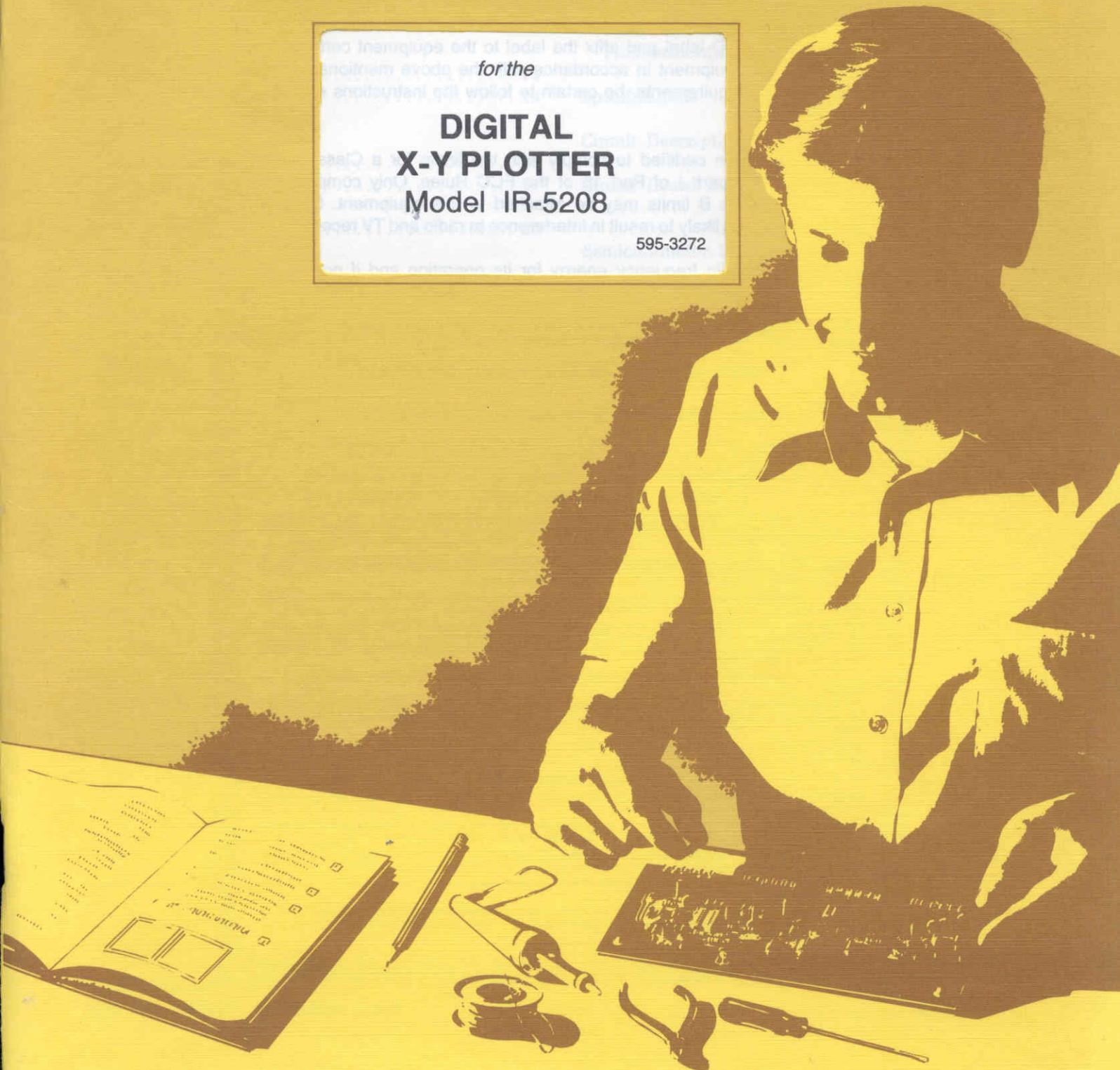


HEATHKIT[®] MANUAL

for the

**DIGITAL
X-Y PLOTTER**
Model IR-5208

595-3272



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
Computers — Software:
Operating Systems, Languages, Utilities (616) 982-3860
Application Programs (616) 982-3884
Heath Craft Wood Works (616) 982-3423



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 X-Y PLOTTER Model IR-5208

595-3272

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

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.

