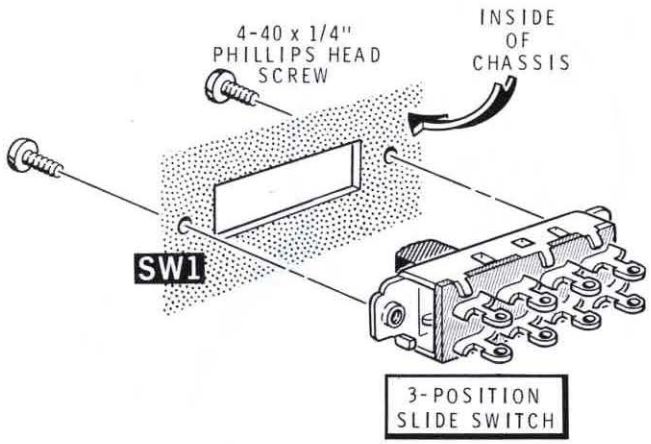


Detail 2-1B

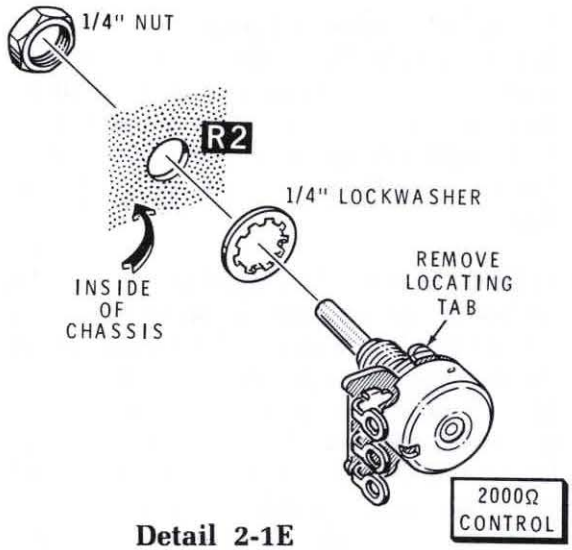


Detail 2-1C





Detail 2-1D



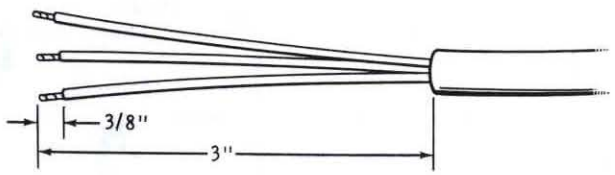
Detail 2-1E

( ) SW1: Refer to Detail 2-1D and mount a 3-position slide switch to the chassis at SW1 with two 4-40 × ¼" phillips screws.

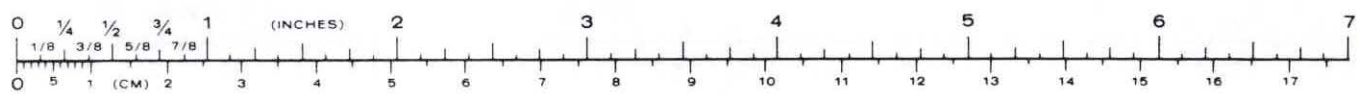
( ) If the control in the next step has a locating tab, remove the tab.

( ) R2: Refer to Detail 2-1E and mount the 2000 Ω (2k) control (#10-1186) at R2 with a ¼" lockwasher and a ¼" nut. Position the control with the lugs as shown.

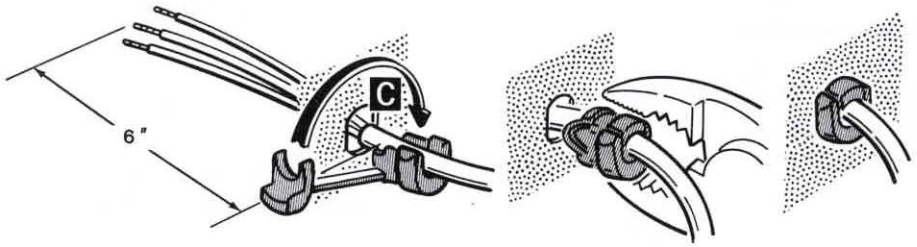
( ) Refer to Detail 2-1F and remove 3" of outer insulation from the free end of the line cord and prepare the ends of the three line cord leads. To prepare the stranded leads, remove ⅜" of insulation from the lead ends, twist the fine wire strands tightly together, and apply a small amount of solder to the wire strands to hold them together. Be careful not to cut into the inner lead insulation when you remove the outer insulation.



Detail 2-1F



( ) Refer to Detail 2-1G Part 1 and crimp the strain relief onto the line cord 6" from the end as shown. Then install the strain relief in chassis hole C. You will connect the line cord leads later on.



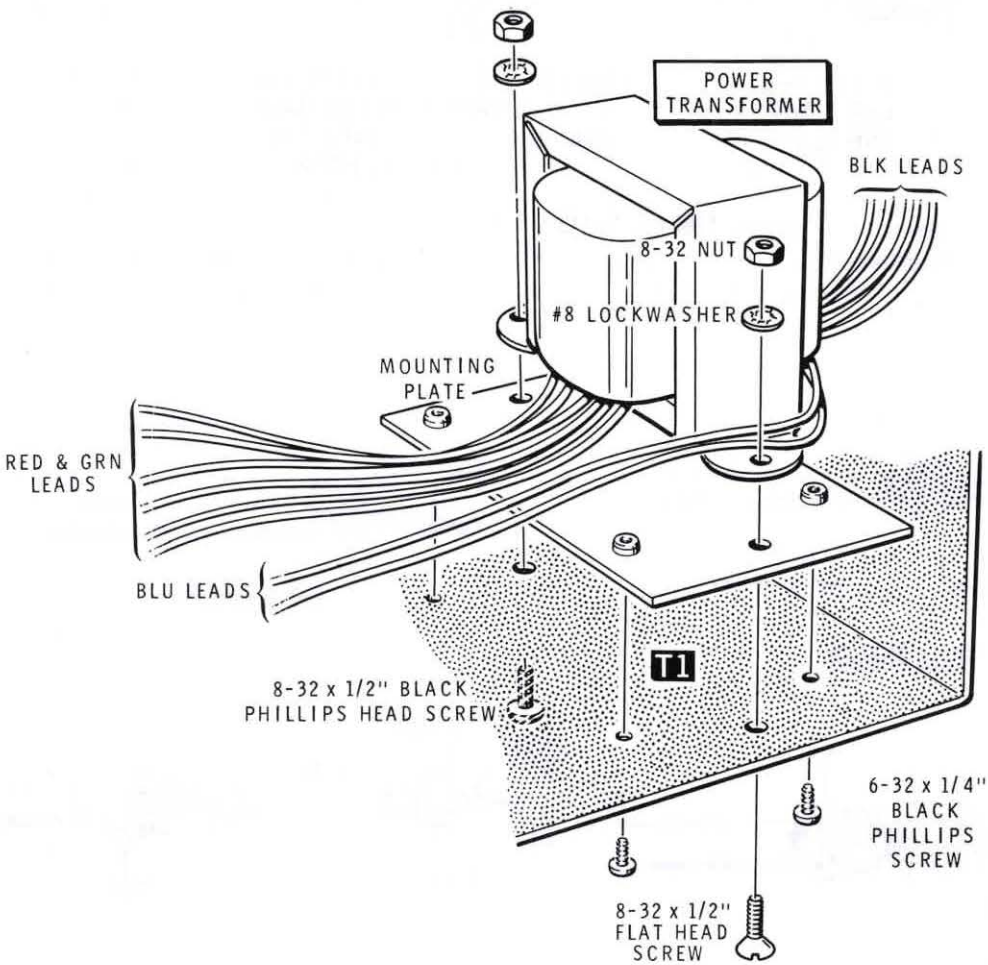
Detail 2-1G

( ) Refer to Detail 2-1H and loosely mount the mounting plate to the chassis with four 6-32 × ¼" black phillips screws.

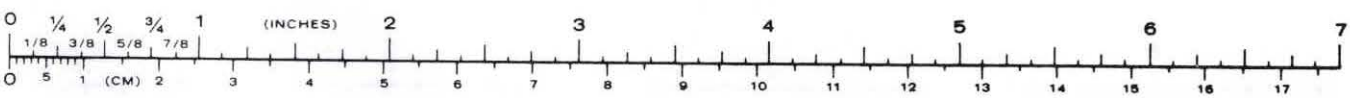
( ) T1: Refer to Detail 2-1H and mount the power transformer and mounting plate to the chassis at T1 with 8-32 × ½" flat head hardware and 8-32 × ½" black phillips hardware. Use the flat head hardware at the indicated location and position the transformer with the lead colors as shown.

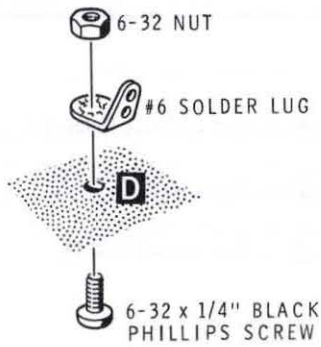
( ) Tighten the four mounting plate screws.

( ) Prepare the transformer leads for ¼" if this has not already been done.

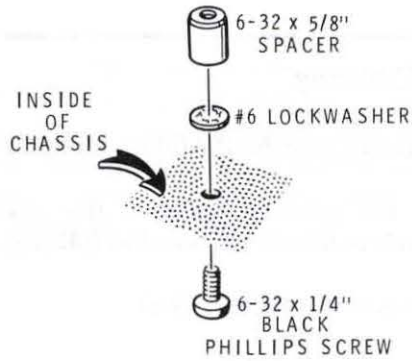


Detail 2-1H





Detail 2-1J



Detail 2-1K

( ) Refer to Detail 2-1J and mount a #6 solder lug to the chassis at D with a 6-32 × ¼" black phillips screw and a 6-32 nut. Position the solder lug as shown in the Pictorial.

( ) Refer to the Pictorial and mount the bezel to the chassis at E and F with #2 × 3/16" self-tapping screws and #2 lockwashers. Position the bezel with the cutout as shown.

( ) Refer to Detail 2-1K and **loosely** mount five 6-32 × ⅝" spacers and #6 lockwashers on the chassis at G, H, I, J, and K with 6-32 × ¼" black phillips screws. Position the lockwashers between the chassis and spacers.

( ) Locate the fuse replacement label and write the following fuse type and rating on the label:

"3AG, 3/16-ampere slow-blow."

( ) Remove the paper backing from the fuse replacement label and press the label onto the inside of the chassis rear panel. Use the indicated dimensions.

CHASSIS WIRING

Refer to Pictorial 2-2 (Illustration Booklet, Page 4) for the following steps.

( ) Cut a 7-½" × 9" piece of cardboard from the shipping carton you set aside earlier.

( ) Position the chassis and the circuit board as shown with the cardboard piece between the circuit board and front bezel.

NOTES:

1. 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 three tells you that there are three wires and/or leads in the connection.

2. Whenever you solder a wire or a lead to the circuit board or a chassis component, **always** cut off any excess wire or lead length from the connection.

Connect the line cord leads as follows:

( ) Green lead to chassis solder lug D (S-1). Make this connection mechanically secure as shown in the inset drawing.

( ) Black lead to circuit board hole A (S-1).

( ) White lead to circuit board hole B (S-1).

ALTERNATE LINE VOLTAGE WIRING

Two sets of line voltage wiring instructions are given below, one for 120 VAC line voltage and the other for 240 VAC line voltage. In the U.S.A., 120 VAC is used, while in other countries, 240 VAC is more common. USE ONLY THE INSTRUCTIONS THAT AGREE WITH THE LINE VOLTAGE IN YOUR AREA.

The plug on the power cord for this kit is for standard 120 VAC outlets in most of North America. For 240 VAC operation in other countries, cut the plug off and replace it with a permanent plug that matches your 240 VAC receptacle.

120 VAC Wiring

Refer to Detail 2-2A for the following steps.

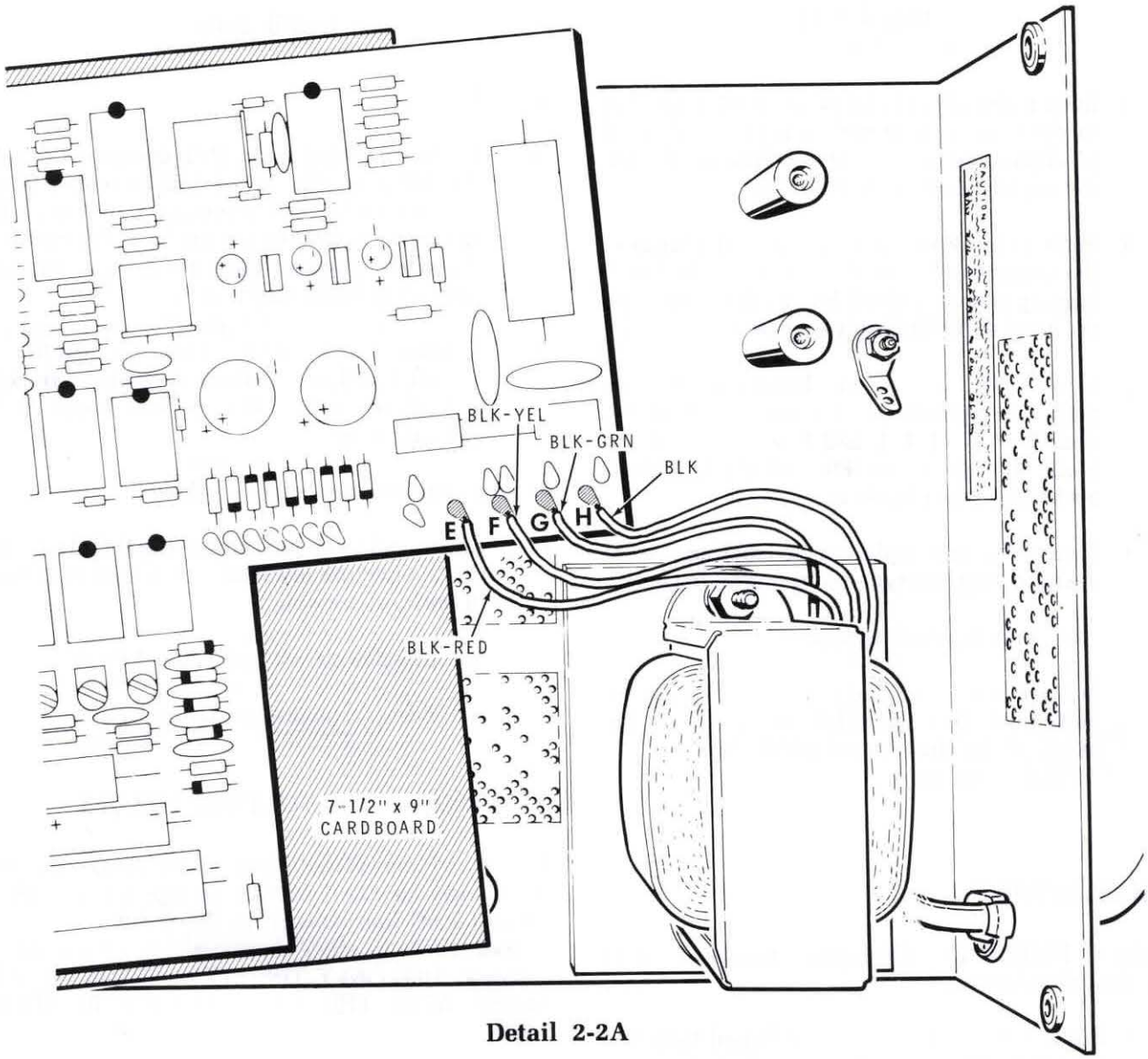
Connect the primary leads of the power transformer to the circuit board as follows:

( ) Black lead to hole H (S-1).

