Heathkit®

COMPONENT TRACER

Model IT-2232

595-3066-03

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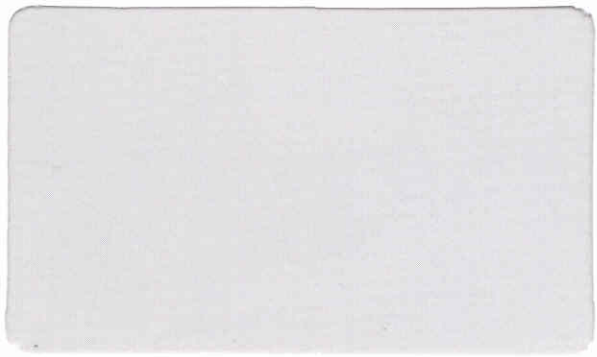
HEATH COMPANY PHONE DIRECTORY

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

COMPONENT TRACER

Model IT-2232

595-3066-03

WARNING: TO PREVENT FIRE OR SHOCK HAZARD, DO NOT EXPOSE THIS INSTRUMENT TO RAIN OR MOISTURE.

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

TABLE OF CONTENTS

INTRODUCTION

The Heathkit Model IT-2232 Component Tracer allows you to quickly troubleshoot, evaluate, and visually compare analog and digital components in or out of circuit with no power applied. The Component Tracer can determine the operational quality of semiconductor components for conditions such as leakage, noise, shorts, opens and any problems between these states.

An electronic component or circuit has a unique voltage-current "signature." The Component Tracer displays this "signature" on its 3" CRT (Cathode Ray Tube) by applying an alternating voltage across the component or circuit under test and simultaneously monitoring the current through it. The voltage is displayed on the horizontal axis and the current is displayed on the vertical axis. The resultant display is the characteristic curve or "signature."

The unique feature of the Component Tracer is the dual display mode (mode A/B). This feature uses a solid line for the A mode display, and a dotted line* for the B mode display. It can also superimpose the two lines (mode A/B) on the display for easy comparison between a known good component or circuit, with one under test. Two sets of color-coded test probes (white, red, and two black) are supplied for testing in the A and B modes.

The Component Tracer is light-weight and self-contained with easy-to-operate controls and color-coded banana jacks.

*Patent Pending

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," and remove Pack #1 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.

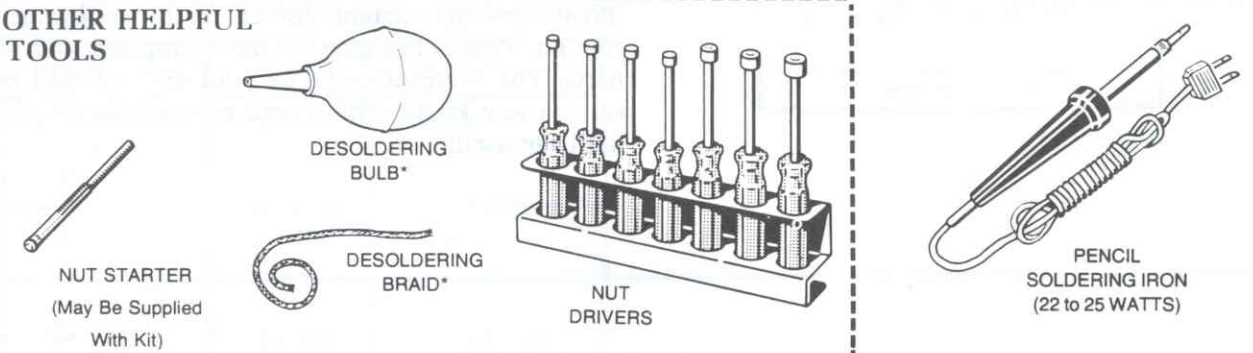
IMPORTANT: To avoid intermixing parts, DO NOT remove anything from a parts pack until you are directed to do so at the beginning of a Parts List. After you identify any part that is packed in an individual envelope with a part number on it, place the part back in its envelope after you check it until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

ASSEMBLY NOTES

TOOLS

You will need these tools to assemble your kit.

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:

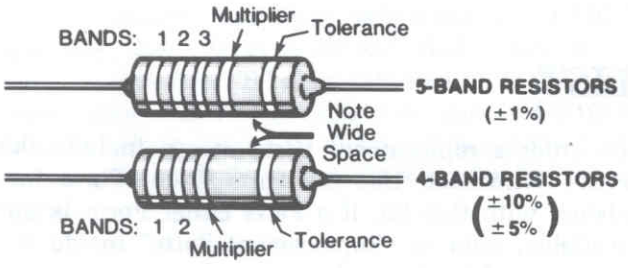
1. Use the right type of soldering iron. A 22 to 25-watt pencil soldering iron with a 1/8" or 3/16" chisel or pyramid tip works best.

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 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.

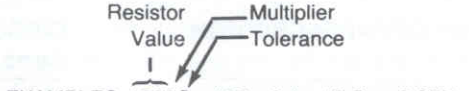
RESISTORS

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.



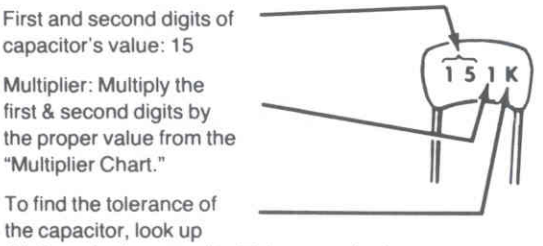
Occasionally, a "precision" or "power" resistor may have the value stamped on it. The letter R, K, or M may also be used at times to signify a decimal point, as in: 2R2 = 2.2 Ω
2K2 = 2.2 kΩ, or 2200 Ω
2M2 = 2.2 MΩ

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:



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. Do not remove components that are supplied on a tape from the tape until you use them in a step. Return any part that is in an individual envelope back into the envelope after you have identified it 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.

TAPED COMPONENTS

Refer to the enclosed "Taped Components Chart" and follow the instructions at the top of it. The taped parts are in assembly sequence. It is not necessary to check them against the Parts List.

RESISTORS

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

All resistors are 1/4-watt unless specified otherwise.

5% Resistors

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
6-100-12	10	10 Ω (brn-blk-blk)	R211, R311, R412, R413, R417, R418, R511, R512, R516, R517
6-150-12	1	15 Ω (brn-grn-blk)	R113
6-101-12	4	100 Ω (brn-blk-brn)	R407, R408, R423, R522
6-181-12	1	180 Ω (brn-gry-brn)	R421
6-201-12	4	200 Ω (red-blk-brn)	R206, R306, R506, R507
6-391-12	1	390 Ω (org-wht-brn)	R504
6-471-12	1	470 Ω (yel-viol-brn)	R134
6-561-12	1	560 Ω (grn-blu-brn)	R112

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HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Resistors (Cont'd.)			
6-102-12	9	1000 Ω (brn-blk-red)	R101, R104, R114, R116, R216, R316, R415, R416, R519
6-152-12	3	1500 Ω (brn-grn-red)	R513, R514, R515
6-202-12	1	2000 Ω (red-blk-red)	R414
6-272-12	4	2700 Ω (red-viol-red)	R406, R409, R505, R508
6-392-12	2	3900 Ω (org-wht-red)	R405, R502
6-472-12	7	4700 Ω (yel-viol-red)	R102, R103, R105, R106, R128, R411, R509
6-562-12	1	5600 Ω (grn-blu-red)	R217
6-103-12	4	10 kΩ (brn-blk-org)	R107, R108, R224, R324
6-123-12	1	12 kΩ (brn-red-org)	R125
6-153-12	1	15 kΩ (brn-grn-org)	R404
6-223-12	7	22 kΩ (red-red-org)	R111, R212, R214, R312, R314, R503, R521
6-273-12	1	27 kΩ (red-viol-org)	R422
6-563-12	2	56 kΩ (grn-blu-org)	R109, R118
6-823-12	1	82 kΩ (gry-red-org)	R501
6-104-12	1	100 kΩ (brn-blk-yel)	R126
6-184-12	1	180 kΩ (brn-gry-yel)	R403
6-334-12	1	330 kΩ (org-org-yel)	R402
6-474	2	470 kΩ, 1/2-watt (yel-viol-yel)	R129, R133
6-105	2	1MΩ, 1/2-watt (brn-blk-grn)	R131, R132
6-225-12	2	2.2 MΩ (red-red-grn)	R222, R322

Precision Resistors

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.

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Resistors (Cont'd.)			
6-7150-12	2	715 Ω (viol-brn-grn-blk)	R208, R308
6-2151-12	1	2150 Ω (red-brn-grn-brn)	R136
6-2211-12	2	2210 Ω (red-red-brn-brn)	R223, R323
6-3321-12	1	3320 Ω (org-org-red-brn)	R135
6-8251-12	2	8250 (gry-red-grn-brn)	R207, R307
6-1003-12	2	100 kΩ (brn-blk-blk-org)	R209, R309
6-1503-12	2	150 kΩ (brn-grn-blk-org)	R221, R321
6-2742-12	4	27.4 kΩ (red-viol-yel-red)	R201, R219, R301, R319
6-4123-12	4	412 kΩ (yel-brn-red-org)	R215, R218, R315, R318
6-1333-12	2	133 kΩ (brn-org-org-org)	R203, R303
6-1004-12	2	1 MΩ (brn-blk-blk-yel)	R202, R302
CAPACITOR			
21-786	6	.1 μF (104) glass ceramic	C101, C102, C401, C402, C501, C502
DIODES			
56-56	11	1N4149	D101, D102, D103, D121, D122, D123, D124, D125, D126, D127, D128
56-67	2	1N4740A zener	D117, D118
56-85	1	5 V, 20 mA zener	D116
56-617	1	1N5277B zener	D111
56-634	1	2EZ82D5 or MZP4762A zener	D119
57-27	8	1N2071	D106 – D109, D112 – D115
57-52	2	DO7	D104, D105

NONTAPED COMPONENTS

The following parts are not taped on strips. The key numbers correspond to the numbers on the "Circuit Board Parts Pictorial" (Illustration Booklet, Page 1).

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
RESISTORS				
1-Watt 5%				
A1	6-333-1	5	33 kΩ (org-org-org)	R115, R424, R425, R523, R524
A1	6-684-1	1	680 kΩ (blu-gry-yel)	R117
2-Watt 5%				
A2	6-680-2	2	68 Ω (blu-gry-blk)	R122, R123
A2	6-151-2	1	150 Ω (brn-grn-brn)	R121
A2	6-181-2	1	180 Ω (brn-gry-brn)	R124
A2	6-472-2	1	4700 Ω (yel-viol-red)	R119
A2	6-103-2	2	10 kΩ (brn-blk-org)	R204, R304
CAPACITORS				
Ceramic				
B1	21-16	9	.01 µF	C105 – C108, C112 – C115, C503
Tubular				
B2	23-62	2	.1 µF	C103, C104
Electrolytic				
B3	25-880	3	10 µF, 35 V	C118, C119, C122
B4	25-147	2	10 µF, 150 V tubular	C202, C302
B4	25-16	1	20 µF tubular	C111
B3	25-928-1	2	33 µF	C203, C303
B4	25-43	1	70 µF tubular	C109
B3	25-891	3	470 µF	C116, C117, C121
Mylar®				
B5	27-145	2	.22 µF	C201, C301

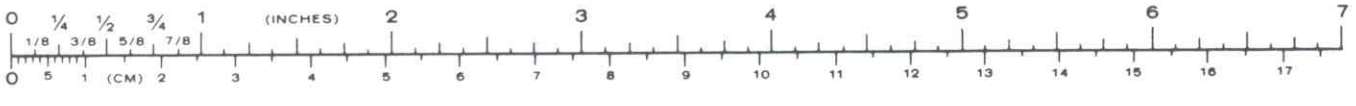
TRANSISTORS – INTEGRATED CIRCUITS (ICs)

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

1. Part number.
2. Type number. (For integrated circuits, this refers only to the numbers and letters shown in BOLD print in the Parts List. Disregard any other numbers or letters shown on the IC.)
3. Part number and type number.
4. Part number with a type number other than the one shown.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
C1	417-811	2	MPSL01 transistor	Q102, Q104
C2	417-834	7	MPSU10 transistor	Q103, Q201, Q301, Q405, Q406, Q505, Q506
C1	417-854	2	Silicone transistor	Q202, Q302
C1	417-875	9	2N3904 transistor	Q101, Q401 – Q404, Q501 – Q504
C3	442-602	1	LM**324** integrated circuit	U107
C3	443-728	1	**74LS00** integrated circuit	U101
C3	443-731	2	**74LS290** integrated circuit	U102, U103
C3	443-780	1	**74LS08** integrated circuit	U106
C3	443-829	2	**74LS76** integrated circuit	U104, U105
CONTROLS				
D1	10-936	1	1000 (1K) Ω	R419
D1	10-312	3	10 kΩ (large)	R213, R313, R518
D2	10-1132	2	10 kΩ (small)	R205, R305
D1	10-941	3	100 kΩ	R127, R317, R401
MISCELLANEOUS				
	85-2948-1	1	Circuit board	
	344-53	18″	Orange solid wire	
	346-1	16″	Fiber sleeving	
	346-20	5″	Large heat-shrinkable sleeving	
E1	390-147	1	Danger label*	
E2	390-1255	1	Fuse replacement label*	
E3		1	Blue and white label*	
E4	434-298	5	14-pin IC socket	
E4	434-299	2	16-pin IC socket	
E5	490-111	1	IC puller	
E6	490-185	1	Desoldering braid	
	597-260	1	Parts Order Form	
	597-3376	1	Taped Component Chart	
		1	Assembly Manual (See Page 1 for part number.)	
			Solder	

*Located inside the Manual



STEP-BY-STEP ASSEMBLY

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

NOTES:

1. Each of the circuit board drawings, like the one shown in Pictorial 1-1, is divided into sections. These sections show you which area of the circuit board you are working on for a specific series of steps. Refer to the Pictorial whenever you are instructed to install a part.

2. Each series of steps has you installing parts in a top-to-bottom, left-to-right sequence. The step for any specially mounted part will be followed by a special illustration. Refer to the illustration and its circuit board location in the Pictorial before you install the part.

3. Check off each step as you perform it. You may also wish to place a check mark near each component on the Pictorial as you install it.

4. In general, solder instructions are given only at the end of a series of similar steps. You may solder more often, if you desire.

NOTE: Refer to the "Taped Component Chart" before you begin. You will be installing the taped components first. They are in assembly sequence.

IMPORTANT: The taped components are placed on the strips in assembly sequence for taped components to make your kit easier to assemble. However, there are cautions that you should observe during the assembly.

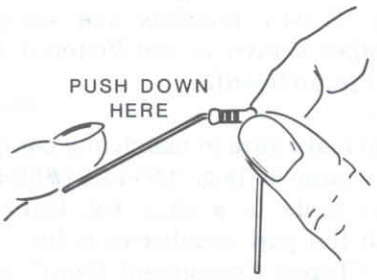
1. Make sure that the circuit component number at the beginning of each step (e.g. R104:) matches the component number shown in the Pictorial and on the circuit board.

2. Also make sure to match any component part number (e.g. 1N4149 (#56-56)) or color code in a step (e.g. brn-blk-red) with the part number or color code on the "Taped Component Chart" and the part. Remember, if you install a taped component out of sequence in a step, the parts in the steps to follow will most likely be out of sequence also.

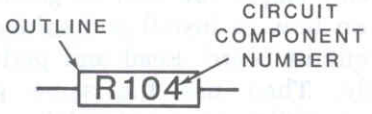
In the following steps, you will be given detailed instructions on how to install and solder the first part on the circuit board. Read and perform each step carefully. Then use the same procedure whenever you install parts on a circuit board.

( ) Note that one side of the circuit board has the component outlines shown on it. This side of the circuit board is referred to as the "component side." Position the circuit board as shown in the Pictorial with the component side up. Always install components on the component side of the circuit board, and solder the leads to the foil on the other side.

( ) R104: Hold a 1000 Ω (brn-blk-red) resistor by the body as shown and bend the leads straight down with your finger to fit the hole spacing on the circuit board.

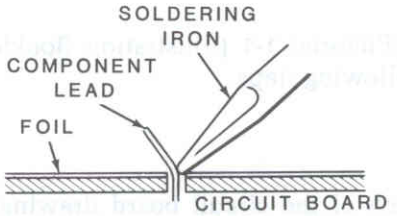


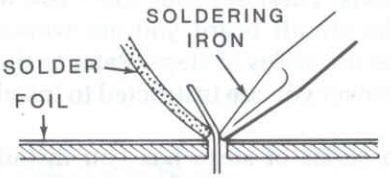
( ) Start the leads into the holes at the resistor's circuit board location. The end with color bands may be positioned either way. NOTE: Resistors are identified by the following circuit board outline:

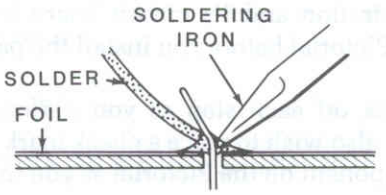


( ) Press the resistor against the circuit board and bend the leads outward slightly to hold it in place.

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



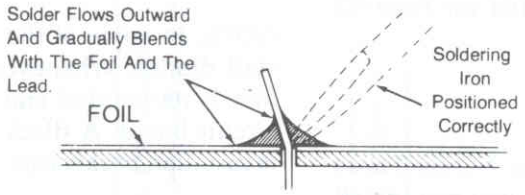




( ) Cut off the excess lead lengths close to the connection. WARNING: Clip the leads so the ends will not fly toward your eyes.

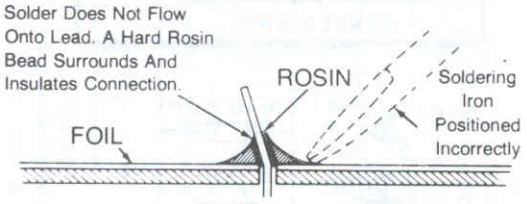
( ) Check each connection. Compare it to the illustration on Page 13. After you have checked the solder connections, proceed with the assembly. Use the same soldering procedure for each connection.

A GOOD SOLDER CONNECTION

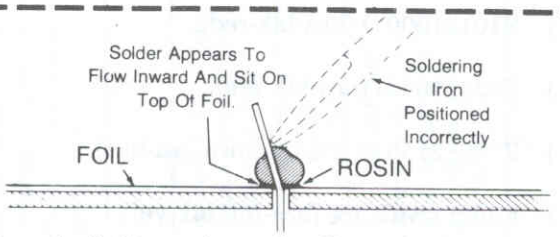


When you heat the lead and the circuit board foil at the same time, the solder will flow evenly onto the lead and the foil. The solder will make a good electrical connection between the lead and the foil.

POOR SOLDER CONNECTIONS



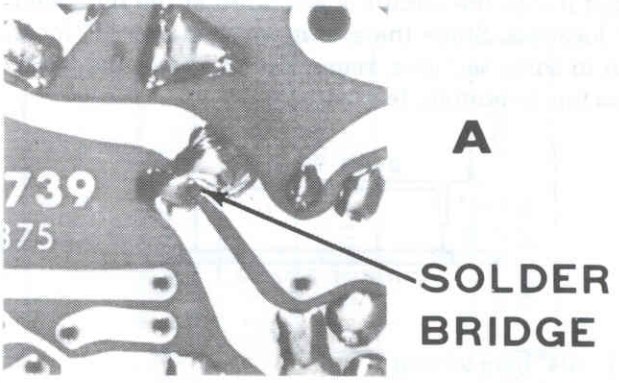
When the lead is not heated sufficiently, the solder will not flow onto the lead as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.



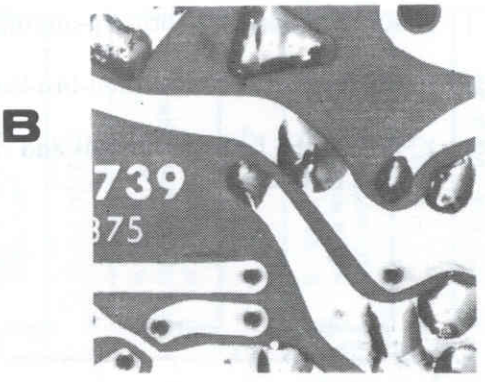
When the foil is not heated sufficiently the solder will blob on the circuit board as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.

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.



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.



Start at the top of Section 1 of the Pictorial and install the following components on the circuit board. Make sure you installed resistor R104 on Page 12 in an earlier step.

( ) R103: 4700 Ω (yel-viol-red).

( ) C102: .1 μF (104) glass ceramic. NOTE: These capacitors are not polarized so you can install them in either direction on the circuit board.

( ) R102: 4700 Ω (yel-viol-red).

( ) C101: .1 μF (104) glass ceramic.

( ) R101: 1000 Ω (brn-blk-red).

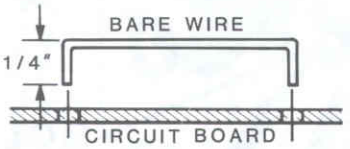
( ) R324: 10 kΩ (brn-blk-org).

( ) R136: 2150 Ω, 1% (red-brn-grn-brn).

