

# HEATHKIT<sup>®</sup> MANUAL

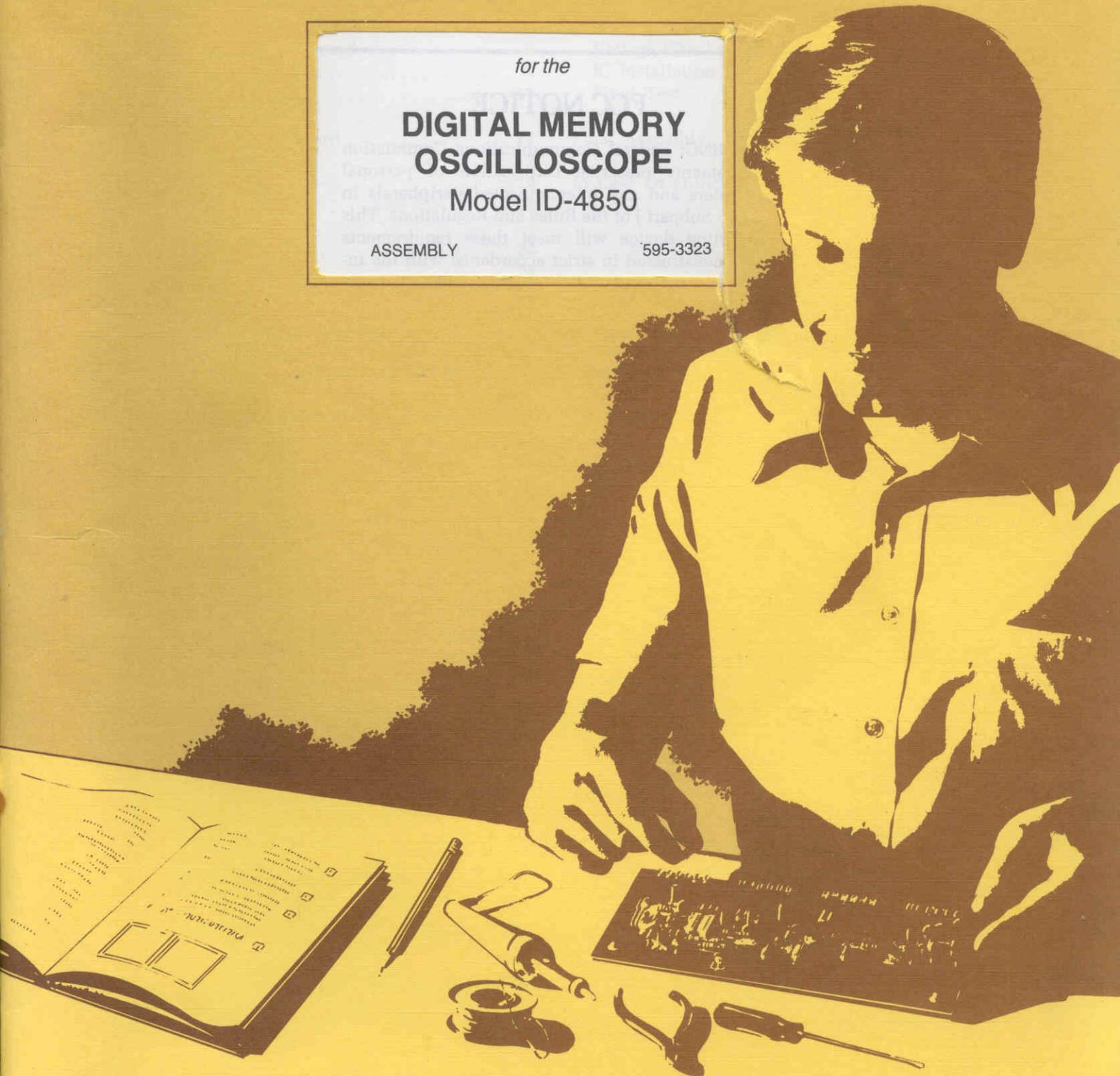
for the

## DIGITAL MEMORY OSCILLOSCOPE

Model ID-4850

ASSEMBLY

595-3323



HEATH COMPANY • BENTON HARBOR, MICHIGAN

# HEATH COMPANY PHONE DIRECTORY

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

Kit orders and delivery information ..... (616) 982-3411  
Credit ..... (616) 982-3561  
Replacement Parts ..... (616) 982-3571

## Technical Assistance Phone Numbers

8:00 A.M. to 12 P.M. and 1:00 P.M. to 4:30 P.M., EST, Weekdays Only  
R/C, Audio, and Electronic Organs ..... (616) 982-3310  
Amateur Radio ..... (616) 982-3296  
Test Equipment, Weather Instruments and  
Home Clocks ..... (616) 982-3315  
Television ..... (616) 982-3307  
Aircraft, Marine, Security, Scanners, Automotive,  
Appliances and General Products ..... (616) 982-3496  
Computers — Hardware ..... (616) 982-3309  
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Operating Systems, Languages, Utilities ..... (616) 982-3860  
Application Programs ..... (616) 982-3884  
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## YOUR HEATHKIT 90-DAY 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 90 days 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 90 days from the date of purchase, any malfunction caused by defective parts or error in design will be corrected at no charge to you. You must deliver the unit at your expense to the Heath factory, any Heathkit Electronic 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 your 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 entirety. 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 FORSEEABLE.

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

#### 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 responsibility.

**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 directly to our Director of Customer Service, Heath Company, Benton Harbor MI 49022. He will make certain your problems receive immediate, personal attention.

# Heathkit® Manual

*for the*

## **DIGITAL MEMORY OSCILLOSCOPE**

Model ID-4850

ASSEMBLY

595-3323

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

### **FCC NOTICE**

WARNING: Federal Communications Commission requirements prescribe certification of personal computers and any interconnected peripherals in Part 15 Subpart J of the Rules and Regulations. This computing device will meet these requirements when constructed in strict accordance with the instructions in this Manual, using only components and materials supplied with the kit or the exact equivalent thereof. You will be instructed to sign and date the enclosed FCC ID label and affix the label to the equipment certifying that you have constructed this equipment in accordance with the above mentioned instructions. In order to meet legal requirements, be certain to follow the instructions exactly as they are stated in this Manual.

## Table of Contents

Introduction .....	4	Chassis .....	48
Unpacking .....	5	Parts List .....	48
Assembly Notes .....	6	Step-By-Step Assembly .....	51
Display Control Circuit Board .....	9	Initial Tests .....	56
Parts List .....	9	Primary Wiring Checks .....	56
Step-By-Step Assembly .....	11	Voltage Checks .....	57
Display Logic Circuit Board .....	17	IC Installation .....	59
Parts List .....	17	Final Test .....	62
Step-By-Step Assembly .....	19	Final Assembly .....	64
Resistance Checks .....	23	In Case Of Difficulty .....	65
Main Circuit Board .....	24		
Parts List .....	24		
Step-By-Step Assembly .....	29		
Resistance Checks .....	46		

## INTRODUCTION

The Heathkit Digital Memory Oscilloscope (DMO), Model ID-4850, is a versatile accessory for an oscilloscope or a PC-compatible computer such as the Zenith Z-100 PC series, the Heath H-100 PC series, or an IBM PC. It can upgrade an oscilloscope that has a low-frequency bandwidth to a 50 MHz bandwidth on repetitive signals, and can also add waveform storage capabilities.

When you connect the DMO to a computer through its RS-232 connector, the supplied software provides you with full control of the DMO functions, from the computer keyboard. The waveforms are displayed on the computer's screen. The computer software also provides you with the added capabilities for disk storage; averaging; and cursor measurement of voltage, time, and frequency. User-written software can be used to customize the DMO for specific applications, such as automated testing.

The DMO is a sampling oscilloscope. It periodically samples analog input signals, converts them into digital code, and then stores them in its memory. When these coded signals are retrieved, they are displayed as waveforms on the oscilloscope or on the computer's CRT. The DMO samples repetitive signals from .4 s/sample to 200 ps/sample, and non-repetitive signals from .4 s/sample to 10  $\mu$ s/sample.

The attenuator networks for channels Y1 and Y2 have ten calibrated ranges, from 5 mV/div to 5 V/div, and are switched in a 1-2-5 sequence. The calibrated time base ranges from 20 s/div to 10 ns/div are also switched in a 1-2-5 sequence. The trigger select and trigger level allows the time base to be triggered at any point along the positive or negative slope of

either the Y1 or Y2 trigger signal. An auto-baseline function is provided to automatically display a base line on the screen when there is no trigger signal present.

Some of the features when you use this unit with a normal oscilloscope include:

- Dual trace.
- 2.5 Hz to 100 kHz real-time sampling rates on non-repetitive signals.
- 50 MHz bandwidth on repetitive signals.
- 7 ns rise time on repetitive signals.
- Single sweep function.
- 5 mV/division vertical sensitivity.
- Waveform storage.
- Comparison of live vs stored waveforms.

Some of the features when you use this unit with a computer include:

- Control over large distances via RS-232.
- Control via modem.
- Signal averaging.
- Inversion of either channel.
- Cursor measurement of voltage and differential voltage.
- Cursor measurement of frequency, time, and time difference.
- Waveform storage on disk.

This digital sampling oscilloscope is a laboratory grade test instrument ideal for the wide range of measurements used in electronics development, education, production lines, and scientific research.

## UNPACKING

The shipping carton in which your kit was packed contained this Manual and some other papers, Packs #1, #2, and #3, which contain the circuit board parts, and a number of loose parts. These loose parts, which consist principally of larger items used in the chassis assembly, will be called the "Final Pack" parts in the Parts Lists.

Refer to the "Pack Index Sheet" and remove Pack #1 from the shipping carton but do not open it.

**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.

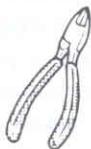
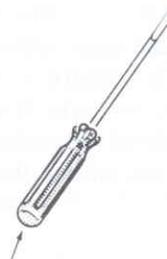
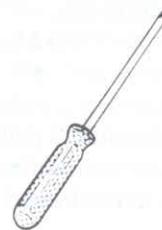
# ASSEMBLY NOTES

## TOOLS

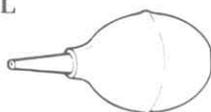
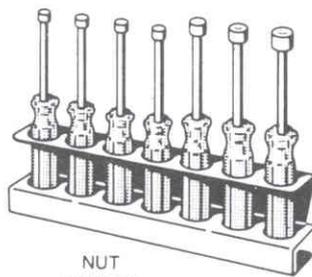
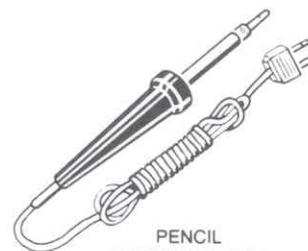
You will need these tools to assemble your kit.



PLIERS

LONG-NOSE  
PLIERSDIAGONAL  
CUTTERSWIRE  
STRIPPERS1/4"-BLADE  
SCREWDRIVERPHILLIPS  
SCREWDRIVER

### OTHER HELPFUL TOOLS

NUT STARTER  
(May Be Supplied  
With Kit)DESOLDERING  
BULB\*DESOLDERING  
BRAID\*NUT  
DRIVERSPENCIL  
SOLDERING IRON  
(22 to 25 WATTS)

\*To Remove Solder From Circuit Connections.

## ASSEMBLY

1. Follow the instructions carefully. Read the entire step before you perform each operation.
2. Refer to the separate "Illustration Booklet" for the Pictorials and Details. Keep the "Illustration Booklet" with the Assembly Manual. The illustrations in it are arranged in the proper sequence, as called for in the steps.
3. 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.
4. Position all parts as shown in the Pictorials.
5. Solder instructions are generally given only at the end of a series of similar steps. You may solder more often if you desire.

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 Troubleshooting Charts,
  - In the Schematic,
  - In the sections 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

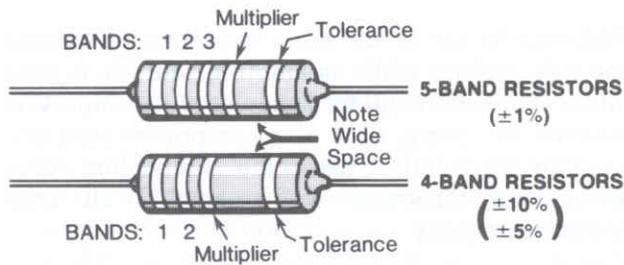
Soldering is one of the most important operations you will perform while assembling your kit. A good solder connection will form an electrical connection between two parts, such as a component lead and a circuit board foil. A bad solder connection could prevent an otherwise well-assembled kit from operating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

## PARTS



**Resistors** are identified in Parts Lists and steps by their resistance value in  $\Omega$  (ohms),  $k\Omega$  (kilohms), or  $M\Omega$  (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 know the color code.

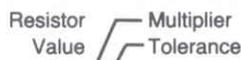
Occasionally, a "precision" or "power" resistor may have the value stamped on it. The letter R, K, or M may also be used at times to signify a decimal point, as in:

$$2R2 = 2.2 \Omega$$

$$2K2 = 2.2 k\Omega, \text{ or } 2200 \Omega$$

$$2M2 = 2.2 M\Omega$$

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.



EXAMPLES:  $1009C = 100 \times 0.1 = 10 \Omega, \pm 0.25\%$

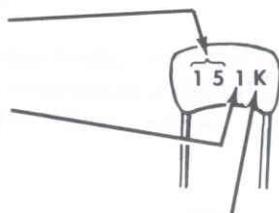
$$1001D = 100 \times 10 = 1000 \Omega, \pm 0.5\%$$

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

First and second digits of capacitor's value: 15

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

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



## RESISTOR COLOR CODE

	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	0.01
Gray	8	8	8	0.1
White	9	9	9	

## RESISTOR TOLERANCE

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

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

EXAMPLES:  $151K = 15 \times 10 = 150 pF$   
 $759 = 75 \times 0.1 = 7.5 pF$

NOTE: The letter "R" may be used at times to signify a decimal point, as in:  $2R2 = 2.2 (pF \text{ or } \mu F)$ .

# DISPLAY CONTROL CIRCUIT BOARD

## PARTS LIST

Remove the parts from Pack 1 and check each part against the following list. The key numbers correspond to the numbers on the "Display Control Circuit Board Parts Pictorial." Return any part that is in an individual envelope with the part number on it, back into the envelope after you have identified it, until that part is called for in a step. Do not remove components that are supplied on a tape from the tape until you use them 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. For prices, refer to the separate "Heath Parts Price List."

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
<b>MISCELLANEOUS</b>				
A1	64-946	19	Pushbutton switch	SW601 – SW609, SW611 – SW619, SW621
A2	255-848	4	LED spacer strip	V601 – V609, V611 – V619,
A3	412-654	51	Red LED HLMP-1002	V621 – V629, V631 – V639, V641 – V649, V651 – V656

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
<b>Miscellaneous (Cont'd)</b>				
A4	432-1227	4	20-pin plug	
A5	462-1196	19	Pushbutton	
A6	390-1855-36	1	FCC label*	
A7	390-147	1	Danger label*	
A8	390-2941	1	Fuse replacement label*	
A9		1	Blue and white label*	
	490-185	1	Desoldering braid	
	891-704	1	Software pack*	
	597-260	1	Parts Order Form*	
		1	Assembly Manual (See front page for part number)	
		1	Operation Manual (See front page for part number)	
			Solder	

\*Packed with the Manual papers. Set these items aside for later use.

KEY HEATH QTY. DESCRIPTION  
 No. Part No. \_\_\_\_\_

**PARTS FROM FINAL PACK**

85-2974-2 1 Display control circuit board

KEY HEATH QTY. DESCRIPTION  
 No. Part No. \_\_\_\_\_

**Cable – Wire – Sleeving**

343-15	12"	Coaxial cable
344-90	2-1/2"	Black wire
344-34	2-1/2"	Brown solid wire
344-91	18"	Brown stranded wire
346-1	2-3/4"	Fiber sleeving
346-35	1-1/4"	Heat-shrinkable sleeving
347-55	12"	8-wire ribbon cable
347-66	12"	25-wire ribbon cable

**TAPED COMPONENTS**

NOTE: The following components are on a taped strip which was checked before shipment. Since these parts are taped in the order of assembly, it is not necessary to check them against the Parts List.

HEATH QTY. DESCRIPTION  
 Part No. \_\_\_\_\_

CIRCUIT  
 Comp. No. \_\_\_\_\_

**RESISTOR**

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

The resistors are rated at 1/4-watt.

6-331-12	9	330 Ω, 1/4-watt, 5% (org-org-brn)	R601 – R609
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HEATH QTY. DESCRIPTION  
 Part No. \_\_\_\_\_

CIRCUIT  
 Comp. No. \_\_\_\_\_

**WIRE**

340-8	12	Bare wire	W601 – W612
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## STEP-BY-STEP ASSEMBLY

- ( ) Remove the "Taped Components Chart" from the back of your Illustration Booklet. Refer to the instructions at the top of the first chart and prepare the taped parts listed under "Display Control Circuit Board."

Refer to Pictorial 1-1 as you read the following notes and steps.

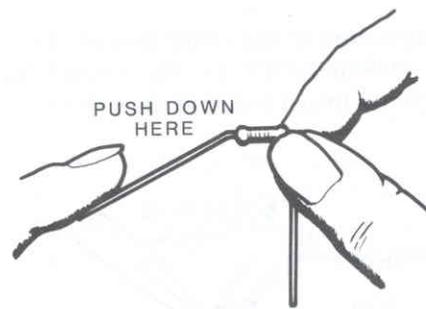
### NOTES:

1. Circuit board drawings, like the one shown in Pictorial 1-1, are divided into sections. These sections show you which area of the circuit board you are working in for a specific series of steps. The numbered sections match the numbered sections on the Taped Components Chart.
2. Usually, each series of steps will have you installing parts in a top-to-bottom, left-to-right sequence. But occasionally, this sequence may be altered briefly so you can install smaller (lower) parts before higher parts. Do not install a part out of sequence, or you may install all of the remaining parts out of sequence also.
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.

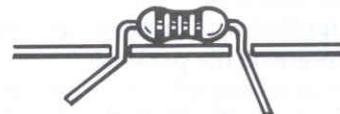
### Section 1

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

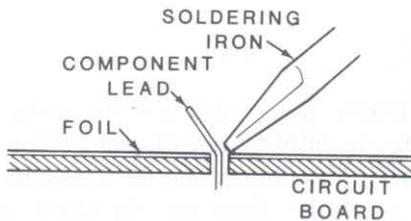
- ( ) Position the circuit board as shown in the Pictorial with the component side (the side with the component outlines on it) facing up. Then start in Section 1 to install the first component.
- ( ) Hold the first component, a 330  $\Omega$  (org-org-brn) resistor, by the body as shown. Bend the leads straight down with your finger to fit the circuit board hole spacing.