This equipment has been certified to comply with the limits for a Class B computing device, pursuant to Subpart J of Part 15 of the FCC Rules. Only computers certified to comply with the Class B limits may be attached to this equipment. Operation with non-certified computers is likely to result in interference to radio and TV reception.

This equipment uses radio frequency energy for its operation and if not installed and used properly, that is, in strict accordance with the instruction manual, may cause interference to radio and television reception. It has been type tested and found to comply with the RF emission limits for a Class B computing device which is intended to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio and television reception, which you can determine by turning the equipment off and on, try to correct the interference by one or more of the following measures:

- Move the computing device away from the receiver being interfered with.
- Relocate the computing device with respect to the receiver.
- Reorient the receiving antenna.
- Plug the computing device into a different AC outlet so that the computing device and receiver are on different branch circuits.
- Be certain that the computing device is plugged into grounded outlet receptacles. (Avoid using AC cheater plugs. Lifting of the power cord ground may increase RF emission levels and may also present a lethal shock to the user.)

If you need additional help, consult your dealer or ask for assistance from the manufacturer. Customer service information is on the inside back cover of this Manual or on an insert sheet supplied with this equipment. You may also find the following booklet helpful: "How to Identify and Resolve Radio-TV Interference Problems." This booklet is available from the US Government Printing Office, Washington, D.C. 20402, Stock No. 004-000-00345-4.

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INTRODUCTION

The Heathkit Model IR-5208 is a fast, highly accurate, and reliable X-Y Plotter that is compact and lightweight enough to be carried in a standard briefcase. Unlike a typical printer, which will only produce letters and documents like a typewriter, this Plotter uses a pen to draw high resolution visual aids (such as graphs and charts) that have excellent line quality. Line segments are accurate to one four-thousandths of an inch (0.004"), which can be drawn at a maximum speed of six inches per second.

Simple commands that you enter into a computer control the operation of the Plotter. All geometric shapes and alphanumeric characters are drawn by a combination of pen and paper movement. The pen travels in a holder across a track, while the paper moves back and forth by means of precision pinch-wheel grip drives.

Not only can you draw a variety of shapes, but you can also change pen colors. You can write programs for the Plotter that contain a pause feature to allow you to change pens. Different color pens allow the Plotter to draw multicolor plots.

Although the Plotter can operate with commercial pens that are available at your local stationary store, we recommend that you use the pens that are available from the Heath Company. For the best results, be sure to use high-quality paper, or overhead transparency material (Mylar™).

This Plotter should provide you with many years of high-quality graphs and charts, and is a welcome addition to any computerized illustration office. It also has a wide range of hobby-oriented applications.

INTRODUCTION

The Heathkit Model 100 is a portable, battery-powered, high-precision digital voltmeter. It is designed for use in the field and in the laboratory. The Model 100 is a true RMS reading voltmeter, which means that it can measure the true RMS value of any periodic waveform, regardless of its shape. This makes the Model 100 a very useful instrument for measuring the true RMS value of AC signals.

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UNPACKING

**DO NOT UNPACK ANY PART OF YOUR KIT
UNTIL A STEP DIRECTS YOU TO DO SO.**

Locate the "Pack Index Sheet" that is packed inside the main shipping carton for your Plotter. Note that the shipping carton is divided into a top layer and a bottom layer. All of the parts in the top layer make up part of Pack 1. In addition, a bag of parts located in the center of the bottom layer is also part of Pack 1. The remainder of the parts in the bottom layer form the Final Pack, which may be made up of several bags, envelopes, small boxes, and loose parts. Do not unpack any of these parts until a step specifically directs you to do so.

When you check parts against a "Parts List," return any part or group of parts packaged in a bag or other container, with the part number on it, to its container after you identify it. Leave these parts there until you actually use them in a step. This will help prevent you from mixing up the parts, and help you identify the parts when you need them.