( ) R302: 1 MΩ, 1% (brn-blk-blk-yel).

( ) R306: 200 Ω (red-blk-brn).

NOTE: When you are instructed to install a bare wire, as in the following step, remove the length of insulation from the orange wire indicated in the step, and then cut off the bare wire from the orange wire. Bend the cutoff bare wire ends down 1/4" and insert it into the circuit board holes at the indicated "J" location. Since there is more than one "J" location in some sections, remember to install the wires from top-to-bottom, left-to-right.



( ) 3/4" bare wire at J.

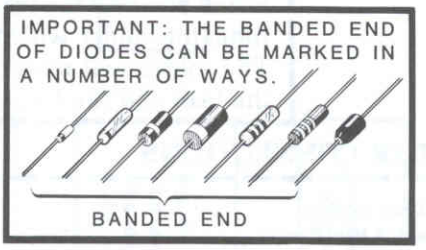
( ) R303: 133 kΩ, 1% (brn-org-org-org).

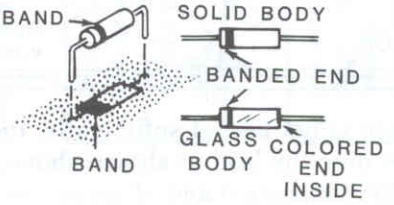
( ) R323: 2210 Ω, 1% (red-red-brn-brn).

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

Install the components in Section 2 of the circuit board as follows:

NOTE: In some of the following steps, you will install diodes. Whenever you install a diode, always match its banded end with the band mark on the circuit board. A diode will not work properly if it is installed backwards.





( ) D105: DO7 diode (#57-52). NOTE: Position the part number stamped on the diode body facing up on this and all other diodes.

( ) D104: DO7 diode (#57-52).

( ) D119: 2EZ82D5 or MZP4762A zener diode (#56-634).

( ) D106: 1N2071 diode (#57-27).

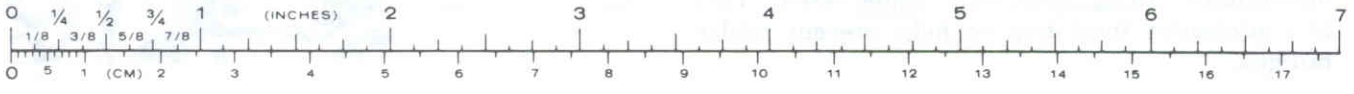
( ) D108: 1N2071 diode (#57-27).

( ) D118: 1N4740A zener diode (#56-67).

( ) D114: 1N2071 diode (#57-27).

( ) D112: 1N2071 diode (#57-27).

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



( ) R111: 22 kΩ (red-red-org).

( ) R106: 4700 Ω (yel-viol-red).

( ) R134: 470 Ω (yel-viol-brn).

( ) 3/4" bare wire at J.

( ) 3/4" bare wire at J.

( ) R105: 4700 Ω (yel-viol-red).

( ) 3/4" bare wire at J.

( ) 1-1/8" bare wire at J.

( ) 1" bare wire at J.

( ) 3/4" bare wire at J.

( ) R301: 27.4 kΩ, 1% (red-yiol-yel-red).

( ) R201: 27.4 kΩ, 1% (red-yiol-yel-red).

( ) R135: 3320 Ω, 1% (org-org-red-brn).

( ) R202: 1 MΩ, 1% (brn-blk-blk-yel).

( ) R224: 10 kΩ (brn-blk-org).

( ) R206: 200 Ω (red-blk-brn).

( ) R312: 22 kΩ (red-red-org).

( ) R223: 2210 Ω, 1% (red-red-brn-brn).

( ) R203: 133 kΩ, 1% (brn-org-org-org).

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

Install the components in Section 3 of the circuit board as follows:

( ) R133: 470 kΩ, 1/2-watt (yel-viol-yel).

( ) R132: 1 MΩ, 1/2-watt (brn-blk-grn).

( ) R131: 1 MΩ, 1/2-watt (brn-blk-grn).

( ) R129: 470 kΩ, 1/2-watt (yel-viol-yel).

( ) D109: 1N2071 diode (#57-27).

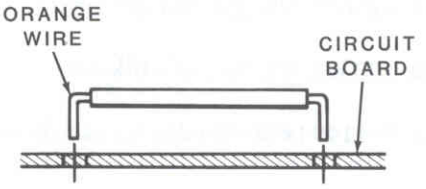
( ) D107: 1N2071 diode (#57-27).

( ) D113: 1N2071 diode (#57-27).

( ) D115: 1N2071 diode (#57-27).

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

NOTE: When you prepare the following jumper wire, cut the orange wire to the indicated length and remove 1/4" of insulation from each end. Bend the bare wire ends down 90° and insert the wire ends into the circuit board holes.



( ) 7/8" jumper wire at J.

( ) R114: 1000 Ω (brn-blk-red).

( ) R112: 560 Ω (grn-blu-brn).

( ) R109: 56 kΩ (grn-blu-org).

( ) R116: 1000 Ω (brn-blk-red).

( ) R108: 10 kΩ (brn-blk-org).

( ) R113: 15 Ω (brn-grn-blk).

Install three 1N4149 (#56-56) diodes as follows:

( ) D102.
( ) D103.
( ) D101.

( ) R107: 10 kΩ (brn-blk-org).

( ) 7/8" bare wire at J.

( ) 7/8" bare wire at J.

( ) 7/8" bare wire at J.

( ) C501: .1 μF (104) glass ceramic.

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

( ) R208: 715 Ω, 1% (viol-brn-grn-blk).

( ) R211: 10 Ω (brn-blk-blk).

( ) R511: 10 Ω (brn-blk-blk).

( ) R308: 715 Ω, 1% (viol-brn-grn-blk).

( ) R311: 10 Ω (brn-blk-blk).

( ) R307: 8250 Ω, 1% (gry-red-grn-brn).

( ) R309: 100 kΩ, 1% (brn-blk-blk-org).

( ) R207: 8250 Ω, 1% (gry-red-grn-brn).

( ) R209: 100 kΩ, 1% (brn-blk-blk-org).

Install four 1N4149 (#56-56) diodes as follows:

( ) D126.
( ) D128.
( ) D125.
( ) D123.

( ) R212: 22 kΩ (red-red-org).

( ) 1" bare wire at J.

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

Install the components in Section 4 of the circuit board as follows:

( ) R118: 56 kΩ (grn-blu-org).

( ) D111: 1N5277B diode (#56-617).

( ) R125: 12 kΩ (brn-red-org).

( ) R126: 100 kΩ (brn-blk-yel).

( ) R128: 4700 Ω (yel-viol-red).

( ) C502: .1 μF (104) glass ceramic.

( ) R522: 100 Ω (brn-blk-brn).

( ) R516: 10 Ω (brn-blk-blk).

( ) R514: 1500 Ω (brn-grn-red).

( ) R519: 1000 Ω (brn-blk-red).

( ) R515: 1500 Ω (brn-grn-red).

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

( ) R505: 2700 Ω (red-viol-red).

( ) R506: 200 Ω (red-blk-brn).

( ) R509: 4700 Ω (yel-viol-red).

( ) R513: 1500 Ω (brn-grn-red).

( ) R501: 82 kΩ (gry-red-org).

( ) R502: 3900 Ω (org-wht-red).

( ) R221: 150 kΩ, 1% (brn-grn-blk-org).

( ) R504: 390 Ω (org-wht-brn).

( ) R222: 2.2 MΩ (red-red-grn).

( ) R218: 412 kΩ, 1% (yel-brn-red-org).

( ) 3/4" bare wire at J.

( ) 3/4" bare wire at J.

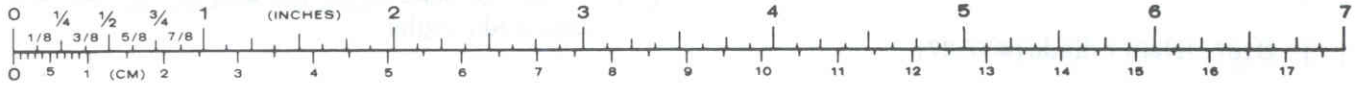
( ) R215: 412 kΩ, 1% (yel-brn-red-org).

( ) R217: 5600 Ω (grn-blu-red).

( ) R214: 22 kΩ (red-red-org).

( ) R216: 1000 Ω (brn-blk-red).

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



Install components in Section 5 of the circuit board as follows:

( ) D116: (#56-85) zener diode.

( ) 3/4" bare wire at J.

( ) 3/4" bare wire at J.

( ) D117: 1N4740A diode (#56-67).

( ) R423: 100 Ω (brn-blk-brn).

( ) R417: 10 Ω (brn-blk-blk).

( ) R517: 10 Ω (brn-blk-blk).

( ) R512: 10 Ω (brn-blk-blk).

( ) R521: 22 kΩ (red-red-org).

( ) R412: 10 Ω (brn-blk-blk).

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

( ) R507: 200 Ω (red-blk-brn).

( ) R508: 2700 Ω (red-viol-red).

( ) 1-1/8" jumper wire at J. Remember not to remove all the wire insulation here.

( ) R503: 22 kΩ (red-red-org).

( ) R219: 27.4 kΩ, 1% (red-viol-yel-red).

Install four 1N4149 (#56-56) diodes as follows:

( ) D122.
( ) D124.
( ) D127.
( ) D121.

( ) R316: 1000 Ω (brn-blk-red).

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

Install components in Section 6 of the circuit board as follows:

( ) 1" bare wire at J.

( ) C402: .1 μF (104) glass ceramic.

( ) R418: 10 Ω (brn-blk-blk).

( ) R415: 1000 Ω (brn-blk-red).

( ) R421: 180 Ω (brn-gry-brn).

( ) R416: 1000 Ω (brn-blk-red).

( ) R422: 27 kΩ (red-viol-org).

( ) R406: 2700 Ω (red-viol-red).

( ) R407: 100 Ω (brn-blk-brn).

( ) R411: 4700 Ω (yel-viol-red).

( ) C401: .1 μF (104) glass ceramic.

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

( ) R414: 2000 Ω (red-blk-red).

( ) R408: 100 Ω (brn-blk-brn).

( ) R409: 2700 Ω (red-viol-red).

( ) R413: 10 Ω (brn-blk-blk).

( ) 1" bare wire at J.

( ) R402: 330 kΩ (org-org-yel).

( ) R403: 180 kΩ (brn-gry-yel).

( ) R404: 15 kΩ (brn-grn-org).

( ) 3/4" bare wire at J.

( ) R321: 150 kΩ, 1% (brn-grn-blk-org).

( ) R319: 27.4 kΩ, 1% (red-viol-yel-red).

( ) R405: 3900 Ω (org-wht-red).

( ) R322: 2.2 MΩ (red-red-grn).

( ) R318: 412 kΩ, 1% (yel-brn-red-org).

( ) R315: 412 kΩ, 1% (yel-brn-red-org).

( ) R314: 22 kΩ (red-red-org).

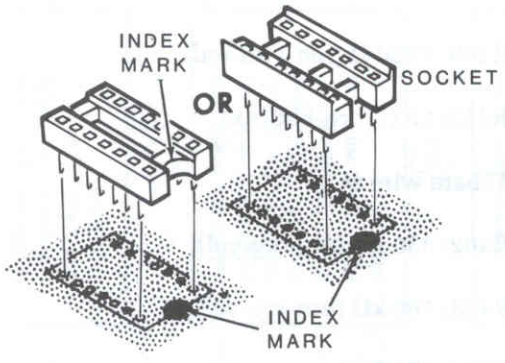
( ) 1" bare wire at J.

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

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

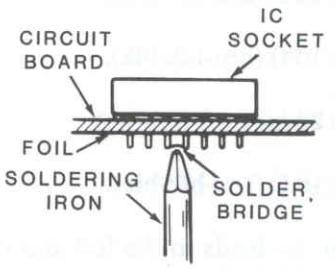
NOTES:

1. 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.



2. It is very easy to form a solder bridge between foils when you solder IC pins. After you install an IC socket, carefully inspect the foil for solder bridges and remove any that you find as described below. If you suspect that you have a solder bridge but are not positive, you can check your foil pattern against the one shown on Page 22 of the Illustration Booklet.

3. To remove a solder bridge, hold the circuit board component-side-up as shown and hold your soldering iron tip between the two points that are bridged. The solder will flow down the soldering iron tip.

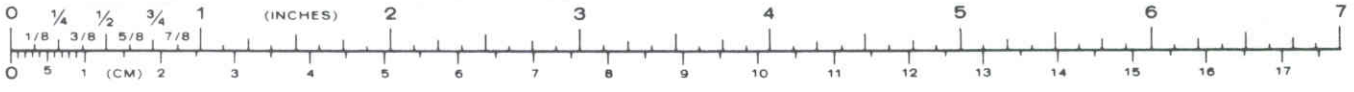


Install IC sockets in Section 1 of the circuit board at the following locations.

( ) Five 14-pin IC sockets at U101, U106, U102, U103, and U107.

( ) Two 16-pin IC sockets at U105 and U104.

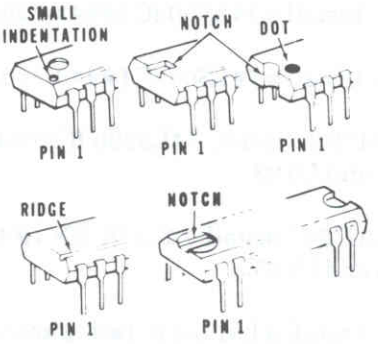
Use the procedure shown in Detail 2-1A on Page 19 whenever you are directed to install ICs.



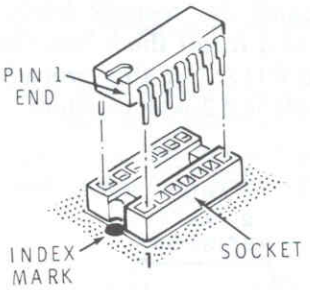
The pins on the ICs may be bent out at an angle, so they do not line up with the holes in the IC socket. DO NOT try to install an IC without first bending the pins as described below. To do so may damage the IC pins or the socket, causing intermittent contact.

Before you install an IC, lay it down on its side as shown below and very carefully roll it toward the pins to bend the lower pins into line. Then turn the IC over and bend the pins on the other side in the same manner.

Compare the IC to the drawing shown below. Then determine which end of the IC is the pin 1 end.



Position the pin 1 end of the IC over the index mark on the circuit board. Then start the IC pins into the socket. Make sure that all of the pins are started into the socket. Then push the IC firmly into the socket. NOTE: An IC pin can become bent under the IC and it will appear as though it is correctly installed in the socket.



Detail 1-2A

Install integrated circuits in the sockets on the circuit board as follows:

( ) U101: Install a 74LS00 IC (#443-728) at U101.

( ) U106: Install a 74LS08 IC (#443-780) at U106.

( ) U102-U103: Install 74LS290 ICs (#443-731) at U102 and U103.

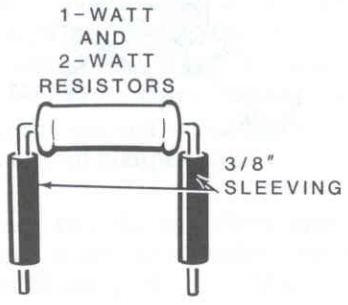
( ) U104-U105: Install 74LS76 ICs (#443-829) at U104 and U105.

( ) U107: Install a LM324 IC (#442-602) at U107.

Install the resistors with sleeving in **Section 1** of the circuit board as follows:

( ) Cut twenty-six 3/8" pieces of fiber sleeving. NOTE: You will use this sleeving when you install 1-watt and 2-watt resistors in the following steps.

( ) R117: Slide 3/8" pieces of sleeving over the leads of a 680 kΩ, 1-watt (blu-gry-yel) resistor. Then bend the resistor leads down 90° as shown and insert them into the circuit board holes at R117. Use this procedure with all of the 1-watt and 2-watt resistors.



( ) R124: 180 Ω, 2-watt (brn-gry-brn) with sleeving.

( ) R304: 10 kΩ, 2-watt (brn-blk-org) with sleeving.

( ) R204: 10 kΩ, 2-watt (brn-blk-org) with sleeving.

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

Refer to **Section 2** of the circuit board to install the following parts.

( ) R119: 4700 Ω, 2-watt (yel-viol-red) with sleeving.

( ) R121: 150 Ω, 2-watt (brn-grn-brn) with sleeving.

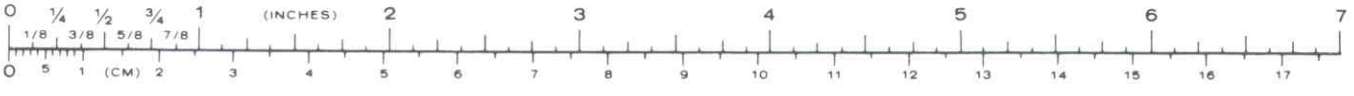
( ) R122: 68 Ω, 2-watt (blu-gry-blk) with sleeving.

( ) R123: 68 Ω, 2-watt (blu-gry-blk) with sleeving.

Install five 33 kΩ, 1-watt (org-org-org) resistors with sleeving as follows:

( ) R115.
( ) R425.
( ) R424.
( ) R524.
( ) R523.

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

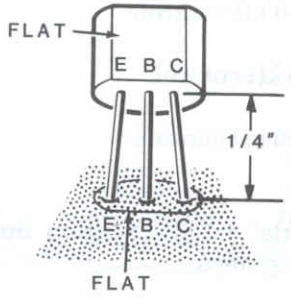


Refer to Pictorial 1-3 (Illustration Booklet, Page 3) for the following steps.

NOTES:

1. In this section, you will install the shorter transistors on the circuit board sections first. Then go back and install the taller ones.

2. When you install each of the following transistors, position it so the flat side of the case is over the outline of the flat on the circuit board. Then insert the E, B, and C leads into their holes and position the bottom of the case 1/4" above the circuit board. Solder the leads to the foil after you install each transistor and cut off the excess lead lengths.



Install transistors in Section 1 of the circuit board as follows:

( ) Q101: 2N3904 transistor (#417-875).

( ) Q102: MPSL01 transistor (#417-811).

( ) Q503: 2N3904 transistor (#417-875).

( ) Q501: 2N3904 transistor (#417-875).

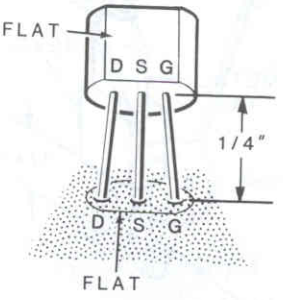
Install transistors in Section 2 of the circuit board as follows:

( ) Q104: MPSL01 transistor (#417-811).

Install six 2N3904 (#417-875) transistors as follows:

( ) Q504.
( ) Q403.
( ) Q404.
( ) Q502.
( ) Q401.
( ) Q402.

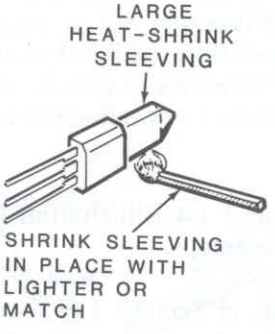
Install two N-channel FETs (#417-854) as follows:



( ) Q202.
( ) Q302.

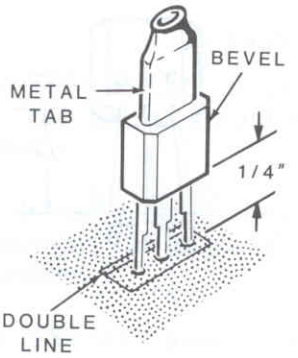
( ) Cut seven 1/2" pieces of large heat-shrinkable sleeving.

( ) Locate the seven MPSU10 (#417-834) transistors. Slide a 1/2" piece of large heat-shrinkable sleeving over each of the transistors metal tabs and shrink the sleeving in place with a lighter or match.



Install transistors in Section 1 of the circuit board as follows:

NOTE: When you install each of the following transistors, position the beveled side as shown with the metal tab over the double outline on the circuit board. Insert the E, B, and C leads into the circuit board holes and position the case bottom 1/4" above the circuit board. Solder the leads to the foil after you install each transistor and cut off the excess lead lengths.



Install two MPSU10 (#417-834) transistors as follows:

( ) Q301.
( ) Q201.

Install transistors in Section 2 of the circuit board as follows:

Install five MPSU10 (#417-834) transistors as follows:

( ) Q103.
( ) Q505.
( ) Q506.
( ) Q405.
( ) Q406.

Refer to Pictorial 1-4 (Illustration Booklet, Page 3) for the following steps.

Install controls in Section 1 of the circuit board as follows:

NOTE: When you install a control, insert the pins into the circuit board holes and position the control so it is perpendicular to the circuit board. Solder each control to the circuit board after you install it.

( ) R127: 100 kΩ control.

( ) R518: Large 10 kΩ control.

NOTE: Install the small controls with the knobs in the same direction as the large controls.

( ) R305: Small 10 kΩ control.

( ) R205: Small 10 kΩ control.

( ) R213: Large 10 kΩ control.

Install controls in Section 2 of the circuit board as follows:

( ) R419: 1000 Ω (1K) control.

( ) R401: 100 kΩ control.