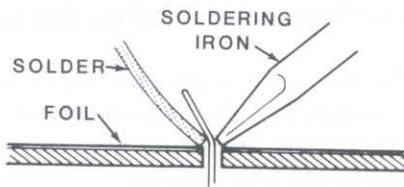
- ( ) R601: Start the resistor leads into their circuit board holes at the indicated location.
- ( ) Press the resistor body against the circuit board and bend the leads outward slightly to hold it in place.



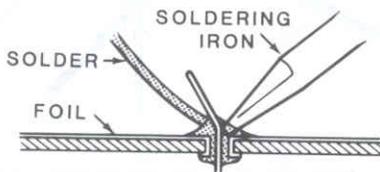
Solder the resistor leads to the circuit board as follows:



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



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



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

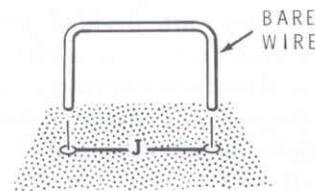
**NOTE:** If you should accidentally fill a circuit board hole with solder and wish to clear it, use the desoldering braid supplied with your kit for this purpose. The instructions are on the package.

- ( ) 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 solder connection and compare it to Detail 1-1A. After you have checked the connections, proceed with the assembly. Use the same soldering procedure for each component.

**IMPORTANT:** Make sure you installed the first component (R601) on Page 11 before you proceed.

- ( ) W601: Cut the bare wire from your taped components strip and bend it to fit the circuit board hole spacing as shown. Then install the wire in the same manner as the previous resistor.



- ( ) W602: Bare wire.
- ( ) W603: Bare wire.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

## Section 2

- ( ) R602: 330  $\Omega$  (org-org-brn) resistor.

Install bare wires at the following locations:

- ( ) W605.
- ( ) W604.
- ( ) W606.
- ( ) W607.
- ( ) W608.
- ( ) R604: 330  $\Omega$  (org-org-brn) resistor.
- ( ) R603: 330  $\Omega$  (org-org-brn) resistor.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

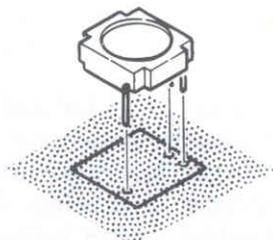
## Section 3

- R609: 330  $\Omega$  (org-org-brn) resistor.
- R607: 330  $\Omega$  (org-org-brn) resistor.
- W609: Bare wire.
- R606: 330  $\Omega$  (org-org-brn) resistor.
- R605: 330  $\Omega$  (org-org-brn) resistor.
- R608: 330  $\Omega$  (org-org-brn) resistor.
- W610: Bare wire.
- W611: Bare wire.
- W612: Bare wire.
- Solder the leads to the foil and cut off the excess lead lengths.

Refer to Pictorial 1-2 for the following steps.

## Section 1

NOTE: When you install the following pushbutton switches, insert the switch pins into the circuit board holes and press the switch body flat against the board. Then solder the pins to the foil and cut off any excess pin lengths. Do not overheat the pins or you could melt the plastic switch body.



Install pushbutton switches at the following locations:

- SW608.
- SW607.
- SW621.
- SW619.
- SW604.

## Section 2

- SW606.
- SW605.
- SW618.
- SW617.
- SW603.

## Section 3

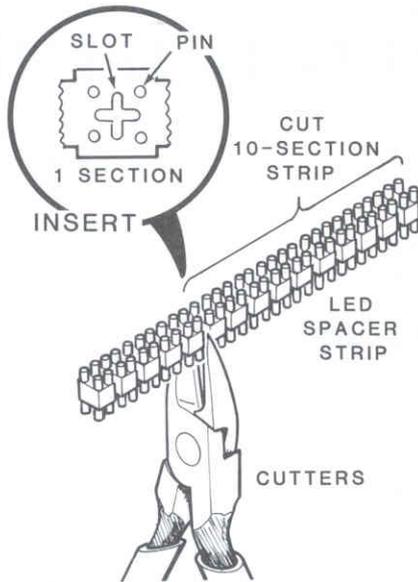
- SW602.
- SW601.
- SW609.

## Section 4

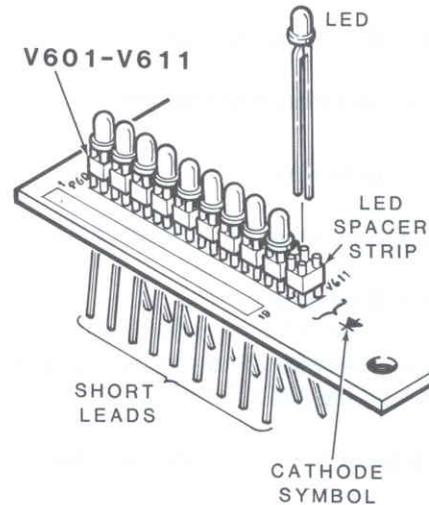
- SW616.
- SW615.
- SW614.
- SW613.
- SW612.
- SW611.

- Check all of the switches and make sure they are flat against the circuit board. If any are not flat, reheat the pin connections as you press the switch against the board. Do not overheat the pins.

- ( ) Use a pair of cutters to remove a 10-section strip from an LED spacer strip as shown. Each four-pin group (see the inset) counts as a section.



the shorter LED lead in the direction of the cathode symbol shown on the circuit board and the following illustration. Insert the leads through the circuit board holes until the LED case is against the top of the spacer; then bend the leads out slightly to hold it in place.



Similarly, cut the following sections from the remaining LED spacer strips. Place the sections on your work surface in the order you prepare them, as you will use them in that order.

- ( ) 3-section.
- ( ) 10-section.
- ( ) 3-section.
- ( ) 9-section.
- ( ) 4-section.
- ( ) 1-section.
- ( ) 2-section.
- ( ) 3-section.
- ( ) 1-section.
- ( ) 2-section.

- ( ) Position a 10-section LED spacer strip over the rectangular outline at V601 through V611. Install an LED into the spacer strip at V601 with

- ( ) Similarly mount nine more LEDs into the LED spacer strip with the short leads toward the cathode symbol.
- ( ) Carefully turn the board over and rest the top of the LEDs against a flat surface. Check to make sure that all the short leads are properly positioned toward the cathode symbol. If you install an LED backwards, it will not light.
- ( ) Solder the leads to the foil and cut off the excess lead lengths. Remember that once the leads are cut off, it is impossible to check the LED for proper orientation. Also, carefully check for solder bridges between the closely spaced foils. Keep the spacer strips flat against the circuit board; otherwise, the LEDs will not fit into the front panel properly when you install the display board later on.

## Section 1

Use the previously outlined procedure to install the remaining LEDs and LED spacer strips in the following steps.

**IMPORTANT:** The cathode symbols do not all face in the same direction, as in the next step. Be sure that you do not forget to check the position of the cathode symbol before you install and solder the leads to the foil.

- ( ) Mount a 3-section LED spacer strip and three LEDs at V612 through V614.

## Section 2

- ( ) Mount a 10-section LED spacer strip and ten LEDs at V615 through V625.
- ( ) Mount a 3-section LED spacer strip and three LEDs at V626 through V628.

## Section 3

- ( ) Mount a 9-section LED spacer strip and nine LEDs at V629 through V638 (the number V630 is not used).
- ( ) Mount a 4-section LED spacer strip and four LEDs at V639 through V643.
- ( ) Mount a 1-section LED spacer strip and an LED at V644.

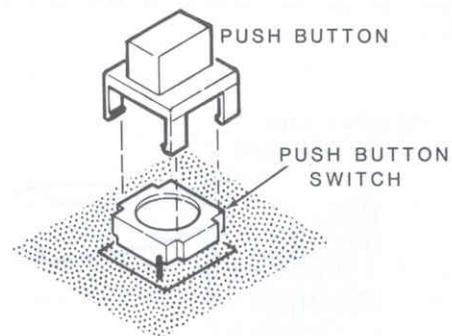
## Section 4

Mount a 1-section LED spacer strip and a single LED at the following circuit board locations. Be sure to check the cathode locations.

- ( ) V656.
- ( ) V655.
- ( ) V654.

- ( ) Mount a 2-section LED spacer strip and two LEDs at V649 and V651.
- ( ) Mount a 3-section LED spacer strip and three LEDs at V645 through V647.
- ( ) Mount a 1-section LED spacer strip and an LED at V648.
- ( ) Mount a 2-section LED spacer strip and two LEDs at V652 and V653.
- ( ) Discard the remaining LED spacers.

Snap pushbuttons onto the following pushbutton switches so the tabs fit into the notches as shown.



## Section 1

- ( ) SW608.
- ( ) SW607.
- ( ) SW621.
- ( ) SW619.
- ( ) SW604.

## Section 2

- ( ) SW606.
- ( ) SW605.
- ( ) SW618.
- ( ) SW617.
- ( ) SW603.

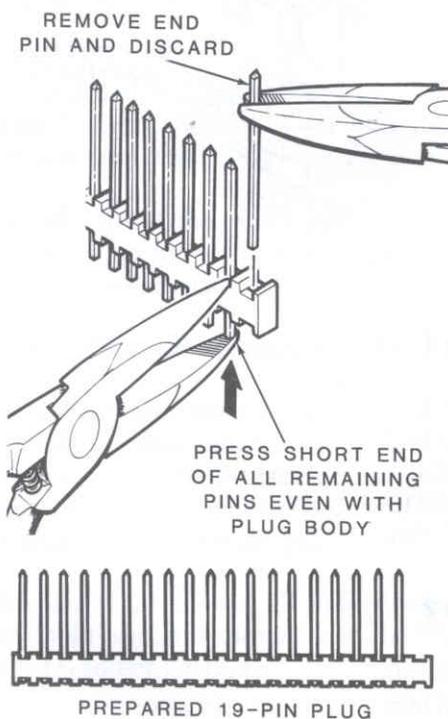
## Section 3

- ( ) SW602.
- ( ) SW601.
- ( ) SW609.

## Section 4

- ( ) SW616.
- ( ) SW615.
- ( ) SW614.
- ( ) SW613.
- ( ) SW612.
- ( ) SW611.

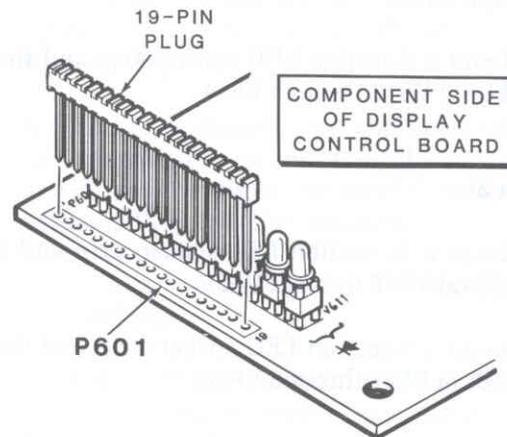
- ( ) Carefully remove and discard the pin from either end of the four 20-pin plugs to make 19-pin plugs as shown in the illustration below.



- ( ) Use a pair of pliers to press the short end of the pins on the four 19-pin plugs down into the plug body until the end of the pins are even with the bottom of the body as shown above.

## Section 1

- ( ) Carefully insert the pins of a 19-pin plug into the circuit board holes on the component side of the board at P601 and press the plug body flat against the board as shown. Solder the pins to the foil and be careful not to get any solder on the upper portion of the pins.



- ( ) Similarly, install a 19-pin plug at P602 in Section 2.
- ( ) Similarly, install a 19-pin plug at P603 in Section 3.
- ( ) Similarly, install a 19-pin plug at P604 in Section 4.

## 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.

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

# DISPLAY LOGIC CIRCUIT BOARD

## PARTS LIST

Remove the parts from Pack 2 and check each part against the following list. The key numbers correspond to the numbers on the "Display Logic Circuit Board Parts Pictorial." Return any part that is in an individual envelope with the part number on it, back into the envelope after you have identified it, until that part is called for in a step. Do not remove components that are supplied on a tape from the tape

until you use them 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. For prices, refer to the separate "Heath Parts Price List."

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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### ELECTRICAL COMPONENTS

A1	9-128	1	10 k $\Omega$ resistor pack	RP501
A2	10-1137	1	2000 $\Omega$ control	R506
A3	25-911	6	22 $\mu$ F electrolytic capacitor	C501 - C506

### TRANSISTOR - INTEGRATED CIRCUITS (ICs)

NOTE: The transistor may be marked for identification in any one of the following four ways:

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

B1	417-937	1	MPS2369 transistor	Q501
B1	442-644	1	78L12 IC	U504
B1	442-646	1	79L12 IC	U503

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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### CONNECTORS - SOCKETS - PLUG

C1	432-121	2	Connector pin	
C2	432-866	29	Spring connector (includes one extra)	
C3	432-1080	1	3-hole socket	
C4	432-1110	4	5-hole socket	
C5	432-1008	4	14-hole socket	
C6	432-948	1	25-hole socket	
C7	434-230	1	8-pin IC socket	
C7	434-298	1	14-pin IC socket	
C7	434-299	2	16-pin IC socket	
C7	434-311	7	20-pin IC socket	
C8	438-55	1	Polarizing plug	

### PART FROM FINAL PACK

85-2973-1	1	Display logic circuit board
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### TAPED COMPONENTS

NOTE: The following components are on a taped strip which was checked before shipment. Since these parts are taped in the order of assembly, it is not necessary to check them against the Parts List.

HEATH QTY. DESCRIPTION  
Part No. \_\_\_\_\_

CIRCUIT  
Comp. No.

#### RESISTORS

All resistors are rated at 1/4-watt, 5% unless stated otherwise.

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

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

6-331-12	6	330 Ω (org-org-brn)	R509, R511, R512, R513, R514, R515
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HEATH QTY. DESCRIPTION  
Part No. \_\_\_\_\_

CIRCUIT  
Comp. No.

#### Resistors (Cont'd)

6-102-12	1	1000 Ω (brn-blk-red)	R518
6-1621-12	1	1620 Ω, 1% (brn-blu-red-brn)	R508
6-3161-12	5	3160 Ω, 1% (org-brn-blu-brn)	R501, R502, R503, R504, R505
6-472-12	2	4700 Ω (yel-viol-red)	R507, R516
6-103-12	1	10 kΩ (brn-blk-org)	R517

#### CAPACITOR

21-786	13	.1 μF (104) axial-lead ceramic	C507, C508, C509, C511, C512 - C519, C521
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## STEP-BY-STEP ASSEMBLY

Refer to Pictorial 2-1 for the following steps.

- ( ) Prepare the taped components listed under "Display Logic Circuit Board" on the Taped Components Chart.
- ( ) Position the circuit board with the component side up as shown in the Pictorial.

### Section 1

- ( ) C519: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- ( ) R516: 4700  $\Omega$  (yel-viol-red) resistor.
- ( ) R518: 1000  $\Omega$  (brn-blk-red) resistor.
- ( ) R517: 10 k $\Omega$  (brn-blk-org) resistor.

Install four .1  $\mu$ F (104) axial-lead ceramic capacitors at the following locations:

- ( ) C521.
- ( ) C512.
- ( ) C513.
- ( ) C516.
- ( ) R514: 330  $\Omega$  (org-org-brn) resistor.
- ( ) R515: 330  $\Omega$  (org-org-brn) resistor.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

### Section 2

- ( ) R504: 3160  $\Omega$ , 1% (org-brn-blu-brn) resistor.
- ( ) R503: 3160  $\Omega$ , 1% (org-brn-blu-brn) resistor.

- ( ) C511: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- ( ) R502: 3160  $\Omega$ , 1% (org-brn-blu-brn) resistor.

Install four .1  $\mu$ F (104) axial-lead ceramic capacitors at the following locations:

- ( ) C508.
- ( ) C507.
- ( ) C509.
- ( ) C517.
- ( ) R505: 3160  $\Omega$ , 1% (org-brn-blu-brn) resistor.
- ( ) R507: 4700  $\Omega$  (yel-viol-red) resistor.
- ( ) R508: 1620  $\Omega$ , 1% (brn-blu-red-brn) resistor.
- ( ) R501: 3160  $\Omega$ , 1% (org-brn-blu-brn) resistor.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

### Section 3

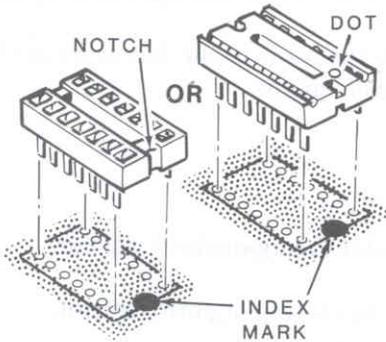
- ( ) R512: 330  $\Omega$  (org-org-brn) resistor.
- ( ) R513: 330  $\Omega$  (org-org-brn) resistor.
- ( ) C518: .1  $\mu$ F (104) axial-lead ceramic.
- ( ) C514: .1  $\mu$ F (104) axial-lead ceramic.
- ( ) R509: 330  $\Omega$  (org-org-brn) resistor.
- ( ) R511: 330  $\Omega$  (org-org-brn) resistor.
- ( ) C515: .1  $\mu$ F (104) axial-lead ceramic.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

Refer to Pictorial 2-2 for the following steps.

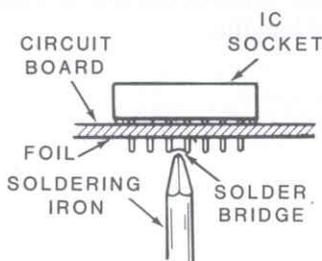
**Section 1**

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

Hold the socket in place while you turn the board over and lay it on top of the socket on your work surface. The board will hold the socket in place. At first, solder only two pins at diagonally opposite corners of the socket. When the solder cools, check to make sure the socket is tight against the circuit board. If not, reheat the pins while you press against the socket to reseat it. Then solder the remaining pins to the foil.



NOTE: A solder bridge may occur when you make solder connections at closely spaced foils. Therefore, after each solder step, carefully inspect the foil for solder bridges and remove any that have formed. To remove a solder bridge, hold the circuit board foil-side-down as shown, and hold the soldering iron tip between the two points that are bridged. The solder will flow down the soldering iron tip to clear the bridge.



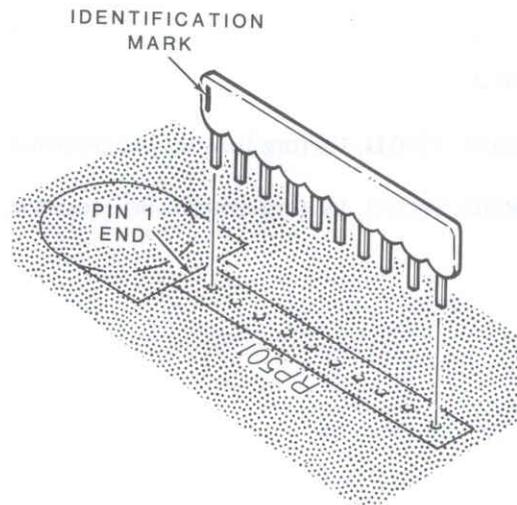
- ( ) 14-pin IC socket at U502.
- ( ) 20-pin IC socket at U514.
- ( ) 20-pin IC socket at U513.
- ( ) 16-pin IC socket at U501.
- ( ) 20-pin IC socket at U512.