Some parts, however, are in a bag or an envelope that is not marked with an actual part number, but with a packaging number that begins with the number "173-." These numbers are used for packaging purposes only and do not appear in the Manual "Parts List." Open each bag or envelope that is marked with only a "173-" packaging number to identify the parts it contains.

NOTE: Never use a "173-" packaging number if you must order a replacement part. Use only the part numbers listed in the Manual Parts List for that purpose.

Save all of the packaging material until you account for all of the parts.

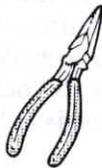
ASSEMBLY NOTES

TOOLS

You will need these tools to assemble your kit.



PLIERS



LONG-NOSE
PLIERS



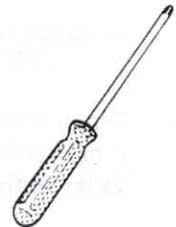
DIAGONAL
CUTTERS



WIRE
STRIPPERS



1/8" -BLADE
SCREWDRIVER

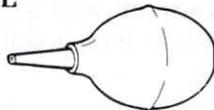


PHILLIPS
SCREWDRIVER

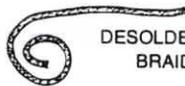
OTHER HELPFUL TOOLS



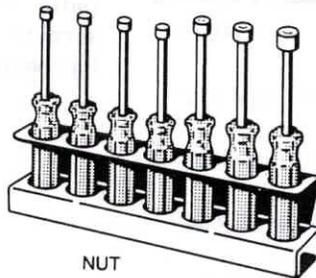
NUT STARTER
(May Be Supplied
With Kit)



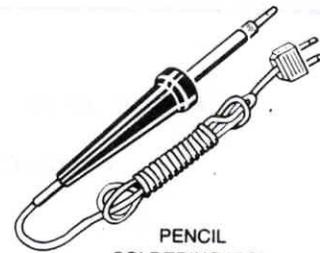
DESOLDERING
BULB*



DESOLDERING
BRAID*



NUT
DRIVERS



PENCIL
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. The illustrations in the Manual are called Pictorials and Details. Pictorials show the overall operation for a group of assembly steps; Details generally illustrate a single step. When you are directed to refer to a certain Pictorial "for the following steps," continue using that Pictorial until you are referred to another Pictorial for another group of steps.
3. 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 Pictorial number sequence.
4. Position all parts as shown in the Pictorials.
5. Solder a part or a group of parts only when you are instructed to do so.

6. Each circuit part in an electronic kit has its own component number (R2, C4, etc.). Use these numbers when you want to identify the same part in the various sections of the Manual. These numbers, which are especially useful if a part has to be replaced, appear:
- In the Parts List,
 - At the beginning of each step where a component is installed,
 - In some illustrations,
 - In 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:

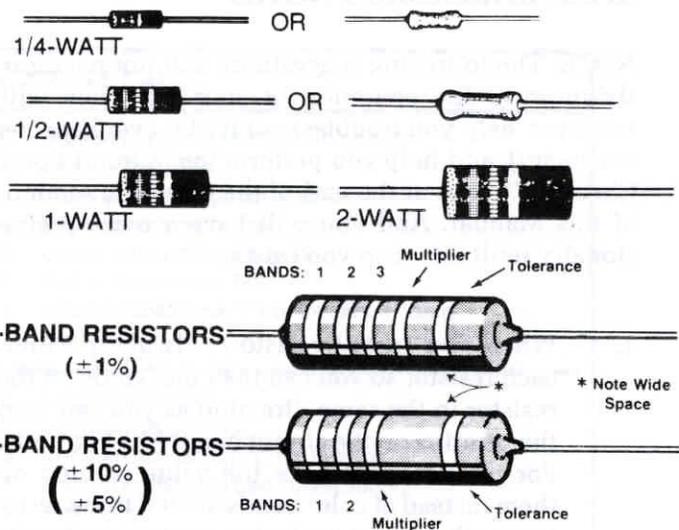
1. Use the right type of soldering iron. A 22 to 25-watt pencil soldering iron with a 1/8" or 3/16" chisel or pyramid tip works best.
2. Keep the soldering iron tip clean. Wipe it often on a wet sponge or cloth; then apply solder to the tip to give the entire tip a wet look. This process is called tinning, 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.