( ) R313: 10 kΩ control.

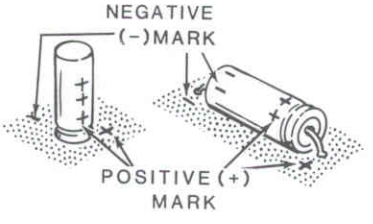
( ) R317: 100 kΩ control.

Refer to Pictorial 1-5 (Illustration Booklet, Page 4) for the following steps.

Install capacitors in Section 1 of the circuit board as follows:

NOTE: When you install capacitors, the shorter components will be installed first, then the taller ones, in ascending order.

There are two types of electrolytic capacitors, tubular and vertical. Before you install either type, look at it and identify the markings on the body. One end will have a positive (+) mark or a negative (−) mark near it. Be sure to install the positive end next to the positive-marked hole, or the negative end next to the negative-marked hole.



( ) C302: 10 μF, 150V tubular electrolytic.

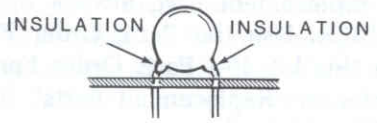
( ) C202: 10 μF, 150V tubular electrolytic.

( ) C122: 10 μF, 35V electrolytic.

( ) C203: 33 μF electrolytic.

( ) C303: 33 μF electrolytic.

NOTE: In some of the following steps, you will install disc-type 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.



Install ceramic and Mylar capacitors in Section 1 of the circuit board as follows. These capacitors are identified on the circuit board by the following outlines:

Install eight .01 μF ceramic capacitors as follows:

( ) C105.
( ) C107.
( ) C108.
( ) C106.
( ) C114.
( ) C112.
( ) C113.
( ) C115.

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

Install two .22 μF Mylar capacitors as follows:

( ) C301.
( ) C201.

Install two .1 μF tubular capacitors as follows. Position these capacitors with the banded end in either direction on the circuit board.

( ) C104.
( ) C103.

( ) C121: Install a 470 μF electrolytic at C121.

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

Install capacitors in Section 2 of the circuit board as follows:

( ) C119: 10 μF, 35V electrolytic.

( ) C118: 10 μF, 35V electrolytic.

( ) C503: .01 μF ceramic.

( ) C111: 20 μF tubular electrolytic.

( ) C109: 70 μF tubular electrolytic.

( ) C117: 470 μF electolytic.

( ) C116: 470 μF electrolytic.

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

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following problems:

( ) Unsoldered connections.

( ) Poor solder connections.

( ) Solder bridges between foil patterns.

( ) Protruding leads which could touch together. Trim all leads as close to the foil pads as possible.

( ) ICs for proper type and installation.

( ) Check transistors for proper type and installation and proper positioning of the case flat.

( ) Diodes for correct type and installation.

This completes the circuit board assembly. Set it and the remaining fiber sleeving aside until it is called for later.

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, Pages 5 and 6). Return any part that is in an individual envelope back into the envelope after you have identified it, 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.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
RESISTORS				
A1	6-101-12	1	100 Ω (brn-blk-brn)	Test
A1	6-102-12	1	1000 Ω (brn-blk-red)	Test
A1	6-104-12	2	100 kΩ (brn-blk-yel)	R6, test
A1	6-154-12	1	150 kΩ (brn-grn-yel)	R2
A1	6-274-12	1	270 kΩ (red-viol-yel)	R1
A1	6-105-12	1	1 MΩ (brn-blk-grn)	R3
A1	1-157-12	1	10 MΩ (brn-blk-blu)	R5
CAPACITORS				
A2	21-821	2	4700 µF(472) ceramic capacitor	C1, C2
A2	21-16	1	.01 µF ceramic	Test
A2	21-38	1	.02 µF ceramic	C3
A3	23-62	1	.1 µF tubular	C4
A4	25-880	1	10 µF electrolytic	Test

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
SEMICONDUCTORS				
A5	57-27	1	1N2071 diode	D1
A6	412-640	1	LST5053 LED	D2
A7	417-875	1	2N3904 transistor	Test
METAL PARTS				
B1	90-1339-1	1	Cabinet	
B2	200-1468-1	1	Chassis	
B3	203-2230	1	Front panel	
B4	205-778	1	Alignment tool blade	
B5	205-1916	1	Transformer mounting plate	
B6	206-584	1	Shield	
B7	207-1	2	Clamp	
B8	210-86	1	Bezel	

Heathkit®

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.

HARDWARE

NOTE: Hardware packets are marked to show the size of the hardware they contain (HDW #4, or HDW #8, etc.). You may have to open more than one packet to locate all of the hardware of any one size (#6, for example).

C1	250-1415	4	4-40 × 3/8" phillips screw
C2	250-1282	4	6-32 × 1/8" black setscrew
C3	250-1325	13	6-32 × 1/4" black phillips screw
C4	250-1419	13	6-32 × 1/4" black phillips flat head screw
C5	250-1430	2	6-32 × 1/2" phillips screw
C6	250-1280	1	6-32 × 3/8" black phillips screw
C7	250-1322	1	#6 × 5/8" black phillips self-tapping screw
C8	250-1441	2	10-32 × 1/2" black phillips screw
C9	252-3	7	6-32 nut
C10	252-5	2	10-32 nut
C11	252-38	4	3/8" black control nut
C12	252-39	2	1/4" control nut
C13	254-1	10	#6 lockwasher
C14	253-9	2	#8 flat washer
C15	254-3	2	#10 lockwasher
C16	254-42	2	1/4" lockwasher
C17	255-811	2	1-5/8" threaded hex spacer
C18	259-1	5	#6 solder lug

CABLE – WIRE – SLEEVING

343-15	30"	Coaxial cable
347-55	30"	Flat ribbon cable
344-15	84"	Black stranded wire
344-50	24"	Black solid wire
344-16	48"	Red stranded wire
344-21	18"	Red solid wire
344-34	48"	Brown solid wire
344-35	9"	Orange solid wire
344-80	12"	Orange stranded wire
344-36	9"	Yellow solid wire
344-81	12"	Violet stranded wire
344-186	14-½"	Violet solid wire
344-82	48"	White stranded wire
344-187	14-½"	White solid wire
344-188	14-½"	Gray solid wire
346-35	12"	Small heat-shrinkable sleeving

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.

CONTROLS – SWITCHES

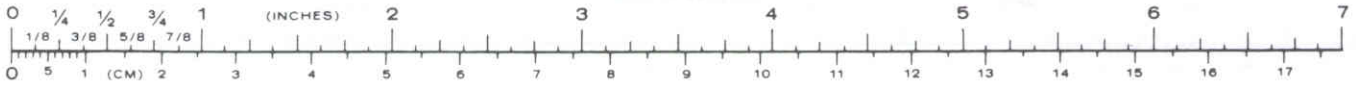
D1	10-1119	2	1 MΩ control	R4, R7
D1	10-1186	2	2000 Ω (2K) control	R8, R9
D2	60-70	1	2-position SPST slide	SW2
D3	60-88	1	2-position 4PDT slide	SW3
D4	60-73	1	3-position DPTT slide	SW1

PLASTIC AND RUBBER PARTS

E1	70-10	2	Black insulator	
E1	70-11	2	Red insulator	
E2	73-5	1	CRT cushion	
E3	73-79	2-1/2"	Rubber U-channel	
E4	73-92	1	Double-stick foam strip	
E5	74-4	1	Plastic tape (roll)	
E6	75-754	1	Strain relief	
E7	260-700	1	LED grommet	
E8	260-701	1	Retaining ring	
E9	260-96	2	Red clip assembly	
E9	260-97	2	Black clip assembly	
E10	261-34	4	Foot	
E11	354-5	7	Cable tie	
E12	414-42-1	1	Graticule	
E13	436-11	2	Red banana jack	J2, J4
E13	436-22	2	Black banana jack	J1, J3
E14	462-1107	2	Skirted knob	
E15	462-1110	2	Knob	
E16	490-5	1	Nut starter	

MISCELLANEOUS

F1	54-1023	1	Power transformer	T1
F2	75-52	1	Switch insulator	
	89-54	1	Line cord	
F3	411-142	1	CRT (cathode ray tube)	V1
F4	421-42	1	3/8-ampere slow-blow fuse	F1
F5	422-1	1	Fuseholder	
F6	431-16	1	2-lug terminal strip	
F7	431-42	2	5-lug terminal strip	
F8	434-41	1	CRT socket	
F9	438-47	4	Banana plug	
F10	490-14	1	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 × 1/4" black phillips hardware," for example, means to use a 6-32 × 1/4" black phillips screw, one or more #6 lockwashers, and a 6-32 nut. Refer to any Pictorial or Details that are used in the steps for the correct number of lockwashers and the correct way to install the hardware.

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

Position the chassis as shown in Pictorial 2-1 (Illustration Booklet, Page 7). The parts that you will mount in the following steps are shown in an exploded view on the chassis in Pictorial 2-1. The Details that are used during the assembly show an exploded view of a particular part being installed and the method for mounting it. Refer to the Pictorials for the positioning of all parts.

( ) SW2: Mount the 2-position SPST slide switch to the chassis at SW2 with 6-32 × 1/4" black phillips flat head screws. Position the two lugs as shown.

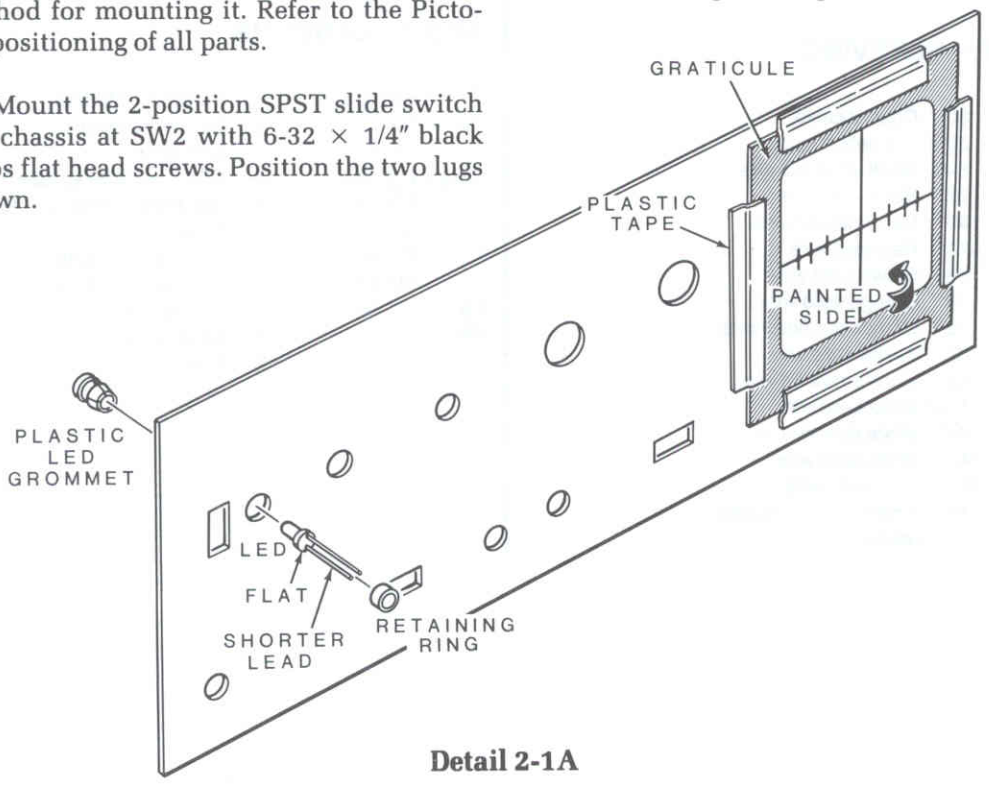
( ) SW1: Mount a 3-position DPTT slide switch to the chassis at SW1 with 6-32 × 1/4" black phillips flat head screws.

( ) SW3: Mount a 2-position 4PDT slide switch to the chassis at SW3 with 6-32 × 1/4" black phillips flat head screws.

( ) Mount the 2-lug terminal strip to the chassis at hole A with 6-32 × 1/4" black phillips flat head hardware. Be sure to position the terminal strip and lockwashers as shown.

( ) Mount a #6 solder lug to the chassis at hole B with 6-32 × 1/4" black phillips flat head hardware. Position the solder lug as shown.

( ) Refer to Detail 2-1A and tape the graticule to the inside of the front panel using the plastic tape. Position the graticule so the painted side faces toward the tape. Center the black border of the graticule along the edges of the front panel cutout so they do not show from the front. Make sure the tape does not extend past the front panel edges.



Detail 2-1A

( ) D2: Refer to Detail 2-1A and install the LED as follows:

1. Push the plastic LED grommet into its front panel hole from the outside until the shoulder is against the panel.

2. Push the LED case all the way into the LED grommet from the inside of the front panel. Position the case flat (shorter lead) down as shown. Be carefull not to bend the leads near the case or they may break off.

3. Place the retaining ring over the LED and press the ring over the grommet until it is against the inside of the front panel.

( ) Insert the LED leads through the chassis front access hole with the front panel cutouts over the slide switches. Hold the front panel against the chassis while you secure the panel to the chassis with the following banana jacks and controls.

( ) Mount a black banana jack at hole J3 with the nut supplied with the jack. Make the nut only finger tight at this time and do not crossthread it.

( ) Similarly, loosely mount a red banana jack at hole J4.

( ) Loosely mount a black banana jack at hole J1.

( ) Loosely mount a red banana jack at hole J2.

( ) Carefully center the three slide switches in their front panel cutouts, then tighten the four banana jacks securely. Do not overtighten the jacks.

( ) R8: Mount a 2000 Ω (2K) control at R8 with a 1/4" control lockwasher and a 1/4" control nut. Position the control with the lugs as shown.

( ) R9: Similarly, mount a 2000 Ω (2K) control at R9.

( ) R4: Mount a 3/8" black control nut onto a 1 MΩ control shaft until it is finger tight against the control. Then mount the control tightly at R4 with another 3/8" black control nut. Position the lugs as shown.

( ) R7: Similarly, mount a second 1 MΩ control and two 3/8" black control nuts at R7.

( ) Mount a #6 solder lug at hole E with 6-32 × 1/4" black phillips hardware. Position the solder lug as shown.

( ) Mount a #6 solder lug a hole F with 6-32 × 1/4" black phillips hardware. Position the solder lug as shown.

( ) Mount a 5-lug terminal strip at hole G with 6-32 × 1/4" black phillips hardware. Position the terminal strip and the two lockwashers as shown.

( ) Similarly, mount a 5-lug terminal strip at hole H. Position the terminal strip and two lockwashers as shown.

( ) Mount a fuseholder at F1 with 6-32 × 3/8" black phillips hardware.

( ) F1: Install a 3/8-ampere, slow-blow fuse into the fuseholder clips.

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

"3AG, 3/8-ampere slow-blow."

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

( ) Remove the paper backing from the "DANGER" label and press the label onto the rear panel at the indicated location.

Set the chassis aside.

FLAT CABLE PREPARATION

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

Use the following procedure when you are instructed to remove wire groups from the flat ribbon cable in the following steps:

1. Refer to the illustration at the top of the Pictorial and locate the group of wires you are instructed to remove.

2. Use a pen to mark each wire to the length indicated in the step.

3. Carefully, at the marks, cut only those wires you intend to remove.

4. Separate the wire groups from the main cable. Use a pair of cutters or a knife to start separating the wires as shown in the inset drawing.

NOTE: Do not cut or remove any wires from the main cable unless you are specifically instructed to do so in a step.

( ) Refer to group A and remove a 13″ length of brown, red, orange, yellow, green, and blue wire, as a group, from the flat ribbon cable.

When you are instructed to prepare a multi-wire cable, as in the next step, use the following procedure:

1. Lay the length of wire over the drawing in the Pictorial called out in the step. Then mark all of the wire separation points with a pen.

2. Separate all of the wires to their separation marks.

3. Cut the individual wires to their indicated lengths and prepare the wire ends as follows: Remove 1/4″ of insulation from each wire end; twist the fine wire strands tightly together; and apply a small amount of solder to the wire end to hold the strands together.

( ) Refer to Part A of the Pictorial and prepare the brown, red, orange, yellow, green, and blue 6-wire cable as shown.

( ) Refer to group B and remove a 6″ length of brown, red, orange, and yellow wire, as a group, from the flat ribbon cable.

( ) Refer to Part B of the Pictorial and prepare the brown, red, orange, and yellow 4-wire cable as shown.

( ) Refer to group C and remove a 6″ orange, yellow, and green wire from the flat ribbon cable.

( ) Refer to Part C of the Pictorial and prepare the orange, yellow, and green 3-wire cable as shown.

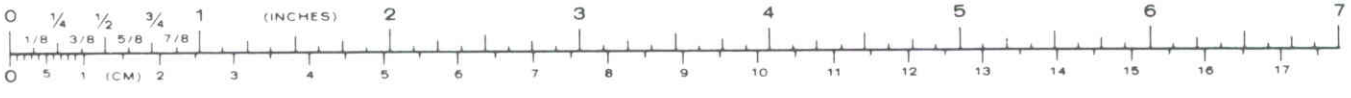
( ) Refer to group D and remove a 6″ blue, violet, and gray wire, as a group, from the flat ribbon cable.

( ) Refer to Part D of the Pictorial and prepare the blue, violet, and gray 3-wire cable as shown.

( ) Refer to group E and prepare the green, blue, violet, and gray wire, as a group, from the flat ribbon cable.

( ) Refer to Part E of the Pictorial and prepare the green, blue, violet, and gray 4-wire cable as shown.

Discard the remaining ribbon cable.



CIRCUIT BOARD WIRING

Refer to Pictorial 2-3 (Illustration Booklet, Page 9) for the following steps.

NOTE: In the following steps, you will connect some of the wires from each of the multi-wire cables to the circuit board. Make sure you connect end A of each cable as shown in the Pictorial. Refer back to Pictorial 2-2 to identify the ends if necessary. Whenever you connect a wire to the circuit board, solder the connection to the foil and cut off the excess wire length after the connection cools.

Connect the wires at end A of the brown, red, orange, yellow, green, and blue, 6-wire cable to the circuit board as follows:

( ) Brown wire to hole C.

( ) Red wire to hole B.

( ) Orange wire to hole X.

( ) Yellow wire to hole A.

( ) Green wire to hole Z.

( ) Blue wire to hole Y.

Connect the wires at end A of the brown, red, orange, and yellow 4-wire cable to the circuit board as follows:

( ) Brown wire to hole M.

( ) Red wire to hole L.

( ) Orange wire to hole D.

( ) Yellow wire to hole E.

Connect the wires at end A of the orange, yellow, and green 3-wire cable to the circuit board as follows:

( ) Orange wire to hole MM.

( ) Yellow wire to hole R.

( ) Green wire to hole S.

Connect the wires at end A of the blue, violet, and gray 3-wire cable to the circuit board as follows:

( ) Blue wire to hole K.

( ) Violet wire to hole J.

( ) Gray wire to hole I.

Connect the two wires at end A of the green, blue, violet, and gray 4-wire cable to the circuit board as follows:

( ) Violet wire to hole P.

( ) Gray wire to hole H.

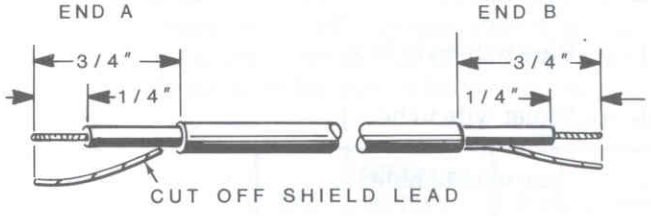
You will connect the remaining wires from both ends of this cable later.

Refer to Pictorial 2-4 (Illustration Booklet, Page 10) for the following steps.

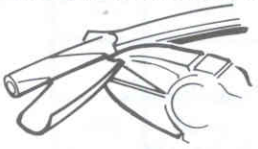
( ) Cut the following lengths of coaxial cable:

5-1/2″
7-1/2″
7-1/2″
8″

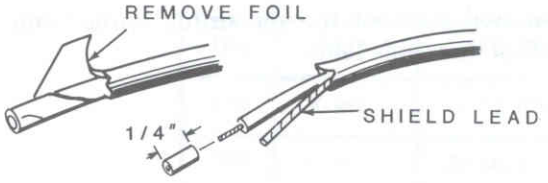
( ) Refer to Detail 2-4A and prepare the ends of the coaxial cables as shown. Remove the shield lead at end A of the cable. Be careful not to pull the center lead out of the cable when you prepare the lead.



TAKING CARE NOT TO CUT THE SHIELD LEAD, REMOVE THE OUTER INSULATION.



PEEL OFF THE FOIL.



REMOVE 1/4″ OF THE INSULATION.

Detail 2-4A

( ) Cut four 3/4″ pieces of small heat-shrinkable sleeving.

( ) Slide the 3/4″ pieces of small heat-shrinkable sleeving over end A (without the shield) of each of the four prepared coaxial cables. Then position the sleeving 1/2″ from the end of each cable and shrink the sleeving in place with a lighter or a match.