( ) Black-green lead to hole G (S-1).

( ) Black-yellow lead to hole F (S-1).

( ) Black-red lead to hole E (S-1).



Detail 2-2A

240 VAC Wiring

Refer to Detail 2-2B for the following steps.

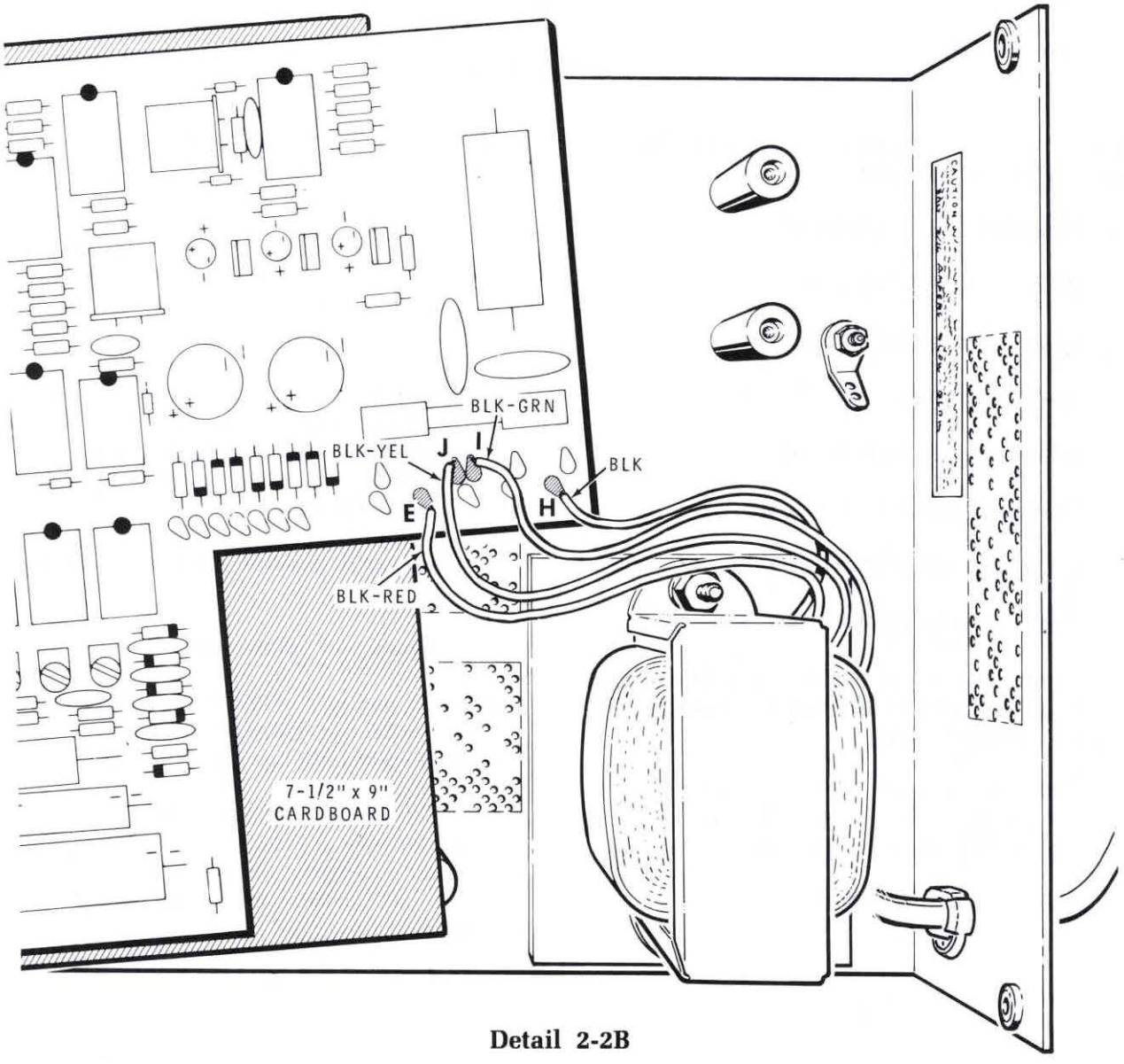
Connect the primary leads of the power transformer to the circuit board as follows:

( ) Black lead to hole H (S-1).

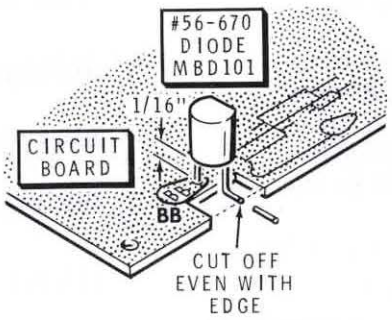
( ) Black-green lead to hole I (S-1).

( ) Black-yellow lead to hole J (S-1).

( ) Black-red lead to hole E (S-1).



Detail 2-2B



Detail 2-3A

Connect the remaining power transformer leads to the circuit board as follows:

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

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

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

( ) Green-yellow lead to hole N (S-1).

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

( ) Either blue lead to hole P (S-1).

( ) Other blue lead to hole Q (S-1).

( ) Prepare two 11" brown wires.

( ) Connect either end of a brown wire to circuit board hole C (S-1) and either end of the other wire to hole D (S-1).

( ) Twist the two 11" brown wires together to make a twisted pair. You will connect the other end of the brown wires later.

Refer to Pictorial 2-3 (Illustration Booklet, Page 5) for the following steps.

( ) D1: Refer to Detail 2-3A and position an MBD101 (#56-670) diode with the flat as shown. Connect the indicated lead to circuit board hole BB (S-1). Position the diode case bottom 1/16" above the circuit board as shown.

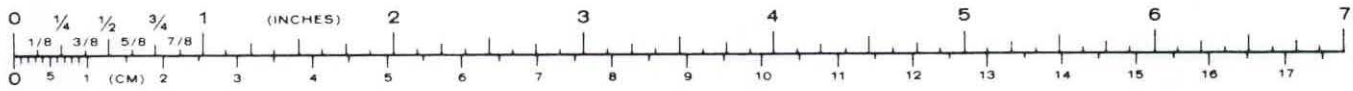
( ) Refer again to Detail 2-3A and carefully bend the remaining diode lead out 90° so it is even with the edge of the circuit board. Cut the lead even with the outside circuit board edge as shown in the Detail.

( ) Temporarily position the circuit board off to the side.

( ) Prepare a 1-1/4" yellow wire.

( ) Insert one end of the 1-1/4" yellow wire into the center pin of BNC connector A (S-1). After the solder cools, bend the wire up 90°.

( ) At this time, check the solder connections on the foil side of the circuit board for any unsoldered or poorly soldered connections. Also look for uncut leads which could cause a short.



Refer to Detail 2-3B for the following steps.

NOTE: The next step is a bit more difficult to perform than most others, so take your time. As always, read the step through completely before you perform it.

( ) Carefully install the circuit board over the chassis spacers and slide it into place so the rotary control shaft and the LED go into their respective chassis holes. Be careful not to damage the diode at D1 or pinch any wires extending from the circuit board. Slide the edge of the circuit board into the female BNC connector tabs at B. Rotate connector B as necessary. Position the control solder lug at A over the circuit board as shown. Once the circuit board is in place, secure it to chassis spacers G, H, I, J, and K with five 6-32 × ¼" phillips screws. NOTE: It may be necessary to further loosen the chassis spacers so you can center them under the circuit board mounting holes.

( ) Mount the rotary switch to the chassis with a control flat washer and a ½" control nut.

( ) Tighten both the top and bottom circuit board screws securely.

( ) Tighten the hardware at connector B securely.

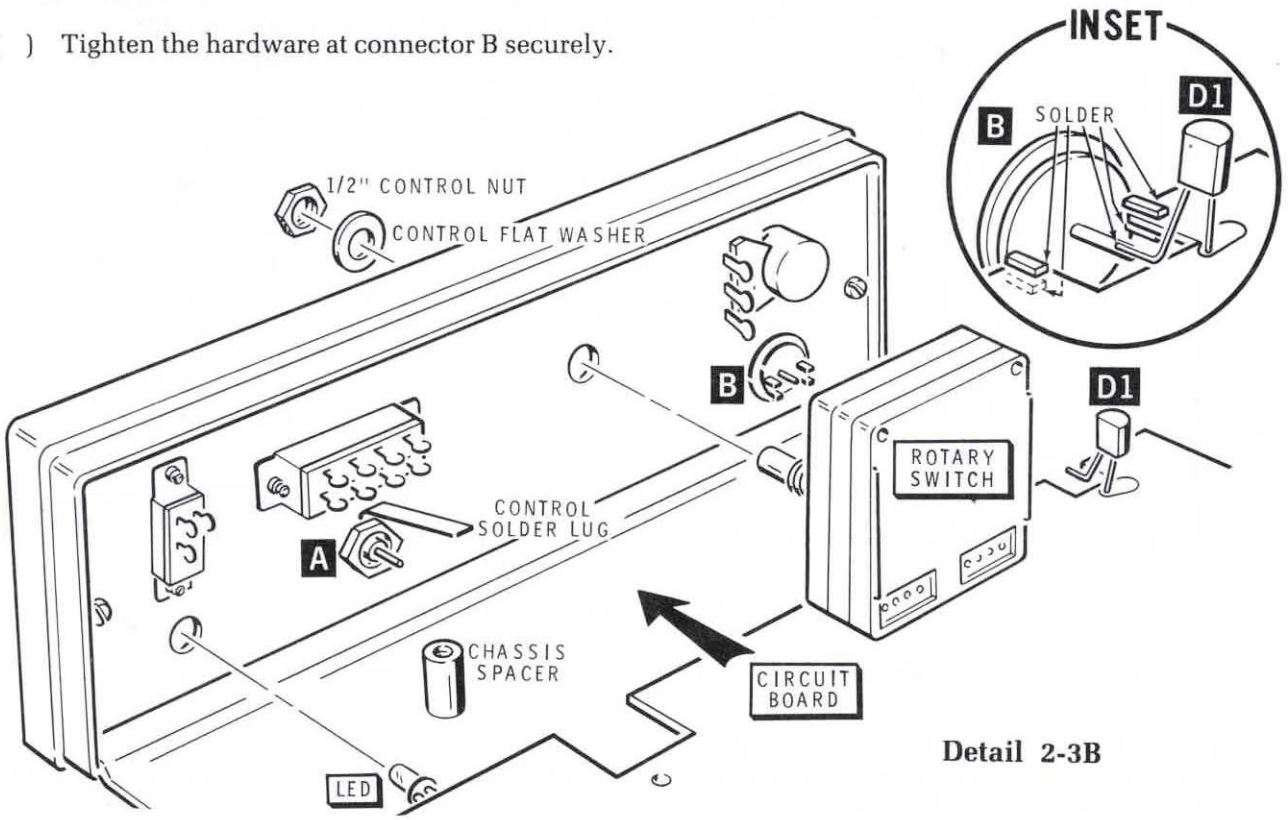
NOTE: When you solder the connections in the following two steps, make sure you do not burn any adjacent components with your soldering iron.

( ) Refer to the inset drawing of Detail 2-3B and position diode D1 so the lead is against and parallel with the center pin of BNC connector B, then solder the lead to the pin. Do not apply too much heat to the connection.

( ) Refer again to the inset drawing of Detail 2-3B and solder the BNC connector tabs to the top and bottom circuit board foil. Make sure you use enough heat to solder the tabs securely.

( ) Refer to inset drawing #1 on the Pictorial and solder the end of control solder lug A to the circuit board foil. Apply a small amount of solder to the foil area just below the end of the solder lug and to the end of the solder lug. Then, use a screwdriver and press the solder lug against the soldered foil area. Apply sufficient heat to both the soldered foil and the solder lug end to melt the solder. When the solder cools, remove the screwdriver.

( ) Connect the yellow wire coming from BNC connector A to switch SW1 lug 7 (S-1).



Detail 2-3B

Refer to Pictorial 2-3 and connect the wires coming from the circuit board to the chassis as follows:

( ) Inner lead of coaxial cable coming from hole Z to SW1 lug 8 (S-1).

( ) Wire coming from hole U to SW1 lug 6 (S-1).

( ) Wire coming from hole V to SW1 lug 1 (NS).

( ) Wire coming from hole W to SW1 lug 2 (S-1).

( ) Wire coming from hole R to R2 lug 3 (S-1).

( ) Wire coming from hole S to R2 lug 2 (S-1).

( ) Wire coming from hole T to R2 lug 1 (S-1).

( ) Prepare a 1" yellow wire.

( ) Connect the 1" yellow wire to SW1 between lugs 1 (S-2) and 3 (S-1).

( ) Cut two 5/8" pieces of small heat-shrinkable sleeving.

( ) Slide a piece of the 5/8" small heat-shrinkable sleeving over each of the twisted brown wires coming from the circuit board holes C and D.

( ) Connect either one of the twisted brown wires coming from the circuit board to SW2 lug 1 (S-1) and the other brown wire to lug 2 (S-1). Make the connections mechanically secure as shown in inset drawing #2.

NOTE: You may wish to remove switch SW2 to more easily shrink the sleeving in place in the next step.

( ) When the solder connections cool, slide the heat-shrinkable sleeving over the switch lugs and shrink it in place with a lighter or a match. See inset drawing #3 on the Pictorial.

( ) Route all of the chassis wiring as shown in the Pictorial. Push all of the power transformer and line cord wiring down against the bottom of the chassis.

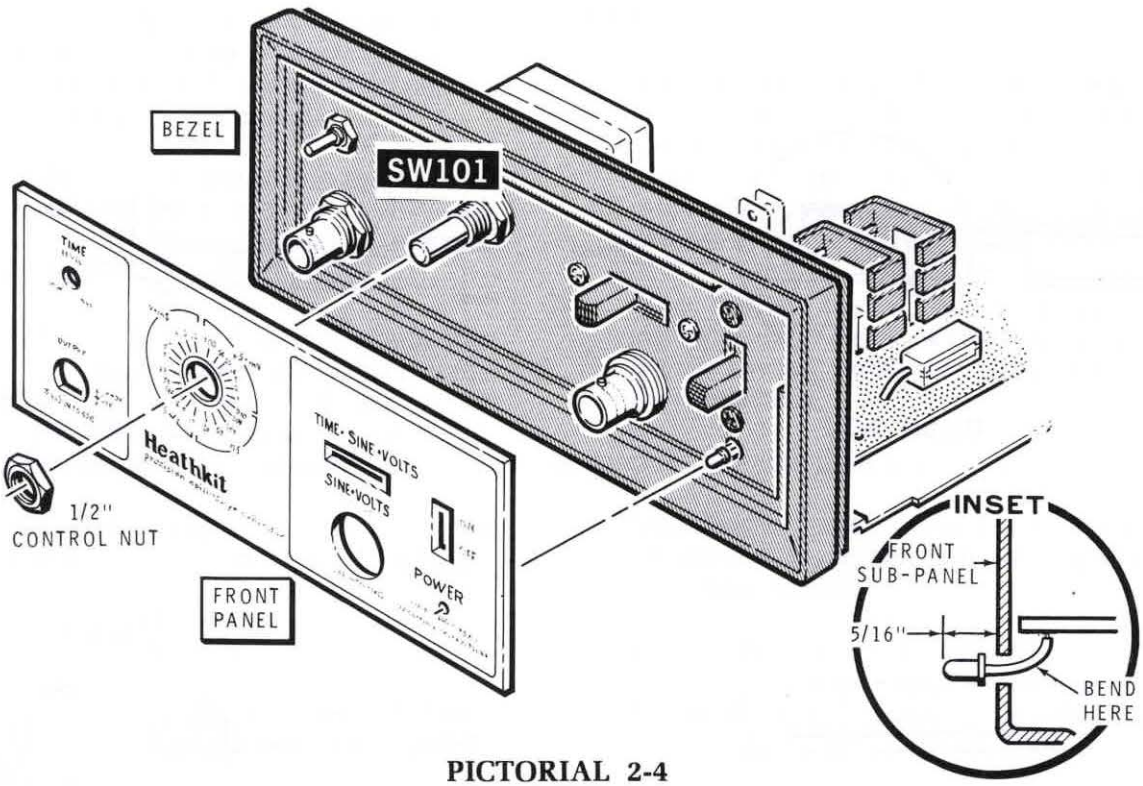
( ) At this time, go back and check all of your connections to make sure they are securely soldered and that there are no long pigtail leads that could short to another component, the chassis, or an adjacent switch lug. Also, make sure all of the components are straight and that none are bent over (especially the transistor heat sinks and metal tabs).