**Section 2**

- ( ) 16-pin IC socket at U506.
- ( ) 8-pin IC socket at U507.
- ( ) 20-pin IC socket at U505.
- ( ) R506: 2000 Ω control. Insert the pins into the circuit board holes and press the control against the circuit board. Solder the pins to the foil and cut off the excess lead lengths.



- ( ) RP501: Install the 10 kΩ resistor pack at RP501 with the identification mark (dot or line) toward the pin 1 end shown on the circuit board. Keep the resistor pack against the board and solder the pins to the foil. Cut off any excess pin lengths.



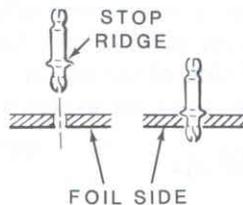
## Section 3

Install three 20-pin IC sockets at the following locations:

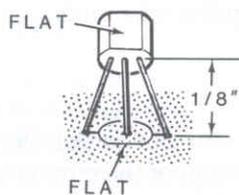
- U509.
- U511.
- U508.

## Section 1

- Install a connector pin at circuit board hole B as shown and solder it to the foil.



NOTE: In each of the next three steps, when you install the transistor and ICs, position the flat side of the case over the flat of the outline on the circuit board as shown. Then insert the leads into their circuit board holes and position the bottom of the case  $1/8$ " above the board. Bend the leads out slightly on the foil side of the board to hold each device in place.



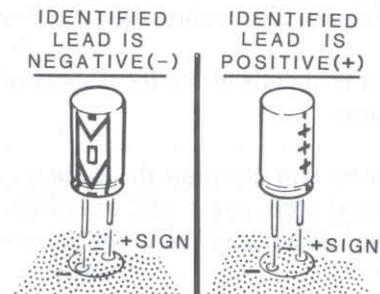
- Q501: MPS2369 transistor (#417-937).
- U504: 78L12 IC (#442-644).
- U503: 79L12 IC (#442-646).
- Solder the leads to the foil and cut off the excess lead lengths.

## Section 2

- Install a connector pin at hole A and solder it to the foil.

Refer to Pictorial 2-3 Part A for the following steps.

When you install an electrolytic capacitor, always look at it and identify the markings near the leads. One lead will have a positive (+) mark or a negative (-) mark near it. Be sure to install the positive lead in the positive-marked hole and the negative lead in the negative-marked hole. Be careful; only the negative lead may have a mark near it.



Install six 22  $\mu$ F electrolytic capacitors at the following locations:

- C505.
- C506.
- C504.
- C503.
- C502.
- C501.

Refer to Pictorial 2-3 Part B for the following steps.

- Turn the circuit board over so the foil side faces up with the notch as shown.
- Install a 14-hole socket and a 5-hole socket at S504. Position each socket with the tabs as shown and press them flat against the board. Turn the board over and solder the end pins of each socket to the component foil. Check to make sure the sockets are against the board. If not, reheat the connection while you press against the socket to reseat the pin. Then solder the remaining pins to the foil.

- ( ) Similarly install a 14-hole and a 5-hole socket at S503.
- ( ) Similarly install a 14-hole and a 5-hole socket at S502.
- ( ) Similarly install a 14-hole and a 5-hole socket at S501.
- ( ) Cut off the tabs from the sockets at S501.
- ( ) Reposition the circuit board with the component side facing up as shown in Part A of the Pictorial.

Refer to Pictorial 2-4 for the following steps.

- ( ) Cut a 6" length of 8-wire ribbon cable and set it aside.

NOTE: When you separate the ribbon cable wires, as in the next step, use a pair of cutters or a sharp knife to start separating the wires as shown in inset drawing #1.

- ( ) Separate and remove the blue, violet, and gray wires, as a group, from the remaining 6" 8-wire ribbon cable. Set the remaining cable aside.
- ( ) Refer to Part 1 of Detail 2-4A and separate the ends of the 3-wire cable for 1". Then remove 1/8" of insulation from the wires at one end of the cable and 1/4" of insulation from the wires at the other end. Tin the bare wire ends by twisting the fine wire strands tightly together and applying a small amount of solder to the bare wires to hold them together.
- ( ) Refer to the inset drawing on the Detail and crimp and solder spring connectors on the 1/8" prepared ends of the 3-wire cable. Be careful not to get solder under the spring portion of the connectors.

Position the 3-hole socket with the slots as shown, and the spring connectors with the locking tabs as shown. Then insert the spring connectors into the socket holes in the following steps until each con-

ductor locks into the socket slot (you will hear a faint latching "click" when this happens). Gently pull on the wire to make sure it is locked firmly in place. NOTE: If you should install a wire out of order, refer to inset drawing #2 on the Pictorial and press down on the small locking tab in the socket slot with a small bladed screwdriver, or a similar item, to disengage the tab. Then pull out on the wire to remove it from the socket.

- ( ) Gray wire into hole 1.
- ( ) Violet wire into hole 2.
- ( ) Blue wire into hole 3.

Connect the wires at the free end of the 3-wire cable to the circuit board at P502 as follows. Solder the wires to the foil side of the circuit board after you connect them and cut off the excess wire lengths.

- ( ) Blue wire to hole 3.
- ( ) Violet wire to hole 2.
- ( ) Gray wire to hole 1.
- ( ) Cut the 25-conductor ribbon cable to 10".
- ( ) Refer to Part 2 of Detail 2-4A and separate the twenty-five wires at both ends of the 10" ribbon cable for 1-3/4". Then remove 1/8" of insulation from the wires at one end of the cable and 1/4" of insulation from the wires at the other end. Tin the wire ends.
- ( ) Crimp and solder a spring connector on each wire at the 1/8" prepared end of the 10" ribbon cable. Be careful not to get any solder under the spring portion of the connectors.
- ( ) Position the spring connector end of the 10" ribbon cable with the outside yellow wire at hole 1 of the 25-hole socket. Then insert the spring connector on the outside yellow wire into hole 1 until the connector latches into the hole. Pull gently on the wire to make sure it has latched into place.



- ( ) Similarly insert the remaining ribbon cable wires, in the order they appear on the cable, into the socket holes 2 through 25. Be careful not to cross any of the wires when you install them.
- ( ) Position the polarizing pin with the tab as shown and insert the pin into hole 5 (black wire) of the 25-hole socket.
- ( ) Position the free end of the 25-conductor ribbon cable at P501 with the outside yellow wire at hole 1. Then insert the wires into the circuit board holes at P501 in the order they appear on the cable. Solder the wires to the foil after you connect them and cut off the excess wire lengths. Be careful not to cross any of the wires when you connect them.
- ( ) Carefully recheck the 3-wire and the 25-wire cable wiring at both ends to make sure that none of the wires are crossed.
- ( ) Remove the outside black wire from the remaining 25-conductor ribbon cable and remove 1/4" of insulation from the ends. Discard the remaining 25-conductor ribbon cable but save the remaining 8-wire ribbon cable.
- ( ) Connect one end of the black wire to the indicated hole next to capacitor C507. Solder the wire to the foil and cut off the excess wire length. NOTE: You will use this wire as the ground (GND) connection for the "Resistance Checks."

## 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.

Refer to Pictorial 2-2 and Detail 2-3A as you make the following visual checks.

- ( ) Transistor for the proper type and installation.
- ( ) ICs for the proper type and installation.
- ( ) Electrolytic capacitors for the correct position of the positive (+) or negative (-) marked ends.

## RESISTANCE CHECKS

Refer to Pictorial 2-4 for the following steps.

You will need a VOM (volt ohmmeter), a VTVM (vacuum tube voltmeter), or a DVM (digital voltmeter) for the following tests. You will use the voltmeter function for voltage tests later in this Manual. The voltmeter should have at least a 10 M $\Omega$  input impedance.

When a specific part (such as U503) is called out as a possible problem, check that part for such errors as improper installation, soldering, or wrong part installation. Also check the circuitry associated with that part for similar errors.

Connect the common meter lead to the block wire next to C507 and the positive lead to the following test points.

TEST POINT #	RESISTANCE RANGE	POSSIBLE CAUSE OF PROBLEM
( ) TP1 (U507, pin 4)	Greater than 4 k $\Omega$	U503
( ) TP2 (U507, pin 7)	Greater than 10 k $\Omega$	U504
( ) TP3 (U501, pin 16)	Greater than 50 k $\Omega$	5-volt foil shorted

- ( ) Disconnect the ohmmeter leads and set the ohmmeter aside.
- ( ) Cut off and discard the black ground wire from the circuit board.

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

# MAIN CIRCUIT BOARD

## PARTS LIST

Remove the parts from Pack 3 and check each part against the following list. The key numbers correspond to the numbers on the "Main Circuit Board Parts Pictorial." 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. For prices, refer to the separate "Heath Parts Price List."

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

#### Mica

A1	20-109	1	62 pF	C316
A1	20-102	1	100 pF	C401

#### Ceramic

A2	21-739	2	2.2 pF	C113, C213
A2	21-716	4	27 pF	C133, C134, C233, C234
A3	21-738	4	68 pF (680)	C131, C135, C231, C235
A2	21-148	1	75 pF	C301
A2	21-75	2	100 pF (100K)	C112, C212
A3	21-788	4	110 pF (111)	C106, C116, C206, C216

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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### Capacitors (Cont'd)

A3	21-715	4	150 pF (151)	C137, C138, C237, C238
A3	21-801	4	680 pF (681)	C136, C236, C433, C434
A2	21-163	3	.001 $\mu$ F	C109, C139, C209
A2	21-16	8	.01 $\mu$ F	C407, C408, C409, C411, C416, C417, C418, C419
A3	21-751	11	.047 $\mu$ F (473)	C117, C119, C122, C124, C141, C142, C329, C217, C219, C222, C242

# Heathkit®

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

A4	25-931	2	10 $\mu$ F	C115, C215
A4	25-911	4	22 $\mu$ F	C413, C415, C422, C424
A4	25-915	1	47 $\mu$ F	C404
A4	25-893	1	1000 $\mu$ F	C423
A4	25-895	1	2200 $\mu$ F	C414
A4	25-946	1	4700 $\mu$ F	C421
A4	25-947	1	6800 $\mu$ F	C412

## Mylar

A5	27-192	2	.027 $\mu$ F	C101, C201
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## Polystyrene

A6	29-67	1	.01 $\mu$ F	C318
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## CONTROLS – TRIMMERS

B1	10-1173	2	50 $\Omega$ control	R156, R256
B1	10-1155	2	200 $\Omega$ control	R148, R248
B1	10-1140	1	500 $\Omega$ control	R315
B1	10-1141	1	1000 $\Omega$ (1K) control	R349
B1	10-1142	12	100 k $\Omega$ control	R123, R126, R152, R168, R269, R171, R223, R226, R252, R268, R269, R271
B2	31-83	4	2-6 pF (red dot) trimmer	C104, C107, C204, C207
B2	31-71	6	3.2-18 pF (blue dot) trimmer	C103, C105, C108, C203, C205, C208
B2	31-85	3	5-25 pF (violet dot) trimmer	C128, C228, C317

## RESISTOR PACKS

NOTE: The resistor packs may be marked for identification in any one of the following four ways:

1. Part number and/or value.
2. Type number. Letters shown in **BOLD** print in the Parts List. Disregard any other numbers or letters.
3. Part number and type number.
4. Part number with a type number other than the one shown.

C1	9-127	2	400 $\Omega$	RP101, RP201
C1	9-138	1	1000 $\Omega$ , 10-pin	RP301
C1	9-141	4	1000 $\Omega$ (1K), <b>102</b> 8-pin	RP102, RP202, RP203, RP303
C1	9-162	1	2700 $\Omega$ , <b>272</b> (2.7K)	RP302
C1	9-163	1	4700 $\Omega$ , <b>472</b> (4.7K)	RP103
C1	9-128	1	10 k $\Omega$	RP401

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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## PLUGS – SOCKETS

D1	432-1171	3	2-pin plug	
D2	432-1265	6	3-pin plug	
D3	432-876	1	8-pin plug	
D4	432-903	1	10-pin plug	
D5	432-946	1	25-pin plug	
D6	434-230	13	8-pin IC socket	
D6	434-298	12	14-pin IC socket	
D6	434-299	14	16-pin IC socket	
D6	434-311	8	20-pin IC socket	
D6	434-307	1	24-pin IC socket	
D6	434-312	1	28-pin IC socket	
D6	434-253	2	40-pin IC socket	

## RELAY – CHOKE – CRYSTAL

E1	69- <del>117</del>	19	Relay	K101-K109, K201-K209, K301
E2	235-229	1	35 $\mu$ H choke	L401
E3	404-646	1	8 MHz crystal	Y401

## DIODES – TRANSISTORS – INTEGRATED CIRCUIT (IC)

NOTE: The transistors and integrated circuit may be marked for identification in any one of the following four ways:

1. Part number.
2. Type number. (For the integrated circuit, 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.

F1	56-676	8	MBD201 diode	D115, D116, D117, D118, D215, D216, D217, D218
<del>F2</del>	417-828	2	304 transistor	Q101, Q201
F2	417-854	2	E304 transistor	Q102, Q202
F2	417-858	2	1078E transistor	Q115, Q215
F3	417-863	2	MFE131 transistor*	Q113, Q213
F2	417-874	14	2N3906 transistor	Q108, Q109, Q112, Q114, Q116, Q117, Q207, Q209, Q212, Q214, Q216, Q217, Q304, Q305

~~F2~~ 417-154 2 2N2369

Q308, Q309

\*Make sure you contact the conductive (anti-static) bag where you handle the transistor. It can be damaged by static electricity.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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**Transistor Integrated Circuit (Cont'd)**

F2	417-875	5	2N3904 transistor	Q107, Q111, Q207, Q211, Q401
F2	417-887	7	MPSH10 transistor	Q103, Q104, Q203, Q204, Q301, Q302, Q303
F2	417-917	1	MPSH81 transistor	Q307
F2	417-937	3	MPS2369 transistor	Q106, Q206, Q306, <del>Q308</del> , <del>Q309</del>
F4	442-54	1	<b>7805C</b> IC	U429
F2	442-627	1	<b>78L05</b> IC	U107
F4	442-630	1	<b>MC7905</b> IC	U431
F4	442-674	1	<b>UA7812</b> IC	U432
F4	442-675	1	<b>UA7912</b> IC	U433

**TAPE - INSULATOR**

G1	73-147	1	Double-stick foam tape
G2	75-139	2	Plastic insulator

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

H1	250-1411	2	4-40 × 1/4" phillips screw
H2	250-1412	4	4-40 × 3/8" phillips screw
H3	252-2	5	4-40 nut
H4	253-198	2	Nylon shoulder spacer
H5	254-9	4	#4 lockwasher

**MISCELLANEOUS**

J1	1-158-12	2	100 MΩ, 1/4-watt, 10% (brn-blk-viol) resistor	R127, R227
J2	215-688	1	Heat sink	
J3	352-13	2	Silicone grease	
J4	490-5	1	Nut starter	

**PART FROM FINAL PACK**

85-3154	-1	1	Main circuit board
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### TAPED COMPONENTS

NOTE: The following components are on a taped strip which was checked before shipment. Since these parts are taped in the order of assembly, it is not necessary to check them against the Parts List.

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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#### RESISTORS

All resistors are rated at 1/4-watt, 5% unless stated otherwise.

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

All color-banded 1% and .25% precision resistors have five color bands (last band brown for 1% and blue for .25%). The last brown or blue band is set apart from the other bands and will not be called out.