Heathkit®

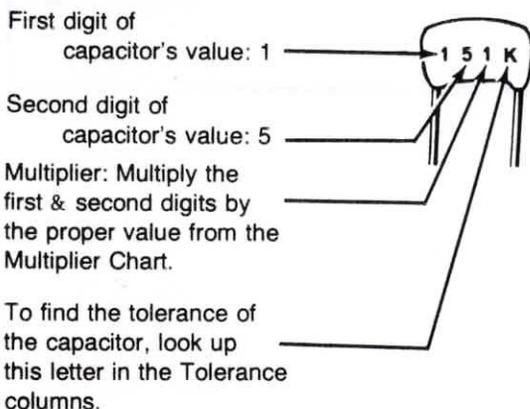
PARTS

Resistors are identified in Parts Lists and steps by their resistance value in Ω (ohms), kΩ (kilohms), or MΩ (megohms). They are usually identified by a color code and four or five color bands, where each color represents a number. These colors (except for the last band, which indicates a resistor's "tolerance") will be given in the steps in their proper order. Therefore, the following color code is given for information only. NOTE: Occasionally, a "precision" or "power" resistor may have the value stamped on it.



Band 1 1st Digit		Band 2 2nd Digit		Band 3 (if used) 3rd Digit		Multiplier		Resistance Tolerance	
Color	Digit	Color	Digit	Color	Digit	Color	Multiplier	Color	Tolerance
Black	0	Black	0	Black	0	Black	1	Silver	± 10%
Brown	1	Brown	1	Brown	1	Brown	10	Gold	± 5%
Red	2	Red	2	Red	2	Red	100	Red	± 2%
Orange	3	Orange	3	Orange	3	Orange	1,000	Brown	± 1%
Yellow	4	Yellow	4	Yellow	4	Yellow	10,000	Green	± .5%
Green	5	Green	5	Green	5	Green	100,000	Blue	± .25%
Blue	6	Blue	6	Blue	6	Blue	1,000,000	Violet	± 1%
Violet	7	Violet	7	Violet	7	Silver	0.01	Gray	± .05%
Gray	8	Gray	8	Gray	8	Gold	0.1		
White	9	White	9	White	9				

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



EXAMPLES:

151K = 15 × 10 = 150 pF

759 = 75 × 0.1 = 7.5 pF

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

MULTIPLIER		TOLERANCE OF CAPACITOR		
FOR THE NUMBER:	MULTIPLY BY:	10 pF OR LESS	LETTER	OVER 10 pF
0	1	±0.1 pF	B	
1	10	±0.25 pF	C	
2	100	±0.5 pF	D	
3	1000	±1.0 pF	F	±1%
4	10,000	±2.0 pF	G	±2%
5	100,000		H	±3%
			J	±5%
8	0.01		K	±10%
9	0.1		M	±20%

SPECIAL ASSEMBLY NOTES

NOTE: The following suggestions will not necessarily improve the operation of your kit. They will, however, help you troubleshoot it (if it ever becomes necessary), and help you perform the "Circuit Board Checkout" steps at the end of the assembly sections of this Manual. And you will have a more professionally-built kit when you finish.

1. When you install resistors, always position each resistor so you can read the bands on the resistor in the same direction as you can read the printing on the circuit board (see Figure 1). For resistors that have the value printed on them instead of color bands, install these resistors so the values are facing away from the circuit board and read in the same direction as the printing on the circuit board.

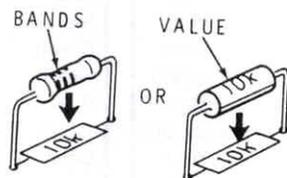


Figure 1

2. When you install ceramic, Mylar, or mica capacitors, always position each capacitor so you can read the value on the capacitor in the same direction as you can read the printing on the circuit board (see Figure 2).