FRONT PANEL MOUNTING

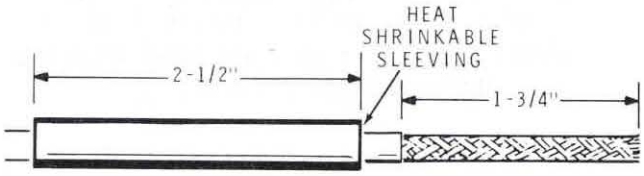
Refer to Pictorial 2-4 for the following steps.

( ) Refer to the inset drawing and make sure that no more than 5/16" of the LED extends through its chassis hole. Use a pair of long-nose pliers to bend the LED leads as necessary.

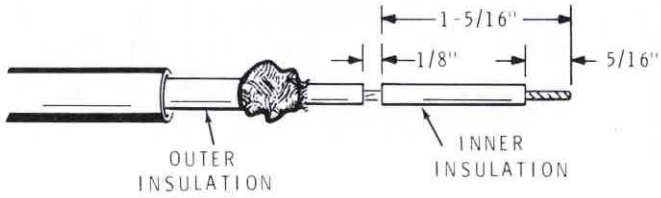
( ) Mount the front panel to the chassis at SW101 with a ½" control nut. Make sure the LED goes into its front panel mounting hole and that the panel fits into the bezel evenly. Center the shaft of SW101 in the front panel mounting hole before you tighten the nut.



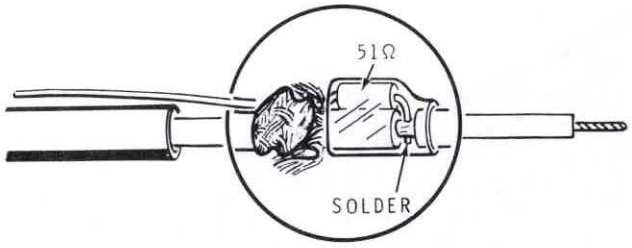
PICTORIAL 2-4



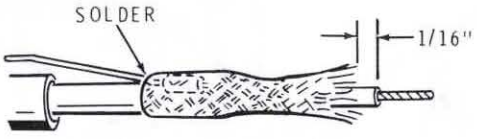
Detail 2-5A



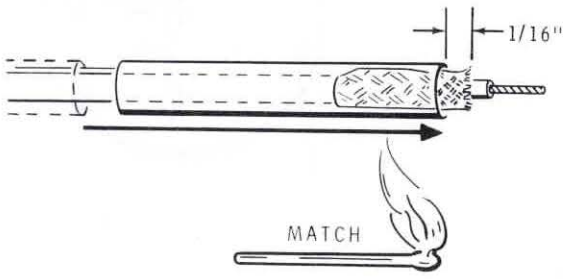
Detail 2-5B



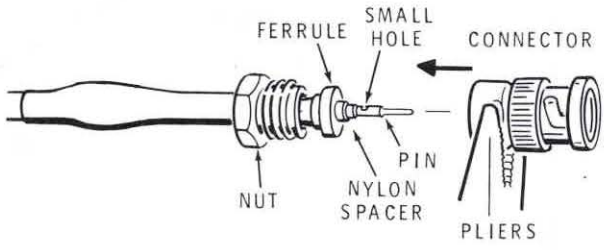
Detail 2-5C



Detail 2-5D



Detail 2-5E



Detail 2-5F

CABLE PREPARATION

Refer to Pictorial 2-5 for the following steps.

Refer to Detail 2-5A and:

1. ( ) Slide a 2-½" length of large heat-shrinkable sleeving onto the free end of the shielded cable assemblies.

2. ( ) Carefully remove 1-¾" of outer insulation from the shielded cable.

Refer to Detail 2-5B and:

1. ( ) Push the braided shield wires back against the outer insulation.

2. ( ) Remove 5/16" of insulation from the end of the inner lead. Then apply a small amount of solder to the bare wire ends.

3. ( ) Measure 1-5/16" from the end of the cable and carefully remove ⅛" of insulation.

Refer to Detail 2-5C and:

1. ( ) Insert one lead of a 51 Ω (grn-brn-blk), ¼-watt resistor through the braided shield wires.

2. ( ) Wrap the other lead around the inner lead of the shielded cable and solder the connection. Keep the resistor as close to the inner lead as possible. Cut off the excess lead length.

3. ( ) Slide a ½" length of small clear sleeving over the resistor and inner lead as shown.

Refer to Detail 2-5D and:

1. ( ) Pull the braided shield wires back over the resistor to their original position. Solder the resistor lead to the shield wires and cut off the excess lead length. Then trim off the braid shield wires 1/16" from the end of the inner lead insulation.

Refer to Detail 2-2E and:

1. ( ) Slide the 2-½" length of heat-shrinkable sleeving up to within 1/16" from the end of the shield braid.

2. ( ) Use the heat from a lighter or a match to shrink the sleeving in place. Turn the cable as you heat it to shrink the sleeving evenly.

Refer to Detail 2-5F and:

1. ( ) Slide the BNC nut over the shield wires onto the end of the cable.

2. ( ) Push the BNC pin (this includes the ferrule and the nylon spacer) onto the end of the inner lead. Solder the pin to the inner lead. To do this, position the pin so the small hole faces upward. Then hold your soldering iron against the underside of the pin and apply a *small* amount of solder into the small hole. Do not allow solder to accumulate on the outside of the pin.

3. ( ) Push the connector onto the pin until it seats against the nylon spacer.

4. ( ) Grasp the connector with long-nose pliers. Slide the nut into the connector and turn the nut until it is tight.

Set this cable assembly aside.

Use the following procedure to prepare the second shielded cable assembly:

Refer to Detail 2-5G and:

1. ( ) Carefully remove ½" of outer insulation from the shielded cable assembly.

Refer to Detail 2-5H and:

1. ( ) Push the braided shield wires back over the outer insulation.

2. ( ) Remove 5/16" of insulation from the end of the inner lead. Then apply a small amount of solder to the bare wire ends.

Refer to Detail 2-5J and:

1. ( ) Pull the braided shield wires back over the inner lead to their original position.

2. ( ) Slide the BNC nut over the shield wires onto the end of the cable.

3. ( ) Push the braided shield wires back enough to expose the end of the inner lead.

4. ( ) Push the BNC pin (this includes the ferrule and the nylon spacer) onto the end of the inner lead. Solder the pin to the inner lead. To do this, position the pin so the small hole faces upward. Then hold your soldering iron against the under side of the pin and apply a small amount of solder into the small hole. Do not allow solder to accumulate on the outside of the pin.

Refer to Detail 2-5K and:

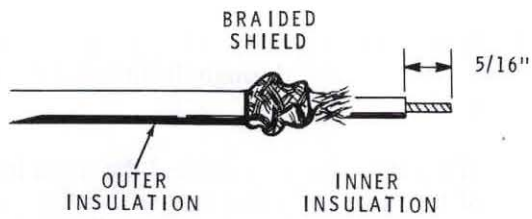
1. ( ) Pull the braided shield wires over the ferrule. Then cut off the shield wires that extend beyond the sides of the ferrule.

2. ( ) Push the connector onto the pin until it seats against the nylon spacer.

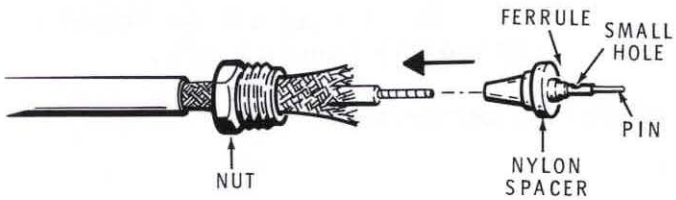
3. ( ) Grasp the connector with long-nosed pliers. Slide the nut onto the connector and turn the nut until it is tight.

This completes the chassis assembly of your Precision Oscilloscope Calibrator. Proceed to "Initial Tests and Calibration."

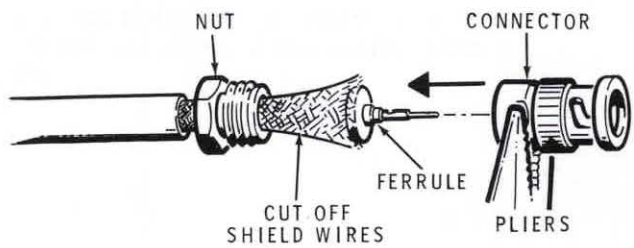
Detail 2-5G



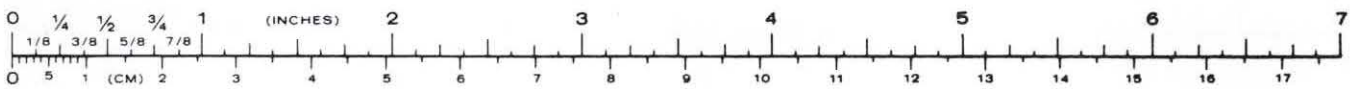
Detail 2-5H



Detail 2-5J



Detail 2-5K



INITIAL TESTS AND CALIBRATION

NOTE: Use a VTVM or VOM (digital or analog type) to perform the following steps under "Ohmmeter Checks" before you apply power to your Precision Oscilloscope Calibrator. If you do not get the intended results using the meter, refer to the "In Case Of Difficulty" section on Page 65 of the Manual. DO NOT apply power to the unit if you do not obtain the correct readings.

OHMMETER CHECKS

Refer to Pictorial 2-6 (Illustration Booklet, Page 6) for the following steps.

NOTE: Most ohmmeters have a positive test voltage polarity ("+" input lead), while others have a negative test voltage polarity. The polarity of your ohmmeter test voltage is determined in the next step.

( ) Touch your ohmmeter input lead to point Y and the common lead to point Z at diode D101, and note the resistance reading. Reverse the ohmmeter leads and note this reading. If the first reading was lower than the second, your ohmmeter has a positive polarity. This identifies the ohmmeter input lead as the "+" lead. If the second reading was lower, your ohmmeter has a negative polarity. This identifies the ohmmeter common lead as the "+" lead. The other ohmmeter lead is the "−" lead. Keep this in mind for the following tests.

( ) Slide the POWER switch to On. DO NOT connect the unit to any AC power at this time.

Refer to the chart on the following page and perform the resistance measurements in the following manner:

1. Set the ohmmeter range switch, for each step, if possible, to obtain a midscale reading.

2. Connect the positive ohmmeter lead to the indicated "(+) Test Point" location.

3. Connect the negative ohmmeter lead to the indicated "(−) Test Point" location. . . . The readings should be (> means greater than) as shown in the "Meter Indication" column. Allow sufficient time for any capacitors to charge before you take a reading.

(+) TEST POINT	(−) TEST POINT	METER INDICATION	FAULT
( ) Either flat prong of the line cord.	Ground	INFINITE with the POWER switch On or Off.	A. Wiring on switch SW2. B. Transformer T1 wiring.
( ) Other flat prong of the line cord.	Ground	INFINITE with the POWER switch On or Off.	A. Wiring on switch SW2. B. Transformer T1 wiring.
( ) Round prong of the line cord.	Ground	0 Ω with the POWER switch On or Off.	A. Green wire not properly connected between line cord and solder lug D. See Pictorial 2-2, Illustration Booklet, Page 4.
( ) Either flat line cord prong.	Other flat prong.	INFINITE with the POWER switch Off.	A. Wiring on switch SW2. B. Transformer T1 wiring.
( ) Either flat line cord prong.	Other flat prong.	Approximately 20 to 60 Ω with the POWER switch On.	A. Wiring on SW2. B. Transformer T1 wiring.
( ) Anode* of D101.	Ground	>6 kΩ	D101, D104, C139, U120.
( ) Cathode* of D107.	Ground	>3 kΩ	D105, D108, C135, U118.
( ) Anode of D108.	Ground	>300 Ω	D105, D108, C137, U119.
( ) Pin 8 of U101.	Ground	>400 Ω	U119, ECL circuits.
( ) Pin 14 of U106.	Ground	>100 Ω	U118, TTL circuits.
( ) Collector of Q107.	Ground	1 kΩ – 4 kΩ	U120, C141, R2, Q107.
( ) (+) lead of C119.	Anode of D115	8 kΩ – 13 kΩ	D109, D112, C119, Q108.
( ) (+) lead of C122.	Anode of D115	70 kΩ – 110 kΩ	Q108, C122, Q110, R177, R135.
( ) Collector tab of Q110.	Anode of D115	6 kΩ – 8 kΩ	R193, R202, SW101, SW1.

( ) Place the POWER switch to Off.

* NOTE: The anode is the unbanded end of a diode and the cathode is the banded end.

Knob Installation

Refer to Pictorial 2-7 (Illustration Booklet, Page 7) for the following steps.

( ) Make sure the ohmmeter is set to read approximately 50 kΩ.

( ) Connect the negative ohmmeter lead to the transformer mounting (ground) screw.

( ) Refer to the inset drawing and connect the positive ohmmeter lead to the indicated lead of resistor R117 (brn-grn-red). Be careful not to short the probe tip to the circuit board foil.

( ) Turn the Range switch control shaft until you locate the high resistance point. All positions of the Range switch will indicate zero resistance on the ohmmeter except one, which will indicate approximately 20 kΩ to 50 kΩ. When you locate this position, stop turning the control shaft. Then remove the positive ohmmeter lead from the resistor lead and set it aside.

( ) Start a 6-32 × 1/8" black setscrew into the large knob with the #6 allen wrench.

( ) Install the large knob on the Range switch control shaft and position the knob pointer towards 10 ns. Space the knob so it does not rub against the front panel and tighten the setscrew securely.

( ) Turn the TIME LEVEL control fully counterclockwise.

( ) Start a 4-40 × 3/32" black setscrew into the small knob with the #4 allen wrench.

( ) Install the small knob onto the TIME LEVEL control shaft. Position the knob pointer toward the MIN marking on the front panel. Space the knob so it does not rub against the front panel and tighten the setscrew.

This completes the "Ohmmeter Checks." Proceed to "Calibration."

CALIBRATION

Refer to Pictorial 2-8 (Illustration Booklet, Page 7) for the following steps.

( ) Slide the Calibrator's POWER switch to Off.

( ) Turn the TIME LEVEL control (R2) to its midrange position.