Connect end A of the four prepared coaxial cables to the circuit board as follows. Solder each lead to the foil after you connect it and cut off the excess lead length. You will connect the cables in the order in which you prepared them.

( ) Inner lead of the 5-1/2″ coaxial cable to hole F.

( ) Inner lead of one of the 7-1/2″ coaxial cables to hole G.

( ) Inner lead of the other 7-1/2″ coaxial cable to hole N.

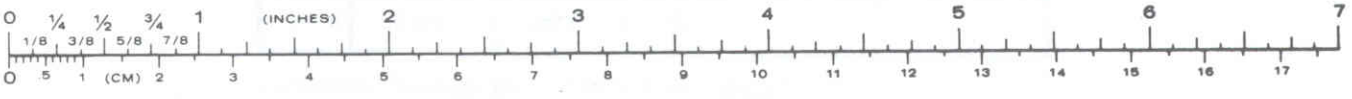
( ) Inner lead of the 8″ coaxial cable to hole O.

You will connect the other end of these cables later.

NOTE: To prepare a wire, as in the following step, cut it to the proper length and remove 1/4″ of insulation from each end. For stranded wires, tightly twist together the strands at each wire end and add a small amount of solder to hold the separate strands together.

( ) Prepare the following lengths of wire:

11-1/2″ black stranded
11″ red stranded
11″ orange stranded
10-1/2″ violet stranded
11-1/2″ white stranded
14-1/2″ violet solid
14-1/2″ white solid
8-1/2″ yellow solid
7-1/2″ orange solid



Connect the prepared wires to the circuit board as follows. Solder each wire to the circuit board foil after you connect it and cut off the excess wire length. You will connect the wires in the order in which you prepared them.

( ) 11-1/2" black stranded wire to hole V.

( ) 11" red stranded wire to hole U.

( ) 11" orange stranded wire to hole T.

( ) 10-1/2" violet stranded wire to hole LL.

( ) 11-1/2" white stranded wire to hole W.

( ) 14-1/2" violet solid wire to hole JJ.

( ) 14-1/2" white solid wire to hole KK.

( ) 8-1/2" yellow solid wire to hole II.

( ) 7-1/2" orange solid wire to hole HH.

You will connect the other end of these wires later.

( ) Position the circuit board and power transformer as shown in Pictorial 2-4.

Connect the power transformer leads to the circuit board as follows. Solder each lead to the foil after you connect it and cut off the excess lead lengths. Be careful not to stress the other cables and wires when you turn the circuit board over or they could break.

( ) Loosely twist the two brown leads together. Then connect the short brown lead to hole AA.

( ) Connect the long brown lead to hole BB.

( ) Connect the white lead to hole FF.

( ) Connect the white-yellow lead to hole EE.

( ) Connect one of the red leads to hole CC.

( ) Connect the other red lead to hole DD.

( ) Connect the yellow lead to hole GG.

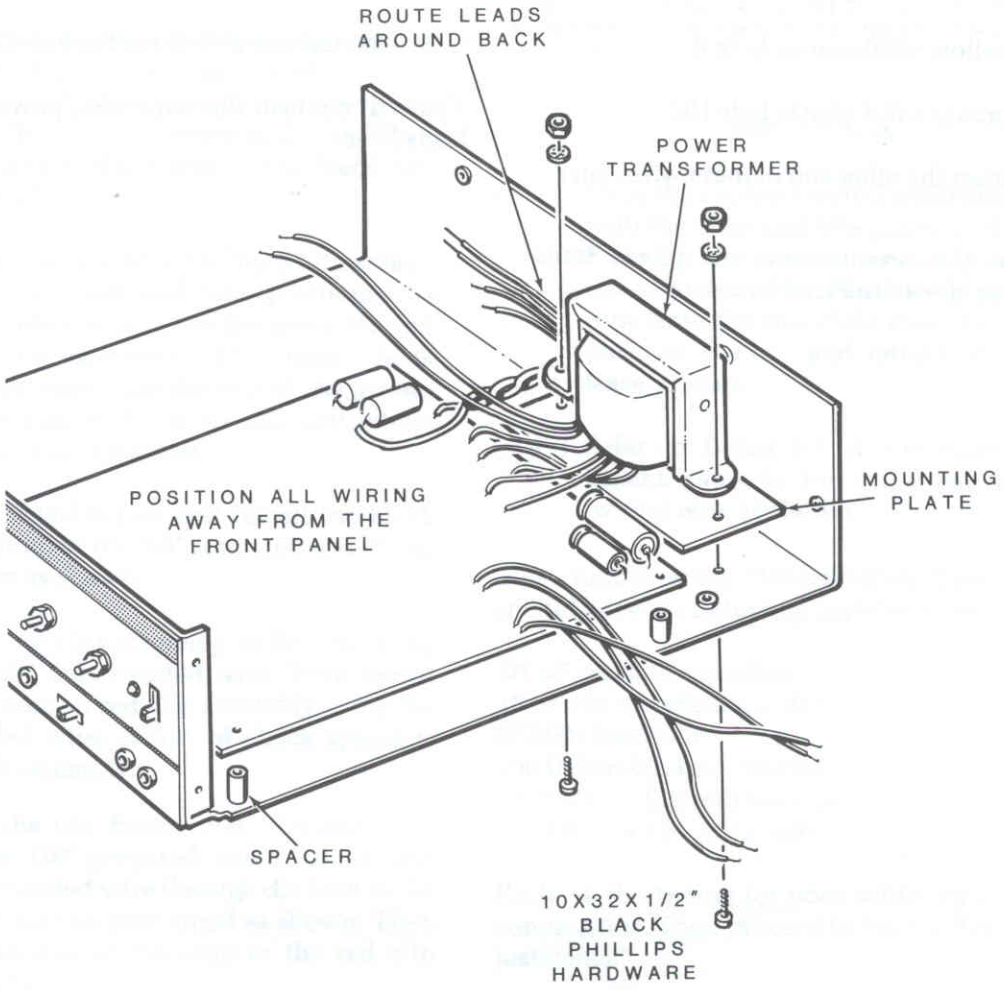
You will connect the remaining power transformer leads later.

Refer to Detail 2-4C for the following steps.

( ) Position the chassis as shown in the Detail.

( ) Lay the transformer mounting plate inside the chassis so that the mounting holes align.

( ) Install the circuit board and power transformer inside the chassis so the transformer flange mounting holes are over the mounting plate holes and the circuit board is resting on the four spacers. Then mount the power transformer and mounting plate to the chassis with 10-32 × 1/2″ black phillips hardware. You will not mount the circuit board at this time. Make sure you route all of the leads as shown.



Detail 2-4C

CHASSIS WIRING

Refer to Pictorial 2-5 (Illustration Booklet, Page 11) for the following steps.

NOTE: Push the circuit board back away from the front of the chassis as far as possible to make connecting to the chassis front easier. Position all circuit board wiring out of the way until you are instructed to connect it.

( ) Prepare the following black solid wires. You will connect the wires in the order in which you prepared them.

3″
1-1/4″
3″
4-1/2″
2-1/2″
1-1/2″
1″

( ) Remove an extra 1/8″ insulation (3/8″ total) from one end of a 3″ wire and use the wire in the next step.

NOTES:

1. When you connect the black solid wires, route them as shown and keep them against the chassis front.

2. In the following steps, (NS) means not to solder the connection because you will add other wires later. "S-" with a number, such as (S-1), means to solder the connection. The number following the "S-" shows you how many wires should be at the connection. This helps you check your work for errors as you go.

( ) Connect the 1/4″ prepared end of the 3″ black solid wire to solder lug B (NS) and the 3/8″ end to SW3 through lug 11 (S-2) to lug 8 (NS). NOTE: The "S-2" connection at lug 11 counts as two connections; one entering and one leaving.

( ) Connect one end of the 1-1/4″black solid wire to SW3 lug 8 (S-2). You will connect the other end of this wire later.

( ) Connect the other 3″ black solid wire from solder lug B (NS) to black banana jack J1 (S-1).

( ) Remove an extra 1/4″ of insulation (1/2″ total) from one end of the 4-1/2″ black solid wire. Connect this end to SW1 through lug 2 (S-2) to lug 3 (S-1). Connect the other end to control R4 lug 2 (NS).

( ) Remove an extra 1/4″ of insulation from one end of the 2-1/2″ black solid wire and connect the 1/2″ prepared end to SW1 through lug 6 (NS) to lug 7 (NS). Connect the other end of the wire to terminal strip A lug 2 (NS).

( ) Connect one end of the 1-1/2″ black solid wire to terminal strip A lug 2 (NS) and the other end to black banana jack J3 (NS).

( ) Connect one end of the 1" black solid wire to black banana jack J3 (S-2). You will connect the other end later.

( ) Cut a 3/4″ piece of fiber sleeving and slide it over the short LED lead. Then connect the lead to terminal strip A lug 2 (NS). Be careful not to stress the leads near the case or you could damage the LED.

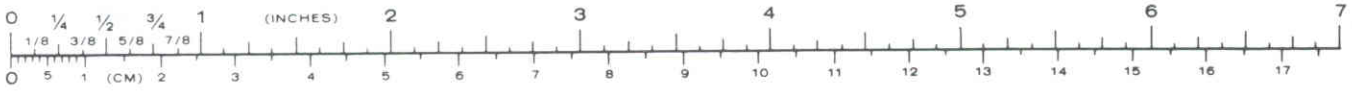
( ) Connect the long LED lead to terminal strip A lug 1 (NS).

( ) R2: Connect one lead of a 150 kΩ (brn-grn-yel) resistor to SW1 lug 1 (S-1) and the other lead to lug 6 (S-3). Position the resistor body as shown.

( ) R1: Connect one lead of a 270 kΩ (red-viol-yel) to SW1 lug 4 (S-1) and the other lead to lug 7 (S-2). Position the resistor body as shown.

( ) Cut two 1/2″ pieces of fiber sleeving.

( ) R3: Slide a 1/2″ piece of fiber sleeving over each lead of a 1 MΩ (brn-blk-grn) resistor. Connect one end of the resistor to solder lug B (NS) and the other lead to control R4 lug 1 (S-1).



( ) Mount a #6 solder lug at chassis spacer C with a 4-40 × 3/8" phillips screw. Secure this solder lug to the spacer and position it as shown.

( ) Similarly, mount another #6 solder lug at chassis spacer D. Position the solder lug as shown.

( ) Connect the free end of the 1" black solid wire coming from black banana jack J3 to solder lug C (S-1).

( ) Connect the free end of the 1/1-4" black solid wire coming from SW3 lug 8 to solder lug D (NS). NOTE: When you connect the wires to solder lug D, use the outer solder lug hole.

NOTES:

1. In the following steps, you will connect the cables coming from the circuit board to the components on the front of the chassis. Position the unconnected wires back out of the way while you connect these cables. Route all of the cables as shown in the Pictorial.

2. Position the circuit board back away from the inside front of the chassis as far as possible and over to the left so that you have clear access to switch SW3. You will wire this switch first. Since SW3 has 12 lugs, connecting wires to the lugs will be somewhat confined and a bit more difficult. The easiest way to make connections to these lugs is to form a hook in the end of the wire you wish to connect. Then hook the wire into the lug hole and crimp it tightly in place.

3. Make sure you use the correct cables and lugs when you wire the switches and controls. Always cut off any excess lead lengths from the solder connections to prevent the lugs or other wires from shorting together. Take your time and be careful not to burn any adjacent wires or cables when you solder to a lug.

Refer to Pictorial 2-5 (Illustration Booklet, Page 11) and inset drawing #1 for the following steps.

Connect the free wire ends of the green, blue, violet, and gray 4-wire cable as follows:

( ) Violet wire to SW3 lug 10 (S-1).

( ) Gray wire to SW3 lug 7 (S-1).

( ) Indicated end of the blue wire to SW3 lug 2 (NS). Connect the other end to red banana jack J4 (S-1).

( ) Connect the inner lead of the coaxial cable coming from hole O to SW3 lug 12 (S-1) and the shield to solder lug D (NS). Remember to use the outer hole.

( ) Connect the inner lead of the coaxial cable coming from hole G to SW3 lug 9 (S-1) and the shield to solder lug D (NS).

( ) Indicated end of the green wire to SW3 lug 5 (NS). Connect the other end to red banana jack J2 (S-1).

( ) Connect the inner lead of the coaxial cable coming from hole N to SW3 lug 5 (S-2) and the shield lead to solder lug D (NS).

( ) Connect the inner lead of the coaxial cable coming from hole F to SW3 lug 2 (S-2) and the shield to solder lug D (S-5). Make sure you solder all of the leads at the solder lug.

Refer to inset drawing #2 on Pictorial 2-5 for the following steps.

Connect the wires at the free end of the brown, red, orange, and yellow 4-wire cable to SW3 as follows. Be careful not to burn any of the other wires at the switch lugs.

( ) Red wire to lug 6 (S-1).

( ) Orange wire to lug 3 (S-1).

( ) Brown wire to lug 4 (S-1).

( ) Yellow wire to lug 1 (S-1).

Refer to Pictorial 2-6 (Illustration Booklet, Page 12) for the following steps.

Connect the free wire ends of the brown, red, orange, yellow, green, and blue 6-wire cable as follows:

( ) Blue wire to solder lug B (S-4). Make sure you solder all the wires at this lug.

( ) Brown wire to control R4 lug 3 (S-1).

( ) Red wire to SW1 lug 5 (S-1).

( ) Yellow wire to SW1 lug 8 (S-1).

( ) Green wire to terminal strip A lug 2 (S-4).

( ) Orange wire to terminal strip A lug 1 (S-2).

Connect the free wire ends of the orange, yellow, and green 3-wire cable to control R9 as follows:

( ) Orange wire to lug 3 (S-1).

( ) Yellow wire to lug 2 (S-1).

( ) Green wire to lug 1 (S-1).

Connect the free wire ends of the blue, violet, and gray 3-wire cable to control R8 as follows:

( ) Blue wire to lug 3 (S-1).

( ) Violet wire to lug 2 (S-1).

( ) Gray wire to lug 1 (S-1).

NOTE: At this time, carefully inspect the front chassis wiring, especially at switch SW3, for any poor or unsoldered connections. (Control R4 lug 2 should not be soldered at this time.) Also inspect closely for fine wire strands shorting to adjacent switch lugs. Cut off any unconnected wire strands. Also make sure all the coaxial cable shields are all soldered to solder lug D.

( ) Route the cables, especially the six-wire cable, against the inside front and bottom of the chassis as shown.

Refer to Pictorial 2-7 (Illustration Booklet, Page 13) for the following steps.

( ) Remove the screws at solder lugs C and D. Mount the circuit board over the solder lugs and the two chassis spacers with 4-40 x 3/8" phillips screws. Position the solder lugs as shown. Then mount the circuit board to the other two chassis spacers with 4-40 × 3/8" phillips screws.

( ) Cut five 3/4" lengths of small heat-shrinkable sleeving.

( ) Slide a piece of sleeving over the free end of the violet wire coming from JJ and the white wire coming from KK.

( ) Connect the end of the violet wire to control R7 lug 1 (S-1).

( ) Connect the end of the white wire to control R7 lug 3 (S-1).

( ) Prepare a 13" gray solid wire.

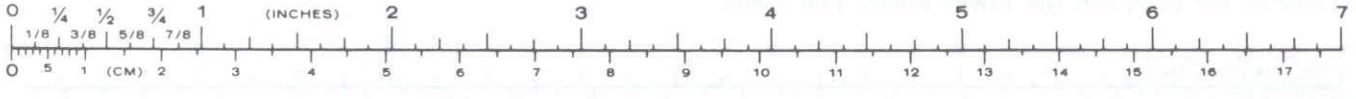
( ) Slide another 3/4" piece of heat-shrinkable sleeving over one end of the gray wire and connect this end of the wire to control R7 lug 2 (S-1). You will connect the other end of this wire later.

( ) Slide the heat-shrinkable sleeving over control lugs 1, 2, and 3 at R7 and shrink them in place with the heat from your soldering iron. Make sure the sleeving covers the lugs.

( ) Slide the switch insulator over the lugs of switch SW2 and against the switch body.

( ) Prepare two 19-1/2" lengths of brown solid wire and twist them together to make a twisted pair.

( ) Slide the remaining 3/4" pieces of heat-shrinkable sleeving over one end of the twisted brown wires. Then route the wires across the inside front of the chassis and around the circuit board to terminal strip G as shown. Connect the wire ends with the sleeving to switch SW2 lugs 1 (S-1) and 2 (S-1). After the connections cool, slide the sleeving over the lugs and shrink it in place.



( ) Connect either brown wire to fuseholder F1 lug 2 (S-1). Make this connection mechanically secure as shown in inset drawing #1 of the Pictorial.

( ) Connect the other brown wire to the lower hole (below the lug) of terminal strip G lug 5 (NS). Make the lower hole connection mechanically secure as shown in inset drawing #2 by bending the wire or lead end up 90° as shown. Be careful not to short this lead or wire to an adjacent terminal.

NOTE: In the following steps, when you connect components to terminal strip G, insert the component leads into the holes below the terminal strip lugs as shown.

( ) Cut a 1/2" piece of fiber sleeving and slide the sleeving over one lead of a 4700 pF(472) capacitor.

( ) C1: Connect this lead with the sleeving to terminal strip G hole 3 (NS) and connect the other lead to fuseholder F1 lug 1 (NS). Make the fuseholder connection mechanically secure. Position the capacitor as shown.

( ) C2: Connect one lead of another 4700 pF(472) ceramic capacitor to terminal strip G hole 2 (NS) and connect the other lead to hole 3 (S-2). Position the capacitor against the chassis as shown.

( ) Cut four 1/2" pieces of fiber sleeving.

( ) R5: Slide a piece of 1/2" sleeving over each of the leads of a 10 MΩ (brn-blk-blu) resistor. Then connect one lead of the resistor to terminal strip H lower hole 2 (S-1) and the other lead through hole 4 (S-2) to hole 5 (NS).

( ) D1: Slide a piece of 1/2" sleeving over each lead of a 1N2071 (#57-27) diode. Then connect the lead at the banded end of the diode to terminal strip H lower hole 1 (S-1), and connect the other lead to hole 3 (S-1).

( ) Connect either lead of a .1 μF tubular capacitor to terminal strip H hole 5 (S-2) and connect the other lead to solder lug E (S-1).

NOTE: The remaining connections to terminal strip H are to the lugs, not the lower holes. The lower hole connections will not count in the following solder steps.

( ) C3: Connect one lead of a .02 μF ceramic capacitor to terminal strip H lug 1 (NS) and connect the other lead to lug 2 (NS). Position the capacitor as shown.

( ) Connect the free end of the orange solid wire coming from circuit board hole HH to terminal strip H lug 4 (S-1).

( ) Prepare a 14" red solid wire.

( ) Connect one end of the 14" large red solid wire to control R4 lug 2 (S-2) and connect the other end to terminal strip H lug 1 (S-2). Route the wire along the chassis bottom as shown.

Refer to Pictorial 2-8 (Illustration Booklet, Page 14) for the following steps.

Connect the following transformer wires to the lower holes of terminal strip G as follows:

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

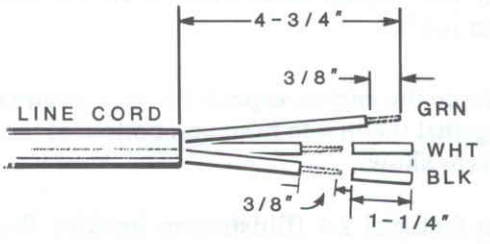
( ) Black-green lead to hole 2 (S-2).

( ) Black-yellow lead to hole 4 (S-1).

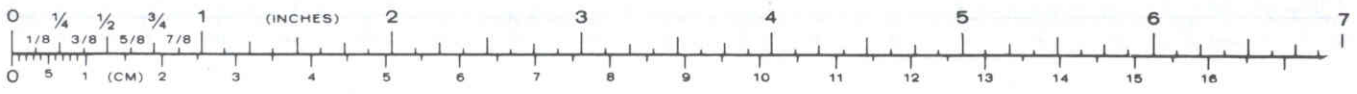
( ) Black-red lead to hole 5 (S-2).

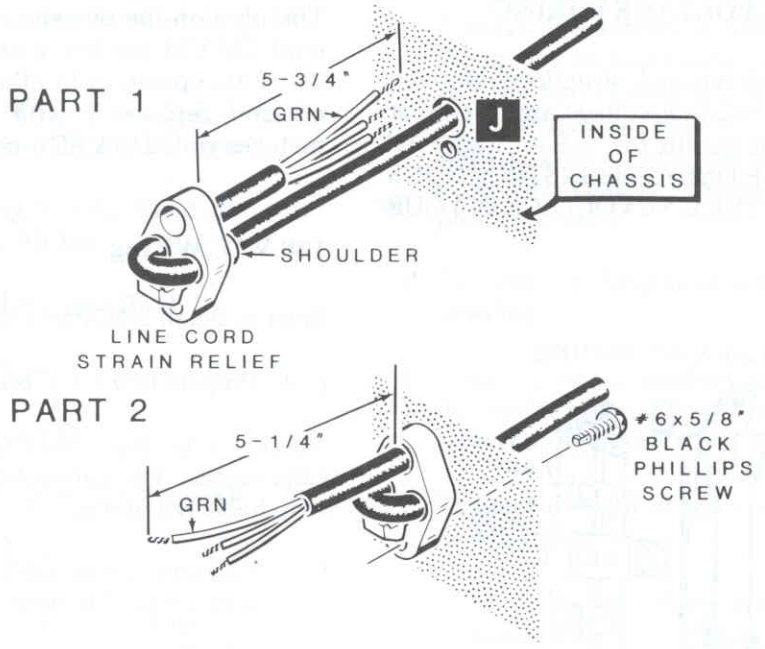
( ) Refer to Detail 2-8A and remove 4-3/4" of outer insulation from the end of the line cord. Be careful not to cut into the inner lead insulation when you remove the outer insulation.