6-109-12	19	1 Ω (brn-blk-gld)	R104, R105, R106, R113, R114, R141, R144, R178, R204, R205, R206, R213, R214, R241, R244, R325, R326, R338, R353
6-1829-12	2	18.2 Ω, 1% (brn-gry-red-gld)	R118, R218
6-3019-12	2	30.1 Ω, 1% (org-blk-brn-gld)	R309, R311
6-470-12	3	47 Ω (yel-viol-blk)	R164, R264, R308
6-4759-12	3	47.5 Ω, 1% (yel-viol-grn-gld)	R111, R211, R307
6-510-12	2	51 Ω (grn-brn-blk)	R102, R202
6-680-12	2	68 Ω (blu-gry-blk)	R103, R203
6-101-12	6	100 Ω (brn-blk-brn)	R166, R179, R266, R318, R327, R328
6-1000-12	2	100 Ω, 1% (brn-blk-blk-blk)	R139, R239
6-1100-12	2	110 Ω, 1% (brn-brn-blk-blk)	R147, R247
6-1500-12	4	150 Ω, 1% (brn-grn-blk-blk)	R112, R143, R219, R243
6-181-12	1	180 Ω (brn-gry-brn)	R411
6-1780-12	1	178 Ω, 1% (brn-viol-gry-blk)	R119
6-2000-12	1	200 Ω, 1% (red-blk-blk-blk)	R212
6-2150-12	1	215 Ω, 1% (red-brn-grn-blk)	R209
6-221-12	4	220 Ω (red-red-brn)	R132, R232, R354, R355
6-2370-12	1	237 Ω, 1% (red-org-viol-blk)	R324
6-2490-12	2	249 Ω, 1% (red-yel-wht-blk)	R133, R233
6-2670-12	1	267 Ω, 1% (red-blu-viol-blk)	R109

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
6-271-12	9	270 Ω (red-viol-brn)	R134, R135, R234, R235, R330, R334, R356, R357, R369
6-3010-12	2	301 Ω, 1% (org-blk-brn-blk)	R322, R323
6-331-12	4	330 Ω (org-org-brn)	R129, R131, R229, R231
6-391-12	1	390 Ω (org-wht-brn)	R365
6-3920-12	4	392 Ω, 1% (org-wht-red-blk)	R146, R149, R246, R249
6-4990-12	6	499 Ω, 1% (yel-wht-wht-blk)	R136, R137, R153, R236, R237, R253
6-511-12	3	510 Ω (grn-brn-brn)	R157, R257, R333
6-6040-12	4	604 Ω, 1% (blu-blk-yel-blk)	R312, R316, R317, R352
6-6810-12	4	681 Ω, 1% (blu-gry-brn-blk)	R159, R165, R259, R265
6-7500-12	1	750 Ω, 1% (viol-grn-blk-blk)	R366
6-8060-12	2	806 Ω, 1% (gry-blk-blu-blk)	R145, R245
6-9530-12	1	953 Ω, 1% (wht-grn-org-blk)	R314
6-102-12	8	1000 Ω (brn-blk-red)	R155, R176, R177, R255, R332, R403, R405, R407
6-1001-12	8	1000 Ω, 1% (brn-blk-blk-brn)	R161, R163, R172, R173, R261, R263, R348, R351
6-1131-12	1	1130 Ω, 1% (brn-brn-org-brn)	R306
6-122-12	2	1200 Ω (brn-red-red)	R138, R238
6-1211-12	1	1210 Ω, 1% (brn-red-brn-brn)	R319
6-1301-12	2	1300 Ω, 1% (brn-org-blk-brn)	R142, R242
6-1371-12	1	1370 Ω, 1% (brn-org-viol-brn)	R367
6-1431-12	2	1430 Ω, 1% (brn-yel-org-brn)	R117, R217
2-782-12	1	1430 Ω precision (brn-yel-org-brn)	R347
6-152-12	2	1500 Ω (brn-grn-red)	R361, R362
6-182-12	2	1800 Ω (brn-gry-red)	R154, R254
6-222-12	1	2200 Ω (red-red-red)	R401
6-272-12	2	2700 Ω (red-viol-red)	R329, R331
2-783-12	1	2870 Ω precision (red-gry-viol-brn)	R346

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
6-3161-12	5	3160 Ω, 1% (org-brn-blu-brn)	R301-R305
6-332-12	1	3300 Ω (org-org-red)	R359
6-3481-12	2	3480 Ω, 1% (org-yel-gry-brn)	R313, R321
6-362-12	1	3600 Ω (org-blu-red)	R408
6-432-12	2	4300 Ω (yel-org-red)	R167, R267
6-472-12	6	4700 Ω (yel-viol-red)	R335, R336, R337, R358, R364, R406
6-5111-12	2	5110 Ω, 1% (grn-brn-brn-brn)	R151, R251
6-562-12	1	5600 Ω (grn-blu-red)	R175
6-822-12	1	8200 Ω (gry-red-red)	R409
2-776-12	1	7150 Ω precision (viol-brn-grn-brn)	R345
6-103-12	3	10 k Ω (brn-blk-org)	R158, R258, R404
2-774-12	2	10.1 kΩ precision (brn-blk-brn-red)	R116, R216
2-777-12	1	14.3 kΩ precision (brn-yel-org-red)	R344
6-2212-12	1	22.1 kΩ, 1% (red-red-brn-red)	R174
2-778-12	1	28.7 kΩ precision (red-gry-viol-red)	R343
6-333-12	1	33 kΩ (org-org-org)	R402
2-779-12	1	71.5 kΩ precision (viol-brn-grn-red)	R342
6-104-12	1	100 kΩ (brn-blk-yel)	R368
2-773-12	2	111 kΩ precision (brn-brn-brn-org)	R108, R208
6-124-12	1	120 kΩ (brn-red-yel)	R181
2-780-12	1	143 kΩ precision (brn-yel-org-org)	R341
2-781-12	1	287 kΩ precision (red-gry-viol-org)	R339
6-3833-12	2	383 kΩ, 1% (org-gry-org-org)	R128, R228
6-4993-12	6	499 kΩ, 1% (yel-wht-wht-org)	R121, R122, R125, R221, R222, R225 R107, R207
2-771-12	2	900 kΩ precision (wht-blk-blk-org)	R115, R215
2-772-12	2	990 kΩ precision (wht-wht-blk-org)	R101, R201, R340
6-105-12	3	1 MΩ (brn-blk-grn)	R124, R224
6-106-12	2	10 MΩ, 10% (brn-blk-blu)	R162, R262
6-225-12	2	2.2 MΩ (red-red-grn)	
6-4872-12	3	48.7 kΩ 1%	R182, R282, R382

**AXIAL-LEAD CERAMIC CAPACITORS**

21-804	1	56 pF (560)	C305
21-785	2	22 pF (220)	C327, C402
21-784	1	1000 pF (102)	C328
21-769	2	.01 μF (103)	C114, C214

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
21-786	57	.1 μF (104)	C102, C111, C118, C121, C123, C125, C126, C127, C129, C132, C202, C211, C225, C226, C227, C229, C232, C302, C303, C304, C306, C307, C308, C311, C312, C313, C314, C315, C319, C321, C323, C324, C325, C326, C331, C403, C405, C406, C425, C426, C427, C428, C429, C431, C432, C435, C436, C437, C438, C439, C441, C442, C443, C444, C445, C446, C447

**DIODES**

56-56	29	1N4149	D101 - D106, D109, D111, D112, D122, D123, D124, D201 - D206, D209, D211, D212, D301, D302, D303, D307, D401, D402, D403, D414
56-84	4	1N4148	D113, D114, D213, D214, D305
56-85	1	5 V zener	D107, D108, D207, D208, D304, D308
56-91	6	1N823A zener	D413
56-637	1	6.8 V zener	D119, D121, D219, D221, D306
56-655	5	1N6263	D408, D409, D411, D412
57-27	4	1N2071	D404, D405, D406, D407
57-609	4	1N5393	

## STEP-BY-STEP ASSEMBLY

- ( ) Prepare the taped components listed under "Main Circuit Board" on the Taped Components Chart.

Refer to Pictorial 3-1 for the following steps.

- ( ) Position the main circuit board with the component side facing up as shown.

**IMPORTANT:** Read the following information carefully before you begin to assemble the main circuit board.

Due to the large concentration of parts on the main circuit board, the sections in some of the Pictorials are divided into several small blocks for easier assembly. Make sure you refer to the proper section for each series of steps.

For each section, you will install components in horizontal rows or in vertical columns, from top to bottom, depending upon the general layout of the parts.

Because of the large number of small circuit board components (e.g. resistors, diodes, wires, etc.), it is easy to install a component at the wrong location. To help you avoid this, carefully compare the circuit component number at the beginning of each step with the number shown on the circuit board at the location you intend to install the part. Once you have installed the part, check off that component shown on the Pictorial.

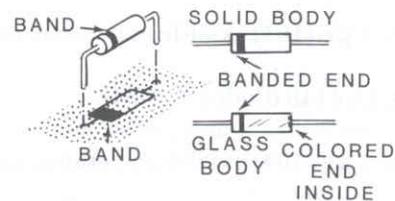
### Section 1

- ( ) R179: 100  $\Omega$  (brn-blk-brn) resistor.  
 ( ) R167: 4300  $\Omega$  (yel-org-red) resistor.  
 ( ) R407: 1000  $\Omega$  (brn-blk-red) resistor.  
 ( ) R161: 1000  $\Omega$ , 1% (brn-blk-blk-brn) resistor.  
 ( ) R163: 1000  $\Omega$ , 1% (brn-blk-blk-brn) resistor.

- ( ) R159: 681  $\Omega$ , 1% (blu-gry-brn-blk) resistor.  
 ( ) R158: 10 k $\Omega$  (brn-blk-org) resistor.  
 ( ) R157: 510  $\Omega$  (grn-brn-brn) resistor.

**NOTE:** When you install a diode, always match the band on the diode with the band mark on the circuit board. The circuit will not work properly if a diode is installed backwards.

If your diode has a solid body, the band is clearly defined. If your diode has a glass body, do not mistake the colored end inside the diode for the banded end. Look for a band painted on the outside of the glass. The diode may not be the same size as the screen on the circuit board.



**CAUTION:** ALWAYS POSITION THE BANDED END OF A DIODE AS SHOWN ON THE CIRCUIT BOARD.

- ( ) D119: 1N6263 diode (#56-655).  
 ( ) R165: 681  $\Omega$ , 1% (blu-gry-brn-blk) resistor.  
 ( ) R166: 100  $\Omega$  (brn-blk-brn) resistor.  
 ( ) R162: 2.2 M $\Omega$  (red-red-grn) resistor.  
 ( ) D121: 1N6263 diode (#56-655).  
 ( ) R266: 100  $\Omega$  (brn-blk-brn) resistor.  
 ( ) R155: 1000  $\Omega$  (brn-blk-red) resistor.  
 ( ) D113: 1N4148 diode (#56-84).  
 ( ) C132: .1  $\mu$ F (104) axial-lead ceramic capacitor.  
 ( ) C125: .1  $\mu$ F (104) axial-lead ceramic capacitor.

- ( ) C126: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- ( ) R141: 1  $\Omega$  (brn-blk-gld) resistor.
- ( ) R144: 1  $\Omega$  (brn-blk-gld) resistor.
- ( ) R151: 5110  $\Omega$ , 1% (grn-brn-brn-brn) resistor.
- ( ) R149: 392  $\Omega$ , 1% (org-wht-red-blk) resistor.
- ( ) R153: 499  $\Omega$ , 1% (yel-wht-wht-blk) resistor.
- ( ) R145: 806  $\Omega$ , 1% (gry-blk-blu-blk) resistor.
- ( ) R143: 150  $\Omega$ , 1% (brn-grn-blk-blk) resistor.
- ( ) R142: 1300  $\Omega$ , 1% (brn-org-blk-brn) resistor.
- ( ) R146: 392  $\Omega$ , 1% (org-wht-red-blk) resistor.
- ( ) R147: 110  $\Omega$ , 1% (brn-brn-blk-blk) resistor.
- ( ) C127: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- ( ) D114: 1N4148 diode (#56-84).
- ( ) C129: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- ( ) R154: 1800  $\Omega$  (brn-gry-red) resistor.
- ( ) R164: 47  $\Omega$  (yel-viol-blk) resistor.
- ( ) R135: 270  $\Omega$  (red-viol-brn) resistor.
- ( ) R134: 270  $\Omega$  (red-viol-brn) resistor.
- ( ) R133: 249  $\Omega$ , 1% (red-yel-wht-blk) resistor.
- ( ) R132: 220  $\Omega$  (red-red-brn) resistor.
- ( ) R137: 499  $\Omega$ , 1% (yel-wht-wht-blk) resistor.
- ( ) R131: 330  $\Omega$  (org-org-brn) resistor.
- ( ) R129: 330  $\Omega$  (org-org-brn) resistor.
- ( ) R138: 1200  $\Omega$  (brn-red-red) resistor.
- ( ) R128: 383 k $\Omega$ , 1% (org-gry-org-org) resistor.
- ( ) R122: 499 k $\Omega$ , 1% (yel-wht-wht-org) resistor.
- ( ) C114: .01  $\mu$ F (103) axial-lead ceramic capacitor.

NOTE: The following part is not on the taped strip.

Install four 1N4149 diodes (#56-56) at the following locations:

- ( ) D112.
- ( ) D111.
- ( ) D109.
- ( ) D301.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

## Section 2

- ( ) R139: 100  $\Omega$ , 1% (brn-blk-blk-blk) resistor.
- ( ) R136: 499  $\Omega$ , 1% (yel-wht-wht-blk) resistor.
- ( ) D108: 1N823A zener diode (#56-91).

- ( ) R127: 100 M $\Omega$  (brn-blk-viol) resistor. Solder the resistor leads to the foil and cut off the excess lead lengths. Save the leads for use later.
- ( ) R121: 499 k $\Omega$ , 1% (yel-wht-wht-org) resistor.
- ( ) R124: 10 M $\Omega$ , ~~10%~~ (brn-blk-blu) resistor.
- ( ) Bend the ends of the cutoff component lead you set aside earlier to fit the hole spacing at W101. Space the wire slightly above the board so it does not contact any of the foils.
- ( ) D107: 1N823A zener diode (#56-91).
- ( ) D106: 1N4149 diode (#56-56).
- ( ) C111: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- ( ) D105: 1N4149 diode (#56-56).
- ( ) R125: 499 k $\Omega$ , 1% (yel-wht-wht-org) resistor.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

## Section 3

- R111: 47.5  $\Omega$ , 1%, (yel-viol-grn-gld) resistor.
- R108: 111 k $\Omega$  precision (brn-brn-brn-org) resistor.
- R107: 900 k $\Omega$  precision (wht-blk-blk-org) resistor.
- R112: 150  $\Omega$ , 1% (brn-grn-blk-blk) resistor.
- R109: 267  $\Omega$ , 1% (red-blu-viol-blk) resistor.
- R106: 1  $\Omega$  (brn-blk-gld) resistor.
- R105: 1  $\Omega$  (brn-blk-gld) resistor.
- R104: 1  $\Omega$  (brn-blk-gld) resistor.
- R103: 68  $\Omega$  (blu-gry-blk) resistor.
- R118: 18.2  $\Omega$ , 1% (brn-gry-red-gld) resistor.
- R119: 178  $\Omega$ , 1% (brn-viol-gry-blk) resistor.
- R116: 10.1 k $\Omega$  precision (brn-blk-brn-red) resistor.
- R115: 990 k $\Omega$  precision (wht-wht-blk-org) resistor.
- R117: 1430  $\Omega$ , 1% (brn-yel-org-brn) resistor.
- R113: 1  $\Omega$  (brn-blk-gld) resistor.
- R114: 1  $\Omega$  (brn-blk-gld) resistor.
- C102: .1  $\mu$ F (104) axial-lead ceramic capacitor.

Install four 1N4149 (#56-56) diodes at the following locations:

- D103.
- D102.
- D104.
- D101.

- R102: 51  $\Omega$  (grn-brn-blk) resistor.
- R101: 1 M $\Omega$  (brn-blk-grn) resistor.
- R178: 1  $\Omega$  (brn-blk-gld) resistor.
- Solder the leads to the foil and cut off the excess lead lengths.

## Section 4

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

- D411.
- D412.
- D408.
- D409.
- R175: 5600  $\Omega$  (grn-blu-red) resistor.
- R409: 8200  $\Omega$  (gry-red-red) resistor.
- R408: 3600  $\Omega$  (org-blu-red) resistor.
- D123: 1N4149 diode (#56-56).
- R176: 1000  $\Omega$  (brn-blk-red) resistor.
- R181: 120 k $\Omega$  (brn-red-yel) resistor.
- R177: 1000  $\Omega$  (brn-blk-red) resistor.
- R173: 1000  $\Omega$ , 1% (brn-blk-blk-brn) resistor.
- D122: 1N4149 diode (#56-56).
- D124: 1N4149 diode (#56-56).
- R174: 22.1 k $\Omega$ , 1% (red-red-brn-red) resistor.
- C441: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- R172: 1000  $\Omega$ , 1% (brn-blk-blk-brn) resistor.
- Solder the leads to the foil and cut off the excess lead lengths.

**Section 5**

- C425: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- R267: 4300  $\Omega$  (yel-org-red) resistor.
- R261: 1000  $\Omega$ , 1% (brn-blk-blk-brn) resistor.
- R263: 1000  $\Omega$ , 1% (brn-blk-blk-brn) resistor.
- R259: 681  $\Omega$ , 1% (blu-gry-brn-blk) resistor.
- R258: 10 k $\Omega$  (brn-blk-org) resistor.
- R257: 510  $\Omega$  (grn-brn-brn) resistor.
- D219: 1N6263 diode (#56-655).
- R265: 681  $\Omega$ , 1% (blu-gry-brn-blk) resistor.
- C426: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- R262: 2.2 M $\Omega$  (red-red-grn) resistor.
- D221: 1N6263 diode (#56-655).
- R255: 1000  $\Omega$  (brn-blk-red) resistor.
- D213: 1N4148 diode (#56-84).
- D413: 6.8 V zener diode (#56-637).
- C232: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- R411: 180  $\Omega$  (brn-gry-brn) resistor.
- C225: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- C226: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- R241: 1  $\Omega$  (brn-blk-gld) resistor.
- R244: 1  $\Omega$  (brn-blk-gld) resistor.
- R251: 5110  $\Omega$ , 1% (grn-brn-brn-brn) resistor.
- R249: 392  $\Omega$ , 1% (org-wht-red-blk) resistor.
- R253: 499  $\Omega$ , 1% (yel-wht-wht-blk) resistor.

- R245: 806  $\Omega$ , 1% (gry-blk-blu-blk) resistor.
- R243: 150  $\Omega$ , 1% (brn-grn-blk-blk) resistor.
- R242: 1300  $\Omega$ , 1% (brn-org-blk-brn) resistor.
- R246: 392  $\Omega$ , 1% (org-wht-red-blk) resistor.
- R247: 110  $\Omega$ , 1% (brn-brn-blk-blk) resistor.
- D214: 1N4148 diode (#56-84).
- R254: 1800  $\Omega$  (brn-gry-red) resistor.
- R264: 47  $\Omega$  (yel-viol-blk) resistor.
- C229: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- C227: .1  $\mu$ F (104) axial-lead ceramic capacitor.

Install three 1N4149 diodes (#56-56) at the following locations:

- D212.
- D211.
- D209.
- Solder the leads to the foil and cut off the excess lead lengths.

**Section 6**

- R239: 100  $\Omega$ , 1% (brn-blk-blk-blk) resistor.
- R236: 499  $\Omega$ , 1% (yel-wht-wht-blk) resistor.
- D208: 1N823A zener diode (#56-91).
- R235: 270  $\Omega$  (red-viol-brn) resistor.
- R234: 270  $\Omega$  (red-viol-brn) resistor.
- R233: 249  $\Omega$ , 1% (red-yel-wht-blk) resistor.
- R232: 220  $\Omega$  (red-red-brn) resistor.
- R237: 499  $\Omega$ , 1% (yel-wht-wht-blk) resistor.
- R231: 330  $\Omega$  (org-org-brn) resistor.

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- ( ) R229: 330  $\Omega$  (org-org-brn) resistor.
- ( ) R238: 1200  $\Omega$  (brn-red-red) resistor.
- ( ) R228: 383 k $\Omega$ , 1% (org-gry-org-org) resistor.
- ( ) R222: 499 k $\Omega$ , 1% (yel-wht-wht-org) resistor.
- ( ) C214: .01  $\mu$ F (103) axial-lead ceramic capacitor.
- ( ) R224: 10 M $\Omega$ , 10% (brn-blk-blk) resistor.
- ( ) R206: 1  $\Omega$  (brn-blk-gld) resistor.
- ( ) R205: 1  $\Omega$  (brn-blk-gld) resistor.
- ( ) R204: 1  $\Omega$  (brn-blk-gld) resistor.
- ( ) R203: 68  $\Omega$  (blu-gry-blk) resistor.
- ( ) R218: 18.2  $\Omega$ , 1% (brn-gry-red-gld) resistor.
- ( ) R219: 150  $\Omega$ , 1% (brn-grn-blk-blk) resistor.

NOTE: The following part is not on the taped strip.