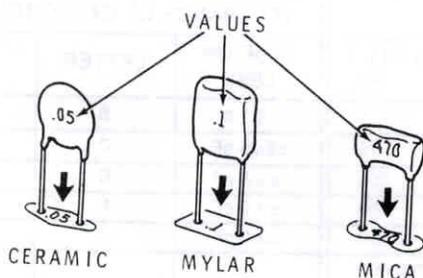


Figure 2

3. When you install electrolytic or other tubular capacitors, always position each capacitor so the value is facing away from the circuit board (see Figure 3). Be sure to observe the correct polarity when you install electrolytic capacitors (as you will be directed in the steps). Other, non-polarized, capacitors should be installed so you can read the values in the same direction as the printing on the circuit board.

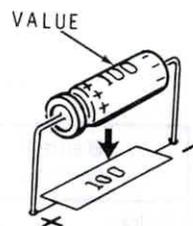


Figure 3

4. Install diodes so the type numbers or part numbers are facing away from the circuit board. Be sure to match the band on one end of each diode with the band mark on the circuit board.

CIRCUIT BOARD

PARTS LIST

Refer to the Pack Index Sheet and locate Pack #1. Then remove the parts from this pack and check each part against the following list. The key numbers correspond to the numbers on the "Circuit Board Parts Pictorial." Return any part that is packed in an individual envelope, with the part number on it, back into its envelope until that part is called for in a step. Do not throw away any packing material until you account for all of 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	HEATH	QTY.	DESCRIPTION	CIRCUIT
No.	Part No.			Comp. No.

RESISTORS

NOTE: The following resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise listed. A 5% tolerance is indicated by a gold fourth color band.

A1	230-5276	9	68 Ω, 2-watt (blu-gry-blk)	R2, R3, R4, R5, R8, R9, R10, R11, R14
A2	230-5290	2	100 Ω (brn-blk-brn)	R12, R13
A2	230-5295	1	220 Ω (red-red-brn)	R15
A2	230-5279	1	1000 Ω (brn-blk-red)	R6
A2	230-5278	1	4700 Ω (yel-viol-red)	R7
A2	230-5277	1	20 kΩ (red-blk-org)	R1
A3	230-5280	1	Resistor network (may be marked 4.7 kΩ J)	RN1

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

CAPACITORS

B1	230-5294	1	1500 pF (152) ceramic	C16
B1	230-5291	1	4700 pF (472) ceramic	C8
B2	230-5281	6	.1 μF (104) axial-lead ceramic	C3, C4, C5, C6, C7, C14
B1	230-5282	3	.1 μF disc ceramic	C9, C10, C11
B3	230-5283	1	1 μF electrolytic	C1
B3	230-5284	1	10 μF electrolytic	C2
B4	230-5286	1	470 μF electrolytic	C15
B5	230-5285	1	10,000 μF electrolytic	C13

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

C1	230-5288	10	1N4001 diode	CR1, CR2, CR3, CR4, CR5, CR6, CR7, CR8, CR9, CR10
C1	230-5287	2	1N5401 diode	CR11, CR12

HARDWARE

D1	250-1325	1	6-32 × 1/4" screw
D2	250-1157	4	6-32 × 1/4" hex stud
D3	254-1	4	#6 lockwasher
D4	252-3	4	6-32 nut

PLUGS – SOCKETS

E1	230-5270	1	2-pin plug	H9
E2	230-5273	3	3-pin plug	H6, H7 H8
E3	230-5274	3	8-pin plug	H2, H3, H5 H1
E4	230-5275	1	20-pin plug	
E5	434-230	9	8-pin IC socket	
E5	434-298	3	14-pin IC socket	
E5	434-299	1	16-pin IC socket	
E5	434-311	4	20-pin IC socket	
E5	230-5272	1	28-pin IC socket	
E5	230-5271	1	40-pin IC socket	

MISCELLANEOUS

F1	230-5263	1	4 MHz crystal	X1
	230-5261	1	Circuit board	

Solder

LABELS – PRINTED MATERIAL

G1	230-5238	1	Paper line label*
G2	390-1855-25	1	FCC label*
G3	390-2689	1	Top label set*
G4	390-2691	1	Rear label*
G5		1	Blue and white label*
G6	230-5308	1	Insulator paper*
	597-3698	1	Quick Reference Guide*
	597-260	1	Parts Order Form
		1	Manual (See Page 1 for the part number.)