( ) Cut 1-1/4" from the end of the black lead and white lead. Remove 3/8" of insulation from the individual leads (if this has not already been done) and apply a small amount of solder to the lead ends to hold the strands together.



Detail 2-8A





Detail 2-8B

( ) Refer to Detail 2-8B Part 1 and insert the prepared end of the line cord through rear chassis hole J. Then insert the end of the line cord through the strain relief hole with the shoulder and weave the line cord through the indicated adjacent hole for a distance of 5-3/4". Route the line cord through the remaining strain relief hole and pull it tight at both ends of the strain relief. Upon completion, you should have approximately 5-1/4" of line cord coming from the strain relief as shown in Part 2.

( ) Refer to Detail 2-8B Part 2 and push the shoulder of the strain relief into hole J, and secure it with a #6 × 5/8" black phillips screw.

Connect the line cord leads as follows. Make mechanically secure connections.

( ) Green lead to solder lug F (S-1).

( ) White lead to terminal strip G lug 1 (NS).

( ) Black lead to fuseholder F1 lug 1 (S-2).

( ) Push the line cord leads against the rear of the chassis.

( ) Prepare a 3" red solid wire.

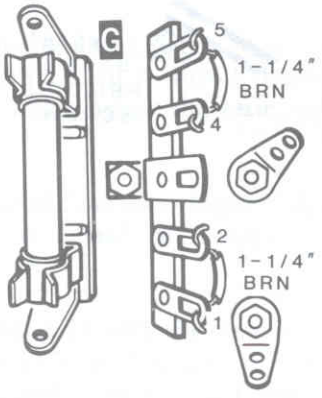
( ) Connect one end of the 3" solid wire to terminal strip H lug 2 (S-2). You will connect the other end later.

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 more common. USE ONLY THE INSTRUCTIONS THAT AGREE WITH THE LINE VOLTAGE IN YOUR AREA.

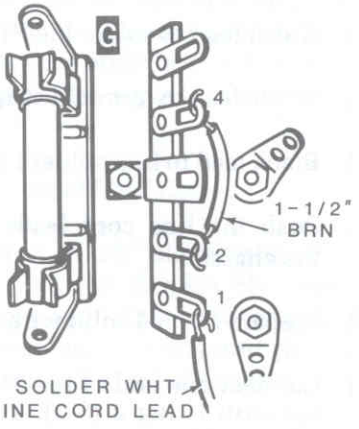
PART 1

120 VAC WIRING



PART 2

240 VAC WIRING



Detail 2-8C

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 2-8C Part 1 for the following steps.

( ) Prepare two 1-1/4" brown solid wires.

NOTE: Make the following connections mechanically secure. The connections to the lower terminal strip holes will not count in the lug solder steps.

( ) Connect one of the 1-1/4" brown wires to terminal strip G between lugs 1 (S-2) and 2 (S-1).

( ) Connect the other 1-1/4" brown wire to terminal strip G between lugs 4 (S-1) and 5 (S-1).

240 VAC Wiring

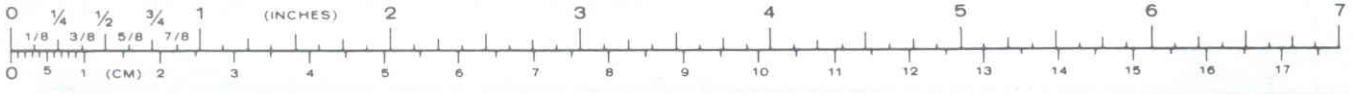
Refer to Detail 2-8C Part 2 for the following steps.

( ) Prepare an 1-1/2" brown solid wire.

NOTE: Make the following connections mechanically secure. The connections to the lower terminal strip holes will not count in the lug solder steps.

( ) Connect the 1-1/2" brown wire to terminal strip G between lugs 2 (S-1) and 4 (S-1).

( ) Solder the white line cord lead to lug 1 of the terminal strip (it was connected previously).



CRT SOCKET WIRING

Refer to Pictorial 2-9 (Illustration Booklet, Page 15) for the following steps.

( ) Position the CRT socket at the bottom of the chassis with the lugs facing up with the key as shown. Make a mechanically secure connection to the socket lugs. The socket lug numbers are stamped on the other side of the socket for reference.

( ) Cut two 1/2″ pieces of fiber sleeving.

( ) R6: Slide the 1/2″ sleeving over the leads of a 100 kΩ (brn-blk-yel) resistor. Then connect one lead to socket lug 1 (NS) and the other to lug 3 (NS).

( ) Connect one of the green transformer leads to socket lug 12 (S-1).

( ) Connect the other green transformer lead to socket lug 1 (S-2).

( ) Connect the gray wire coming from control R7 to socket lug 4 (S-1).

Connect the wires coming from the circuit board to the CRT socket as follows:

( ) Yellow wire from hole II to lug 3 (S-2).

( ) White wire from hole W to lug 6 (S-1).

( ) Black wire from hole V to lug 7 (S-1).

( ) Violet wire from hole LL to lug 8 (S-1).

( ) Orange wire from hole T to lug 9 (S-1).

( ) Red wire from hole U to lug 10 (S-1).

( ) Connect the red wire coming from terminal strip H to socket lug 2 (S-1).

NOTE: Socket lugs 5 and 11 are unused.

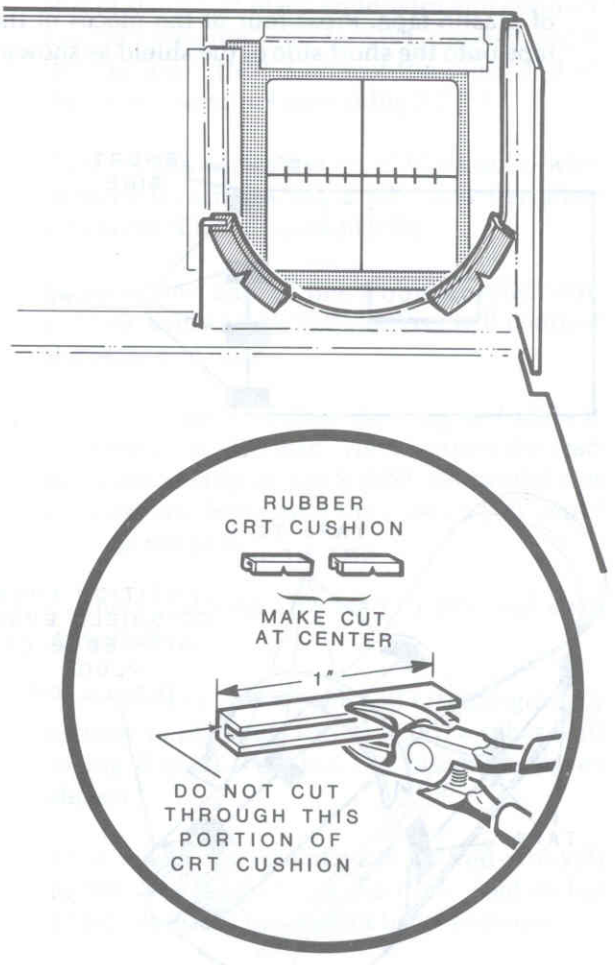
( ) Install cable ties at the seven indicated locations. Refer to the inset drawing for the cable tie installation. After you install a cable tie, cut off the excess tie and use your soldering iron to melt the sharp cutoff end down as shown.

CRT MOUNTING

Refer to Pictorial 2-10 (Illustration Booklet, Page 16) for the following steps.

( ) Refer to the inset drawing on Detail 2-10A and prepare two 1″ pieces of rubber CRT cushion as shown.

( ) Refer to Detail 2-10A and insert the grooved side of the two CRT cushions over the round edge of the chassis.

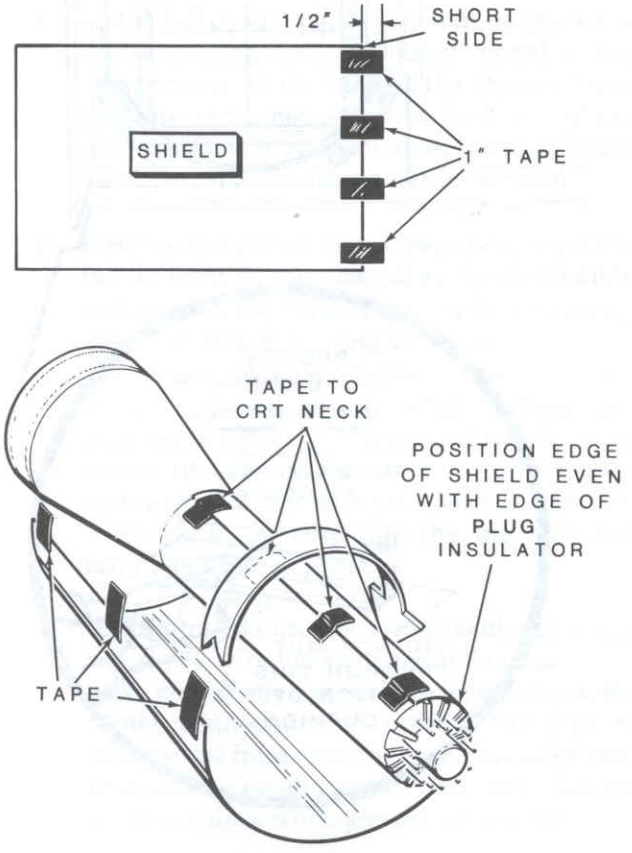


Detail 2-10A

( ) Mount two 1-5/8″ threaded hex spacers at chassis holes M and N with two #8 flat washers, two #6 lockwashers, a 6-32 × 1/4″ black phillips screw at M, and a 6-32 × 1/4″ black phillips flat head screw at N.

WARNING: Be careful when you handle the CRT in the following steps. Do not strike, scratch, or subject the CRT to more than moderate pressure at any time. Due to its high vacuum, a fracture of the glass could cause an implosion of considerable violence capable of causing personal injury.

( ) Refer to Detail 2-10B and cut seven 1″ pieces of plastic tape. Press four of the pieces of the tape onto the short side of the shield as shown.



Detail 2-10B

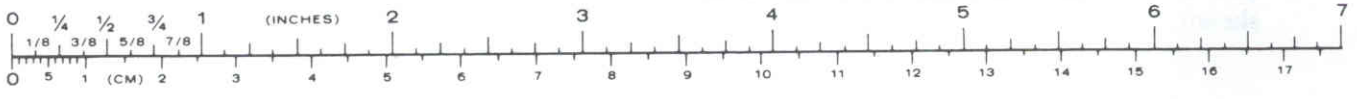
( ) Refer to Detail 2-10B and tape the short side of the shield to the CRT neck so the edge of the shield is even with the outer edge of the CRT plug insulator. Wrap the shield tightly around the CRT neck and use the three remaining pieces of tape to hold the shield in place at the end and center locations. Then wrap three turns of tape over the three taped locations.

( ) Wrap the rubber "U" channel around the neck of the CRT. If the ends overlap, cut off any excess until they just meet when you wrap them around the neck.

( ) Cut a 1″ piece of plastic tape and press 1/2″ of the tape onto the inside of the rubber "U" channel. Wrap the rubber "U" channel around the neck of the CRT and position it 5/8″ from the end of the plug insulator. Then press the other end of the tape over the rubber "U" channel to hold it in place.

( ) Position the front of the CRT onto the CRT cushion and against the graticule. Rotate the CRT so the plug key is at the 11 o'clock position; then mount the two clamps around the rubber "U" channel. Position the clamps and "U" channel so the clamp mounting holes align with the 1-3/4″ threaded hex spacer. Loosely secure the clamps to the spacers with two 6-32 × 1/2″ phillips screws. Position the rubber "U" channel as necessary.

( ) Refer to the inset drawing and press the CRT socket onto the CRT pins. The socket may fit tightly, so be careful not to break the fiber insulator portion of the socket. Once the socket is in place, carefully push the front of the CRT so it is touching the graticule. Keep the socket key at the 11 o'clock position. Do not tighten the clamp screws since you will reposition the CRT later.



Refer to Pictorial 2-11 for the following steps.

( ) Rotate the front panel controls to their fully counterclockwise positions.

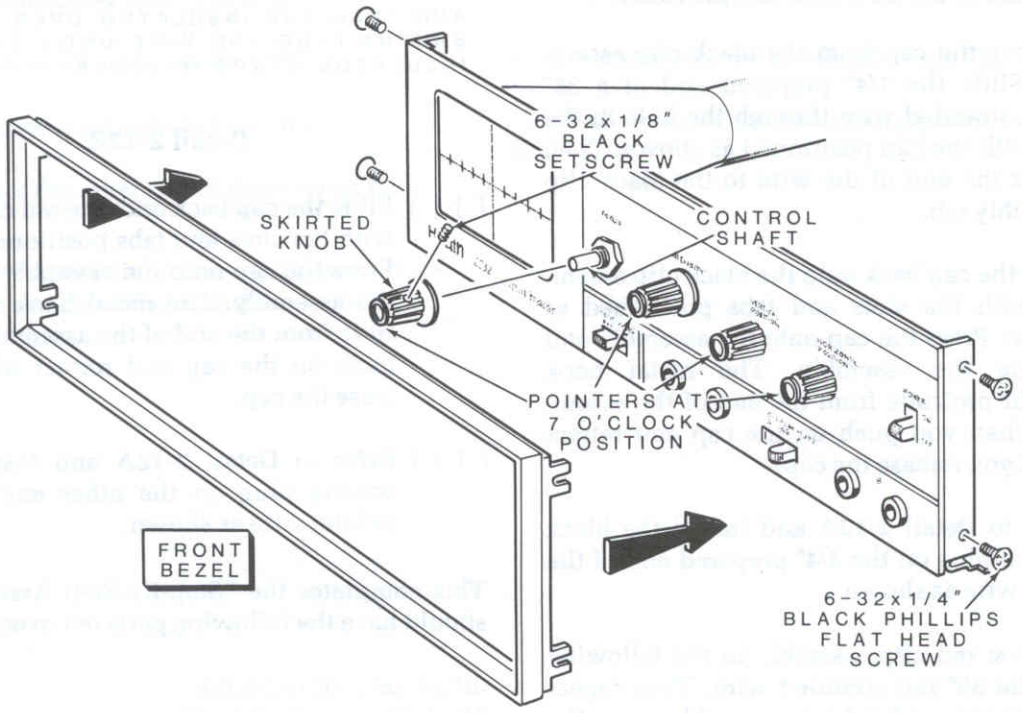
( ) Use the allen wrench supplied with your kit to hold and start a 6-32 × 1/8" black setscrew into a skirted knob. Then slide the knob over the FOCUS control shaft as far as it will go and position the pointer at the 7 o'clock position. Tighten the setscrew securely.

( ) Similarly install a skirted knob on the INTENSITY control shaft.

( ) Similarly install a knob on the VERTICAL POSITION control shaft.

( ) Similarly install a knob on the HORIZONTAL POSITION control shaft.

( ) Mount the front bezel to the chassis with four 6-32 × 1/4" black phillips flat head screws. Make sure the bezel fits against the front panel at all four sides. The CRT should just fit under the top of the bezel and against the rubber cushion.



PICTORIAL 2-11

TEST CABLE ASSEMBLY

Refer to Pictorial 2-12 (Illustration Booklet, Page 16) for the following steps.

( ) Prepare the following stranded wires. Remove an extra 1/2" of insulation from one end of each wire (3/4" total). Do not apply solder to the 3/4" prepared end of the wires.

35" black
35" black
35" red
35" white

In the following steps you will prepare two black test leads. When you complete one of the black test leads, go back and repeat the steps for the second lead. Two rows of check spaces are provided.

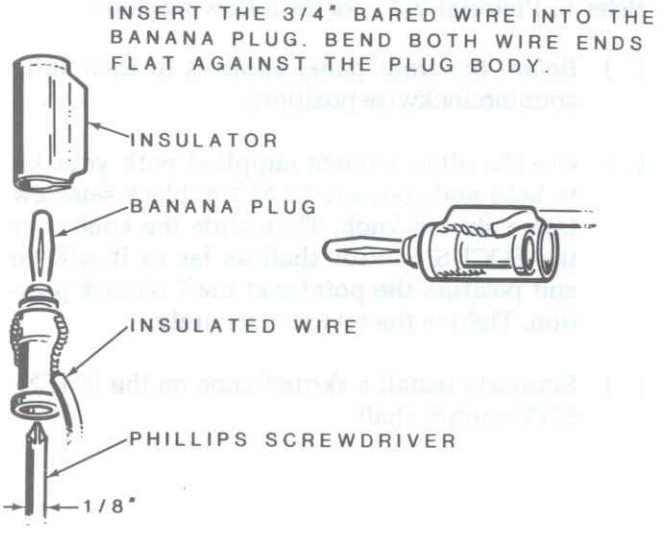
( ) ( ) Remove the cap from the black clip assembly. Slide the 1/4" prepared end of a 35" black stranded wire through the hole in the cap with the cap positioned as shown. Then solder the end of the wire to the black clip assembly tab.

( ) ( ) Slide the cap back onto the black clip assembly with the slots and tabs positioned as shown. Press the cap onto the assembly and operate the assembly. The metal hook should protrude from the end of the assembly when you push on the cap and retract when you release the cap.

( ) ( ) Refer to Detail 2-12A and install the black banana plug on the 3/4" prepared end of the black wire as shown.

Prepare the first red clip assembly in the following steps using the 35" red stranded wire. Then repeat the steps for the second red clip assembly using the 35" white stranded wire. A row of check spaces is provided for each assembly.

( ) ( ) Remove the cap from a red clip assembly. Slide the 1/4" prepared end of a 35" red (white) stranded wire through the hole in the cap with the cap positioned as shown. Then solder the end of the wire to the red clip assembly tab.



Detail 2-12A

( ) ( ) Slide the cap back onto the red clip assembly with the slots and tabs positioned as shown. Press the cap onto the assembly and operate the assembly. The metal hook should protrude from the end of the assembly when you push on the cap and retract when you release the cap.

( ) ( ) Refer to Detail 2-12A and install the red banana plug on the other end of the red (white) wire as shown.

This completes the "Step-By-Step Assembly." You should have the following parts left over:

.01 μF ceramic capacitor
10 μF electrolytic capacitor
2N3904 transistor
100 Ω (brn-blk-brn) resistor
1000 Ω (brn-blk-red) resistor
100 kΩ (brn-blk-yel) resistor

Recheck the wiring for poor soldering or no solder connections. Then proceed to "Initial Tests And Adjustments."

INITIAL TESTS AND ADJUSTMENTS

PRIMARY WIRING TESTS

A wiring error in the primary wiring circuit (transformer wiring, line cord, etc.) of your Component Tracer could cause you to receive a severe electrical shock. These "Primary Wiring Tests" will assure you that no such wiring errors exist.

You will need a VOM, a VTVM, or a DMM (digital multimeter) to perform the resistance and voltage tests in this kit. If you do not have one of these meters, try to obtain one from a friend. It is important that you perform the tests. If you do not get the proper resistance or voltage readings, refer directly to the "In Case Of Difficulty" section on Page 53. DO NOT apply power to the unit if you do not obtain the correct initial resistance readings.

Refer to Pictorial 3-1 (Illustration Booklet, Page 17) for the following steps.

NOTE: Most ohmmeters have a positive test voltage polarity ("+" input lead), while others have a negative test voltage polarity. If you do not obtain the correct readings, reverse the meter leads and make the measurement once more.

( ) Connect the common (−) ohmmeter lead to the indicated solder lug.

( ) Make sure the POWER switch is off.

( ) Connect the positive (+) ohmmeter lead to either flat prong of the line cord plug. The meter should measure infinite (∞) resistance.

( ) Switch the POWER switch to on and the reading should be the same.

( ) Connect the positive ohmmeter lead to the other flat prong of the line cord plug. The meter should still measure infinite resistance with the POWER switch on or off.

( ) Connect the positive ohmmeter lead to the round pin of the line cord plug. The meter should measure 0 ohms.

( ) Connect the negative ohmmeter lead to one flat line cord prong and the positive lead to the other flat line cord prong. The meter should measure infinite resistance with the POWER switch off.

( ) Turn the POWER switch on. The meter should indicate at least 3 ohms.

( ) Turn the POWER switch off.

This completes the "Primary Wiring Tests." Proceed to "Resistance Tests."