- ( ) R227: 100 M $\Omega$  (brn-blk-viol) resistor.
- ( ) R221: 499 k $\Omega$ , 1% (yel-wht-wht-org) resistor.
- ( ) D207: 1N823A zener diode (#56-91).
- ( ) D206: 1N4149 diode (#56-56).
- ( ) C211: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- ( ) D205: 1N4149 diode (#56-56).
- ( ) R225: 499 k $\Omega$ , 1% (yel-wht-wht-org) resistor.
- ( ) Solder the leads to the foil and cut off excess lead lengths.
- ( ) R215: 990 k $\Omega$  precision (wht-wht-blk-org) resistor.
- ( ) R217: 1430  $\Omega$ , 1% (brn-yel-org-brn) resistor.
- ( ) R213: 1  $\Omega$  (brn-blk-gld) resistor.
- ( ) R214: 1  $\Omega$  (brn-blk-gld) resistor.
- ( ) C202: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- ( ) C121: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- ( ) C123: .1  $\mu$ F (104) axial-lead ceramic capacitor.

Install four 1N4149 (#56-56) diodes at the following locations:

## Section 7

- ( ) R211: 47.5  $\Omega$ , 1%, (yel-viol-grn-gld) resistor.
- ( ) R208: 111 k $\Omega$  precision (brn-brn-brn-org) resistor.
- ( ) R207: 900 k $\Omega$  precision (wht-blk-blk-org) resistor.
- ( ) R212: 200  $\Omega$ , 1% (red-blk-blk-blk) resistor.
- ( ) R209: 215  $\Omega$ , 1% (red-brn-grn-blk) resistor.
- ( ) D203.
- ( ) D202.
- ( ) D204.
- ( ) D201.
- ( ) R201: 1 M $\Omega$  (brn-blk-grn) resistor.
- ( ) C118: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- ( ) R202: 51  $\Omega$  (grn-brn-blk) resistor.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

**Section 8**

Install four 1N5393 (#57-609) diodes at the following locations:

- D406.
- D407.
- D404.
- D405.
- C447: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- C439: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- C438: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- C437: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- C402: 22 pF (220) axial-lead ceramic capacitor.
- R403: 1000  $\Omega$  (brn-blk-red) resistor.
- D402: 1N4149 diode (#56-56).
- D401: 1N4149 diode (#56-56).
- R401: 2200  $\Omega$  (red-red-red) resistor.
- R402: 33 k $\Omega$  (org-org-org) resistor.
- C436: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- C435: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- D403: 1N4149 diode (#56-56).
- R404: 10 k $\Omega$  (brn-blk-org) resistor.
- C443: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- C406: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- R405: 1000  $\Omega$  (brn-blk-red) resistor.
- C405: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- R406: 4700  $\Omega$  (yel-viol-red) resistor.

Install five .1  $\mu$ F (104) axial-lead ceramic capacitors at the following locations:

- C445.
- C446.
- C442.
- C444.
- C403.
- Solder the leads to the foil and cut off the excess lead lengths.
- Cut the leads of the 1N4149 (#56-56) diode to 1/2". Then bend 1/4" of the lead ends down 90°.
- Add a bead of solder to the diode lead ends.
- D414: Refer to the inset drawing and solder the lead at the banded end of the prepared diode to the indicated lead of resistor R411 in Section 5. Solder the other diode lead to the indicated lead of capacitor C446 in Section 8. Be careful not to create a solder bridge and do not use more heat than necessary to make a good connection.

**Section 9**

- C427: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- C428: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- Bend the ends of the cutoff component lead you set aside earlier to fit the hole spacing and install the lead at W301. Space the wire slightly above the board.
- C304: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- R326: 1  $\Omega$  (brn-blk-gld) resistor.
- C306: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- R307: 47.5  $\Omega$ , 1% (yel-viol-grn-gld) resistor.
- C305: 56 pF (560) axial-lead ceramic capacitor.

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- ( ) R308: 47  $\Omega$  (yel-viol-blk) resistor.
- ( ) R328: 100  $\Omega$  (brn-blk-brn) resistor.
- ( ) R323: 301  $\Omega$ , 1% (org-blk-brn-blk) resistor.
- ( ) R324: 237, 1% (red-org-viol-blk) resistor.
- ( ) R322: 301  $\Omega$ , 1% (org-blk-brn-blk) resistor.
- ( ) R327: 100  $\Omega$  (brn-blk-brn) resistor.
- ( ) C311: .1  $\mu\text{F}$  (104) axial-lead ceramic capacitor.
- ( ) R313: 3480  $\Omega$ , 1% (org-yel-gry-brn) resistor.
- ( ) D302: 1N4149 diode (#56-56).
- ( ) R312: 604  $\Omega$ , 1% (blu-blk-yel-blk) resistor.
- ( ) R314: 953  $\Omega$ , 1% (wht-grn-org-blk) resistor.
- ( ) R311: 30.1  $\Omega$ , 1% (org-blk-brn-gld) resistor.
- ( ) R317: 604  $\Omega$ , 1% (blu-blk-yel-blk) resistor.
- ( ) R318: 100  $\Omega$  (brn-blk-brn) resistor.
- ( ) R309: 30.1  $\Omega$ , 1% (org-blk-brn-gld) resistor.
- ( ) R316: 604  $\Omega$ , 1% (blu-blk-yel-blk) resistor.
- ( ) C331: .1  $\mu\text{F}$  (104) axial-lead ceramic capacitor.
- ( ) R325: 1  $\Omega$  (brn-blk-gld) resistor.
- ( ) C303: .1  $\mu\text{F}$  (104) axial-lead ceramic capacitor.
- ( ) D303: 1N4149 diode (#56-56).
- ( ) R361: 1500  $\Omega$  (brn-grn-red) resistor.
- ( ) R362: 1500  $\Omega$  (brn-grn-red) resistor.
- ( ) R359: 3300  $\Omega$  (org-org-red) resistor.
- ( ) C307: .1  $\mu\text{F}$  (104) axial-lead ceramic capacitor.
- ( ) R319: 1210  $\Omega$ , 1% (brn-red-brn-brn) resistor.
- ( ) R321: 3480  $\Omega$ , 1% (org-yel-gry-brn) resistor.
- ( ) R306: 1130  $\Omega$ , 1% (brn-brn-org-brn) resistor.
- ( ) C308: .1  $\mu\text{F}$  (104) axial-lead ceramic capacitor.
- ( ) R369: 270  $\Omega$  (red-viol-brn) resistor.
- ( ) R356: 270  $\Omega$  (red-viol-brn) resistor.
- ( ) R330: 270  $\Omega$  (red-viol-brn) resistor.
- ( ) C319: .1  $\mu\text{F}$  (104) axial-lead ceramic capacitor.
- ( ) R357: 270  $\Omega$  (red-viol-brn) resistor.
- ( ) R331: 2700  $\Omega$  (red-viol-red) resistor.
- ( ) R329: 2700  $\Omega$  (red-viol-red) resistor.
- ( ) C323: .1  $\mu\text{F}$  (104) axial-lead ceramic capacitor.
- ( ) C324: .1  $\mu\text{F}$  (104) axial-lead ceramic capacitor.
- ( ) C328: 1000 pF (102) axial-lead ceramic capacitor.
- ( ) R364: 4700  $\Omega$  (yel-viol-red) resistor.
- ( ) R305: 3160  $\Omega$ , 1% (org-brn-blu-brn) resistor.
- ( ) D304: 1N823A diode (#56-91).
- ( ) R352: 604  $\Omega$ , 1% (blu-blk-yel-blk) resistor.
- ( ) R351: 1000  $\Omega$ , 1% (brn-blk-blk-brn) resistor.
- ( ) C314: .1  $\mu\text{F}$  (104) axial-lead ceramic capacitor.
- ( ) C312: .1  $\mu\text{F}$  (104) axial-lead ceramic capacitor.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

## Section 10

- ( ) R348: 1000  $\Omega$ , 1% (brn-blk-blk-brn) resistor.
- ( ) R333: 510  $\Omega$  (grn-brn-brn) resistor.
- ( ) R332: 1000  $\Omega$  (brn-blk-red) resistor.
- ( ) R353: 1  $\Omega$  (brn-blk-gld) resistor.
- ( ) R334: 270  $\Omega$  (red-viol-brn) resistor.

- ( ) R358: 4700  $\Omega$  (yel-viol-red) resistor.
- ( ) C429: .1  $\mu$ F (104) axial-lead ceramic capacitors.
- ( ) R366: 750  $\Omega$ , 1% (viol-grn-blk-blk) resistor.
- ( ) R367: 1370, 1% (brn-org-viol-brn) resistor.
- ( ) R302: 3160  $\Omega$ , 1% (org-brn-blu-brn) resistor.
- ( ) R301: 3160  $\Omega$ , 1% (org-brn-blu-brn) resistor.
- ( ) C302: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- ( ) C326: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- ( ) R365: 390  $\Omega$  (org-wht-brn) resistor.
- ( ) D308: 1N823A diode (#56-91).
- ( ) R303: 3160  $\Omega$ , 1% (org-brn-blu-brn) resistor.
- ( ) R304: 3160  $\Omega$ , 1% (org-brn-blu-brn) resistor.
- ( ) R340: 1 M $\Omega$  (brn-blk-grn) resistor.
- ( ) C315: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- ( ) R354: 220  $\Omega$  (red-red-brn) resistor.
- ( ) C431: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- ( ) C327: 22 pF (220) axial-lead ceramic capacitor.
- ( ) C325: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- ( ) D305: 5 V zener diode (#56-85).
- ( ) R355: 220  $\Omega$  (red-red-brn) resistor.
- ( ) C432: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- ( ) R368: 100 k $\Omega$  (brn-blk-yel) resistor.
- ( ) D307: 1N4149 diode (#56-56).
- ( ) C321: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- ( ) R344: 14.3 k $\Omega$  precision (brn-yel-org-red) resistor.

- ( ) R342: 71.5 k $\Omega$  precision (viol-brn-grn-red) resistor.
- ( ) R346: 2870  $\Omega$  precision (red-gry-viol-brn) resistor.
- ( ) R341: 143 k $\Omega$  precision (brn-yel-org-org) resistor.
- ( ) R339: 287 k $\Omega$  precision (red-gry-viol-org) resistor.
- ( ) R347: 1430  $\Omega$  precision (brn-yel-org-brn) resistor.
- ( ) R343: 28.7 k $\Omega$  precision (red-gry-viol-red) resistor.
- ( ) R345: 7150  $\Omega$  precision (viol-brn-grn-brn) resistor.

Install three 4700  $\Omega$  (yel-viol-red) resistors at the following locations:

- ( ) R335.
- ( ) R336.
- ( ) R337.
- ( ) R338: 1  $\Omega$  (brn-blk-gld) resistor.
- ( ) C313: .1  $\mu$ F (104) axial-lead ceramic capacitor.
- ( ) D306: 1N6263 diode (#56-655).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

Refer to Pictorial 3-2 for the following steps.

#### NOTES:

1. When you install components in the following sections, you will start at the top and work in rows from left to right.
2. Use the same installation procedure for the IC sockets and controls that you used on the display logic circuit board earlier. Remember to keep the components flat against the board while you solder the pins to the foils. Solder each component after you install it and cut off the excess pin lengths on each control.

## Section 1

8-pin IC socket at U104.

Install 100 k $\Omega$  controls at the following three locations:

R171.

R168.

R169.

8-pin IC socket at U204.

Install 100 k $\Omega$  controls at the following three locations:

R271.

R268.

R269.

8-pin IC socket at U103.

8-pin IC socket at U102.

R156: 50  $\Omega$  control.

8-pin IC socket at U203.

8-pin IC socket at U202.

R256: 50  $\Omega$  control.

R152: 100 k $\Omega$  control.

R148: 200  $\Omega$  control.

16-pin IC socket at Q105.

R252: 100 k $\Omega$  control.

R248: 200  $\Omega$  control.

16-pin IC socket at Q205.

## Section 2

8-pin IC socket at U101.

R123: 100 k $\Omega$  control.

R126: 100 k $\Omega$  control.

8-pin IC socket at U201.

R223: 100 k $\Omega$  control.

R226: 100 k $\Omega$  control.

## Section 3

8-pin IC socket at U105.

14-pin IC socket at U106.

16-pin IC socket at U428.

14-pin IC socket at U405.

14-pin IC socket at U404.

14-pin IC socket at U403.

16-pin IC socket at U402.

14-pin IC socket at U401.

20-pin IC socket at U415.

28-pin IC socket at U408.

24-pin IC socket at U411.

40-pin IC socket at U407.

16-pin IC socket at U413.

16-pin IC socket at U412.

40-pin IC socket at U406.

20-pin IC socket at U416.

16-pin IC socket at U409.

14-pin IC socket at U414.

## Section 4

( ) 14-pin IC socket at U424.

Install six 20-pin IC sockets at the following locations:

( ) U418.

( ) U417.

( ) U419.

( ) U421.

( ) U423.

( ) U422.

( ) R315: 500  $\Omega$  control.

NOTE: You will install the remaining IC sockets in vertical rows.

( ) 14-pin IC socket at U427.

( ) 14-pin IC socket at U426.

( ) 14-pin IC socket at U425.

( ) 16-pin IC socket at U303.

( ) 16-pin IC socket at U304.

( ) 14-pin IC socket at U311.

( ) 8-pin IC socket at U313.

( ) 16-pin IC socket at U305.

( ) 16-pin IC socket at U301.

( ) 8-pin IC socket at U302.

( ) R349: 1000  $\Omega$  (1K) control.

( ) 16-pin IC socket at U308.

( ) 8-pin IC socket at U309.

( ) 16-pin IC socket at U312.

( ) 16-pin IC socket at U307.

( ) 8-pin IC socket at Q311.

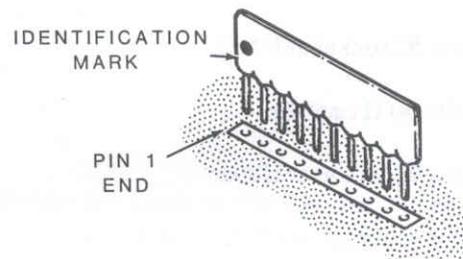
( ) 14-pin IC socket at U306.

( ) Carefully recheck each pin connection to make sure it is properly soldered and that there are no solder bridges between the closely-spaced foils.

Refer to Pictorial 3-3 for the following steps.

## Section 1

( ) RP103: 4700  $\Omega$  (4.7K), **472** resistor pack. Remember to position the end with the dot or line towards the "1" shown on the circuit board. After you install a resistor pack and the pins are fully seated in their holes, solder the pins to the foil.



( ) C138: 150 pF (151) ceramic capacitor.

( ) C137: 150 pF (151) ceramic capacitor.

( ) RP102: 1000  $\Omega$  (1K), **102**, 8-pin resistor pack. Do not confuse the "1" near U104 for use with this part.

( ) C131: 68 pF (680) ceramic capacitor.

( ) C136: 680 pF (681) ceramic capacitor.

( ) C135: 68 pF (680) ceramic capacitor.

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

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NOTE: When you install a trimmer capacitor, position the trimmer with the flat part of the body over the flat shown on the circuit board outline as shown. Insert the pins into the holes and press the body flat against the board. Then solder the pins to the foil.



- ( ) C128: 5-25 pF (violet dot) trimmer capacitor.

## Section 2

- ( ) C119: .047  $\mu$ F (473) ceramic capacitor.  
 ( ) C122: .047  $\mu$ F (473) ceramic capacitor.  
 ( ) C124: .047  $\mu$ F (473) ceramic capacitor.  
 ( ) C116: 110 pF (111) ceramic capacitor.  
 ( ) C117: .047  $\mu$ F (473) ceramic capacitor.  
 ( ) C106: 110 pF (111) ceramic capacitor.  
 ( ) C105: 3.2-18 pF (blue dot) trimmer capacitor.  
 ( ) C104: 2-6 pF (red dot) trimmer capacitor.  
 ( ) C103: 3.2-18 pF (blue dot) trimmer capacitor.  
 ( ) C142: .047  $\mu$ F (473) ceramic capacitor.  
 ( ) C108: 3.2-18 pF (blue dot) trimmer capacitor.  
 ( ) C107: 2-6 pF (red dot) trimmer capacitor.  
 ( ) Solder the leads to the foil and cut off the excess lead lengths.

## Section 3

- ( ) RP203: 1000  $\Omega$  (1K), **102**, 8-pin resistor pack.  
 ( ) C238: 150 pF (151) ceramic capacitor.  
 ( ) C237: 150 pF (151) ceramic capacitor.

- ( ) RP202: 1000  $\Omega$  (1K), **102**, 8-pin resistor pack.  
 NOTE: Do not mistake the "1" at U204 for use with this part.

- ( ) C231: 68 pF (680) ceramic capacitor.  
 ( ) C236: 680 pF (681) ceramic capacitor.  
 ( ) C235: 68 pF (680) ceramic capacitor.  
 ( ) C228: 5-25 pF (violet dot) trimmer capacitor.  
 ( ) C434: 680 pF (681) ceramic capacitor (top center of board).  
 ( ) C433: 680 pF (681) ceramic capacitor.  
 ( ) RP401: 10 k $\Omega$  resistor pack.  
 ( ) Solder the leads to the foil and cut off the excess lead lengths.

## Section 4

- ( ) C329: .047  $\mu$ F (473) ceramic capacitor.  
 ( ) C141: .047  $\mu$ F (473) ceramic capacitor.  
 ( ) C219: .047  $\mu$ F (473) ceramic capacitor.  
 ( ) C222: .047  $\mu$ F (473) ceramic capacitor.  
 ( ) C216: 110 pF (111) ceramic capacitor.  
 ( ) C217: .047  $\mu$ F (473) ceramic capacitor.  
 ( ) C206: 110 pF (111) ceramic capacitor.  
 ( ) C205: 3.2-18 pF (blue dot) trimmer capacitor.  
 ( ) C204: 2-6 pF (red dot) trimmer capacitor.  
 ( ) C203: 3.2-18 pF (blue dot) trimmer capacitor.  
 ( ) C242: .047  $\mu$ F (473) ceramic capacitor.  
 ( ) C208: 3.2-18 pF (blue dot) trimmer capacitor.  
 ( ) C207: 2-6 pF (red dot) trimmer capacitor.

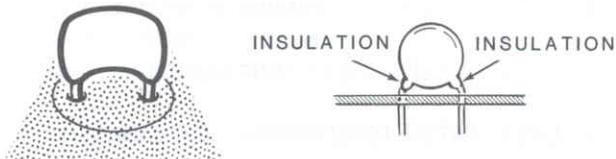
- ( ) RP301: 1000  $\Omega$  (1K), **102**, 10-pin resistor pack.
- ( ) RP302: 2700  $\Omega$  (2.7K), **272**, resistor pack.
- ( ) RP303: 1000  $\Omega$  (1K), **102**, 8-pin resistor pack.

NOTE: The following two resistor packs are installed out of sequence.