( ) Slide the TIME – SINE – VOLTS switch (SW1) to the VOLTS position.

( ) Insert the 2-hole jumper over the two plug P101 pins at the DC position. See the inset drawing.

( ) Preset the 20 V (R178), 100 V (R179), and 50 V (R181) controls to their midrange positions.

NOTE: In the following steps, set your voltmeter to display a near full-scale reading, or the best resolution on your DVM to insure the accuracy of the readings. The more accurate the readings are, the more accurate the calibration will be.

( ) Connect the negative (−) lead of your voltmeter to the outer portion of the SINE - VOLTS output connector. Connect the positive (+) voltmeter lead to a cutoff resistor lead or a short piece of solder and insert the lead into the center conductor of the connector.

( ) Refer to Pictorial 2-6 and check to make sure that the heat sink of IC U118 does not touch against the case top of transistor Q113. Bend the heat sink up if necessary.

WARNING: When the line cord is connected to an AC outlet, AC voltage is present at several places. These areas are shown in the boxed-in area on Pictorial 2-9. Be careful – you could receive a severe shock if you touch this voltage.

( ) Connect the Calibrator line cord plug to the appropriate AC receptacle.

( ) Slide the Calibrator's POWER switch to On. The POWER indicator should light.

WARNING: To avoid a possible shock, do not touch the shielded cable center pin when the Range switch is in the VOLTS positions in the following steps.

( ) Turn the Range switch (SW101) to the 20 V position.

( ) Use a small-bladed screwdriver and turn the 20 V control (R178) until the voltmeter indicates exactly 20.00 volts.

( ) Turn the Range switch to the 50 V position.

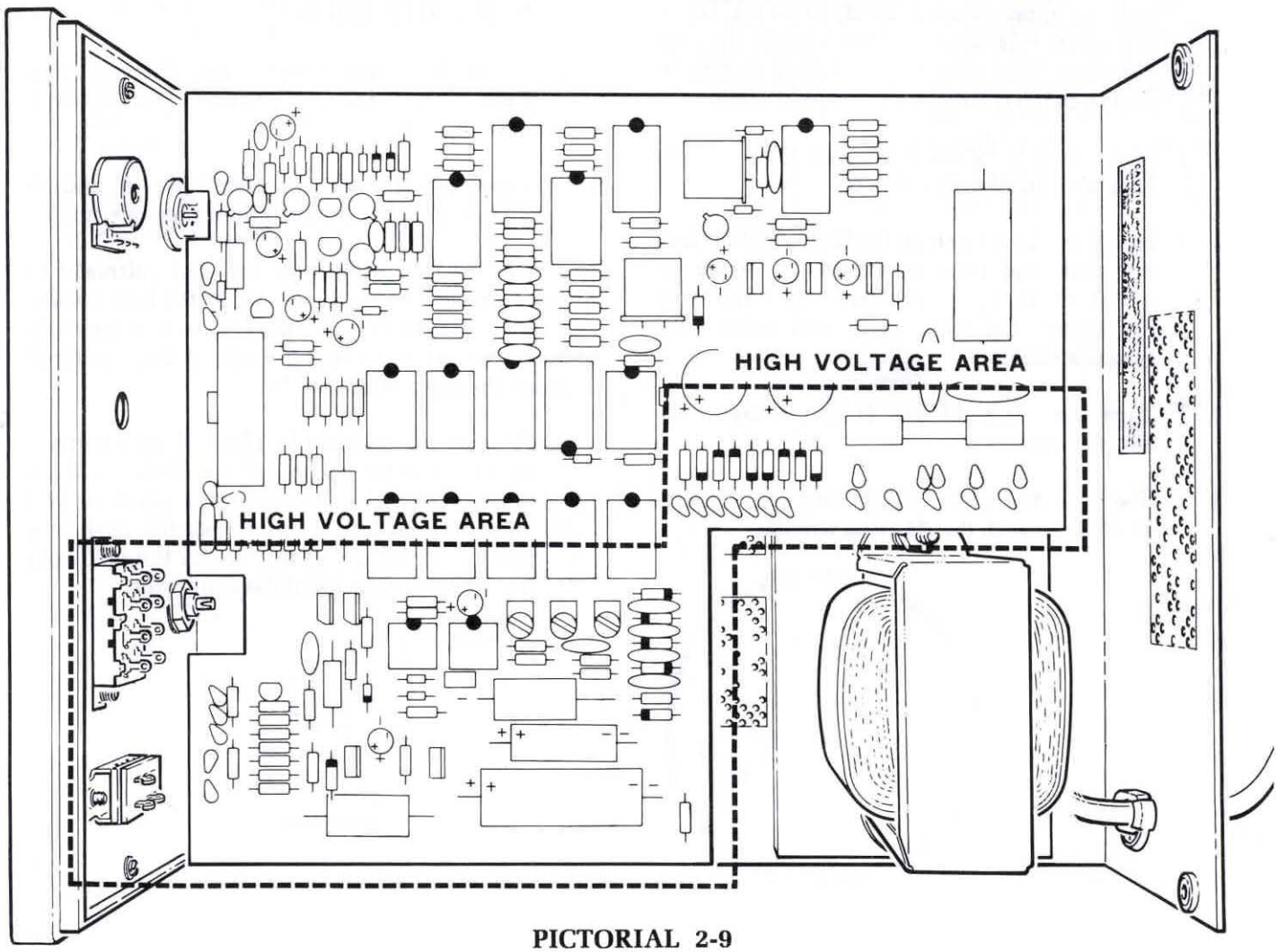
( ) Turn the 50 V control (R181) to obtain a 50.00 volt reading on the voltmeter.

( ) Turn the Range switch to the 100 V position.

( ) Turn the 100 V control (R179) to obtain a 100.0 volt reading on the voltmeter.

( ) Turn the Range switch to the 20 V position.

( ) Disconnect the voltmeter and set the meter aside.



PICTORIAL 2-9

Refer to Pictorial 2-10 for the following steps.

( ) Connect the end of the shielded cable assembly with the 51 Ω resistor to the oscilloscope. Connect the other end of the cable to the TIME Output BNC connector of the Calibrator.

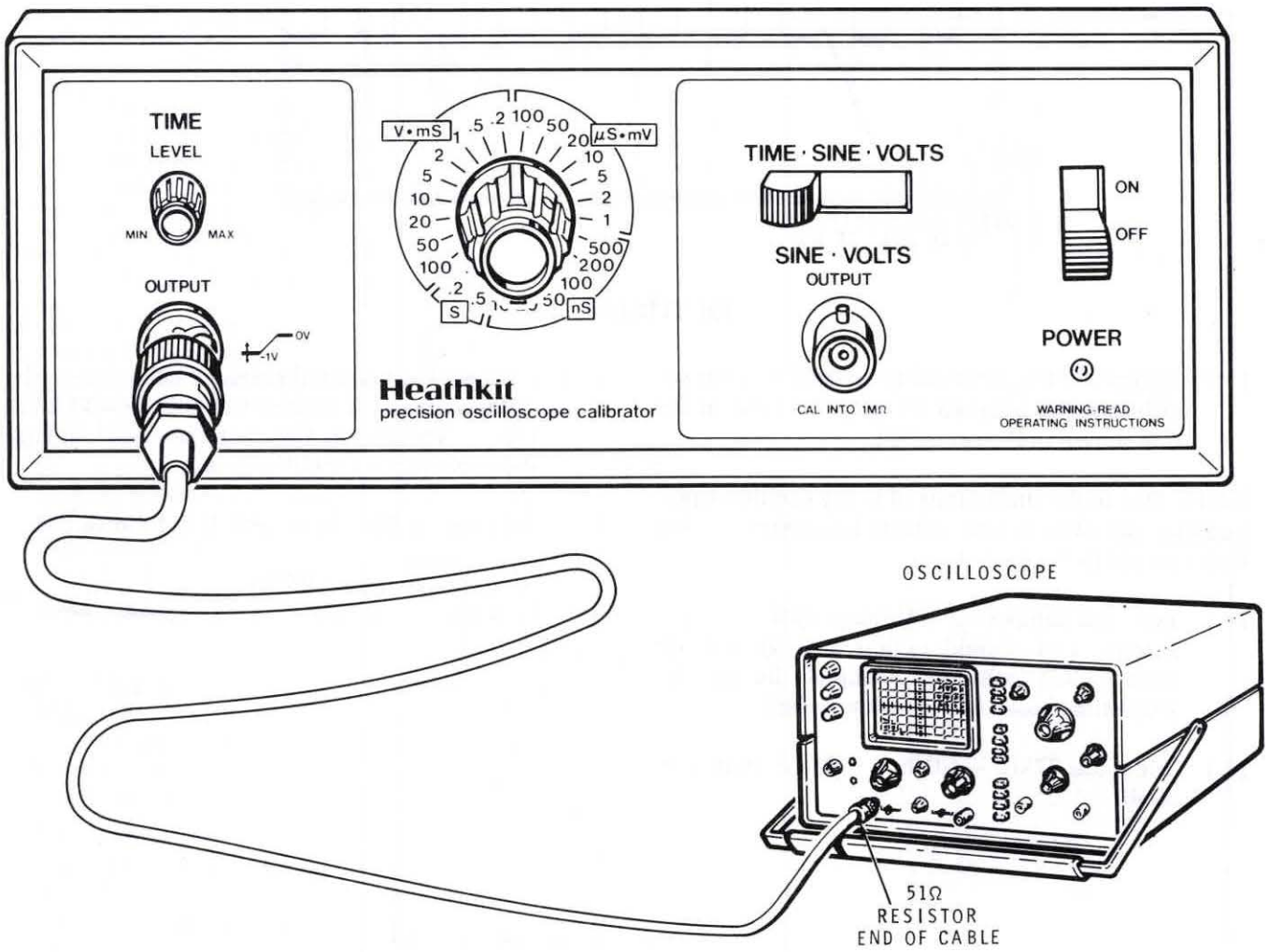
( ) Set your oscilloscope controls as follows:

INPUT ATTENUATOR – .2V/div.

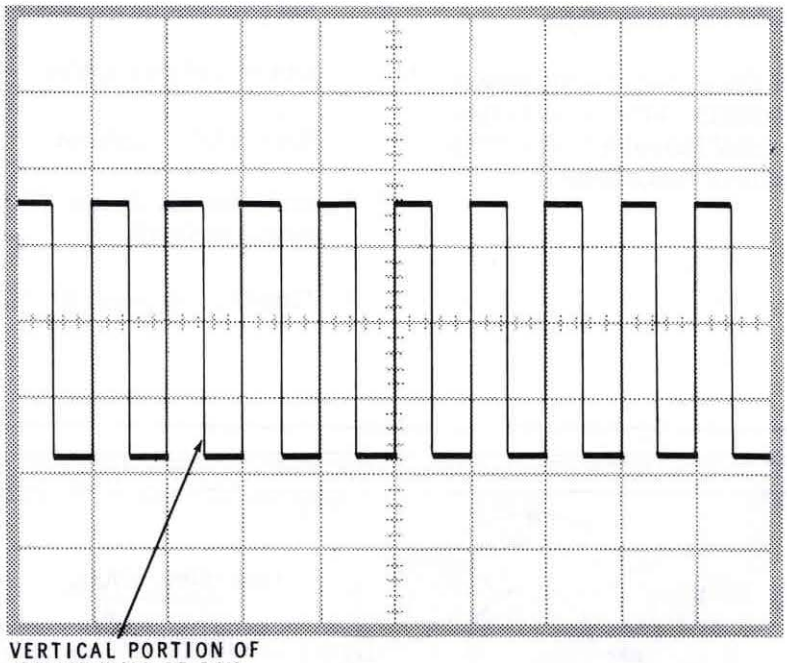
TIME BASE – .2μS/div.

( ) Slide the Calibrator TIME – SINE – VOLTS switch to TIME.

( ) Turn the Calibrator RANGE switch to 200 nS.



PICTORIAL 2-10



PICTORIAL 2-11

( ) Adjust the trigger stability control on your oscilloscope to obtain a waveform similar to the one shown in Pictorial 2-11.

NOTE: Due to the limitations of many oscilloscopes, you may not observe the indicated waveform on the faster ranges in the next step.

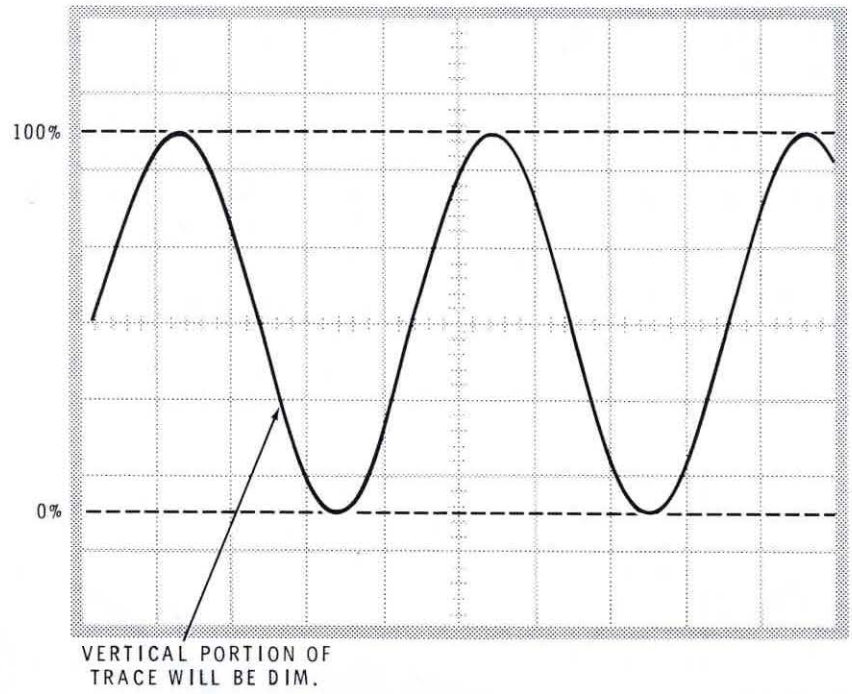
( ) Turn the Range switch through each of its positions. You should obtain a waveform for each switch position. Readjust the oscilloscope time base controls as necessary.

( ) Slide the TIME – SINE – VOLTS switch to SINE.

( ) Connect the prepared shielded cable assembly **without** the 51 Ω resistor to the SINE – VOLTS Output connector. Connect the other end of the cable to your oscilloscope.

( ) Set your oscilloscope controls as follows:

Input Attenuator: .2 V/div.
Time Base: .2 ms/div.



PICTORIAL 2-12

( ) Refer back to Pictorial 2-6 (Illustration Booklet, Page 6). Adjust control R192 on the bottom side of the circuit board (see the inset drawing) counterclockwise for the best looking 1 V p-p sine wave as shown in Pictorial 2-12. Readjust the input attenuator of your oscilloscope as necessary.

( ) Slide the Calibrator's POWER switch to Off.

( ) Remove the 2-hole jumper at P101 from the DC pins and place it over the NORMAL pins. See the inset drawing on Pictorial 2-13.

( ) Turn the Calibrator's Range switch to 1 V.

( ) Slide the Calibrator's TIME – SINE – VOLTS switch to VOLTS.

( ) Set your oscilloscope's controls as follows:

Input Attenuator: .2 V/div.

Time Base: 1 ms/div.

( ) Turn the Calibrator on.