* These items may be packed inside the Manual. Set them aside until they are called for during the assembly of the chassis.

NOTES:

- Integrated circuits may be marked for identification in any of the following four ways:
 - Part number.
 - Type number. (This refers only to the numbers and letters shown in **bold** print in the Parts List. Disregard any other numbers and letters on the IC.)
 - Part number and type number.
 - Part number with a type number other than the one listed.
- Some integrated circuits may be packed in conductive foam. Do not remove these ICs from the conductive foam until a step directs you to do so.

C2	230-5262	1	7805 IC	U19
C3	230-5292	1	74LS00 IC	U20
C3	230-5267	1	74LS05 IC	U4
C3	230-5266	1	74LS74 IC	U15
C3	230-5264	1	74LS138 IC	U7
C3	230-5265	1	74LS240 IC	U14
C3	230-5269	2	74LS273 IC	U8, U11
C3	230-5293	1	74LS374 IC	U1
C3	230-5268	9	75452 IC	U5, U6, U9, U10, U12, U13, U16, U17, U18
C3	230-5296	1	46802 IC	U3
C3	230-5297	1	150008-1 IC	U2

NOTE: You will need to use acetone (lacquer thinner or fingernail polish remover) later in this Manual when you are assembling the paper mover. If you do not have any, you may wish to obtain some before you get started.

STEP-BY-STEP ASSEMBLY

Refer to Pictorial 1-1 (Illustration Booklet, Page 2) as you read the following notes and steps.

NOTES:

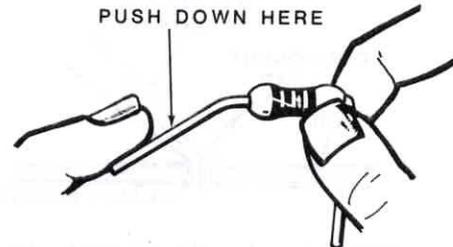
1. Many circuit board drawings, such as the one shown in Pictorial 1-1, are divided into two or more sections. These sections show you which area of the circuit board you are working in for a specific series of steps.
2. Each series of steps has you installing parts in a top-to-bottom, left-to-right sequence. Occasionally, you may be directed to install a particular component in an area out of sequence. These components are each identified in the step and on the Pictorial with a special callout.
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.

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

- () Note that the circuit board has foil on both sides, but only one side has the component outlines shown on it. This side of the circuit board is referred to as the "component side."

Position the circuit board as shown in the Pictorial with the component side up. Always install components on the component side of the circuit board, and solder the leads to the foil on the other side unless a step specifically directs you otherwise.

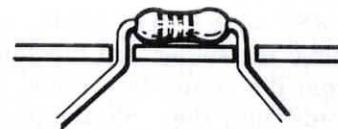
- (✓) Hold a 20 kΩ (red-blk-org) resistor by the body and bend the leads straight down with your finger as shown.



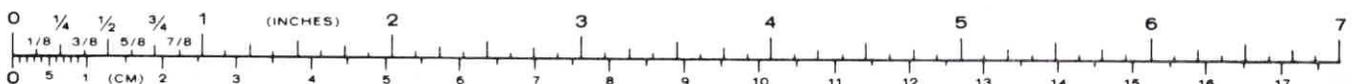
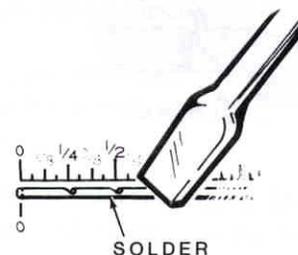
- (✓) R1: Push the leads through the holes at the "R1" location at the top of Section 1 of the circuit board. The end with the color bands may be positioned either way. NOTE: Resistors are identified by the following outline:



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

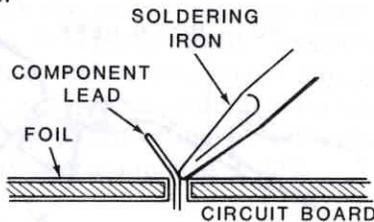


- (✓) Stretch a few inches of solder over the scale at the bottom of this page. Then start at the end of the solder and use a screwdriver blade tip (or your fingernail) to make two indent marks, 1/4" apart, as shown.