- ( ) RP201: 400  $\Omega$  (9-127) resistor pack in Section 4.
- ( ) RP101: Install a 400  $\Omega$  (9-127) resistor pack at RP101 in Section 2.
- ( ) C317: 5-25 pin pF (viol dot) trimmer capacitor.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

Refer to Pictorial 3-4 for the following steps.

NOTE: When you mount the following style ceramic capacitor, do not push the leads all the way down through the circuit board holes. The leads can have a coating of insulation that may keep you from making a good solder connection.



### Section 1

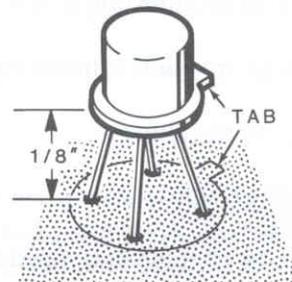
- ( ) C139: .001  $\mu$ F ceramic capacitor.

NOTE: When you install the following transistors, use the same spacing procedure as you did in the display circuit board.

- ( ) Q114: 2N3906 transistor (#417-874).
- ( ) Q112: 2N3906 transistor (#417-874).

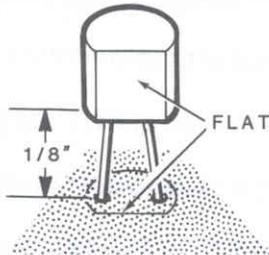
NOTE: The transistor you will install in the following step is protected in a special conductive envelope. Be sure it does not get damaged by static electricity. Once you remove the transistor from the special envelope, DO NOT let go of it until it is inserted into the circuit board. Install it as follows:

1. Open the coin envelope and remove the conductive envelope from inside. Then touch the conductive envelope and the circuit board with both hands.
2. Hold the conductive envelope with one hand and remove the transistor with the other hand.
3. Continue to hold the transistor with the one hand and form the pins to fit the circuit board hole spacing with the other hand.
4. Position the transistor so the metal tab of the case is over the tab outline on the circuit board as shown. Then insert the leads into their circuit board holes and position the bottom of the case 1/8" above the board. Solder the leads to the foil and cut off the excess lead lengths.



- ( ) Q113: MFE131 transistor (#417-863).
- ( ) C133: 27 pF ceramic capacitor.
- ( ) Q107: 2N3904 transistor (#417-875).
- ( ) Q109: 2N3906 transistor (#417-874).
- ( ) Q108: 2N3906 transistor (#417-874).
- ( ) Q111: 2N3904 transistor (#417-875).

NOTE: When you install each of the following diodes, position it so the flat of the case is over the flat outlined on the circuit board as shown. Then insert both leads into their circuit board holes and position the bottom of the case  $1/8''$  above the board. Bend the diode leads out slightly on the foil side of the board to hold it in place.



Install four MBD201 (#56-676) diodes at the following locations:

- D118.
- D117.
- D116.
- D115.
- Q117: 2N3906 transistor (#417-874).
- Q116: 2N3906 transistor (#417-874).
- Q115: 1078E transistor (#417-858).
- C134: 27 pF ceramic capacitor.
- Q106: MPS2369 transistor (#417-937).
- Q214: 2N3906 transistor (#417-874).
- Q212: 2N3906 transistor (#417-874).

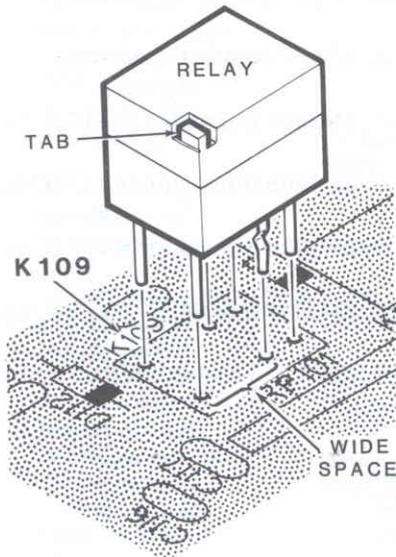
- Q213: MFE131 transistor (#417-863). NOTE: Install this transistor in the same manner as you did for the other protected transistor.
- Q217: 2N3906 transistor (#417-874).
- Q216: 2N3906 transistor (#417-874).
- Q215: 1078E transistor (#417-858).
- C233: 27 pF ceramic capacitor.
- C234: 27 pF ceramic capacitor.
- Q207: 2N3904 transistor (#417-875).
- Q209: 2N3906 transistor (#417-874).
- Q208: 2N3906 transistor (#417-874).
- Q211: 2N3904 transistor (#417-875).

Install four MBD201 (#56-676) diodes at the following locations:

- D218.
- D217.
- D216.
- D215.
- U107: 78L05 IC (#442-627). NOTE: This IC looks and mounts the same as the previous transistors.
- Q206: MPS2369 transistor (#417-937).
- Solder the leads to the foil and cut off the excess lead lengths.

## Section 2

NOTE: When you install each of the following relays, position the relay case with the tab as shown and insert the pins into the circuit board holes. Press the relay case flat against the board and then turn the board over and solder the pins to the foil side. Make sure that the case remains flat against the board.



Install relays at the following locations:

- K109.
- K108.
- K107.
- K301.
- K209.
- K208.
- K207.
  
- C113: 2.2 pF ceramic capacitor.
- C213: 2.2 pF ceramic capacitor.
  
- C115: 10  $\mu$ F electrolytic. Remember to observe the polarity markings and install the electrolytic capacitor correctly.
  
- Q102: E304 transistor (#417-854).

- Q103: MPSH10 transistor (#417-887).
- Q101: 304 transistor (#417-828).
- Q104: MPSH10 transistor (#417-887).
- C215: 10  $\mu$ F electrolytic.
- Q202: E304 transistor (#417-854).
- Q203: MPSH10 transistor (#417-887).
- Q201: 304 transistor (#417-828).
- Q204: MPSH10 transistor (#417-887).
- C112: 100 pF (100K) ceramic capacitor.
- C212: 100 pF (100K) ceramic capacitor.

Install four relays at the following locations:

- K106.
- K105.
- K206.
- K205.
  
- Solder the leads to the foil and cut off the excess lead lengths.

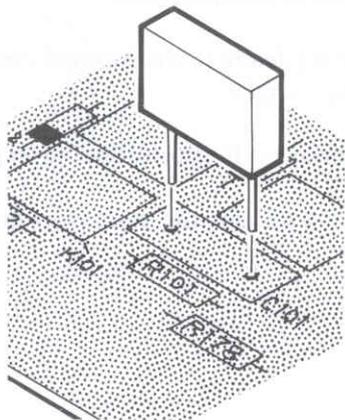
## Section 3

- C109: .001  $\mu$ F ceramic capacitor.
- C209: .001  $\mu$ F ceramic capacitor.

Install eight relays at the following locations:

- K103.
- K102.
- K104.
- K101.
- K203.
- K202.
- K204.
- K201.

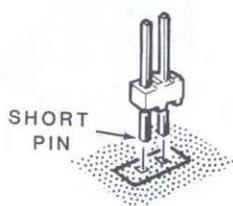
NOTE: When you install each of the following Mylar capacitors, insert the pins into the circuit board holes and press the capacitor body flat against the board. Solder the pins to the foil, making sure that the capacitor remains flat against the board.



( ) C101: .027  $\mu$ F Mylar capacitor.

( ) C201: .027  $\mu$ F Mylar capacitor.

NOTE: When you install each of the following plugs, insert the short pins into the circuit board holes and press the plug body flat against the board so the pins are perpendicular to the board. Solder the pins to the foil, making sure the plug remains flat and perpendicular to the board.



( ) P101: 2-pin plug.

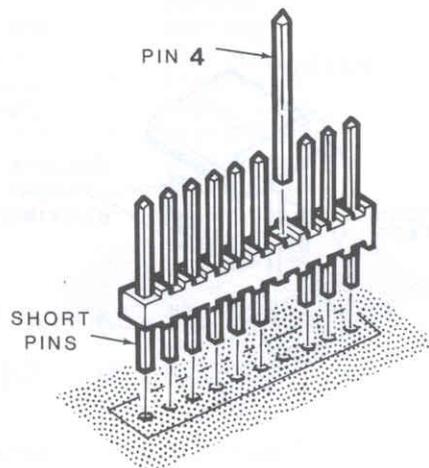
( ) P201: 2-pin plug.

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

## Section 4

( ) Pull out the fourth pin from the 10-pin plug.

( ) P402: 10-pin plug. Solder the pins to the foil.



Install six 3-pin plugs at the following locations. Solder each plug to the foil after you install it, making sure that each remains perpendicular to the board:

( ) JP400.

( ) JP401.

( ) JP402.

( ) JP403.

( ) JP404.

( ) JP405.

( ) L401: 35 'H choke (#235-229).

( ) C401: 100 pF mica capacitor.

( ) Q401: 2N3904 transistor (#417-875).

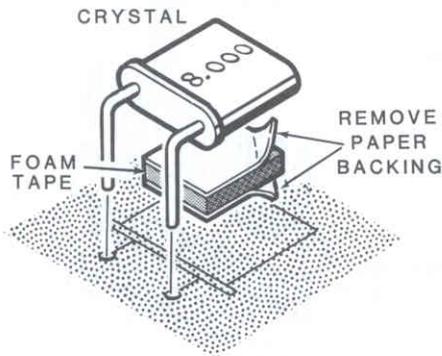
( ) Cut a 1/2" piece of double-stick foam tape.

( ) Remove the paper backing from one side of the 1/2" double-stick foam tape and press the adhesive side against the case side of the 8 MHz crystal that is not marked with the frequency.

( ) Remove the remaining paper backing from the crystal foam tape.



- ( ) Y401: Bend the leads of the prepared 8 MHz crystal down 90° towards the foam tape side of the case as shown. Then insert the crystal leads into the circuit board holes at Y401 and press the adhesive side of the tape against the board inside the outline as shown.



- ( ) Pull out pin 5 from the 25-pin plug.
- ( ) P401: 25-pin plug. Solder the pins to the foil.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

### Section 5

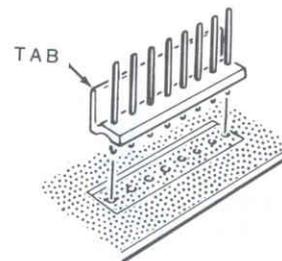
- ( ) Q302: MPSH10 transistor (#417-887).
- ( ) Q303: MPSH10 transistor (#417-887).
- ( ) Q305: 2N3906 transistor (#417-874).
- ( ) Q304: 2N3906 transistor (#417-874).
- ( ) Q301: MPSH10 transistor (#417-887).
- ( ) P301: 2-pin plug. Solder the pins to the foil after you install the plug.
- ( ) C301: 75 pF ceramic capacitor.
- ( ) Q306: MPS2369 transistor (#417-937).
- ( ) Q307: MPSH81 transistor (#417-917).

- ( ) Q308: MPS2369 transistor (#417-937).
- ( ) C318: .01  $\mu$ F (#29-67) polystyrene capacitor.
- ( ) Q309: MPS2369 transistor (#417-937).
- ( ) C316: 62 pF mica capacitor.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

Refer to Pictorial 3-5 for the following steps.

Install eight .01  $\mu$ F ceramic capacitors at the following locations:

- ( ) C419.
- ( ) C418.
- ( ) C417.
- ( ) C416.
- ( ) C411.
- ( ) C409.
- ( ) C408.
- ( ) C407.
- ( ) P403: Install an 8-pin plug at P403 with the flange over the double outline shown on the circuit board. Press the plug body flat against the circuit board and solder the pins to the foil.



NOTE: Use the plastic nut starter to start and hold 4-40 and 6-32 nuts on screws, as in the next step.

- ( ) Mount the heat sink to the circuit board with a 4-40  $\times$  1/4" phillips screw at the center mounting flange hole and a 4-40  $\times$  1/4" phillips screw and a 4-40 nut at the outer flange mounting hole. Tighten the outer screw and nut finger tight. You will remove them later.

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Refer to inset drawing #1 on Pictorial 3-5 and bend the leads of the following ICs as shown:

- 7805C (#442-54).
- 7905 (#442-630).
- 7812 (#442-674).
- 7912 (#442-675).

Refer to inset drawing #2 and open the container of silicone grease.

Prepare a plastic insulator by spreading a thin coat of silicone grease over one side. Then press the coated side of the insulator against the heat sink at location U433 so the mounting holes align.

U433: Spread a thin film of silicone grease over the bare metal side of IC 7912 (#442-675). Then insert the IC leads into the circuit board holes at U433 and mount the IC to the heat sink and insulator with a 4-40 × 3/8" phillips screw, a nylon shoulder spacer, a #4 lock-washer, and a 4-40 nut. Make sure that the shoulder spacer seats into the mounting hole properly.

Solder the leads of IC U433 to the foil side of the board.

Similarly prepare and install a plastic insulator on the heat sink at location U431.

U431: Similarly prepare and install IC 7905 (#442-630) at plastic insulator and heat sink location U431. Solder the leads to the foil.

NOTE: The following ICs do not use insulators.

U429: Spread a thin coating of silicone grease on the bare metal side of IC 7805C (#442-54). Then mount the IC to the heat sink at U429 with a 4-40 × 3/8" phillips screw, a #4 lock-washer, and a 4-40 nut. Solder the leads to the foil.

U432: Similarly prepare and mount 7812 IC (#442-674) at heat sink location U432 and solder the leads to the foil.

Set the remaining silicone grease aside.

Remove the 4-40 × 1/4" phillips screw and the 4-40 nut from the outer heat sink flange and set the hardware aside for later use.

NOTE: When you are instructed to prepare a stranded wire, remove 1/4" of insulation from the ends. Then twist the fine wire strands tightly together and apply a small amount of solder to the wire strands ("tin the leads") to hold them together.

Cut the 18" brown stranded wire to 12-1/4" and prepare the ends.

Note hole locations A and B on the component side of the circuit board between the heavy dotted lines shown in the Pictorial. From the foil side of the circuit board, connect one end of the prepared 12-1/4" brown stranded wire to hole A, and solder it to the foil pad on the component side of the board. Then similarly connect and solder the other end of the wire to hole B.

C404: 47 μF electrolytic capacitor.

Install four 22 μF electrolytic capacitors at the following locations:

- C413.
- C415.
- C422.
- C424.

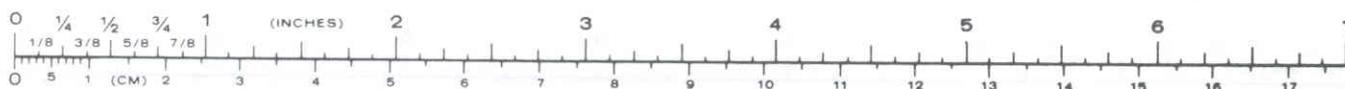
C412: 6800 μF electrolytic capacitor.

C421: 4700 μF electrolytic capacitor.

C423: 1000 μF electrolytic capacitor.

C414: 2200 μF electrolytic capacitor.

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



- ( ) Refer to Detail 3-5A and prepare the ends of a 5-1/2" shielded cable for 1" as shown. Be careful not to cut into the insulation of the inner lead when you remove the outer insulation from the shielded cable.
- ( ) Cut two 1/2" pieces of fiber sleeving.
- ( ) Slide a 1/2" piece of fiber sleeving over the shield lead at one end of the 5-1/2" shielded cable. Connect and solder the shield lead to the circuit board at hole D and the center lead to hole C. Pull the shield lead through the circuit board hole so the fiber sleeving completely covers it. After you solder the leads, cut off the excess lead lengths.
- ( ) Similarly slide the other 1/2" piece of fiber sleeving over the shielded lead at the free end of the shielded cable. Connect and solder the shield lead to circuit board hole F and the center lead to hole E. Cut off the excess wire 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.

Refer to the illustration where the parts were installed as you make the following visual checks.

- ( ) Transistors and ICs for the proper type and installation.
- ( ) Diodes for the proper type and positioning of the banded end.
- ( ) Electrolytic capacitors for the correct position of the positive (+) or negative (-) marked ends.

## RESISTANCE CHECKS

Use your ohmmeter to perform the following checks. Connect the ohmmeter's negative lead to the indicated ground location, and connect its positive lead to each of the following test points (TP). If any of the readings do not fall within the resistance ranges shown in the chart, try reversing the meter leads and repeat the test. If the test is still incorrect, refer to the "Possible Cause of Problem" column for help. Do not proceed with any further testing until you have located and corrected the cause of the problem.

If you find a problem, check each part or group of parts called out in the "Possible Cause" column, and any other components connected to them, 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.



## RESISTANCE CHART

METER RANGE	TEST POINT#	READING	POSSIBLE CAUSE OF PROBLEM
R × 100	TP1	200-600 ohms	Q101 – Q105. Socket at U101.
"	TP2	200-1500 ohms	Q101 – Q105. Socket at U101.
"	TP3	200-600 ohms	Q201 – Q205. Socket at U201.
"	TP4	200-1500 ohms	Q201 – Q205. Socket at U201.
"	TP5	200-700 ohms	– 12 volt circuitry
"	TP6	200-1500 ohms	+ 12 volt circuitry
"	TP7	500-2500 ohms	+ 5 volt circuitry
"	TP8	400-2500 ohms	– 5.2 volt circuitry
"	TP9	500-5000 ohms	U107. Socket at U415.
"	TP10	400-1500 ohms	D413. Socket at U415.
"	TP11	400-800 ohms	Sockets at U306, U301, U312, U313, D308.
"	TP12	400-800 ohms	D304, R349, R351, R352. Socket at U309.
R × 1000	TP13*	Over 15 k Ω	D408-D412, C416-C419, C412, C414. Sockets at U429, U431.
"	TP14*	"	See the components in the previous step.
"	TP15*	"	D404-D407, C407-C411, C421, C423, Sockets at U432, U433
"	TP16*	"	See the components in the previous step.
"	TP17*	"	IC U431, plastic insulator, shoulder washer
"	TP18*	"	IC U433, plastic insulator, shoulder washer

\*Allow the capacitors to charge and the readings to stabilize at this location.

This completes the "Resistance Checks." Set the circuit board 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." Return any part that is in an individual envelope with the part number on it, 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. For prices, refer to the separate "Heath Parts Price List."