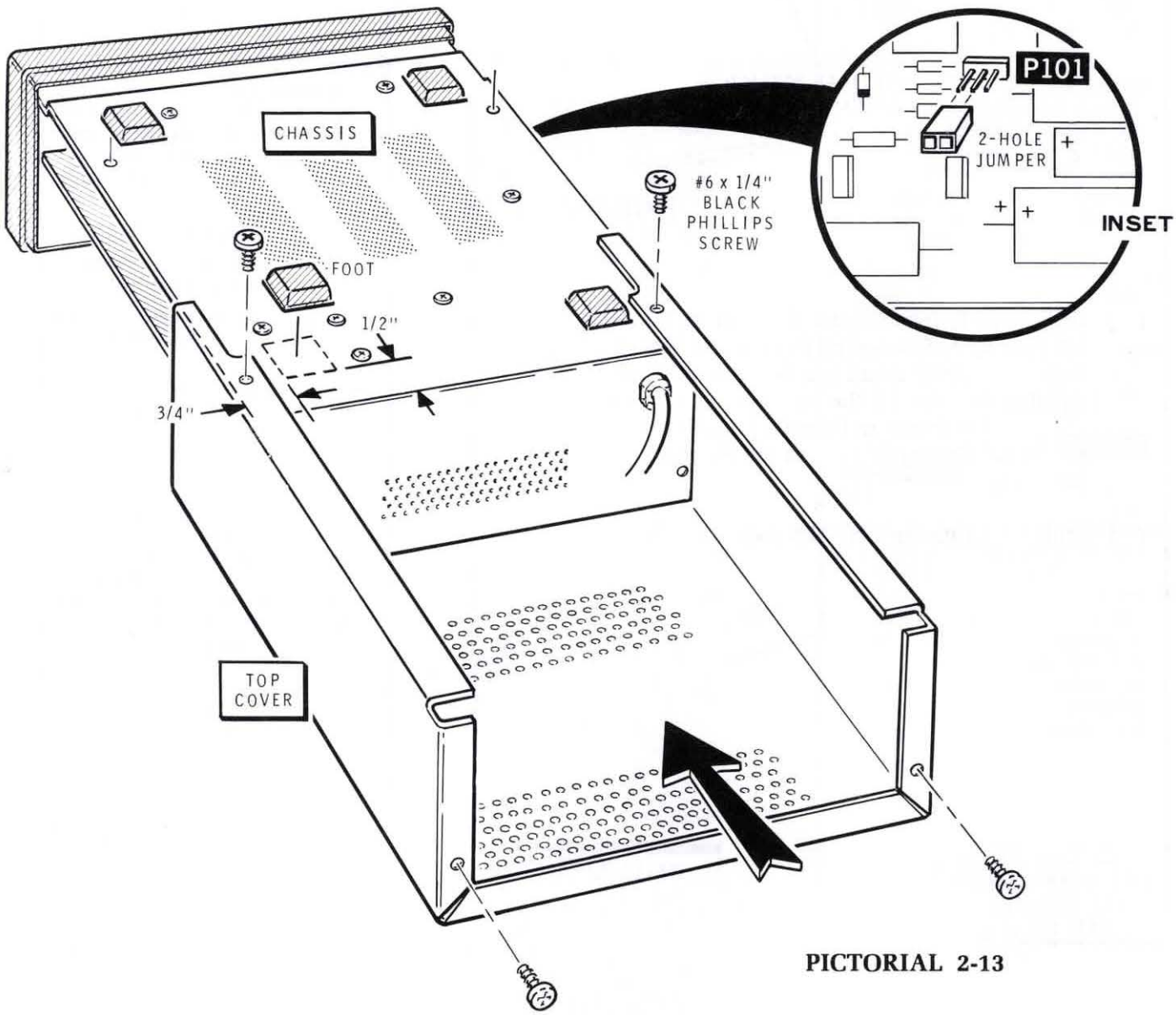
( ) Adjust the trigger stability control on your oscilloscope to obtain a waveform similar to the one shown in Pictorial 2-11.

( ) Turn the Calibrator's Range switch through each of its positions from 1 mV to 100 V. You should obtain a waveform for each switch position. Readjust the oscilloscope's vertical attenuator control as necessary.

( ) Disconnect the cable from the Calibrator.

( ) Slide the POWER switch to off. Then disconnect the Calibrator's line cord from the wall outlet.

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



PICTORIAL 2-13

FINAL ASSEMBLY

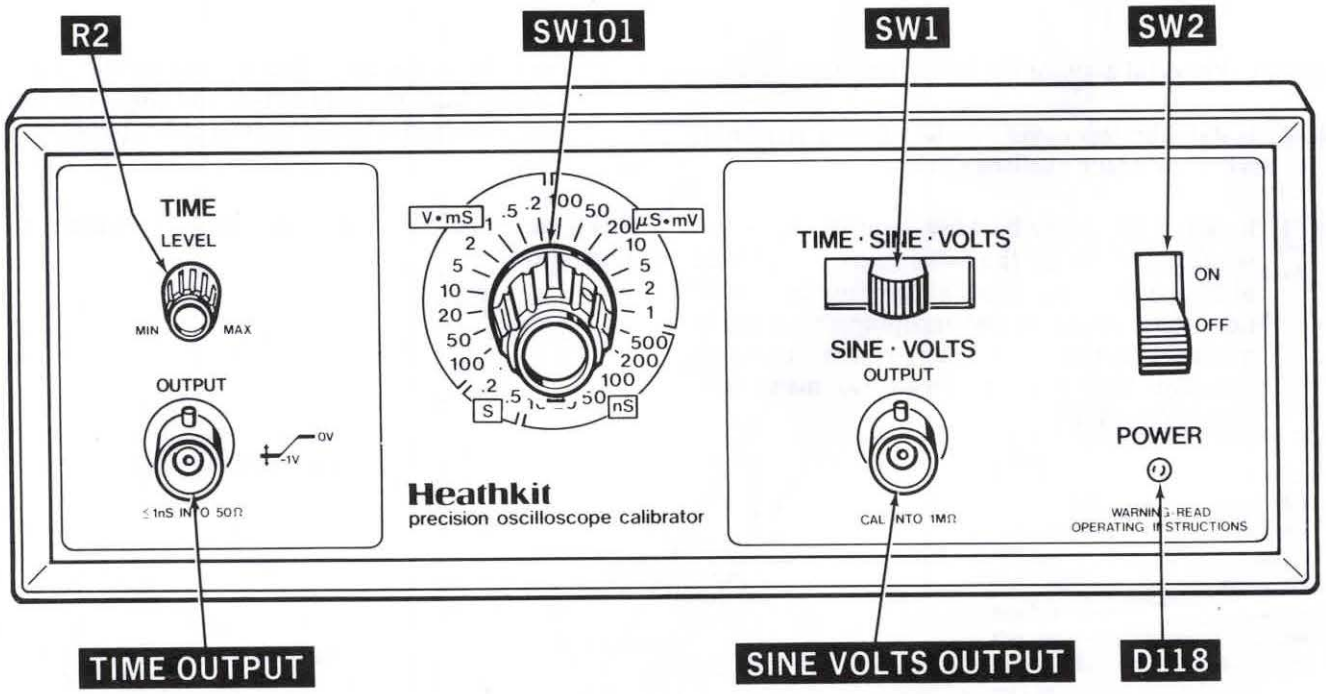
Refer to Pictorial 2-13 for the following steps.

( ) Install the top cover on the chassis with four #6 × ¼" black phillips screws.

( ) Remove the paper backing from the blue and white label. Press the label onto the outside of the chassis rear panel at the indicated location. Refer to the model and production series numbers on this label in any communications you may have with the Heath Company concerning this kit.

( ) Turn the unit upside down. Remove the paper backing from the rubber feet and press the feet onto the chassis bottom at the indicated corner locations.

This completes the "Final Assembly." Proceed to "Operation."



PICTORIAL 3-1

OPERATION

WARNING: Whenever the Range switch is in the 100 V position, there will be 100 volts present at the BNC Volts Output connector. Be careful when you connect or disconnect cables from this connector with the switch in the 100-volt position, and do not touch the inside pin of the cable.

Pictorial 3-1 shows the front panel of the Calibrator. Study this Pictorial carefully to become familiar with each switch, control, and BNC output connector.

The Calibrator provides both the accurate time and amplitude signals needed to calibrate Heathkit Oscilloscopes, as well as most other oscilloscopes. An output cable with a 50 Ω termination assures good frequency response. The Calibrator is also quite useful as a bench standard. Use it to calibrate other test equipment or as a signal source when you build and test experimental circuits.

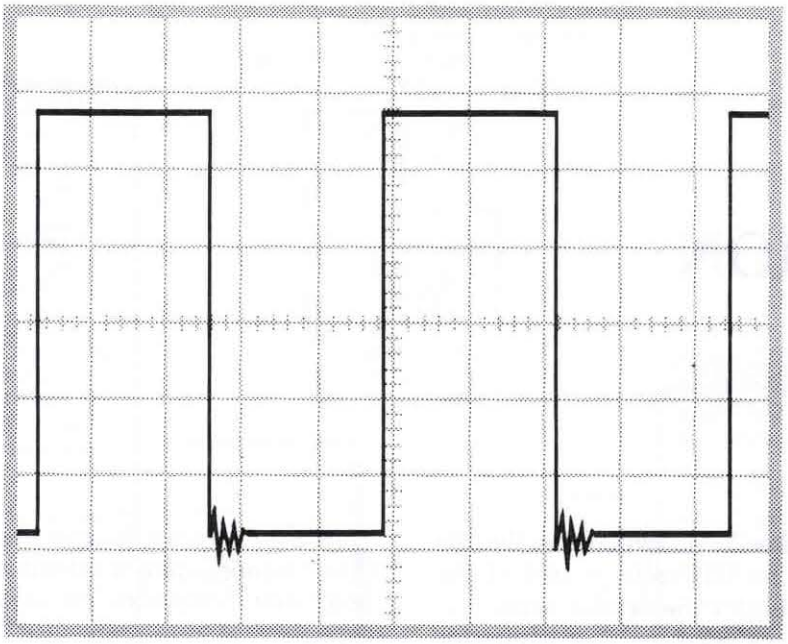
TIME OUTPUT SIGNAL

The Calibrator provides 24 accurate fast-rise output signals from .5 S (2Hz) to 10 ns (100 MHz) in a 1-2-5 sequence. Because the rise time of this signal is less than 1 nanosecond, it is well suited for making high frequency compensation adjustments on oscilloscope vertical amplifiers. Oscilloscope time base adjustments can also be made using these signals. The amplitude of this signal is approximately 100 millivolts to 1 volt.

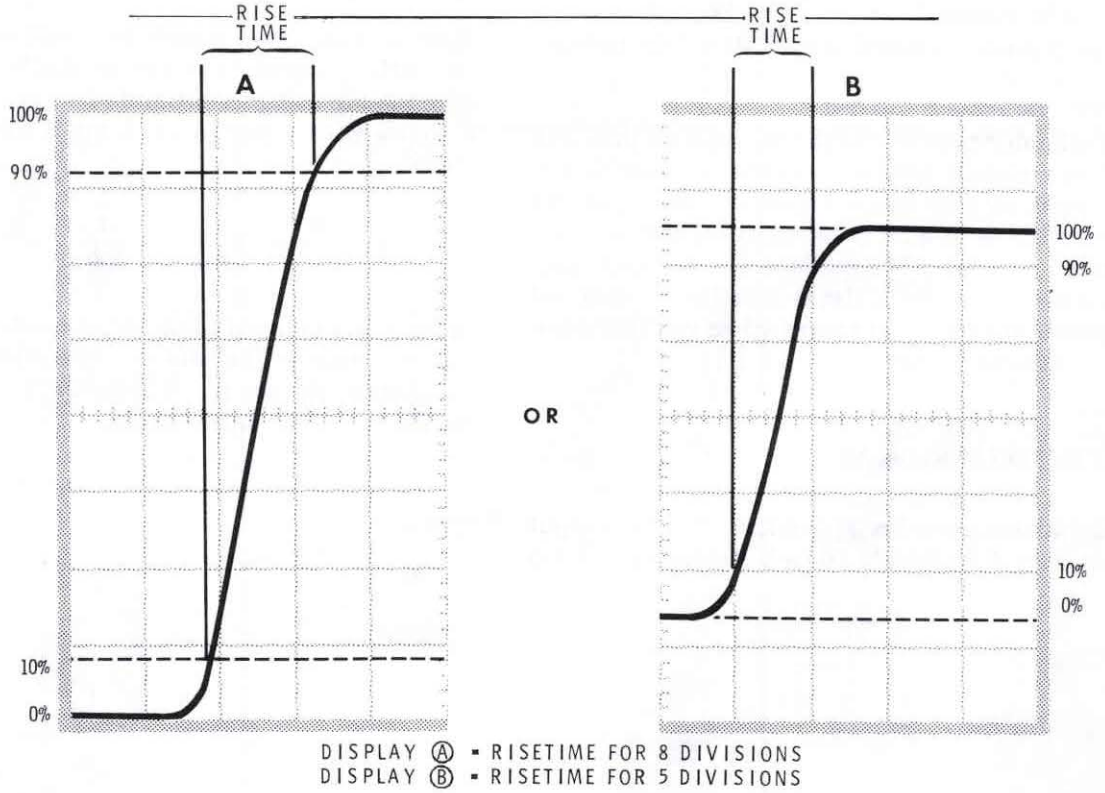
Even though these signals are indicated as a time (or period) signal, they can be easily converted to a frequency using the formula f = 1/t. For example, a signal with a period of .2 ms is also a 5000 Hz signal.

$$f = \frac{1}{t} = \frac{1}{.2ms} = \frac{1}{.0002} = 5000\ Hz$$

If you use an output cable with a built-in 50 Ω termination, such as the one you assembled with your Calibrator, do not use a separate 50 Ω terminator on the end of the output cable.



PICTORIAL 3-2



PICTORIAL 3-3

Because the components in most oscilloscope vertical amplifiers have a rather short time constant (as compared to the vertical attenuators), use a high frequency square wave signal (1 μS) to make vertical amplifier compensation adjustments. The optimum overall high frequency response of an oscilloscope vertical amplifier occurs when it can display a square wave signal that has a fast rise time without excessive overshoot. The 1 μS (1 MHz) TIME OUTPUT signal is best suited for this purpose. Adjust the appropriate vertical amplifier compensation control to "fill- in" the leading corner of the square wave to obtain the squarest corner, flattest top, and the steepest leading edge as shown in Pictorial 3-2. Only the leading edge of the Calibrator signal is defined as being "good," so do not attempt to adjust the signal for a flat bottom or squarest bottom corner.

Whenever you adjust vertical amplifiers, it is also advisable to check and adjust for a flat top (minimum droop or tilt) at slower speeds, which is an indication of flat frequency response throughout the oscilloscope bandwidth. The slower Time Output ranges (1 μS through 1 ms) are best suited for this purpose.

You can also use the Calibrator to measure the rise time of most oscilloscopes as shown in Pictorial 3-3. Rise time, Tr, is defined as the time required for the trace to move from 10% to 90% of the total waveform. This measurement is usually made with the 1 μS (1 MHz) signal from the Calibrator and the fastest sweep speed of your oscilloscope (including any sweep magnifier if it has this feature).