RESISTANCE TESTS

Refer to Pictorial 3-1 (Illustration Booklet, Page 17) for the following steps.

Refer to the following chart 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 "TP" location.

3. Allow any capacitor in the circuit you measure to fully charge after you connect your meter and allow your meter to stabilize before you take a reading.

The following "Resistance Chart" lists several test points (TP) that you will measure. If the reading you obtain is incorrect, refer to the "Possible Cause" column in the chart to help you locate the problem. When you locate a problem, always check the solder connections in the area of the problem and make sure the part is installed properly, or that the correct part is installed. If the problem still exists, refer to the "In Case Of Difficulty" section.

( ) Connect the negative ohmmeter lead to the solder lug indicated in the Pictorial and the positive lead to the following indicated test point locations:

RESISTANCE CHART

TP#	MINIMUM METER READING	POSSIBLE CAUSE
TP1	50 kΩ	C104, power transformer wiring, D105.
TP2	50 kΩ	D104, D105, C104.
TP3	50 kΩ	Power transformer, D106, D107, C105, C106.
TP4	30 kΩ	D111, C109, C111.
TP5	500 Ω	D118, C122, C121, D112, D113, C112, C113.
TP6	30 kΩ	C111, C109, D111, Q103.
TP7	1 kΩ	D116, C119, C116, D114, D115, C114, C115.
TP8	1 kΩ	C118, D117, C117, C116, C114, C115, D114, D115.
TP9	30 kΩ	Q301, C302.
TP10	30 kΩ	Q201, C202.
TP11	5 kΩ	R307, R309.
TP12	5 kΩ	R207, R209.
TP13	50 kΩ	Q405, CRT wiring.
TP14	50 kΩ	Q406, CRT wiring.
TP15	50 kΩ	Q505, CRT wiring.
TP16	50 kΩ	Q506, CRT wiring.

Proceed to "Voltage Tests And Adjustments."

VOLTAGE TESTS AND ADJUSTMENTS

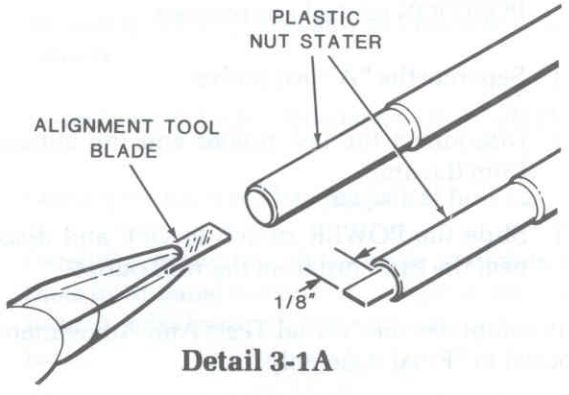
Refer to Pictorial 3-1 (Illustration Booklet, Page 17) for the following steps.

NOTE: When you apply power to the Component Tracer and a trace is visible, the baseline (line across the screen) may have a slight bow. This condition is normal. Also, the trace may appear to be slightly short until the unit has warmed up sufficiently.

When you apply power to the Component Tracer, if you experience any difficulties, turn the power off and disconnect the line cord. Do not proceed with any other tests until you correct the problem.

WARNING: When the line cord is connected to an AC outlet, potentially hazardous voltages are present at several places. These areas are shown in the boxed-in area on Pictorial 3-2 (Illustration Booklet, Page 18). Be careful – you could receive a severe shock if you touch these voltages.

( ) Refer to Detail 3-1A and push the alignment tool blade into the small end of the plastic nut starter. Always use this tool to adjust the circuit board controls.



Detail 3-1A

( ) Set all nine of the circuit board controls to their center positions.

( ) Set all four of the front panel control to their center positions.

( ) If it is not already there, slide the POWER switch to OFF.

( ) Connect the Circuit Tracer's line cord to an appropriate AC receptacle.

( ) Slide the POWER switch to ON. The POWER LED should light. You may or may not see a trace at this time.

Refer to the following chart and perform the voltage measurements in the following manner:

1. Set the voltmeter range switch for each step, if possible, to obtain a near full-scale DC reading.

2. Connect the positive voltmeter lead to the indicated "TP" location and the negative lead to the indicated solder lug.

VOLTAGE CHART

TP#	METER INDICATION
TP8	+9 to +11 VDC
TP7	+4.5 to +5.5 VDC
TP5	−9 to −11 VDC
TP4	Approximately +195 to +230 VDC
TP6	+150 to +175 VDC

( ) Allow approximately 10 to 15 minutes for the unit to warm up.

( ) Set the voltmeter to read "AC VOLTS."

( ) Slide the TEST VOLTS switch to 50V.

( ) Slide the DISPLAY MODE switch to the "A" position.

( ) Attach the voltmeter probes to the red and black "A" test jacks. Adjust the **"A Ramp Adj"** control (R305) for a meter reading of 12.4 VAC. NOTE: If you are using a true rms voltmeter, set the voltage for a reading of 14.1 VAC.

( ) Slide the DISPLAY MODE switch to the "B" position.

( ) Attach the voltmeter probes to the red and black "B" test jacks. Adjust the **"B Ramp Adj"** control (R205) for a meter reading of 12.4 VAC, (14.1 VAC true rms).

( ) Adjust the HORIZONTAL POSITION and VERTICAL POSITION controls to center the trace on the screen. Alternately adjust the circuit board **"Astig Adj"** control (R127) and the front panel FOCUS control for the sharpest trace.

( ) Insert the red plug on the end of the white test wire into the red "B" test jack and insert a black plug on one of the black test wires into the black "B" test jack. Clip the "B" test probes together.

( ) Rotate the front of the CRT until the trace is parallel to the vertical graticule line. Adjust the front panel HORIZONTAL POSITION control as necessary. Then tighten the two clamp screws until the ends of the clamp are approximately 1/8" apart.

( ) Separate the "B" test clips.

( ) Adjust the **"B Tilt Adj"** control (R213) until the trace is parallel to the horizontal graticule line. Adjust the front panel VERTICAL POSITION control as necessary.

( ) Slide the DISPLAY MODE switch to the "A" position. Readjust the VERTICAL POSITION control as necessary to center the trace.

( ) Adjust the **"A Tilt Adj"** control (R313) until the trace is parallel to the horizontal graticule line.

( ) Slide the DISPLAY MODE switch to the "A/B" position. Center the "B" trace (dotted line) with the VERTICAL POSITION control.

( ) Adjust the **"Vert Sep"** control (R317) until the "A" and "B" traces overlap.

( ) Adjust the **"Horiz Sep"** control (R401) until the "A" and "B" traces are even at each end.

( ) Readjust the **"A Tilt Adj"** control (R313) as necessary.

( ) Slide the TEST/VOLTS switch to the 5V position.

( ) Adjust the **"Horiz Gain"** control (R419) until the trace fills the screen at both ends of the CRT. Adjust the front panel HORIZONTAL POSITION control accordingly.

( ) Insert the red plug on the end of the red test wire into the red "A" test jack and insert the black plug on the other black test wire into the black "A" test jack. Clip the "A" test probes together.

( ) Adjust the **"Vert Gain"** control (R518) until the trace fills the screen at the top and bottom of the CRT. Adjust the front panel VERTICAL POSITION control as necessary.

( ) Separate the "A" test probes.

( ) Disconnect the test probes and the voltmeter from the unit.

( ) Slide the POWER switch to OFF and disconnect the line cord from the wall outlet.

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

FINAL ASSEMBLY

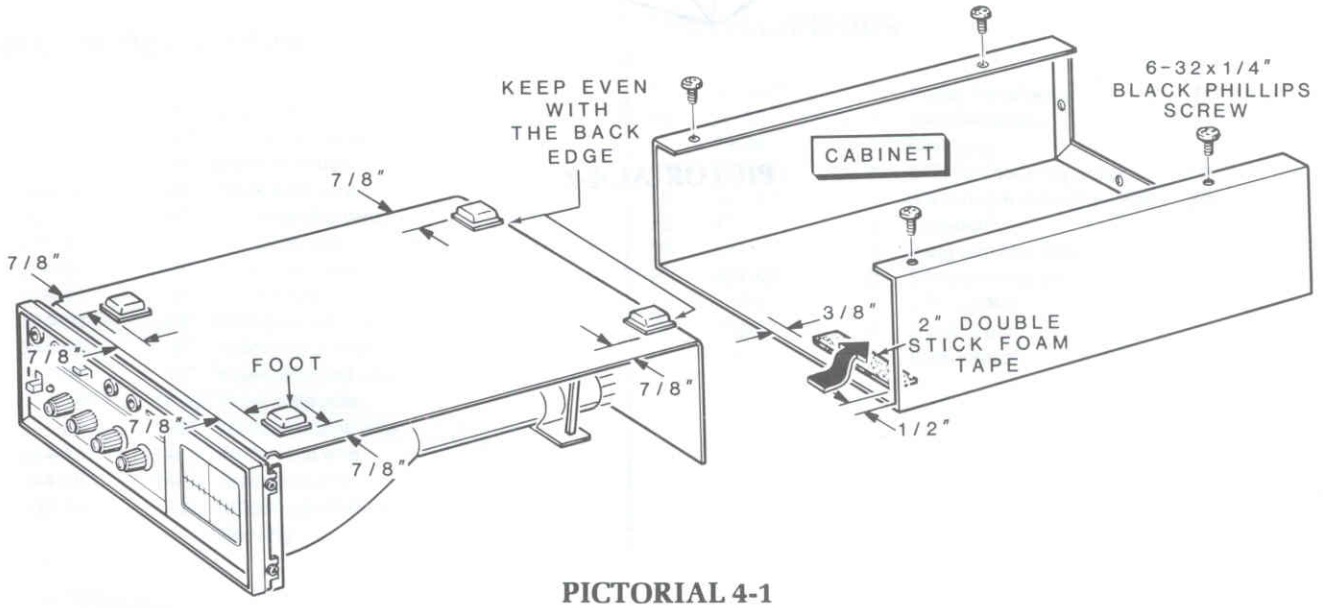
Refer to Pictorial 4-1 for the following steps.

( ) Position the unit and the cabinet upside down on your work surface.

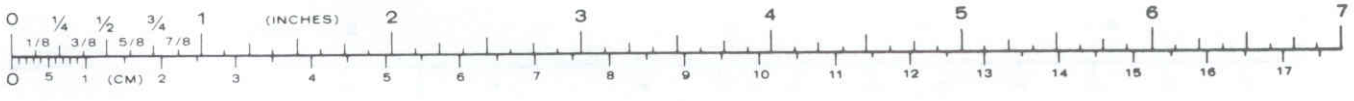
( ) Cut a 2″ piece of double-stick foam tape. Then remove the paper backing from one side and press the foam tape onto the inside of the cabinet at the indicated location. Do not remove the other piece of paper backing.

( ) One at a time, remove the paper backing from the four feet and press a foot at each corner of the chassis bottom using the dimensions shown.

( ) Slide the cabinet with the foam tape over the chassis and secure it with eight 6-32 × 1/4″ black phillips screws. Make sure the back panel goes over the foam tape.



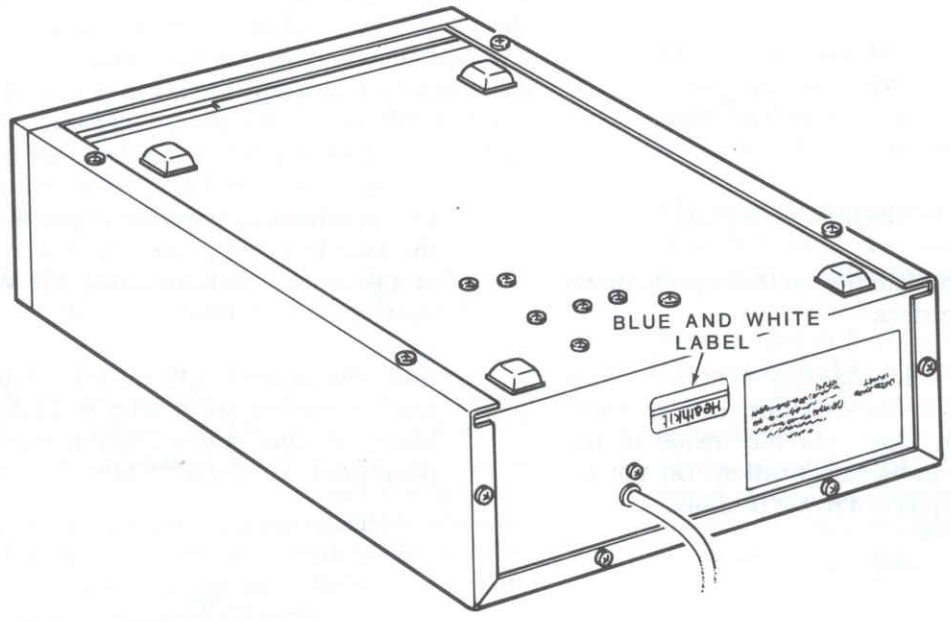
PICTORIAL 4-1



Refer to Pictorial 4-2 for the following steps.

( ) Remove the backing from the blue and white label and press the label onto the back of the chassis at the indicated location. Refer to the model and production series numbers on this label in any correspondance you may have with the Heath Company concerning this kit.

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



PICTORIAL 4-2

OPERATION

The Component Tracer operates on the same principle as a curve tracer. An AC voltage is applied to the device or circuit under test. The voltage across the device or circuit is displayed horizontally, while the current through it is displayed vertically. Positive current flow is displayed in an upward direction and positive voltage will cause an indication to the right.

For example, a resistor shows on the display as a straight line with a slope inversely proportional to the value of the resistance. The lower the resistance, the more vertical the line due to increased current.

As another example, a diode junction breakover is shown as follows. The display for the diode under test will show a horizontal line until the diode junction goes into conduction, at which point the device begins to draw current and a vertical line is produced. The sharper the "knee," the better the device.

Pictorial 5-1 (Illustration Booklet, Page 19) shows the front panel of the Component Tracer. Study this Pictorial to become familiar with each control and switch location.

WARNING: Do not apply power to the component or circuit under test or you may damage the circuit and the Component Tracer.

The following steps are intended to help you when you troubleshoot electronic circuitry. Since each circuit will have its own unique display and characteristic, the steps should help you to become more familiar with what you can expect to see when you use your Component Tracer.

1. Under no conditions should you ever apply power to the circuit under test, since damage to the circuit and the Component Tracer can occur.

2. Attach the black probes to a convenient common circuit point.

3. Use the red test probe and/or the white test probe to check key points in the circuit and note the display.

4. Where possible, compare the suspect circuit with a known good circuit using the "A/B" display mode. When you compare similar circuits, such as in a stereo amplifier, always attach the test probes to the same circuit points for accurate comparisons.

5. When you find a trouble area in a circuit, use the red and black test probes to check the individual components (without removing the component from the circuit) to isolate the defective part. Refer to the "Component Waveform Chart" (Illustration Booklet, Page 20) to check for the typical waveform.

6. On circuits with an impedance of less than 10 kΩ, a short vertical line will appear on the display if you are in the 50 V TEST VOLTS range. Switch to the 5 V range to obtain a more accurate display.

7. When you measure large value electrolytic capacitors (over 500 μF) and small value resistors (less than 100 Ω) within a circuit, the indication for a shorted component will be displayed. It will be necessary to further isolate the circuit components for more accurate results.

OPERATIONAL EXAMPLES

1. Plug the line cord into its appropriate AC wall outlet and turn the POWER switch to ON. Allow the unit to operate for ten minutes to stabilize.

2. Turn the INTENSITY control to its midrange position. Set the VERT POS and HORIZ POS controls to center the trace. Readjust the INTENSITY control to the preferred level. Set the focus control for a sharp clear trace.

3. Set the TEST VOLTS to the 5 V position.

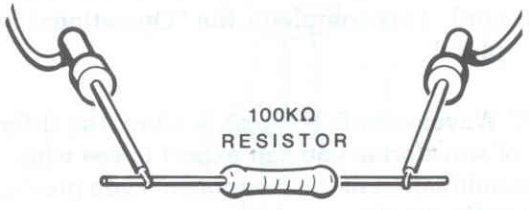
4. Set the DISPLAY MODE to the A position.

5. Plug the red wire probe connector into the red A test jack and one of the black probe connectors into the black A test jack.

6. Plug the white wire probe connector into the red B test jack and the other black probe connector into the black B test jack.

In the following section, you will be given a general method of testing several types of individual components. You will also be given typical waveforms for comparison (Illustration Booklet, Page 20). Different types of circuits and components will vary somewhat from those shown in the examples. You may wish to make your own waveform chart once you are familiar with the units operation. You have been supplied with three resistors, two capacitors, and a transistor for testing purposes. Check the display for channel A first.

7. Refer to Pictorial 5-2 and connect the A channel test probes to the leads of the 100 kΩ (brn-blk-yel) test resistor as shown. The display should be similar to waveform A on the Waveform Chart.



PICTORIAL 5-2

8. Slide the TEST VOLTS switch to the 50 V position. The display should be similar to the one shown in waveform B.

9. Disconnect the 100 kΩ resistor and connect the 1000 Ω (brn-blk-red) resistor to the test probes. The display should be similar to waveform C.

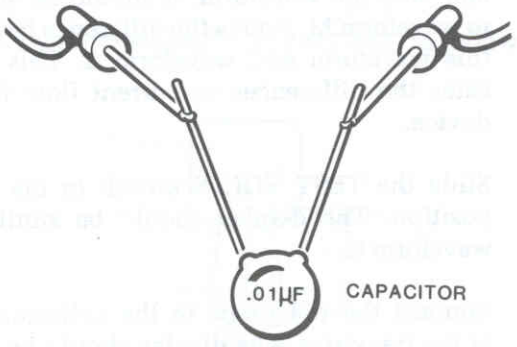
10. Slide the TEST VOLTS switch to the 5 V position. The display should be similar to waveform D.

11. Disconnect the 1000 Ω resistor and connect the 100 Ω (brn-blk-brn) resistor. The display should be similar to waveform E.

12. Slide the TEST VOLTS switch to the 50 V position. The display should be similar to waveform F.

NOTE: As the resistance value decreases, the more vertical the trace will become.

13. Disconnect the probes from the resistor and reconnect them to the .01 μF capacitor as shown in Pictorial 5-3. The display should be similar to waveform G.



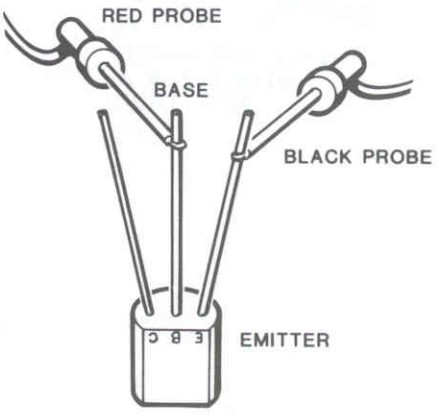
PICTORIAL 5-3

14. Slide the TEST VOLTS switch to the 5 V position. The display should be similar to waveform H.

15. Disconnet the .01 μF capacitor and connect the 10 μF electrolytic capacitor the test probes. The display should be similar to waveform I.

16. Slide the TEST VOLTS switch to the 50 V position. The display should be similar to waveform J.

17. Disconnect the 10 μF capacitor and connect the red probe to the B (base) lead and the black probe to the E (emitter) lead of the test transistor as shown in Pictorial 5-4. The display should be similar to waveform K.



PICTORIAL 5-4

18. Slide the TEST VOLTS switch to the 5 V position. The display should be similar to waveform L.

NOTE: At the higher voltage range, notice that the "zener" action of the transistor is displayed.

19. Reverse the probe leads at the B and E leads and note the waveform. It should be similar to waveform M. Notice the difference between this waveform and waveform L. This indicates the differences in current flow in the device.

20. Slide the TEST VOLTS switch to the 50 V position. The display should be similar to waveform K.

21. Connect the red probe to the collector lead of the transistor. The display should be similar to waveform N.

22. Slide the TEST VOLTS switch to the 5 V position. The display should be similar to waveform O.

23. Reconnect the black probe to the E lead of the transistor. The display should be similar to waveform Q.

24. Slide the TEST VOLTS switch to the 50 V position. The display should be similar to waveform P.

Refer back to step 7 and repeat the steps to check display channel B. It is not necessary to go through all of the steps if you do not wish to. When you are finished checking the B channel, proceed to step 25.

25. Connect both black leads to the B (base) lead of the test transistor. Then connect the red lead (channel A) to the E (emitter) and the white lead (channel B) to the C (collector).

26. Slide the TEST VOLTS switch to the 50 V position and the DISPLAY MODE to the A/B position. The display should be similar to waveform S.

27. Turn the POWER off and disconnect the line cord. This completes the "Operational Examples."

NOTE: Waveforms R through X show the different types of waveforms you can expect to see when you use a combination of the components you previously tested individually.

IN CASE OF DIFFICULTY

This part of the Manual will help you locate and correct difficulties which might occur in your Component Tracer. 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 Component Tracer in which the difficulty is located ("How to troubleshoot Your Circuit Tracer").