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
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### METAL PARTS

A1	90-1364-1	1	Cabinet top
A2	200-1478-1	1	Chassis
A3	203-2235	1	Front panel
A4	203-2236	1	Front subpanel
A5	205-1953	1	Transformer mounting plate
A6	206-1492	1	Shield
A7	210-86	1	Bezel

### HARDWARE

NOTE: Hardware is shown full size in the Parts Pictorial so you can place any screw, nut, etc., you are uncertain about over the illustration. The hardware may be packed in more than one envelope. Open all of the hardware envelopes before you check the screws, nuts, lockwashers, etc. against the Parts List.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
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### #4 Hardware

B1	250-1411	13	4-40 × 1/4" phillips screw
B2	250-1412	1	4-40 × 3/8" phillips screw
B3	252-2	2	4-40 nut
B4	254-9	2	#4 lockwasher
B5	259-9	1	#4 solder lug

### #6 Hardware

C1	250-1164	2	6-32 × 3/16" flat-head screw
C2	250-1508	2	6-32 × 3/16" screw
C3	250-1325	13	6-32 × 1/4" phillips screw
C4	250-1307	2	#6 × 1/4" phillips sheet metal screw
C5	250-1280	5	6-32 × 3/8" phillips screw
C6	252-3	10	6-32 nut
C7	254-1	12	#6 lockwasher
C8	254-6	4	#6 external tooth lockwasher
C9	259-1	1	#6 solder lug

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KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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## #8 Hardware

D1	250-1436	1	8-32 × 3/8" phillips screw	
D2	250-1476	1	8-32 × 1/2" phillips flat-head screw	
D3	252-4	2	8-32 nut	
D4	254-2	2	#8 lockwasher	

## Other Hardware

E1	253-198	1	Nylon shoulder spacer	
E2	255-49	6	5/16" round spacer	
E3	255-860	2	3/8" hex spacer	
E4	255-757	2	Threaded hex spacer	
E5	259-27	2	3/8" solder lug	

## 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. (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 device.)
3. Part number and type number.
4. Part number with a type number other than the one shown.

F1	417-902	1	NPD5566 transistor	Q311
F1	417-975	2	CA3127 transistor	Q105, Q205

CAUTION: Some of the following integrated circuits can be easily damaged by static electricity. DO NOT remove any ICs that are installed in conductive foam pads until you are instructed to do so in a step.

F2	442-54	1	UA7805 IC	U1
F1	442-640	4	CA3080 IC	U103, U104, U203, U204
<del>F1</del>	<del>442-644</del>	<del>1</del>	<del>LM78L12 IC</del>	<del>U504</del>
<del>F1</del>	<del>442-646</del>	<del>1</del>	<del>LM79L12 IC</del>	<del>U503</del>
F1	442-751	2	LM1408N-8 IC	U301, U506
F1	442-759	8	LF411 IC	U101, U102, U201, U202, U302, U309, U313, U507

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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## Integrated Circuits (Cont'd)

F1	442-768	1	<b>DAC1021</b> IC	U312
F1	442-769	1	<b>ADC0820</b> IC	U415
F1	442-771	1	LM361 IC	U311
F1	442-782	1	LF357 IC	U105
F1	443-636	1	MC10116 IC	U303
F1	443-679	1	MC10131 IC	U305
F1	443-683	1	MC10102 IC	U304
F1	443-730	1	<b>74LS74</b> IC	U401
F1	443-794	1	<b>75188</b> or 1488 IC	U405
F1	443-795	1	<b>75189</b> or 1489 IC	U404
F1	443-811	1	<b>74LS125</b> IC	U502
F1	443-863	13	<b>74LS374</b> IC	U417, U418, U419, U421, U422, U423, U505, U508, U509, U511, U512, U513, U514
F1	443-877	3	<b>74LS138</b> IC	U412, U413, U501
F1	443-885	1	<b>74LS245</b> IC	U416
F1	443-896	1	<b>74S02</b> IC	U106
F1	443-942	1	<b>74LS123</b> IC	U428
F1	443-948	1	<b>74LS112</b> IC	U402
F1	443-951	1	<b>74LS51</b> IC	U414
F1	443-952	1	<b>8250</b> IC	U407
F1	443-953	1	<b>3880/Z80A</b> IC	U406
F1	443-967	1	<b>7406</b> IC	U306
F1	443-992	2	<b>4051</b> IC	U307, U308
F1	443-1020	3	<b>7407</b> IC	U425, U426, U427
F1	443-1027	1	<b>6116-P4</b> IC	U411
F1	443-1039	1	<b>74LS365A</b>	U409
F1	443-1080	1	<b>74ALS00</b> IC	U403
F1	443-1367	1	<b>74HCT00</b> IC	U424
F1	444-344-1	1	<b>2764-3</b> IC	U408

## PINS – CONNECTORS

G1	432-120	2	Female pin
G2	432-1033	9	Gold male pin (includes one extra)
G3	438-55	1	Polarizing pin
G4	432-1142	5	Small gold-plated spring connector (includes one extra)
G4	432-866	9	Small spring connector (includes two extra)
G4	432-753	8	Large spring connector (includes two extra)

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

H1	432-1030	2	2-hole socket	
H2	432-1041	6	Jumper socket	
H3	432-1022	1	8-hole socket	
H4	432-958	1	10-hole socket	
H5	432-1032	1	25-hole D-connector	

**INSULATORS**

J1	73-34	2	Rubber insulator	
J2	75-139	1	Plastic insulator	
J3	75-736	1	Strain relief	
	75-860	1	2-1/2" square insulating paper	
	75-872	2	1" x 4" insulating paper	

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

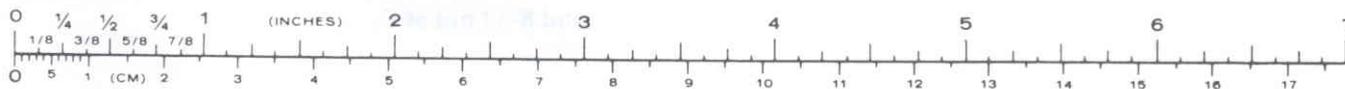
K1	21-72	2	.005 $\mu$ F ceramic capacitor	C1, C2
	54-1039	1	Power transformer	T1
K2	61-48	1	Rocker switch	SW1
	89-54	1	Line cord	
K3	134-237	1	Cable with BNC connector	
K4	205-778	1	Alignment tool blade	
K5	206-1505	1	Mylar-coated aluminum shield	
K6	260-16	2	Alligator clip	
K7	261-34	4	Plastic foot	
K8	421-42	1	3/8-ampere slow-blow fuse	F1
K9	431-609	1	5-lug terminal strip w/fuse clips	
K10	432-59	4	BNC connector	
K11	490-111	1	IC puller	

K12 261-50 2 Rubber Spacers

## STEP-BY-STEP ASSEMBLY

Refer to Pictorial 4-1 for the following steps.

- ( ) Turn the chassis over and position it with the bottom facing up.
- ( ) Remove the backing from a rubber foot and press it onto one of the four corner chassis locations using the indicated dimensions. Do not cover any of the mounting holes.
- ( ) Similarly install the remaining rubber feet at the three other corner locations.
- ( ) Position the chassis as shown in the Pictorial.
- ( ) Mount a #6 solder lug at chassis hole A with a 6-32  $\times$  1/4" phillips screw and 6-32 nut. Position the solder lug as shown.
- ( ) Refer to the inset drawing of Detail 4-1A on the following page of the Illustration Booklet and remove an additional 2-1/2" of outer insulation from the free end of the line cord. Be careful not to cut into the inner lead insulation.
- ( ) Refer to the inset drawing and shorten the black and white line cord leads to 2-1/2". Then remove 1/2" of insulation and "tin" each of the three line cord lead ends.
- ( ) Refer to Detail 4-1A and install the strain relief 1/2" from the end of the outer insulation on the line cord as shown, and install the strain relief and line cord into chassis hole B. Use a pair of pliers to squeeze the strain relief around the line cord as you insert it into the hole.
- ( ) Position the 5-lug terminal strip w/fuse clips as shown; then cut off lug 1 and discard it.
- ( ) Mount the 4-lug terminal strip at chassis hole C with a 6-32  $\times$  3/8" phillips screw, two lockwashers, and a 6-32 nut. Mount the lockwashers as shown.
- ( ) SW1: Position the rocker switch with the lugs as shown and press it into the chassis cutout at SW1 until it snaps into place.
- ( ) Cut a 5" length of 8-wire ribbon cable.
- ( ) Remove and discard the brown wire from the 5" ribbon cable to make a 7-wire ribbon cable.
- ( ) Refer to Detail 4-1B and separate the ends of the 5" 7-wire ribbon cable. Then remove 1/8" of insulation from the wires at both ends and tin the wire ends.
- ( ) Cut a 2-1/2" black wire.
- ( ) Remove 1/8" of insulation from one end of the 2-1/2" black wire and 1/4" from the other end and tin the ends.
- ( ) Refer to the inset drawing on Detail 4-1B and crimp and solder a gold male pin on the 1/8" prepared end of the 2-1/2" black wire. Be careful not to get any solder on the outside of the pin or it will not fit into the connector. Set this wire aside temporarily.
- ( ) Similarly crimp and solder gold male pins on the wires at one end of the 7-wire ribbon cable.
- ( ) Crimp and solder small spring connectors (do not use the small gold-plated spring connectors) on the wires at the other end of the 7-wire ribbon cable. Be careful not to get any solder on the spring portion of the connectors.



Refer to Detail 4-1C for the following steps.

- ( ) Position the 25-hole D-connector with hole 1 and the beveled ends as shown in the Detail.

You will insert the gold male pins on the ends of the wires into the 25-hole D-connector in numerical sequence in the following steps. The pin numbers are stamped next to the connector holes. Insert each pin into its designated connector hole until you hear a faint latching "click." Then gently pull on the wire to make sure the pin is properly latched into the connector. Be careful not to insert a pin into the wrong connector hole, since it is impossible to remove the pin without destroying it.

- ( ) Insert the gold male pin on the end of the 2-1/2" black wire into hole 1.

Insert the gold male pins on 7-wire ribbon cable wires into the following connector holes:

- ( ) Blue wire into hole 2.
- ( ) Red wire into hole 3.
- ( ) Violet wire into hole 4.
- ( ) Orange wire into hole 5.
- ( ) Yellow wire into hole 6.
- ( ) Green wire into hole 7.
- ( ) Gray wire into hole 20.

Position the 10-hole socket with the slots up as shown and connect the spring connectors on the wires at the other end of the 7-wire cable into the connector holes as follows. Position the spring connectors with the locking tabs toward the socket slots as shown.

- ( ) Red wire into hole 1.
- ( ) Orange wire into hole 2.
- ( ) Yellow wire into hole 3.
- ( ) Green wire into hole 7.
- ( ) Blue wire into hole 8.

- ( ) Violet wire into hole 9.
- ( ) Gray wire into hole 10.
- ( ) Insert polarizing pin into hole 4.
- ( ) Refer to the Pictorial and position the the 25-hole D-connector with the black wire at the top of the chassis and mount the connector to the chassis with two threaded hex spacers, a #4 solder lug, a #4 lockwasher, and two 4-40 nuts (one nut was used earlier and then removed). Mount the solder lug at D and position it as shown.
- ( ) If it has not already been done, cut the bare wire ends of the six secondary power transformer wires to 1/8". NOTE: This does not include the black primary wires.
- ( ) Crimp and solder large spring connectors on the ends of the secondary power transformer wires. Mount these in the same manner as you did for the small spring connectors.

Position the 8-hole socket with the slots facing up and insert the large spring connectors on the ends of the power transformer wires into the connector holes as follows:

- ( ) Either green wire into hole 1.
- ( ) Green-yellow wire into hole 2.
- ( ) Other green wire into hole 3.
- ( ) Either red wire into hole 6.
- ( ) Red-yellow wire into hole 7.
- ( ) Other red wire into hole 8.
- ( ) Mount the transformer mounting plate to the chassis with four 6-32 × 3/8" phillips screws, #6 lockwashers, and 6-32 nuts as shown. Make sure the other two mounting holes are aligned before you tighten the hardware.
- ( ) T1: Position the power transformer with the leads as shown and mount it to the chassis with an 8-32 × 3/8" phillips screw, a #8 lockwasher, and an 8-32 nut at E and an 8-32 × 1/2" phillips flat-head screw, #8 lockwasher, and 8-32 nut at F.

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Refer to Pictorial 4-2 for the following steps.

NOTE: In the following steps, (NS) means not to solder because other wires will be added later. "S-" with a number following it, such as (S-2), means to solder the connection. The number "-2" tells you that there are two wires and/or leads in the connection.

- ( ) Cut the leads of the two .005  $\mu$ F ceramic capacitors to 3/4".
- ( ) Cut two 1/4" pieces of fiber sleeving.

Whenever you are instructed to connect a wire or a lead in the following steps, make each connection mechanically secure as shown in inset drawing #1.

- ( ) C1: Slide a 1/4" piece of fiber sleeving over each lead of a .005  $\mu$ F ceramic capacitor. Then connect one lead to terminal strip C lug 2 (NS) and the other lead to lug 4 (NS).
- ( ) C2: Connect one lead of the other .005  $\mu$ F ceramic capacitor to terminal strip C lug 2 (S-2) and the other lead to lug 3 (NS).

Connect the line cord leads to the following locations:

- ( ) Green lead to solder lug A (S-1).
- ( ) White lead to terminal strip C lug 4 (NS).
- ( ) Black lead to terminal strip C lug 3 (S-2).
- ( ) Cut a 1-1/2" brown solid wire.
- ( ) Remove 1/2" of insulation from each end of the 1-1/2" brown solid wire.
- ( ) Connect one end of the 1-1/2" brown solid wire to terminal strip C lug 1 (S-1) and the other end to rocker switch SW1 lug 1 (S-1).
- ( ) Connect either black power transformer lead to terminal strip C lug 4 (S-3).

- ( ) Connect the other black power transformer lead to rocker switch SW1 lug 2 (S-1).
- ( ) Connect the black wire coming from hole 1 of the 25-hole D-connector to solder lug D (S-1).
- ( ) F1: Snap the 3/8-ampere 250V slow-blow fuse into the fuse clips of terminal strip C. Make sure the capacitor leads at lug 3 of the terminal strip are not touching lug 2 (ground).
- ( ) Write "3/8-ampere, 250V slow-blow" on the fuse replacement label. Then remove the backing from the label and press it onto the inside rear panel of the chassis at the indicated location.
- ( ) Spread a thin film of silicone grease over the back of the heat sink, but do not cover the four IC mounting screws.
- ( ) Position the main circuit board inside the chassis and over the mounting studs so the mounting holes align. Loosely install 4-40  $\times$  1/4" phillips screws at the twelve chassis stud locations. Make sure that you do not pinch the brown wire between the board and studs.
- ( ) Mount the heat sink to the chassis rear panel with two 4-40  $\times$  1/4" phillips screws.
- ( ) Tighten the twelve circuit board mounting screws.
- ( ) Connect 8-hole socket S403 to circuit board plug P403 as shown.
- ( ) Connect 10-hole socket P402 to plug P402 as shown.
- ( ) Refer to inset drawing #2 and remove the backing from the blue and white label. Press the label onto the chassis back panel at the indicated location.

Set the chassis assembly aside.



Refer to Pictorial 4-3 for the following steps.

- ( ) Refer to inset drawing #1 and bend the ends of the two 3/8" solder lugs up approximately 45°.
- ( ) Mount the front subpanel, two 3/8" solder lugs, and four BNC connectors to the front panel at G, H, J, and K with the hardware supplied with the connectors. Mount the solder lugs at connectors G and H and position them against a flat section of the nut as shown in inset drawing #2.
- ( ) Refer to Detail 4-3A and prepare two 3" shielded cables as shown. Remove 1/8" of insulation from the inner lead at both ends of each cable.
- ( ) Crimp and solder small gold-plated spring connectors on the shield and inner leads at one end of each 3" shielded cable.
- ( ) Position a 2-hole socket with the slots facing up. Insert the small gold-plated spring connector on the inner lead of one 3" shielded cable into hole 1 and the shield lead into hole 2.
- ( ) Similarly insert the small gold-plated spring connectors on the other 3" shielded cable into the other 2-hole socket.
- ( ) Cut two 1/2" pieces of small fiber sleeving.
- ( ) Insert the center lead at the free end of one 3" shielded cable into the center pin of BNC connector G (S-1). Be careful not to use too much heat at the center pin or you will melt the insulation around the pin.
- ( ) Slide a 1/2" piece of small fiber sleeving over the shield lead and connect it to the BNC connector G solder lug (S-1).
- ( ) Similarly insert the center lead end at the free end of the other 3" shielded cable into the center pin of BNC connector H (S-1).
- ( ) Slide the other 1/2" piece of small fiber sleeving over the shield lead and connect it to the BNC connector H solder lug (S-1).
- ( ) Remove and separate an orange wire and a yellow wire from the remaining 5-wire ribbon cable. Then cut the orange wire to 6" and the yellow wire to 5". Prepare the ends of both wires for 1/8".
- ( ) Refer to inset drawing #4 and crimp and solder female pins on one end of the 6" orange and 5" yellow wires. Be careful not to allow solder to flow into the connector.
- ( ) Cut the 1-1/4" heat-shrinkable sleeving into two 5/8" pieces.
- ( ) Slide the 5/8" heat-shrinkable sleeving over the female pins on the ends of the orange and yellow wires until the sleeving covers the female pins and is even with the ends. Then shrink the sleeving over the pins with a lighter or a match. Do not use more heat than necessary to shrink the sleeving over the pins or you will split the sleeving.
- ( ) Connect the free end of the yellow wire to the center pin of BNC connector J (S-1),
- ( ) Connect the free end of the orange wire to the center pin of BNC connector K (S-1).
- ( ) Slide a 5/16" round spacer over each of the six front panel studs. Then insert the cable and wires coming from the front panel connectors through the large holes in the display circuit board and mount the board to the studs with six #6 lockwashers, four 6-32 nuts, and two 3/8" hex threaded spacers at L and M. Carefully press the LEDs and pushbuttons through their front panel holes until they are properly seated and centered.



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- ( ) Spread a small amount of silicone grease over one side of a plastic insulator. Then press the coated side of the insulator against front panel location U1 so the mounting holes align.
- ( ) U1: If necessary, straighten the pins of IC UA7805 (#442-54). Then spread a small amount of silicone grease over the bare metal side of the IC and mount it over the front panel insulator at U1 with a 4-40 × 3/8" phillips screw, a nylon shoulder spacer, #4 lockwasher, and 4-40 nut. Position the IC as shown. Discard the silicone grease container.
- ( ) Plug display logic circuit board sockets S501 through S504 into display circuit board plugs P601 through P604. Route the cables and wires as shown and make sure all of the pins fit into the socket holes properly.
- ( ) Plug the female pin on the end of the yellow wire over display logic circuit board pin B.
- ( ) Plug the female pin on the end of the orange wire over display logic circuit board pin A.
- ( ) Position 3-hole socket S502 with the slots facing down and slide it over the leads of IC U1.
- ( ) Mount the front bezel to the front panel with two 6-32 × 3/16" flat-head screws at the two lower holes P and Q. Squeeze the bezel tight against the panel while you tighten the two screws. You will install screws in the upper bezel holes when you mount the cabinet top later on.