However, if your oscilloscope has sufficient bandwidth (approximately 100 MHz, where the rise time is less than 3.5 ns), the inherent rise time of the Calibrator signal becomes a significant factor. In this case, you should use the formula:

$$\text{Tr scope} = \sqrt{(\text{Tr display})^2 - (1\text{ ns})^2}.$$

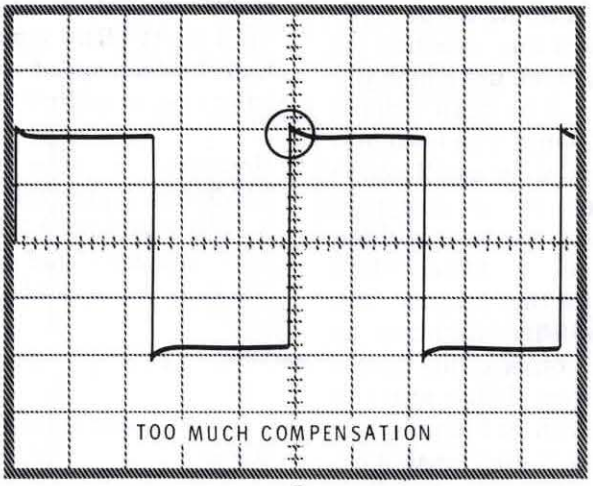
The 1 ns is the maximum rise time of the Calibrator signal.

The bandwidth of most oscilloscopes can be approximated from the formula:

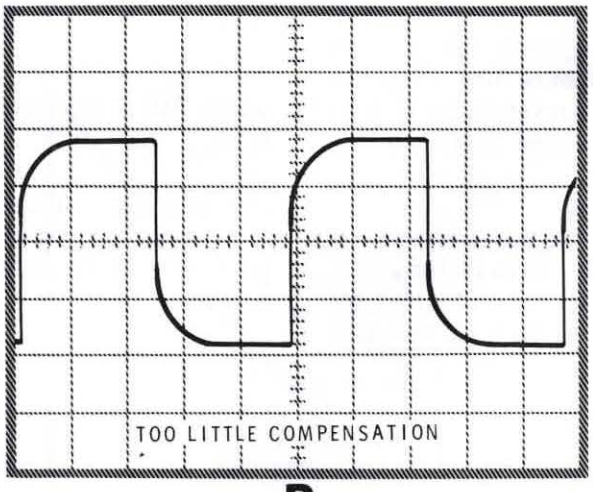
$$\text{BW} = \frac{.35}{\text{Tr}}$$

where BW is expressed in MHz and Tr is expressed in ns.

NOTE: When you make rise time measurements, always keep the vertical attenuator in its calibrated position. Otherwise, the measurement may not be accurate.

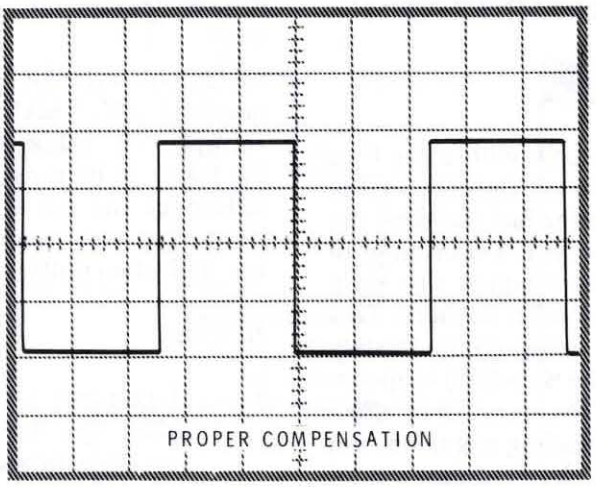


A



B

PICTORIAL 3-4



Pictorial 3-4 (cont'd)

VOLTAGE OUTPUT SIGNAL

The 1 ms (1000 Hz) output is best suited for oscilloscope vertical input attenuator and probe compensation. Since the VOLTS OUTPUT signal has a slower rise time than the TIME OUTPUT signal, it is not meant to be a high frequency signal. Steady state DC voltages are available from the VOLTS OUTPUT when the internal jumper at P101 is placed in the DC position. These are reference voltages and they should not be used as power supply voltages.

Since the components in most oscilloscope vertical input attenuators have a rather long time constant (compared to the vertical amplifier circuits), use a lower frequency square wave signal (1 ms) to make vertical attenuator compensation adjustments. Also, an adjustable amplitude signal is needed for the various attenuator ranges, especially the highly attenuated ranges.

When you make vertical attenuator compensation adjustments on an oscilloscope, set the Range switch to obtain a trace approximately 4-5 div high. You will encounter one of three waveforms. Parts A, B, and C of Pictorial 3-4 show the conditions of too much compensation, too little compensation, and the correct amount of compensation respectively. Adjust the appropriate trimmer capacitors in the vertical attenuator to obtain the waveform shown in Part C.

SINE OUTPUT SIGNAL

The approximate 1 mS (1000 Hz) sine wave signal is available for making trigger amplifier adjustments. These adjustments usually involve setting the amplifiers for an identical plus and minus triggering point and a zero level DC triggering point.

NORMAL OPERATING CHARACTERISTICS

Time Output

Always use a 50 Ω shielded cable with some type of 50 Ω termination load at the oscilloscope end of the cable. This will assure that the fast rise time signal arrives at the oscilloscope with a minimum of ringing. Inputs which have impedances that drop at high frequencies will cause some reflections. This will be noticeable as a small bump approximately 10 ns into the leading edge of the waveform (depending upon the cable length). This should not affect calibration procedures as the leading edge does not change. It is normal for there to be a reduced output on the 10 ns range. Only the leading edge of the Time Output is defined as being "good." The trailing edge is slower and may ring.

On oscilloscopes of 100 MHz or slower, the signal on the top ranges (10 ns, 50 ns, 100 ns, etc.) may appear as a sine wave. This is due to the relatively slow rise time of the oscilloscope and is not the fault of the Calibrator.

Sine/Volts Output

When you use the voltage output on the lowest ranges (1 mV, 2 mV, etc.), ground currents may be set up in the cable. This will show up as hum on the trace. To help prevent this, connect both the oscilloscope and the Calibrator to the same grounded AC outlet. Also remove any other connection between the two units, such as the Time output cable.

NOTES:

1. If you use a "cheater plug" or remove the ground pin from the line cord plug, the hum level may increase.

2. The Volts Output is calibrated into ≥1 MΩ. Do not use a 50 Ω load on the Sine/Volts Output BNC.

3. The duty cycle of the Volts Output may vary slightly from range to range. This is normal and does not effect the voltage accuracy.

4. When the Range switch is not in a valid voltage position, (.2-.5 S or 10-500 nS), there may be some hum and noise present on the Sine/Volts Output BNC.

IN CASE OF DIFFICULTY

This part of the Manual will help you locate and correct difficulties which might occur in your Calibrator. This information is divided into two sections. The first section, "General," contains suggestions in the following areas:

A. Visual checks and inspection.

B. Precautions to observe when bench testing.

C. How to determine the area of the Calibrator in which the difficulty is located ("How to Troubleshoot Your Calibrator").

D. Locating and correcting both the cause and effect of a difficulty ("Repairing the Calibrator").

The second section consists of a series of three "Troubleshooting Charts:"

TEST #1 – If the Calibrator is completely inoperative.

TEST #2 – If the TIME OUTPUT function is inoperative.

TEST #3 – If the VOLTS and/or SINE OUTPUT function is inoperative.

The resistor R numbers, capacitor C numbers, transistor Q numbers, and diode D numbers are identified in this chart by the same numbers that are used on the Schematic Diagram. Circuit Board X-Ray Views are also provided to help you locate the component and test points. Begin your troubleshooting procedure by first reading the following "General" section. Then proceed to the appropriate Test.

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

GENERAL

VISUAL CHECKS

1. About 90% of the kits that are returned for repair do not function properly due to poor connections and soldering. Therefore, you can eliminate many difficulties by a careful inspection of connections to make sure they are soldered as described in the "Soldering" section of the "Assembly Notes." Reheat any doubtful connections and be sure all the wires are soldered at places where several wires are connected.

2. Check the circuit board to be sure there are no solder bridges between adjacent connections. Remove any solder bridges by holding a clean soldering iron tip between the two points that are bridged until the solder flows down the tip of the soldering iron.

3. Be sure each transistor and any integrated circuits are in the proper location (correct part number and type number). Be sure that each transistor lead is positioned properly and has a good solder connection to the foil. Check any integrated circuits for the proper positioning and good contact of all pin connections.

4. Check capacitor values carefully. Be sure the proper part is wired into the circuit at each capacitor location.

5. Chech each resistor carefully. It would be easy, for example, to install a 1200 Ω (brown-red-red) resistor where a 220 Ω (red-red-brown) resistor is called for. A resistor that is discolored, or cracked, or shows signs of bulging would indicate that it is faulty and should be replaced.

6. Be sure the correct diode is installed at each diode location, and that the banded end is positioned correctly.

7. Recheck the wiring. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something you have consistently overlooked.

8. Check all component leads connected to the circuit board. Make sure the leads do not extend through the circuit board and make contact with other connections or components.

PRECAUTIONS FOR BENCH TESTING

1. Be cautious when you test solid-state circuits. Although transistors and integrated circuits have almost unlimited life when used properly, they are much more vulnerable to damage from excessive voltage or current than other circuit components.

2. Be sure you do not short any terminals to ground when you make voltage measurements. If the probe should slip, for example, and short out a bias or voltage supply, this could cause damage to one or more transistors or diodes.

3. Do not remove transistors or any integrated circuits while the Calibrator is turned on, since this could damage the Calibrator.

WARNING: The full AC line voltage is present at several points (fuseholder, ON-OFF switch, etc.). Be careful to avoid personal shock when performing the checks described.

HOW TO TROUBLESHOOT YOUR CALIBRATOR

If you know which area your trouble is in, apply the "Visual Checks" to that area.

You may also go directly to one or more of the "Troubleshooting Charts" to see if the difficulty you are having is listed there. If your difficulty is listed there, apply the "Visual Checks" listed to the area of difficulty.

REPAIRING THE CALIBRATOR

When you make repairs to the Calibrator, make sure you eliminate the cause as well as the effect of the difficulty. If, for example, you should find a damaged resistor, be sure that you find out what caused the resistor to become damaged. If the cause is not eliminated, the replacement resistor may also become damaged when you put the Calibrator back into operation.

SHIPPING

IMPORTANT: If it becomes necessary to ship the Calibrator to the Heath Company or a Heath Electronic Center, attach the top cover to protect the circuit board during shipment.

TROUBLESHOOTING CHARTS

The following symbols and procedures are used in the troubleshooting charts:

Follow the "YES" arrow when you obtain the proper measurement or condition.

Follow the "NO" arrow when you do not obtain the proper measurement or condition.

All voltages given in the Troubleshooting Charts were taken with a normal line voltage of 117 VAC.

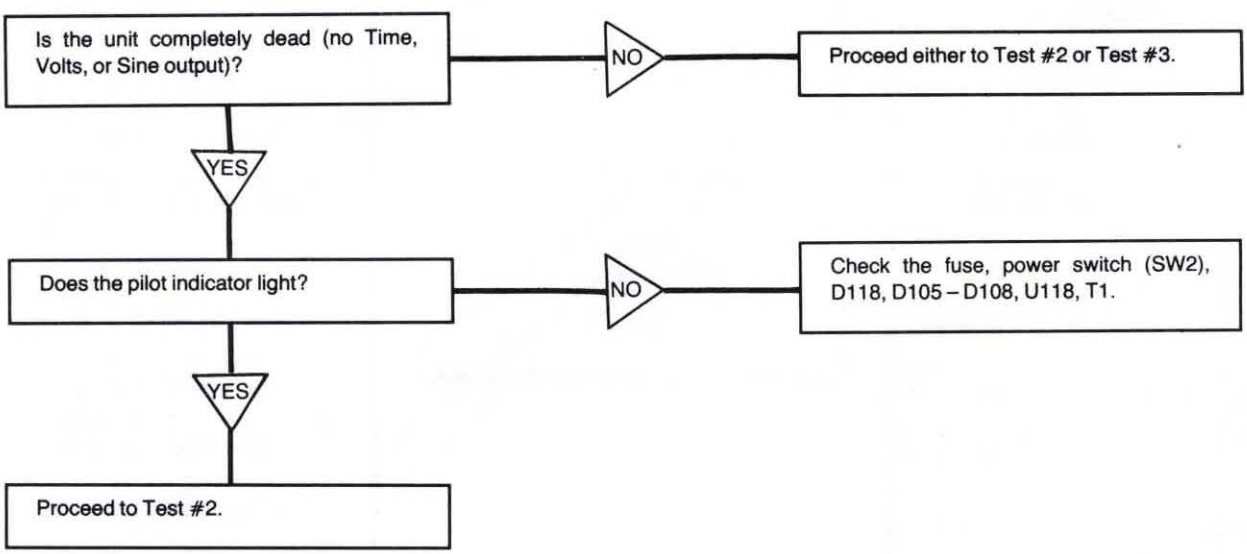
Components are listed in the order in which failure or a problem is most likely to occur. If a particular part is mentioned (R1 for example) as a possible cause, check that part and other components connected to that part to see that they are installed and/or wired correctly. Also check for solder bridges and poor connections in the surrounding area. It is also possible, on rare occasions, for a part to be faulty and require replacement. Refer to the "Circuit Board X-Ray Views" for the physical location of parts on the circuit board.

NOTE: Check each indicated resistor in the problem area and make sure they are not interchanged with a similar color-coded resistor. This applies mainly to the 1% precision resistors which are especially easy to misread.

Pictorial 4-1 on Page 72 shows the internal connections for the Range switch (SW101).