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

The second section consists of a series of "Troubleshooting Charts." These charts call out specific problems that may occur and list one or more conditions or components that could cause each difficulty. 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. A "Circuit Board X-Ray View" (Illustration Booklet, Page 22) is also provided to help you locate the component and test points.

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 on Pages 12 and 13. 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. Refer to Page 13 for instructions on how to remove a solder bridge.

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. Check 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 components.

3. Do not remove transistors or any integrated circuits from the Component Tracer while it is turned on; this could damage it.

WARNING: The full AC line voltage is present at several places in the Component Tracer (fuseholder, ON-OFF switch, etc.). Refer to Pictorial 3-2 (Illustration Booklet, Page 18) for the location of these high voltage areas. Be careful so you do not get a shock when you perform the checks described.

HOW TO TROUBLESHOOT YOUR COMPONENT TRACER

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

You may also go directly to the "Troubleshooting Charts" to see if the difficulty you are having is listed in one of the sections.

REPAIRING THE COMPONENT TRACER

When you make repairs to the Component Tracer, 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 Component Tracer back into operation.

SHIPPING

IMPORTANT: If it becomes necessary to ship the Component Tracer to the Heath Company or a Heath Electronic Center, attach the cabinet to the chassis to protect the circuit board and CRT during shipment.

TROUBLESHOOTING CHARTS

Refer to the X-Ray View of the circuit board (Illustration Booklet, Page 22) and the Schematic Diagram (fold-in) to locate and identify the parts listed in these charts.

If a particular part is mentioned (R1 for example) as a possible cause, check that part and other components connected to it 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.

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.

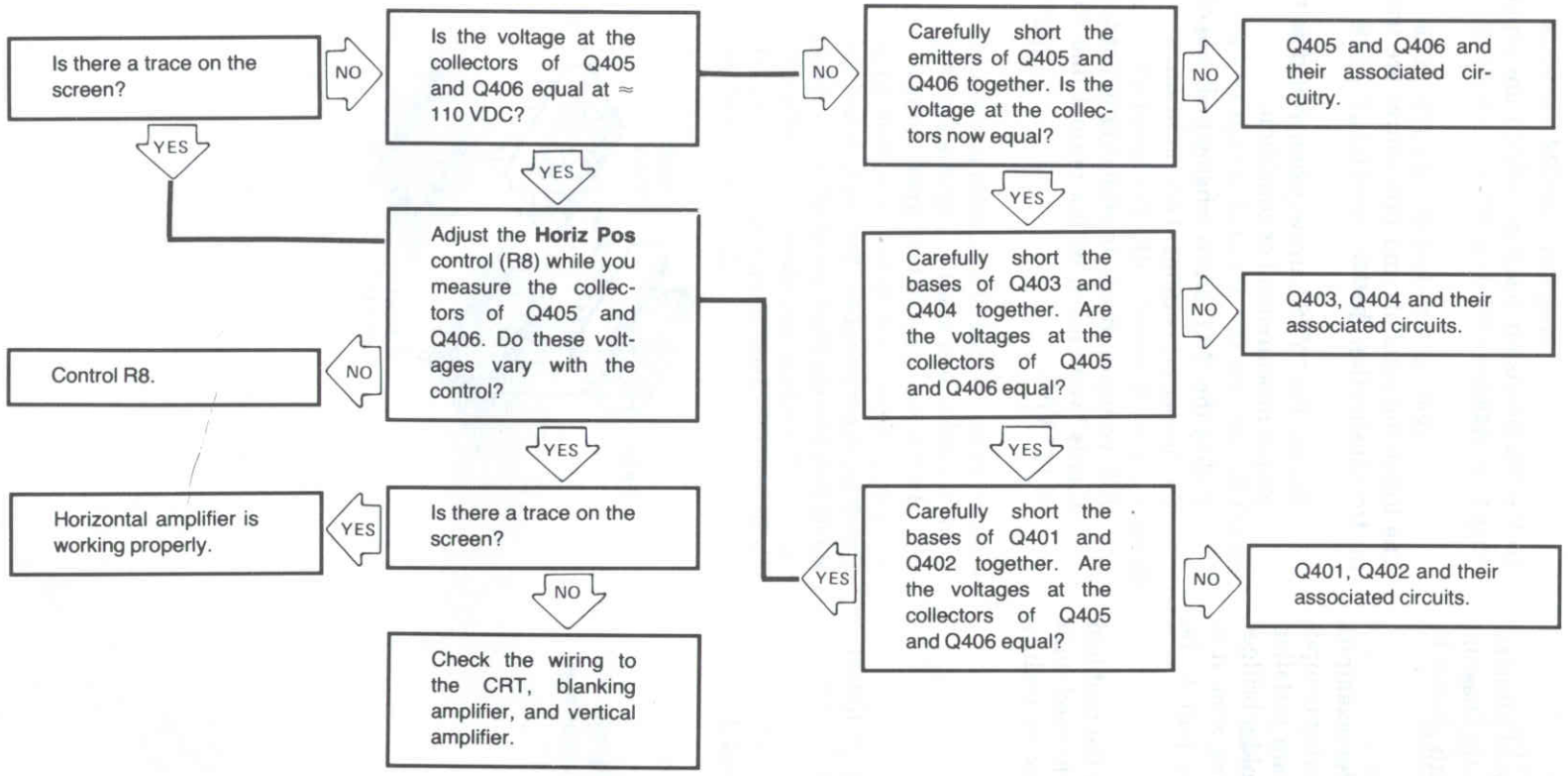
The following symbols and procedures are used in the troubleshooting charts:

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

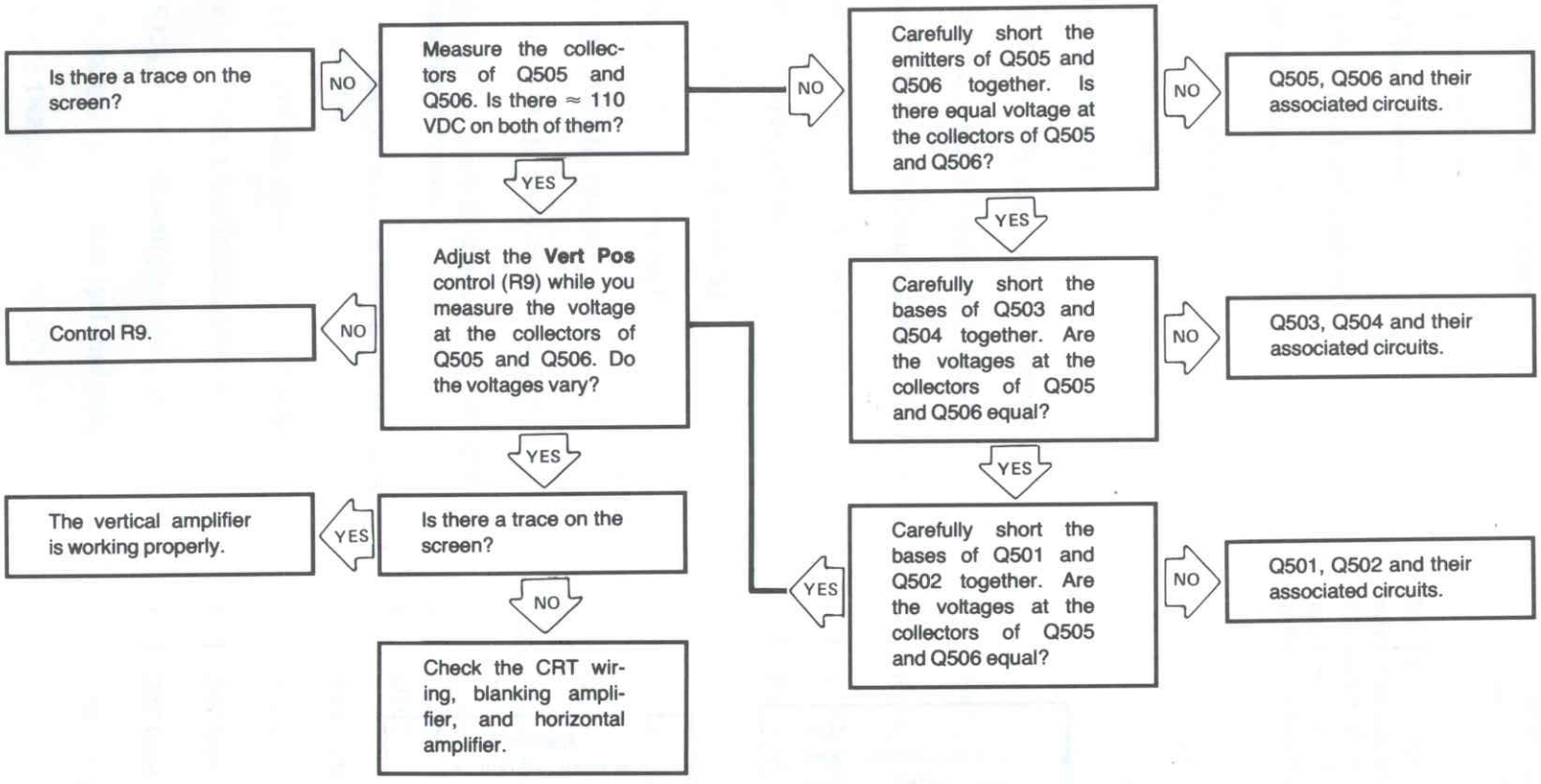
Follow the "NO" arrow when you do not obtain the proper measurement or condition.

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

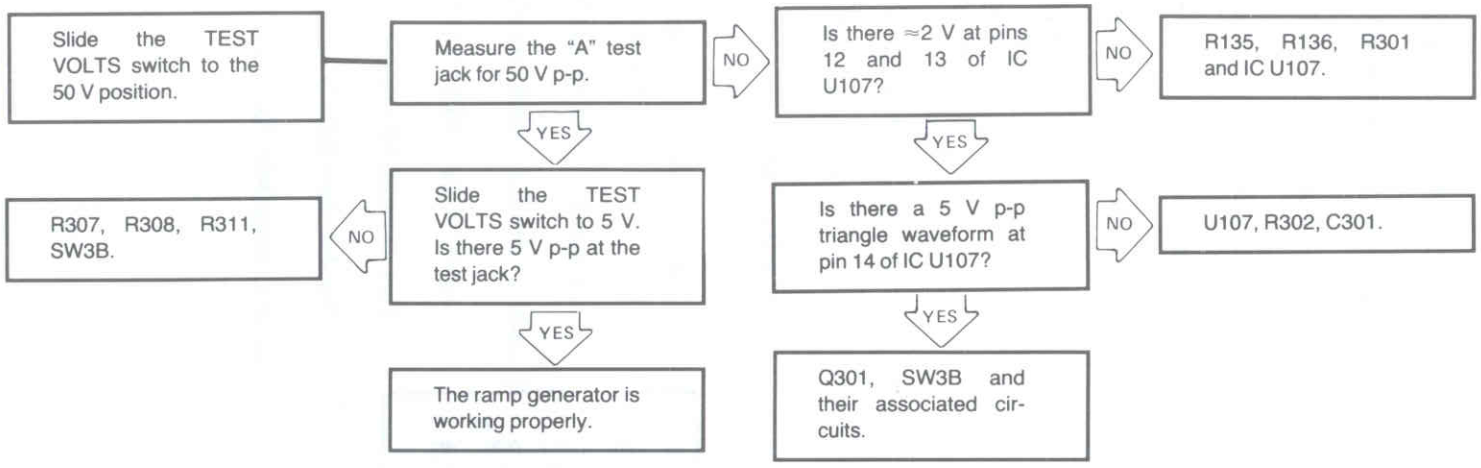
HORIZONTAL AMPLIFIER



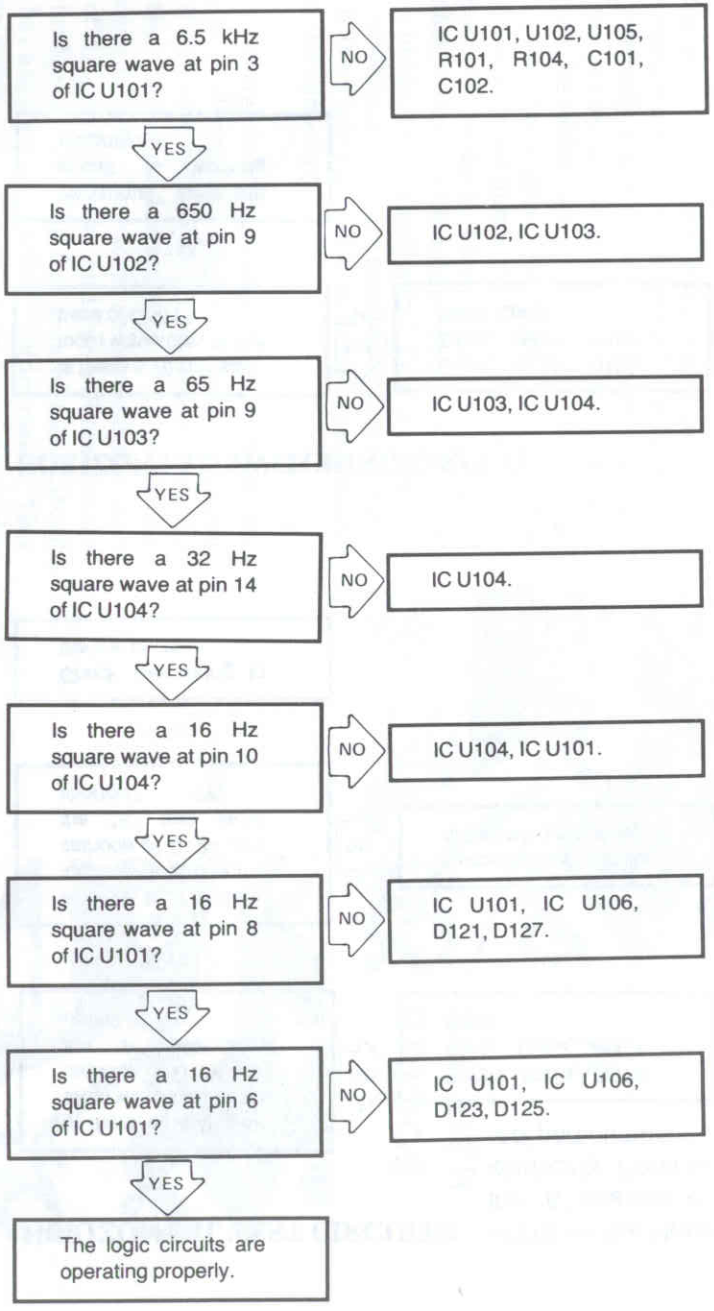
VERTICAL AMPLIFIER



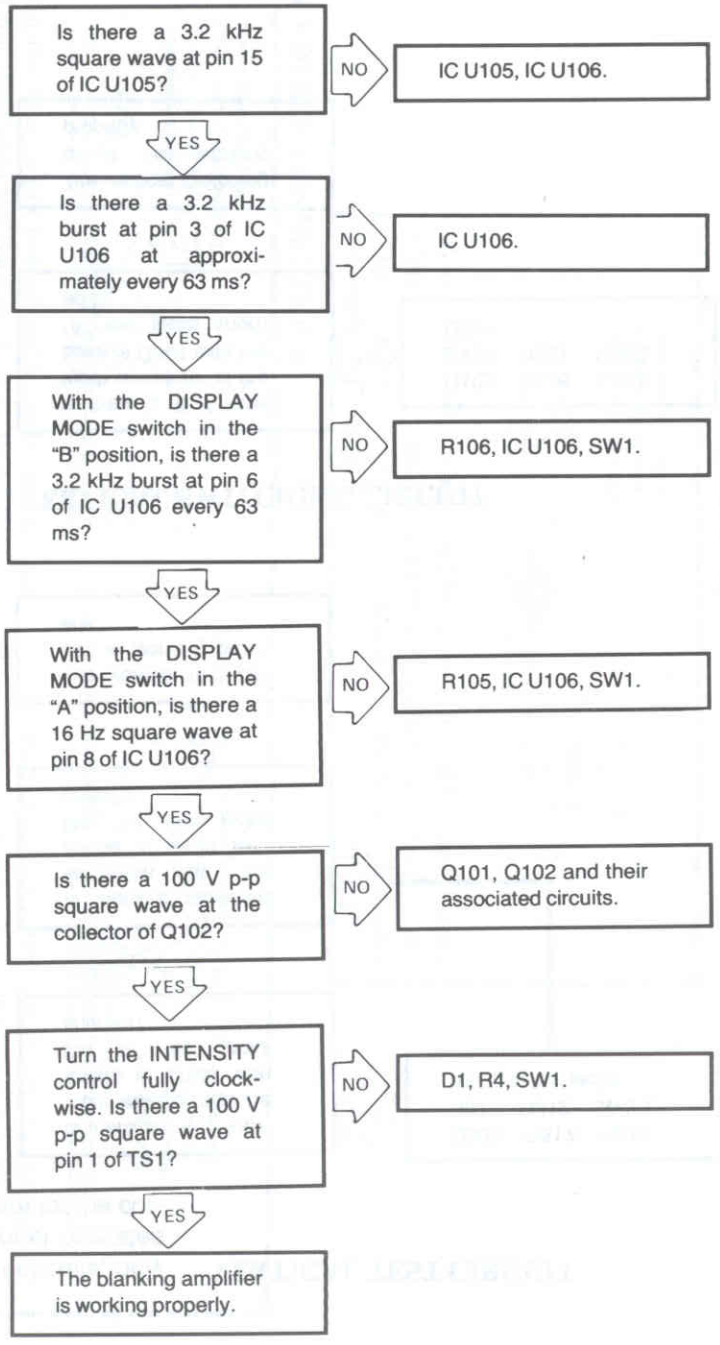
RAMP GENERATOR (Logic circuits must be operating properly)



LOGIC CIRCUITS

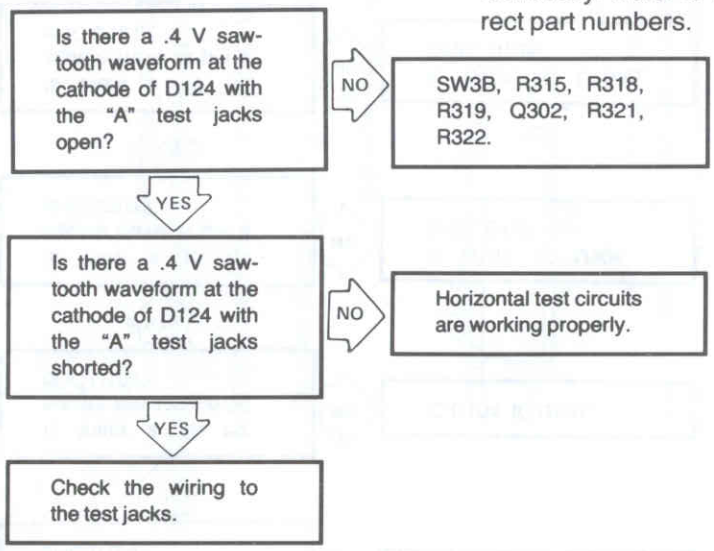


BLANKING CIRCUITS
(Logic circuits must be working.)

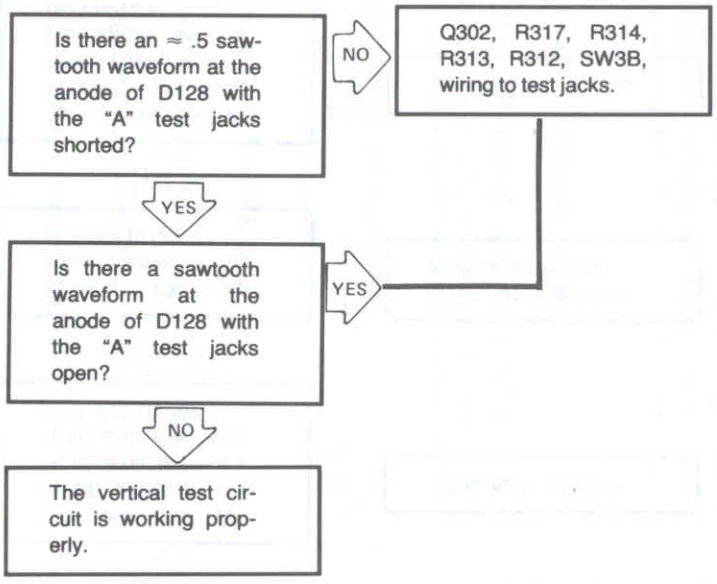


HORIZONTAL TEST CIRCUITS

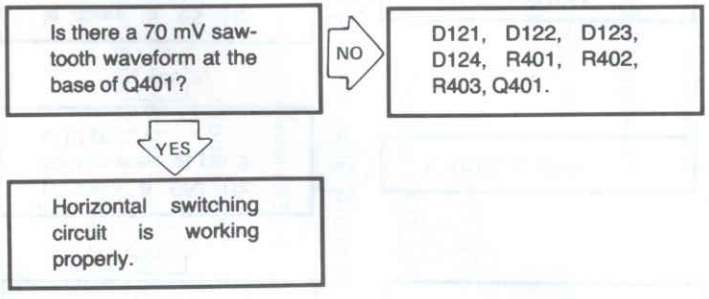
NOTE: In the Horizontal and Vertical test circuits, only the "A" channel is shown. The "B" channel operates identically. Refer to the Schematic Diagram for the correct part numbers.