Proceed to the "Initial Tests."

# INITIAL TESTS

## PRIMARY WIRING CHECKS

Refer to Pictorial 5-1 for the following steps.

NOTE: Do not connect the line cord of your Digital Memory Oscilloscope to an AC outlet until you are instructed to do so in a step.

A wiring error in the primary wiring circuit (line cord, power switch, power transformer socket wiring, etc.) of your unit could cause you to receive a severe electrical shock. These "Primary Wiring Checks" will assure you that no such wiring errors exist. If you do not get the proper results in any of these tests, refer to the "In Case Of Difficulty" section on Page 65.

- ( ) Set the AC POWER switch on the rear panel to OFF.
- ( ) Place the ohmmeter range switch to the R X 10 position.
- ( ) Connect the common ohmmeter lead to the solder lug ground point.
- ( ) Connect the positive ohmmeter lead to either flat prong of the line cord. The meter should show INFINITE resistance with the AC switch off or on.
- ( ) Connect the positive ohmmeter lead to the other flat prong of the line cord. The meter should show INFINITE resistance with the AC switch off or on.
- ( ) Connect the positive ohmmeter lead to the round prong of the line cord. The meter should show 0 ohms resistance with the AC switch off or on.
- ( ) Connect the positive ohmmeter lead to the one flat prong of the line cord and the common lead to the other flat prong. The meter should show INFINITE resistance with the AC switch off and approximately 23 ohms with the switch on.
- ( ) Connect the common ohmmeter lead to the front subpanel.
- ( ) Touch the positive ohmmeter lead to the metal tab of front subpanel IC U1. The meter reading should be greater than 50 k $\Omega$ . If the reading is below 50 k $\Omega$ , check the IC mounting hardware and nylon shoulder washer for proper installation. Also make sure the IC case is properly installed over the insulator and is not shorting to the chassis.

- ( ) Disconnect the meter leads and set the meter aside.
- ( ) Refer to Detail 5-1A Part 1 and remove the backing from the two 1" × 4" strips of insulating paper. Press the paper onto the shield flanges with the creases in the corners.
- ( ) Refer to Detail 5-1A Part 1 and remove the backing from the 2-1/2" square insulating paper and press the paper against the inside of the shield as shown.
- ( ) Remove the paper packing from the Danger label and press it against the AC shield.
- ( ) Mount the shield to the rear of the chassis with two #6 × 1/4" phillips screws. Make sure that you do not pinch any of the wiring between the shield and the chassis, and that the shield is between capacitors C407 and C408 as shown.

This completes the "Primary Wiring Checks." If all of the checks were satisfactory, proceed to "Voltage Checks."

## VOLTAGE CHECKS

Refer to Pictorial 5-1 for the following steps.

When you apply power to your Digital Memory Oscilloscope, 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 plugged into an AC outlet, potentially hazardous voltage is present in the area covered by the AC shield. Do not remove this shield with the line cord connected to an AC outlet; you could receive a severe electrical shock if you should come in contact with the AC voltage.

- ( ) Refer to Detail 5-1B and push the alignment tool blade into the small end of the plastic nut starter. Always use this tool to adjust the main circuit board controls.
- ( ) Position the front panel assembly next to the chassis assembly as shown. Connect 25-hole socket S501 to main circuit board plug P401. The plug is polarized to fit only one way.
- ( ) If it is not already there, set the POWER switch to off.
- ( ) Connect the Digital Memory Oscilloscope's line cord to an AC outlet.

Refer to the following chart and perform the 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 test point (TP) location and the negative (common) voltmeter lead to the indicated power transformer screw.
3. If you do not get the proper response at one of the test points, first check your voltmeter's accuracy. If it's okay, then refer to the "Possible Cause of Problem" column. You may also want to refer to the "In Case of Difficulty" section on Page 65. Make sure you correct any problems before you go on to install the ICs in the next section.

**NOTE:** When a specific part is called out in a voltage chart as the possible cause of a problem, such as U101, it could mean that the part was not soldered properly, or it was installed incorrectly, (backwards, bent pins, wrong part, etc.), or that the associated circuit components are incorrectly installed or are interchanged.

- ( ) Press the POWER switch to turn the unit on.

### MAIN CIRCUIT BOARD VOLTAGE CHART

TEST POINT #	VOLTAGE RANGE (DC)	POSSIBLE CAUSE OF PROBLEM
TP1	- 5.85 to - 6.55	D108, Y1 front end circuits
TP2	+ 5.85 to + 6.55	D107, Y1 front end circuits
TP3	- 5.85 to - 6.55	D208, Y2 front end circuits
TP4	+ 5.85 to + 6.55	D207, Y2 front end circuits
TP5	- 11.4 to - 12.6	U433, - 12 volt circuits
TP6	+ 11.4 to + 12.6	U432, + 12 volt circuits
TP7	+ 4.75 to + 5.25	U429, + 5 volt circuits
TP8	- 4.94 to - 5.46	U432 and the - 5 volt circuits.
TP9	+ 4.75 to + 5.25	U107, C426, Q116, Q216, Q117, Q118, R493, D124
TP10	+ 6.45 to + 7.15	D413, R411
TP11	- 5.85 to - 6.55	D306, R303, R304, R365
TP12	+ 5.22 to + 6.38	D304, R351, R352, R349, R348

### DISPLAY LOGIC CIRCUIT BOARD VOLTAGE CHART

TEST POINT #	VOLTAGE RANGE (DC)	POSSIBLE CAUSE OF PROBLEM
TP13	- 11.4 to - 12.6	U503, - 12 volt circuits
TP14	+ 11.4 to + 12.6	U504, + 12 volt circuits
TP15	+ 4.75 to + 5.25	U1, + 5 volt circuits

( ) Turn off the Digital Memory Oscilloscope power and disconnect the line cord.

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

Proceed to "IC Installation."

## IC INSTALLATION

Refer to Pictorial 5-2 for the following steps.

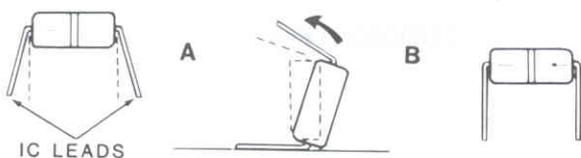
( ) Position the unit as shown.

NOTE: You will install the following ICs on the display logic circuit board.

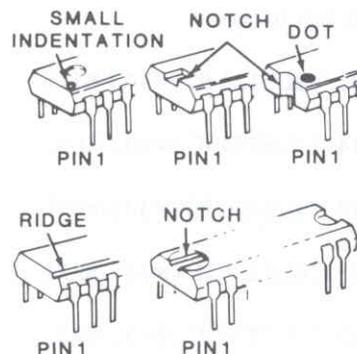
CAUTION: Integrated circuits (ICs) are complex electrical devices that perform many complicated operations in a circuit. These devices can be damaged during installation. Read all of the following information before you install the ICs.

Some of the ICs you will install in the following steps are MOS (metal oxide semiconductor) devices. Be sure they do not get damaged by static electricity. Once you remove the IC from the foam pad, **do not let go of it** or lay it down until it is in its socket. Install it as follows. Read all of the following steps before you pick up an IC.

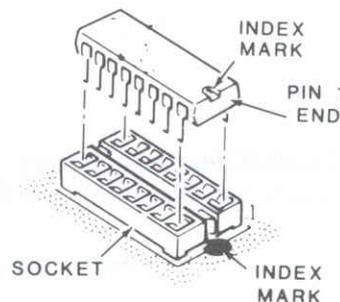
1. Pick up the IC and touch the foam pad with both hands.
2. Hold the foam pad with one hand and remove the IC with the other hand.
3. Continue to hold the IC with the one hand and straighten any bent pins with the other hand.
4. The pins on the ICs may be bent out at an angle as shown in A, and if this is the case, they will not line up with the holes in the IC socket. Lay the IC down on its side as shown in B 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. Do not try to install an IC without first bending the pins as described. To do so may damage the IC pins or the socket, causing an intermittent contact.



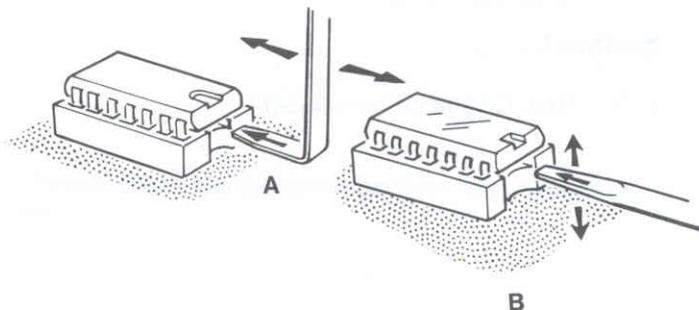
5. Compare the IC to the drawing shown below. Then determine which end of the IC is the pin 1 end.



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



NOTE: If it ever becomes necessary to remove an IC from its socket, use the IC puller (if supplied with your kit) as shown at A, or a small-bladed screwdriver as shown at B. Push the end of the IC puller or screwdriver blade between the IC and the socket and carefully lift the IC free. If any IC pins become bent, straighten them carefully.



**DISPLAY LOGIC CIRCUIT BOARD**

- ( ) Unplug S501 from P401 and position the front panel face down on a soft cloth so the display logic circuit board faces up as shown in Pictorial 5-2.

Install the following ICs on the display logic circuit board from left to right:

- ( ) U502: 74LS125 IC (#443-811).  
 ( ) U514: 74LS374 IC (#443-863).  
 ( ) U513: 74LS374 IC (#443-863).  
 ( ) U501: 74LS138 IC (#443-877).  
 ( ) U512: 74LS374 IC (#443-863).  
 ( ) U506: LM1408N-8 IC (#442-751).  
 ( ) U507: LF411 IC (#442-759).  
 ( ) U505: 74LS374 IC (#443-863).

Install three 74LS374 (#443-863) ICs at the following locations:

- ( ) U509.  
 ( ) U511.  
 ( ) U508.  
 ( ) Recheck each IC for the proper type and installation. Then set the front panel assembly aside.

**MAIN CIRCUIT BOARD**

- ( ) Position the chassis with the main circuit board as shown in Pictorial 5-2.

Install ICs on the main circuit board at the following locations:

**Section 1**

- ( ) U104: CA3080 IC (#442-640).

- ( ) U103: CA3080 IC (#442-640).  
 ( ) U102: LF411 IC (#442-759).  
 ( ) Q105: CA3127 transistor (#417-975).  
 ( ) U101: LF411 IC (#442-759).  
 ( ) U204: CA3080 IC (#442-640).  
 ( ) U203: CA3080 IC (#442-640).  
 ( ) U202: LF411 IC (#442-759).  
 ( ) Q205: CA3127 transistor (#417-975).  
 ( ) U201: LF411 IC (#442-759).

**Section 2**

- ( ) U105: LF357 IC (#442-782).  
 ( ) U106: 74S02 IC (#443-896).  
 ( ) U428: 74LS123 IC (#443-942).  
 ( ) U405: 75188 or 1488 IC (#443-794).  
 ( ) U404: 75189 or 1489 IC (#443-795).  
 ( ) U403: 74ALS00 IC (#443-1080).  
 ( ) U402: 74LS112 IC (#443-948).  
 ( ) U401: 74LS74 IC (#443-730).  
 ( ) U415: ADC0820 IC (#442-769).  
 ( ) U408: 2764-3 IC (#444-344).  
 ( ) U409: 74LS365A IC (#443-1039).  
 ( ) U411: 6116-P4 IC (#443-1027).  
 ( ) U414: 74LS51 IC (#443-951).  
 ( ) U407: 8250 IC (#443-952).  
 ( ) U413: 74LS138 IC (#443-877).

- ( ) U412: 74LS138 IC (#443-877).
- ( ) U406: 3880 or Z80A IC (#443-953).
- ( ) U416: 74LS245 IC (#443-885).
- ( ) U425: 7407 IC (#443-1020).
- ( ) U304: MC10102 IC (#443-683).
- ( ) U305: MC10131 IC (#443-679).

### Section 3

- ( ) U424: 74HCT00 IC (#443-1367).

Install six 74LS374 (#443-863) ICs at the following locations:

- ( ) U418.
- ( ) U417.
- ( ) U419.
- ( ) U421.
- ( ) U423.
- ( ) U422.
- ( ) U427: 7407 IC (#443-1020).
- ( ) U311: LM361 IC (#442-771).
- ( ) U301: LM1408N-8 IC (#442-751).
- ( ) U312: DAC1021 IC (#442-768).
- ( ) U306: 7406 IC (#443-967).
- ( ) U426: 7407 IC (#443-1020).
- ( ) U303: MC10116 IC (#443-636).
- ( ) U313: LF411 IC (#442-759).
- ( ) U302: LF411 IC (#442-759).
- ( ) U308: 4051 IC (#443-992).
- ( ) U307: 4051 IC (#443-992).

- ( ) U309: LF411 IC (#442-759).
- ( ) Q311: NPD5566 transistor (#417-902).

- ( ) This completes the IC installation. Carefully inspect each IC for proper installation, (bent pins, backwards, etc.) and for proper type.

Refer to Pictorial 5-3 for the following steps.

- ( ) Mount the display logic circuit board to spacer G and the Mylar-coated aluminum shield to spacer H with 6-32 × 3/16" phillips screws as shown.
- ( ) Mount the front panel assembly to the chassis at J and K with two 6-32 × 1/4" phillips screws. Pull the panel back as far as possible as you tighten the two screws.
- ( ) Connect 25-hole socket S501 to main circuit board plug P401.
- ( ) Connect the shielded cable socket coming from BNC connector Y1 to main circuit board plug P101 with the socket slots positioned towards the front panel as shown.
- ( ) Connect the shielded cable socket coming from BNC connector Y2 to main circuit board plug P201 with the socket slots positioned towards the front panel as shown.

## FINAL TEST

Refer to Pictorial 5-4 for the following steps.

NOTE: The following test will check the basic internal circuitry by flashing all of the front panel display LEDs in a top to bottom sequence for each column of LEDs — except the Time Base LEDs which go from bottom to top. The check will take ten seconds to run. Afterwards, there should be specific LEDs still lit. The LEDs are indicated in Pictorial 5-4. If these tests do not run as indicated, turn off the power and disconnect the line cord. Then proceed to the “In Case Of Difficulty” section on Page 78.

- Make sure the unit's power is switched off, and plug the line cord into an AC outlet.
- Watch the front panel and switch on the power. The rows of LEDs should flash in sequence from top to bottom for ten seconds, and then stop with the LEDs shown in Pictorial 5-4 remaining lit. Make sure each LED lights during this test. Turn the POWER switch off and on as many times as necessary to check the LEDs.
- Switch off the power and unplug the line cord.

Proceed to “Test Cable Preparation.”

### TEST CABLE PREPARATION

Refer to Pictorial 5-5 for the following steps.

- Prepare the free end of the test cable as shown.
- Push rubber insulators onto the inner lead and the shield lead of the test cable.
- Solder an alligator clip to the inner lead.
- Solder an alligator clip to the shield lead.
- When the solder cools, bend the tabs around the solder connections and slide the rubber insulators over the alligator clips.

### CONTROL PRESETS

NOTE: Refer to Pictorial 6-1 for the locations of controls on the display logic circuit board and Pictorial 6-2 for locations on the main circuit board.

- Preset the Output Cal control R506 on the display logic circuit board as shown (note the position of the arrow on the control).

Preset the following main circuit board controls as shown:

- R171.
- R169.
- R168.
- R271.
- R269.
- R268.
- R156.
- R256.
- R152.
- R148.
- R252.
- R248.
- R123.
- R126.
- R223.
- R226.
- R315.
- R349.

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Preset the following main circuit board trimmers as shown. NOTE: Pay particular attention to the locations of the solder globs on the top of these trimmers.

- C128.
- C228.
- C105.
- C104.
- C103.
- C108.
- C107.
- C205.
- C204.
- C203.
- C208.
- C207.
- C317.
- Preset jumpers JP400 through JP405 on the main circuit board as shown in the inset drawing.

This completes the assembly and initial testing of your Digital Memory Oscilloscope. Discard any remaining wire or sleeving. Set the remaining screws aside. You will use them to mount the cabinet top later. Proceed to the "Calibration," section in the "Operation" manual. Then return to the "Final Assembly" in this manual on Page 64.

## FINAL ASSEMBLY

Refer to Pictorial 7-1 for the following steps.

NOTE: When you perform the following steps, be very careful not to disturb any of the circuit board control settings.

- ( ) Carefully slide the cabinet top over the chassis. Loosely install it to the back panel with four 6-32 × 1/4" phillips screws.
- ( ) Loosely install six 6-32 × 1/4" phillips screws and four #6 external tooth lockwashers in the

cabinet bottom and side locations shown. After you install the hardware, tighten it securely.

- ( ) Read the information on the FCC label; then sign and date it. Remove the backing from the label and press the label onto the bottom of the chassis.

This completes the "Final Assembly." Refer to the "Operation" section in your Operation Manual.

## IN CASE OF DIFFICULTY

The "Visual Checks" that are provided below will help you locate any difficulties that might occur during the assembly and testing of your Digital Memory Oscilloscope. Additional "In Case Of Difficulty" information is also provided in your Operation Manual.

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

**IMPORTANT:** Disregard the Warranties covered in any Manual other than this Assembly Manual.

### 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 carefully inspecting each connection to make sure it is soldered as described in Detail 1-1A. Reheat any doubtful connections and be sure all the wires are soldered at points where several wires are connected.
2. Check the circuit board to be sure there are no solder bridges between adjacent connections. Check the "Circuit Board X-Ray View" for any questions you may have concerning the foil pattern.
3. Check capacitor values carefully. Be sure the proper value part is installed at each capacitor location and that the positive (+) or negative (-) marks are oriented correctly.
4. Check each resistor value carefully. A resistor that is discolored, cracked, or shows signs of bulging is faulty and must be replaced.
5. Be sure the correct diode is installed at each diode location, and that the banded end is positioned correctly.
6. 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.
7. Check all component leads connected to the circuit board. Make sure that none of the leads make contact with other connections or components.

**WARNING: The full AC line voltage is present at several points and is potentially lethal. Be careful to avoid personal shock when you work on this unit with the power applied.**







# CUSTOMER SERVICE

## REPLACEMENT PARTS

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

## ORDERING FROM THE FACTORY

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

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

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

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

## OBTAINING REPLACEMENTS FROM HEATH ELECTRONIC CENTERS

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

## TECHNICAL CONSULTATION

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

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

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

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

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

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

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

## REPAIR SERVICE

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

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

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

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

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

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

Heath Company  
Service Department  
Benton Harbor, Michigan 49022



HEATH COMPANY • BENTON HARBOR, MICHIGAN  
***THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM***

LITHO IN U.S.A.