Test #1

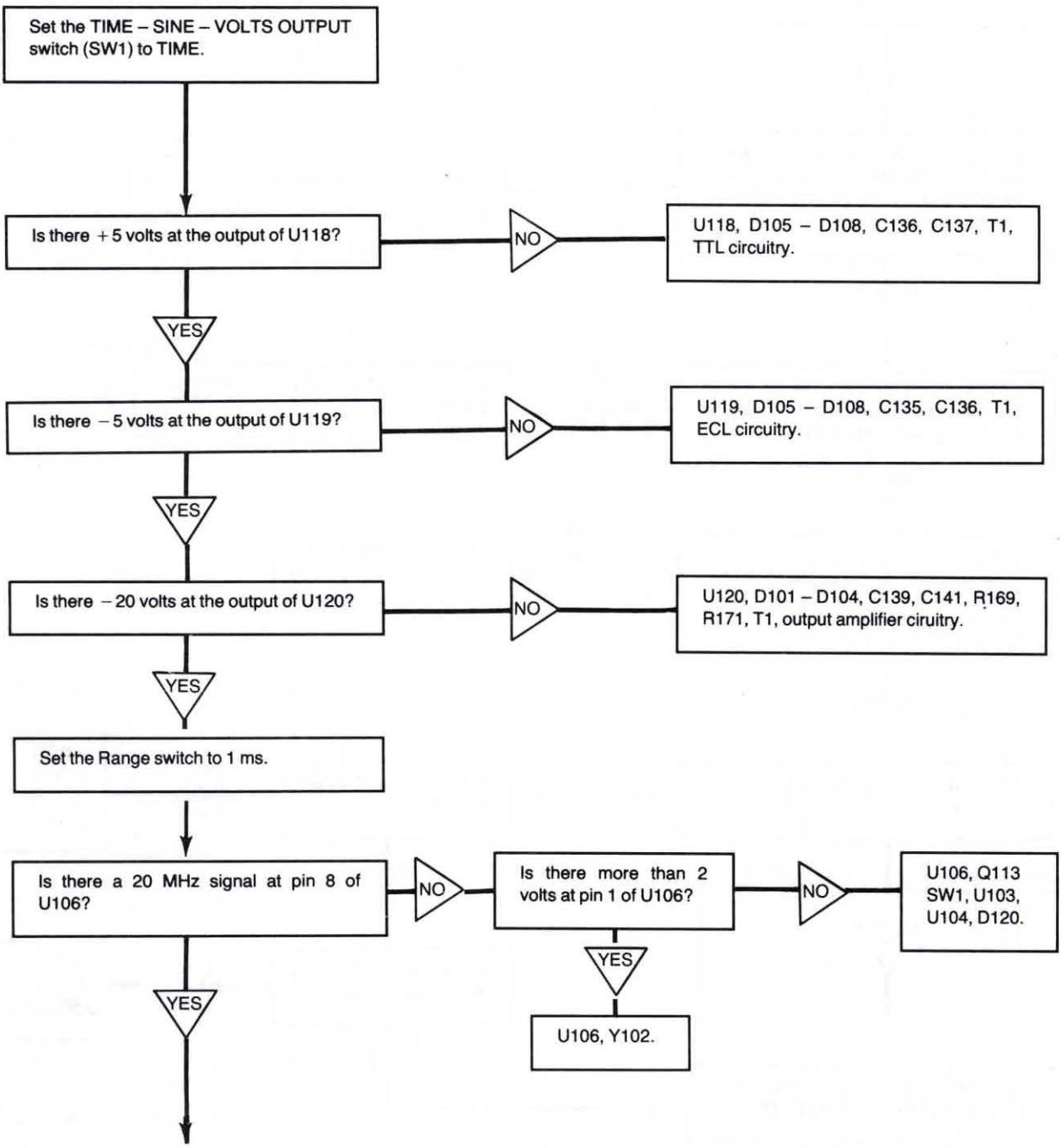
START HERE

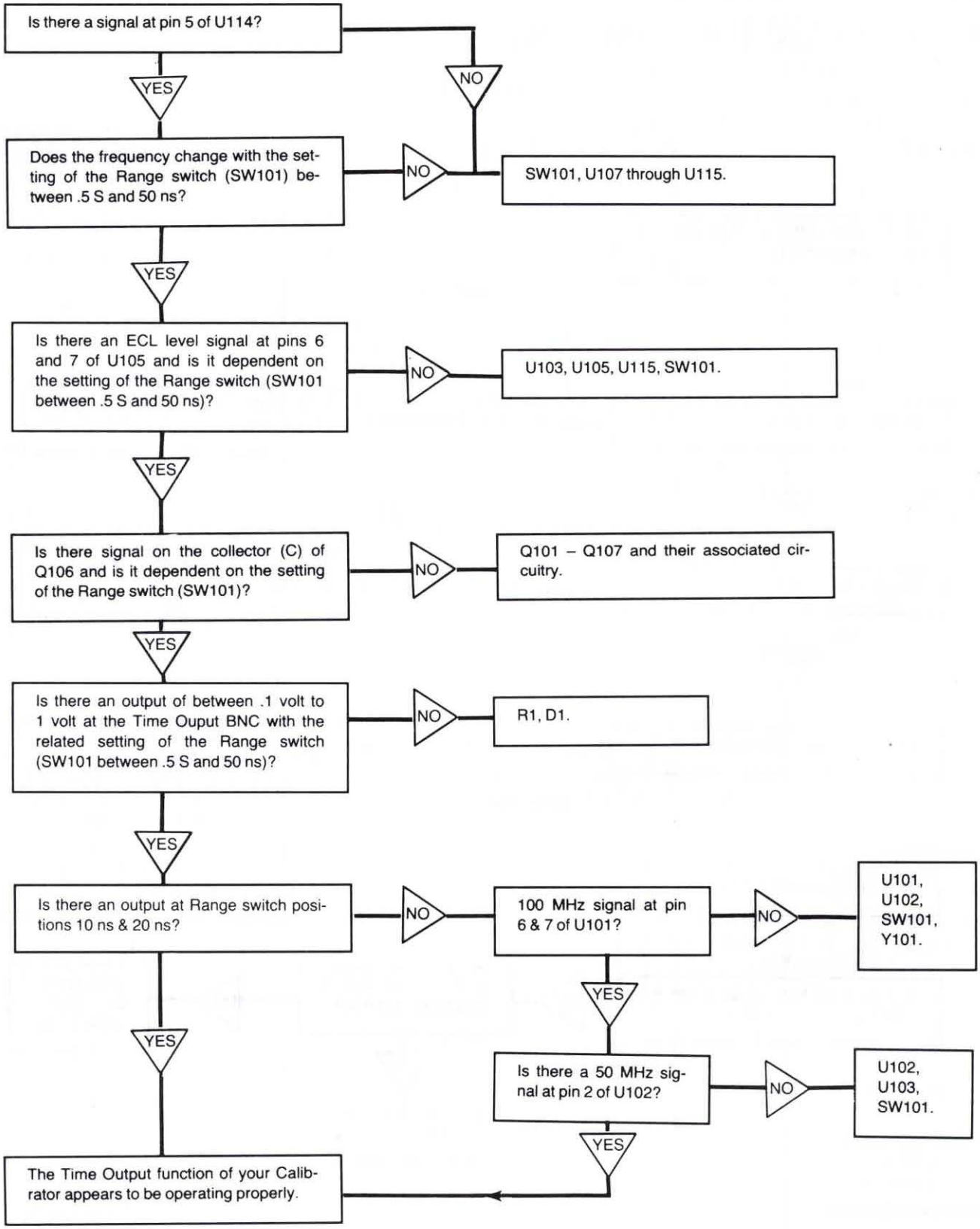


Test #2

Perform this test if you have **no** Time Output signal.

START

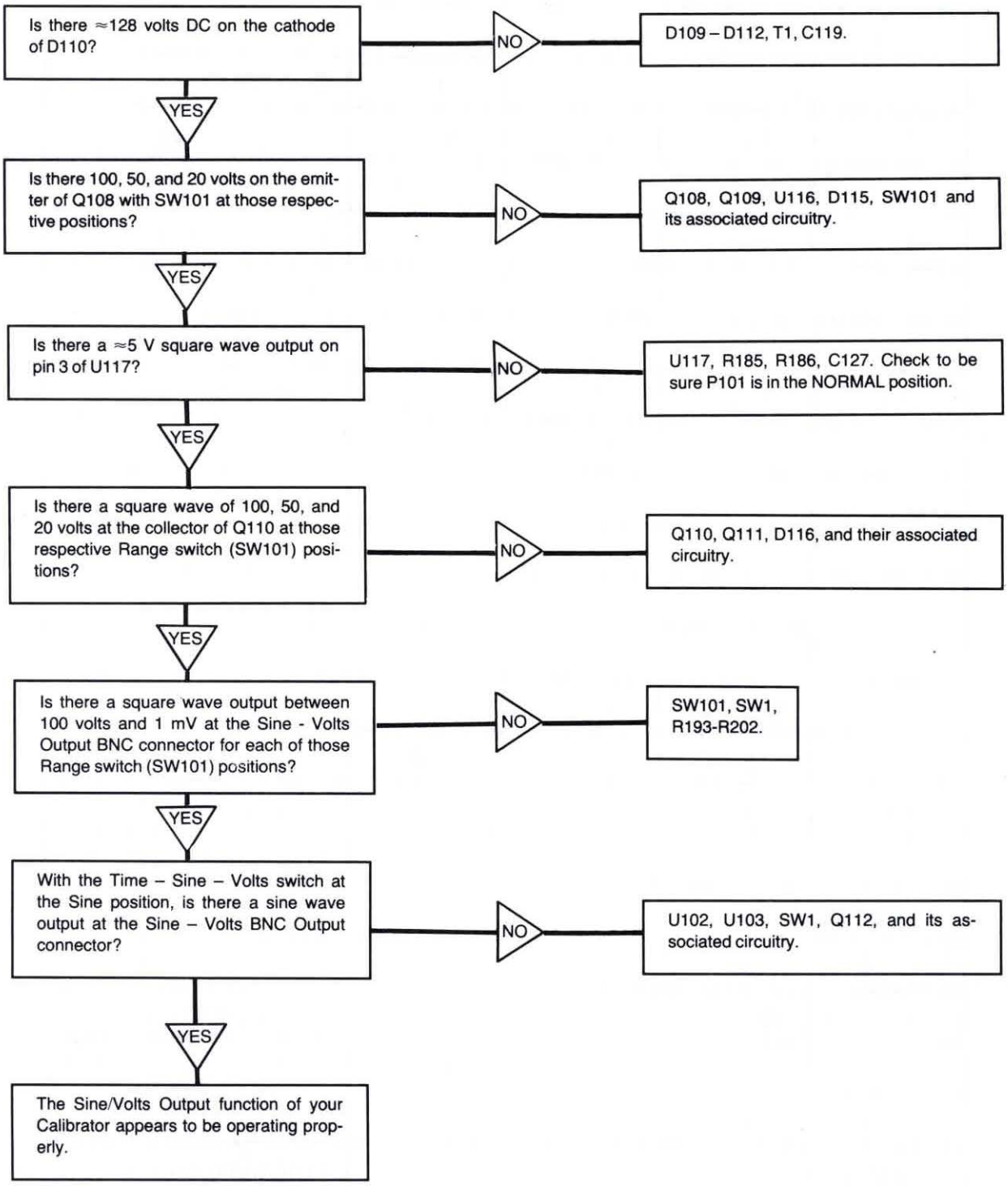



Is there a signal at pin 5 of U114?
YES
NO
Does the frequency change with the setting of the Range switch (SW101) between .5 S and 50 ns?
NO
SW101, U107 through U115.
YES
Is there an ECL level signal at pins 6 and 7 of U105 and is it dependent on the setting of the Range switch (SW101 between .5 S and 50 ns)?
NO
U103, U105, U115, SW101.
YES
Is there signal on the collector (C) of Q106 and is it dependent on the setting of the Range switch (SW101)?
NO
Q101 – Q107 and their associated circuitry.
YES
Is there an output of between .1 volt to 1 volt at the Time Ouput BNC with the related setting of the Range switch (SW101 between .5 S and 50 ns)?
NO
R1, D1.
YES
Is there an output at Range switch positions 10 ns & 20 ns?
NO
100 MHz signal at pin 6 & 7 of U101?
NO
U101, U102, SW101, Y101.
YES
Is there a 50 MHz signal at pin 2 of U102?
NO
U102, U103, SW101.
YES
YES
The Time Output function of your Calibrator appears to be operating properly.

Test #3

Perform this test if you have **no** Volts Output signal.*

START



*These measurements are referenced to the Volts Output BNC connector ground.

RANGE SWITCH (SW101) INTERNAL CONNECTIONS

DECK NO. 1			DECK NO. 2	
POSITION	SHORTED PINS		POSITION	SHORTED PINS
.5 S	5,6,7		.5 S	14,15,16,17,19,20
.2 S	5,6,7		.2 S	13,15,16,17,18,19,20
100 V	1,2	5,6	100 mS	13,14,15,18,19,20
50 V	1,2	4,6	50 mS	13,14,15,17,19,20
20 V	1,2		20 mS	12,15,17,18,19,20
10 V	1,3	5,6	10 mS	12,14,15,18,19,20
5 V	1,3	4,6	5 mS	12,14,15,17,19,20
2 V	1,3		2 mS	12,13,15,17,18,19,20
1 V	1,10	5,6	1 mS	12,13,14,15,18,19,20
.5 V	1,10	4,6	.5 mS	12,13,14,15,17,19,20
.2 V	1,10		.2 mS	11,15,17,18,19,20
100 mV	1,9	5,6	100 µS	11,14,15,18,19,20
50 mV	1,9	4,6	50 µS	11,14,15,17,19,20
20 mV	1,9		20 µS	11,13,15,17,18,19,20
10 mV	1,8	5,6	10 µS	11,13,14,15,18,19,20
5 mV	1,8	4,6	5 µS	11,13,14,15,17,19,20
2 mV	1,8		2 µS	11,12,15,17,18,19,20
1 mV	1,7	5,6	1 µS	11,12,14,15,18,19,20
500 nS	5,6,7		500 nS	11,12,14,15,16,17,19,20
200 nS	5,6,7		200 nS	11,12,13,15,16,17,18,19,20
100 nS	5,6,7		100 nS	11,12,13,14,15,16,18,19,20
50 nS	5,6,7		50 nS	11,12,13,14,15,16,17,19,20
20 nS	5,6,7		20 nS	11,12,13,14,15,16,17,18,20
10 nS	5,6,7		10 nS	11,12,13,14,15,16,17,18,19

PICTORIAL 4-1

SPECIFICATIONS

TIME OUTPUT SIGNAL

Range	0.5 s to 10 ns square wave in a 1-2-5 sequence.
Accuracy	.015%.
Amplitude	0.5 s to 20 ns – 100 mV to 1 V peak. 10 ns – 100 mV to .5 V peak.
Rise Time	<1 ns.
Leading Edge Aberations	<2% of peak-to-peak amplitude or 10 mV, whichever is greater.
Output	50 Ω nominal.

VOLTAGE OUTPUT SIGNAL

Ranges	1 mV to 100 V peak square wave in a 1-2-5 sequence.
Accuracy	Within 1% into a ≥1 MΩ load when calibrated with an external voltmeter (the error of the calibrating voltmeter will add to the above accuracy specification).
Rise Time	<5 μS.
Frequency	≈1 kHz.

≥ means "equal to or greater than."

SINE WAVE OUTPUT SIGNAL

Frequency	≈1kHz.
Amplitude	≈1 V peak-to-peak.

GENERAL

Power Requirements	120/240 VAC, 50/60 Hz, 25 watts maximum.
Operating Temperature	10°C to 40°C.
Dimensions:	
Height	3" (7.62 cm).
Width	7-1/4" (18.42 cm).
Depth	9-1/2" (24.13 cm).
Weight	4 lbs. (1.8 kg).

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 (fold-in) and Block Diagram (Illustration Booklet, Page 8) as you read this "Circuit Description."

The Calibrator is divided into two sections: Time and Sine/Volts. Both of these sections are electrically separated from each other to prevent ground loops in the output cables. The Time section is connected to chassis ground while the Sine/Volts sections are completely floating. The low voltage regulators, consisting of IC's U118, U119, and U120, are all referenced to chassis ground. These supply the Time section. Diodes D109 through D112 and capacitor C119 form a raw DC supply for the Sine/Volts section. These are not referenced to the chassis. Their common return connects to the Sine/Volts BNC output connector.

A 20 MHz and a 100 MHz oscillator supplies the Time section frequencies. The 20 MHz oscillator consists of IC U106 and crystal Y102 and is turned on and off by the Time/Sine/Volts switch SW1 through pins 1 and 5 of IC U106. The 100 MHz oscillator consists of IC U101, crystal Y101, capacitor C101, and coil L101. It also is turned on and off by SW1 through IC's U101 and U103.

When pin 12 of IC U104 and pin 6 of IC U103 are high, the outputs of the IC's at pins 15 and 3 respectively are at a low state. The low on these pins sends a high to pin 9 of IC U103 which causes pins 12 and 15 of IC U101 to go high. This high connects to pin 2 of IC U101 and prevents the 100 MHz oscillator from running. The oscillator only runs when the output of Range switch SW101 pulls either pin 6 of IC U103 or 12 of IC U104 low through resistors R116 or R117. The 100 MHz signal is divided in half by flip-flop IC U102.