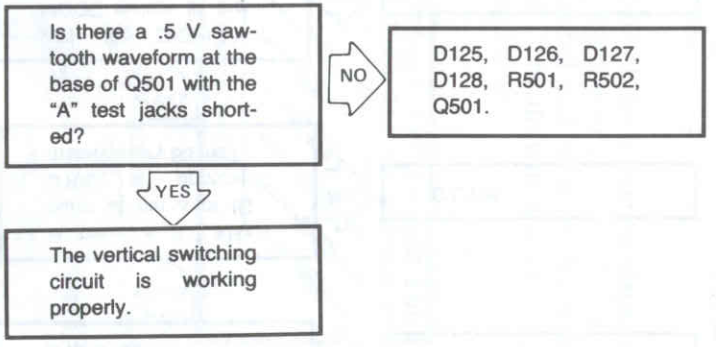
VERTICAL TEST CIRCUIT



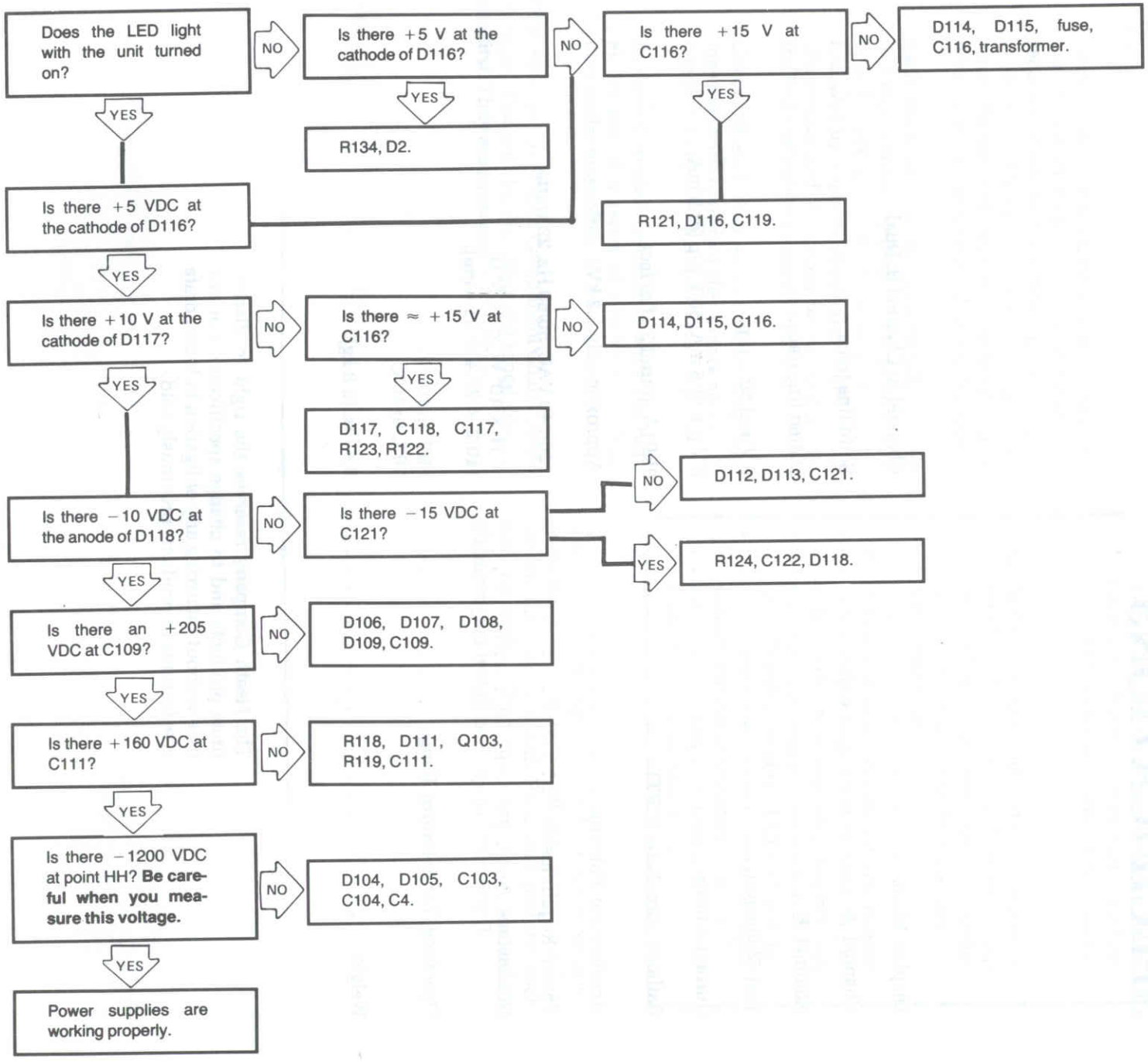
HORIZONTAL SWITCHING CIRCUIT



VERTICAL SWITCHING CIRCUIT



POWER SUPPLIES



SPECIFICATIONS

Display Mode	Channel A; Channel B; Dual.
Channel A	Solid line trace.
Channel B	Dotted line trace.
Test Voltages	5 V and 50 V p-p.
Current Limits	5 V p-p @ 5 mA; 50 V p-p @ .5 mA.
Cathode Ray Tube (CRT)	3RP1A, round 3", flat face.
Accelerating Potential	Approximately 1.2 kV.
Power Requirements	120/240 VAC, 50/60 Hz, 22 watts.
Dimensions	4" H × 10" W × 12.5" D (10.2 × 25.4 × 31.8 cm).
Operating Temperature Range	50°F to 104°F. 10°C to 40°C.
Weight	8.4 lbs. (3.8 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 Block Diagram (Illustration Booklet, Page 21) and the Schematic Diagram (fold-in) as you read this "Circuit Description."

INTRODUCTION

The Component Tracer is divided into the oscillator, blanking, ramp, test, switching, and power supply circuits. Each of these will be discussed below in detail.

The 6.5 kHz oscillator is divided by five stages to develop the appropriate timing pulses. The following frequencies are used: 3250 Hz for the "B" blanking; 32 Hz for the "A" and "B" ramp generators; and 16 Hz for the "A" and "B" blanking and horizontal and vertical switching circuits. 3250 Hz pulses are gated by 16 Hz pulses to develop a pulse "burst" for the "B" blanking signal. This signal is amplified and applied to the CRT during the "B" sweep and results in a dotted trace. The "A" blanking uses 16 Hz pulses directly to obtain a solid trace. The "A/B" mode displays both the "A" and "B" channels alternately.

The 32 Hz pulse is applied to both the "A" and the "B" ramp generators to develop shaped ramps. Each ramp is amplified and applied to the test circuit.

The test voltage attenuators allow the selection of 50 V p-p or 5 V p-p test voltages at the "A" and "B" test jacks. The horizontal test circuit applies an attenuated portion of the triangle waveform to the horizontal switching circuitry. The horizontal display indicates the voltage across the device. At the same time, the vertical test circuit waveform is compared to the triangle wave generated by the ramp generator. As long as these waveforms remain complimentary and equal, no signal results.

If a circuit or component is under test, "loading" of the test voltage changes the waveform applied to the horizontal switching circuits. The same loading also produces a difference voltage between the ramp and test waveforms. This difference is detected and applied to the vertical switching circuits. The loading is proportional to the current through the device and is displayed on the vertical axis.

Timing pulses to the horizontal and vertical switching circuits alternate either the "A" and/or "B" test signals to the horizontal and vertical amplifiers. These are amplified and applied to the CRT deflection plates.

OSCILLATOR AND LOGIC CIRCUITS

The timing oscillator is made up of ICs U101A and U101D. Resistors R101 and R104 and capacitors C101 and C102 make up the timing networks that set the oscillator at 6.5 kHz. The output at pin 3 of U101A is applied to pins 6 and 11 of U102, and also to pin 1 of U105 in the blanking circuits.

The output at pin 9 of U102 divides the signal by 10. This 650 Hz waveform is applied to pins 6 and 11 of U103. U103 is also a divide-by-10 stage and results in a 65 Hz signal at pin 9. This 65 Hz signal is applied to the clock input at pin 1 of U104A. This is a divide-by-two J-K flip-flop stage with its $\overline{Q}$ output at pin 14 applied to the clock input at pin 6 of U104B. The Q output at pin 15 is used to drive both "A" and "B" ramp generators. Pins 10 and 11 of U104B is also used as a divide-by-two stage. Pin 10 of IC U104B is applied to pins 9 and 10 of U101C, which acts as a buffer. The output at pin 8 of U101C drives pin 10 of U106C in the blanking circuitry and switch diodes D121 and D127. Pin 11 of U104B is applied to pins 4 and 5 of U101B which is also used as a buffer stage. The output at pin 6 of U101B is applied to pin 2 of U106A in the blanking amplifier, and to channel switch diodes D123 and D125.

BLANKING CIRCUIT

Dotted trace "B" is developed using a 3250 Hz signal. The output at pin 3 of U101A is coupled to pin 1 of U105, a divide-by-two stage that produces a 3.25 kHz signal at pin 15. This signal is applied to pin 1 of U106A. Pin 2 of U106A is toggled by output pin 6 of U101B at a 16 Hz rate. The output at pin 3 of U106A is a 3.25 kHz burst every 63 ms. This is applied to pin 4 of U106B. When switch SW1 is in the "B" position, resistor R105 pulls pin 5 of U106B high and turns on U106B. This results in the burst signal at pin 6 of U106B.

Solid line trace "A" is developed using the output at pin 8 of U101C, which is applied to pin 10 of U106C. When SW1 is in the "A" position, pin 9 of U106C is pulled high by resistor R106. This allows U106C to couple the pulse to pin 8 of U106C. In the A/B mode, both pins 5 and 9 of U106 are high which produces a combined output and permits dual operation.

Resistors R107 and R108 couple the unblanking signals to the base of transistor Q101. Resistor R114 couples the signal from the collector of Q101 to the base of Q102, which further amplifies the pulses. Resistor R4 adjusts the intensity of the display by adjusting the amplitude of the unblanking signals. Diode D1 provides protection for Q102 during turn on. The signal at resistor R4 is coupled through capacitor C3 to the control grid of the CRT.

RAMP CIRCUITS

The 32 Hz output at pin 15 of U104A is coupled through isolation resistor R201 to pin 9 of U107A. This stage is used as an integrator with resistor R202 and capacitor C201 setting the amplitude to produce the "B" ramp, a triangular output, from the square wave input. Resistors R135 and R136 form a resistive divider to set the reference voltage at pin 10 of U107A and pin 12 of U107B. Capacitor C203 couples the triangle wave to the base of transistor Q201.

The gain of Q201 is determined by resistors R204, R203, and R206. R205 is adjusted to set the amplitude of the test signal to the attenuator. Capacitor C202 couples the ramp signal to the divider network of resistors R207 and R208 to provide 50 V p-p at R209 and 5 V p-p at resistor R211. Switch SW3A selects either 50 V or 5 V for testing at the "B" test jack. Resistor R209 serves as a current limit in the 50 V test position, and resistor R207 serves as a current limit in the 5 V test position. U107B and transistor Q301 make up the "A" ramp generator. Switch SW3B selects either 50 V p-p or 5 V p-p at the "A" test jack.

HORIZONTAL TEST AND SWITCHING CIRCUITS

Resistors R215, R218, R219, R221, and R222 make up the horizontal test circuit. When switch section SW3A is in the 50 V position, R219 is grounded by section SW3C. Divider resistors R215 and R219 produce 3 V p-p at the junction of R219 and R218. When switch section SW3A is in the 5 V p-p position, resistors R215, R218, and R222 form a divider that results in a 3 V p-p signal at the junction of R218 and R219. The voltage at this junction is coupled through R218 and R221 to the cathode of diode D122.

The test circuit for "A" ramp is identical to the "B" test circuit, except that switch sections SW3B and SW3D are used. The signal at the junction of resistors R318 and R319 is coupled through resistors R318 and R321 to the cathode of diode D124.

Diodes D121, D122, D123, and D124 make up the horizontal switching. When pin 8 of U101C goes high, diode D121 is biased "on," causing D122 to turn "off." At the same time, pin 6 of U101B is low which is applied to the anode of diode D123 turning it off. With D123 off, the cathode of D124 remains on coupling the signal from the "A" ramp generator to the horizontal amplifier. When pin 8 of U101C goes low, diode D121 is off and diode D122 is on, which couples the "B" ramp information to the horizontal amplifier. At the same time, pin 6 of U101B is high, which biases D123 on, coupling the high to the cathode of D124 and blocking the "A" ramp signal.

VERTICAL TEST CIRCUIT

Transistor Q202 is used as a "voltage reference," with its gate connected to the junction of resistors R218 and R219. It drives one end of vertical test circuit resistors R212, R213, and R214. The other end of the circuit is driven by the ramp (triangle) waveform at the U107A output. The triangle waves at the R218/R219 junction and the output if U107A are 180° out of phase. Resistor R213 serves as a null (tilt) adjustment. With no device being tested, the two triangle waves are unchanged and the output of resistor R213 is "balanced" to a null voltage. When a device or circuit is under test, the waveform at the R218/R219 junction will show changes in the triangle wave as the test circuit conducts. With the complimentary waveforms no longer equally balanced, the output of R213 will no longer be nulled. The output of R213 is applied to the anode of diode D126.

The test circuit for the "A" channel is identical except for resistor R317, which is adjusted for minimum vertical separation when operating in the A/B mode. The output of resistor R313 is applied to the anode of diode D128.

VERTICAL SWITCH

When pin 8 of U101C is high, diode D127 is biased off and diode D128 is biased on, which couples the signal from the "A" test circuit to the vertical amplifier circuit. At the same time, pin 6 of U101B is low and is applied to the cathode of diode D125, which biases it on. The low is coupled through diode D125 to the anode of diode D126, turning it off and blocking the "B" signal from the vertical amplifier circuit.

When pin 8 of U101C is low, diode D127 turns on and diode D128 turns off blocking the "A" signal from the vertical amplifier circuit. At the same time, pin 6 of U101B is high, turning diode D125 off and diode D126 on, and coupling the "B" signal to the vertical amplifier circuit.

VERTICAL AMPLIFIER

Transistors Q501 and Q502 form a single-ended to differential stage. The vertical signal from the "A" and "B" test circuits is applied to the base of Q501. The base of Q502 is driven by vertical position control R9. The gain of this stage is approximately 12. Transistors Q503, Q504, Q505, and Q506 make up a differential cascode output stage that drives the CRT. The gain of the cascode stage is approximately 30, with the gain of the amplifier set by resistor R518.

HORIZONTAL AMPLIFIER

NOTE: The Horizontal circuitry operates identically to the Vertical circuitry. Refer to the Schematic Diagram for the component numbers.

−1200 VDC SUPPLY

Diodes D104 and D105 and capacitors C103 and C104 make up a voltage doubler that produces approximately −1600 VDC at nominal 120 VAC line voltage. Resistor R117 and capacitor C4 filter and reduce the voltage to approximately −1200 VDC. Diode D119, resistors R129, R131, R132, and R133, and control R7 supply cathode bias and reduce the voltage for Focus control R7. Resistor R6 biases the filaments to the cathode of the CRT. Astigmatism adjustment resistor R127 and emitter follower transistor Q104 set the astigmatism voltage for the CRT.

+205 VDC AND +160 VDC SUPPLIES

Full-wave bridge rectifier diodes D106, D107, D108, and D109 produce the +205 VDC which is filtered by capacitor C109. The +205 VDC is used by the horizontal and vertical output amplifiers. It is also used to develop the +160 VDC used for the blanking amplifier, astigmatism, and the "A" and "B" ramp generators. Transistor Q103, resistor R118, and diode D111 form a zener voltage reference to keep the emitter of Q103 at a constant +160 VDC. Resistor R119 is a current shunt to keep the Q103 power dissipation down. Capacitor C111 provides additional filtering.

+10 VDC AND +5 VDC SUPPLIES

Diodes D112, D113, D114, and D115 make up two full-wave rectifiers that produce +15 VDC. Capacitor C116 filters the +15 VDC, which is used to produce both the +10 VDC and the +5 VDC.

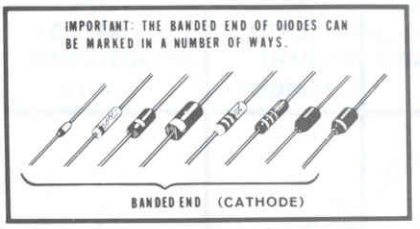
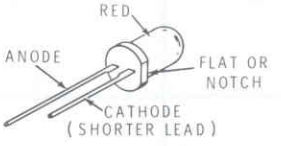
Resistor R121, capacitor C119, and diode D116 make up the +5 VDC supply. Resistor R121 drops the +15 VDC to +5 VDC. Diode D116 requlates the output at +5 VDC, and capacitor C119 provides the filtering.

Resistors R122 and R123, capacitors C117 and C118, and diode D117 make up the +10 VDC supply. Capacitors C117 and C118 and resistor R123 provide additional filtering. Resistors R122 and R123 drop the +15 VDC to +10 VDC. Diode D117 regulates the output at +10 VDC.

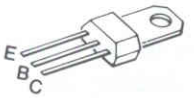
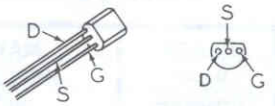
Capacitor C121 provides filtering of the −15 VDC from the rectifiers. Resistor R124 drops the −15 VDC to −10 VDC, and diode D118 regulates the output at −10 VDC. Capacitor C122 provides additional filtering.

SEMICONDUCTOR IDENTIFICATION CHARTS

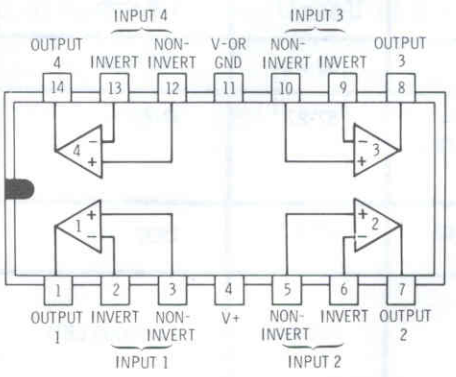
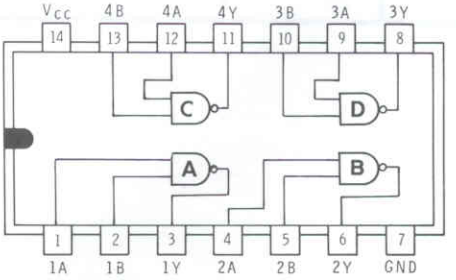
DIODES

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION
D101, D102, D103, D121 – D128	56-56	1N4149	
D117, D118	56-67	1N4740A	
D116	56-85		
D111	56-617	1N5277B	
D119	56-634	2EZ82D5	
D1, D106 – D109, D112 – D115	57-27	1N2071	
D104, D105	57-52	DO7	
D2	412-640	LST5053 LED	

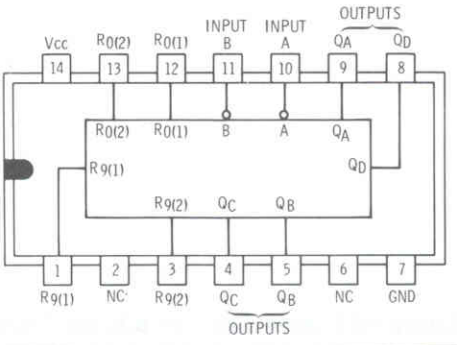
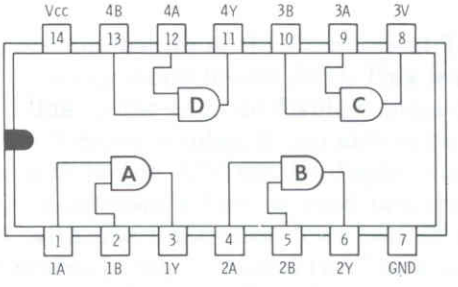
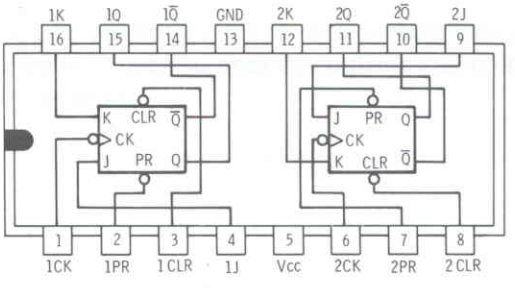
TRANSISTORS

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION
Q102, Q104	417-811	MPSL01	
Q101, Q401, Q402, Q403, Q404, Q501 – Q504	417-875	2N3904	
Q103, Q201, Q301, Q405, Q406, Q505, Q506	417-834	MPSU10	
Q202, Q302,	417-854		

INTEGRATED CIRCUITS

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
U107	442-602	LM324	
U101	443-728	74LS00	

Integrated Circuits (Cont'd.)

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
U102, U103	443-731	74LS290	
U106	443-780	74LS08	
U104, U105	443-829	74LS76	

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