The 20 MHz oscillator is divided down in decade steps by IC's U107 through U113, and these signals are sent to IC U114, a 1 of 8 selector gate. Range switch SW101 sends a signal to pins 9, 10, and 11 of IC U114 to select the desired decade sequence. To obtain a 1-2-5 sequence, the signals are: 1. Used straight through; 2. Divided by 2 at flip-flop IC U115, or; 3. Divided by 2 again (÷4) at IC U115. The "2" decades (20 MHz, 2 MHz, etc.) are divided by 4 to give the "5" decades (5 MHz, 500 kHz, etc.). All these signals (including 100 MHz and 50 MHz) are sent to a one-of-five selector formed by IC's U103 and U104. These gates are "OR" wired and are activated by switch SW101 through resistors R116 through R121. A low state voltage selects a particular signal.

The output of the 1-of-5 selector is amplified by IC U105. It is further amplified by a differential amplifier consisting of transistors Q101 through Q104. The output amplifier consists of driver transistor Q105 and common base output transistor Q106. The output amplitude of transistor Q106 is controlled by transistor Q107 and is set by level control R2. When the output at the collector of transistor Q106 goes negative, diode D1 turns on and there is an output present at the Time BNC connector. As the collector of transistor Q106 approaches zero, the diode turns off. Diode D1 is a special high speed diode with low capacitance to turn off very quickly and produce a fast edge. The disc resistor R1 in the Time BNC connector, produces a very good 50 Ω load for the circuit and prevents ringing and overshoot and minimizes cable reflections.

In the voltage section, the raw DC is regulated by transistor Q108. Transistor Q109 is a driver/translator which allows the voltage output of IC U116 to control the high voltage at transistor Q108. Diode D115 sets up a stable reference of 6.2 volts which is divided in half to 3.1 volts and then applied to pin 2 of operational amplifier IC U116. The voltage at pin 2 of U116 is compared with the voltage on pin 3 to produce a correction voltage when necessary. The voltage on pin 3 of IC U116 is set by the resistor divider R177, R135 and one of the calibrate controls R178, R179, or R181. These calibrate controls are selected by switch SW101 in a 1, 2, 5, pattern. Their values are such that when a "1" position is selected, 100 volts is present on the emitter of transistor Q108. When a "2" position is selected, 20 volts is present on the emitter of transistor Q108, and in the "5" position, 50 volts is present. In all three positions, there is 3.1 volts at pin 3 of IC U116.

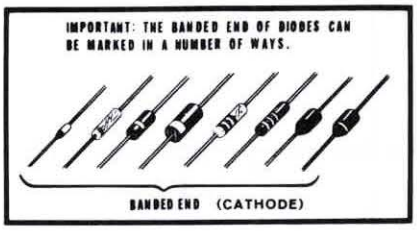
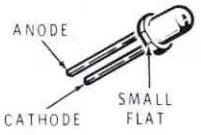
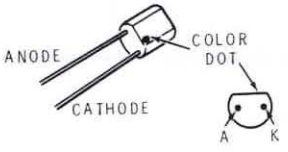
Transistor Q110 forms a switch which applies this voltage to the resistive divider string, R193 through R202. Q110 is controlled by the square wave generated by timer IC U117 and translated by transistor Q111. The frequency of the timer IC is set by resistors R185, R186, and capacitor C127. A jumper at P101 grounds pins 2 and 6 of IC U117, locking the timer IC and leaving transistor Q110 on. This allows a DC voltage to be present at the BNC connector for calibration.

Transistor Q112 forms a feedback oscillator consisting of resistors R188 through R191, Control R192, and capacitors C129 through C132. The sine wave is sent to switch SW1 along with the output of the decade divider.

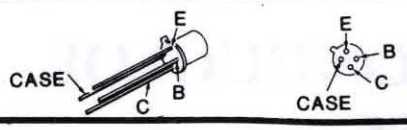
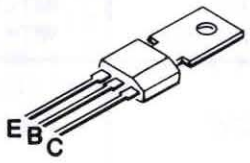
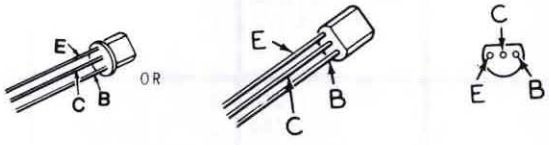
Control R192 adjusts the feedback gain to match the gain of transistor Q112 and produce a low distortion waveform.

SEMICONDUCTOR IDENTIFICATION CHARTS

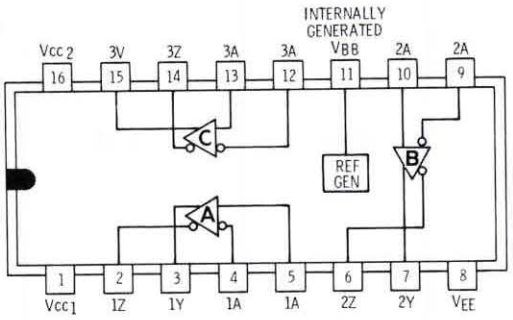
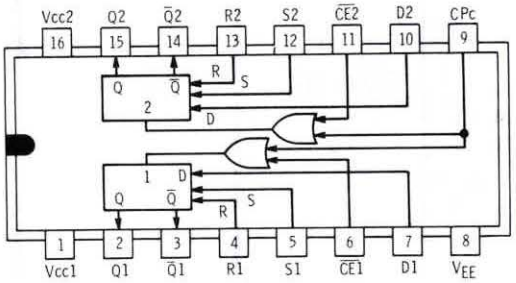
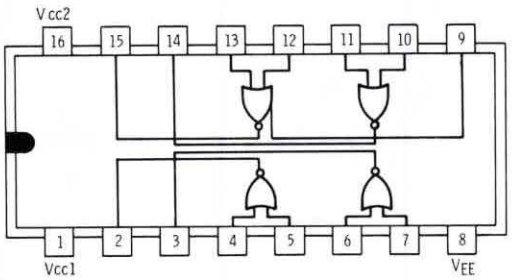
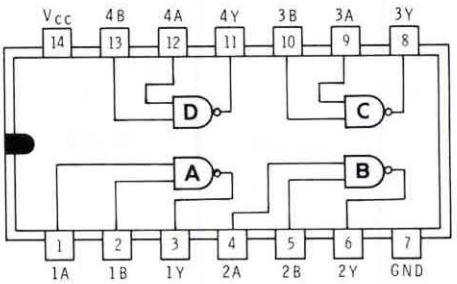
DIODES

COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION
D101 through D112	57-27	1N2071	
D113, D116, D119	56-56	1N4149	
D114	56-99	1N5223B	
D115	56-688	1N825A	
D120	56-602	—	
D118	412-637	NSL5076 LED	
D1	56-670	MBD101	

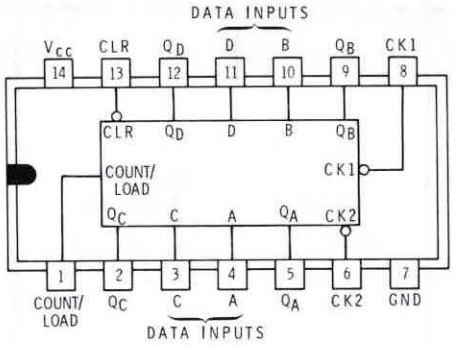
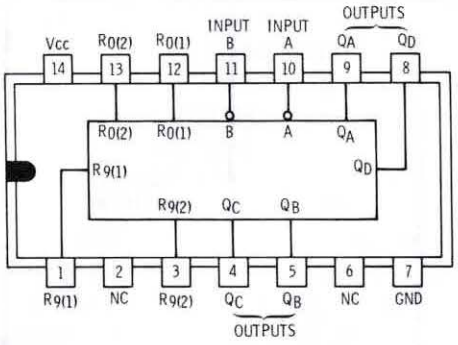
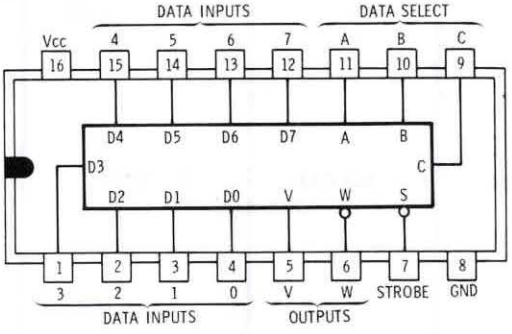
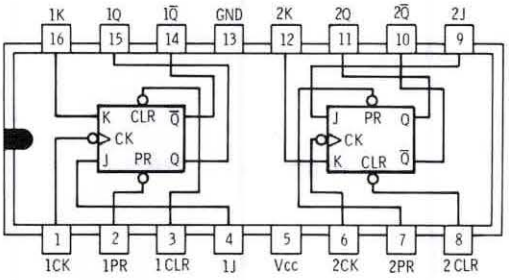
TRANSISTORS

COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION
Q101, Q102, Q105, Q106	417-979	2N6304	
Q103	417-293	2N5770	
Q104	417-292	2N5771	
Q107	417-885	MPSA65	
Q108, Q109, Q111	417-245	D40N1	
Q110	417-948	MDS60	
Q113	417-154	2N2369	
Q112	417-91	2N5232A	

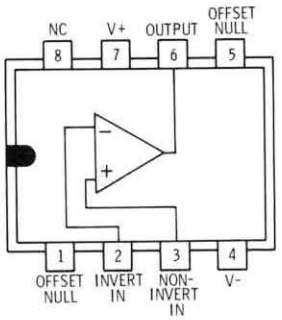
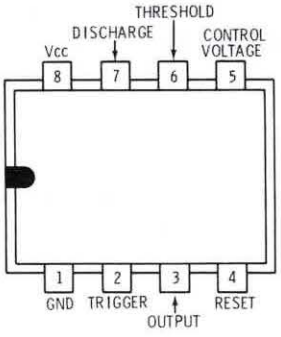
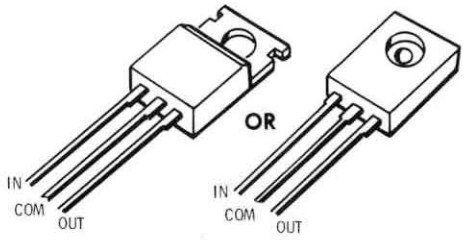
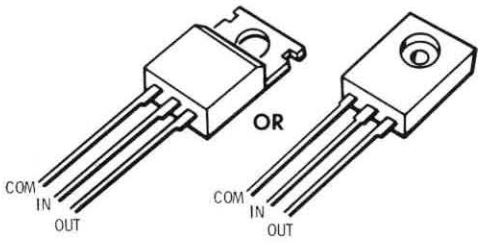
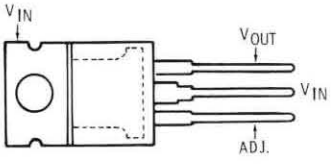
INTEGRATED CIRCUITS

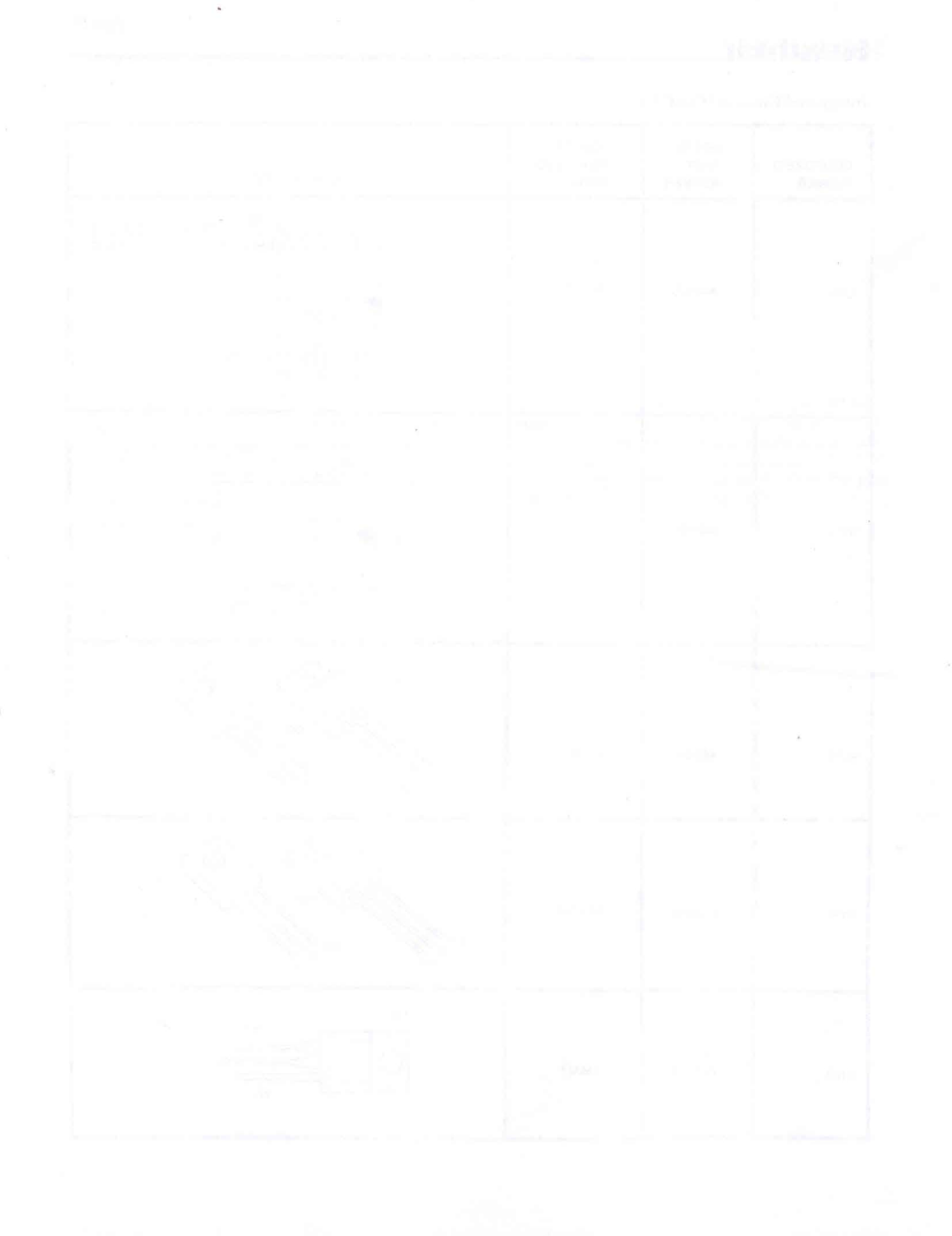
COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION
U101, U105	443-636	MC10116	
U102	443-679	MC10131	
U103, U104	443-683	MC10102	
U106	443-1121	74F00	

Integrated Circuits (Cont'd.)

COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION
U107	443-628	SN74196	
U108, U109, U110, U111, U112, U113	443-731	74LS290	
U114	443-25	SN74151AN	
U115	443-829	74LS76	

Integrated Circuits (Cont'd.)

COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION
U116	442-22	N 741	
U117	442-53	NE555	
U118	442-54	UA7805	
U119	442-630	MC7905	
U120	442-709	LM337	



CUSTOMER SERVICE

REPLACEMENT PARTS

Please provide complete information when you request replacements from either the factory or Heath/Zenith Computers and Electronics centers. Be certain to include the **HEATH** part number exactly as it appears in the parts list.

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/ZENITH COMPUTER AND ELECTRONICS CENTERS

For your convenience, "over the counter" replacement parts are available from the Heath/Zenith Computer and Electronics 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/Zenith Computer and Electronics 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.

Heath/Zenith Computer and Electronics 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 Heath/Zenith Computers and Electronics 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 Company
Benton Harbor, Michigan