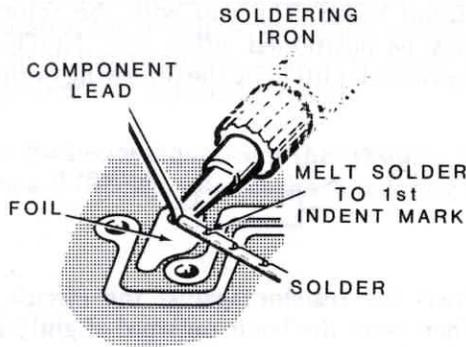


(✓) Turn the circuit board over and use the following procedure to solder the leads to the circuit board as follows:

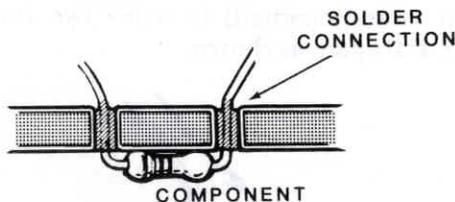
1. Push your soldering iron tip against both the resistor lead and the circuit board foil. Heat **both** of these for a second or two.



2. Apply the end of the solder to the resistor lead, the circuit board foil, and the end of the soldering iron.



3. Allow the solder to melt **UP TO THE FIRST MARK YOU MADE** and then remove the solder and the soldering iron from the connection point. **NOTE:** The solder may flow into the plated-through hole and make it appear that the connection is not solid, but do not add more solder to the connection, since this is normal.



4. Repeat steps 1, 2, and 3 for the other resistor lead. Allow the solder to melt up to the second indent mark.

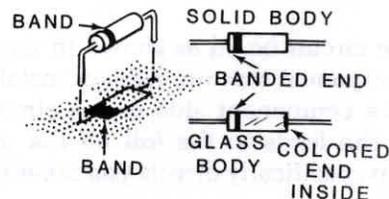
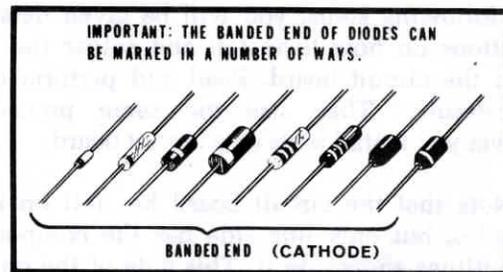
- (✓) Cut off the excess lead lengths close to the connection. **WARNING:** Clip the leads so the ends will not fly toward your eyes.
- (✓) Check each connection. Compare it to the illustrations on Page 17. After you have checked the solder connections, proceed with the assembly on this page. Use the same soldering procedure for each connection. Try to estimate the 1/4" solder segments without marking them for the remaining connections.

NOTE: Always clean your soldering iron tip as soon as residue begins to build up. This is normally required after you have made four or five connections.

Section 1

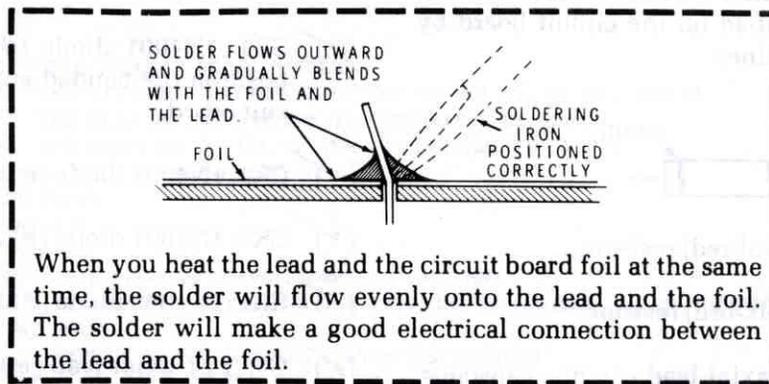
Start at the top of Section 1 and install the following components. **NOTE:** Make sure you installed resistor R1 in an earlier step.

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

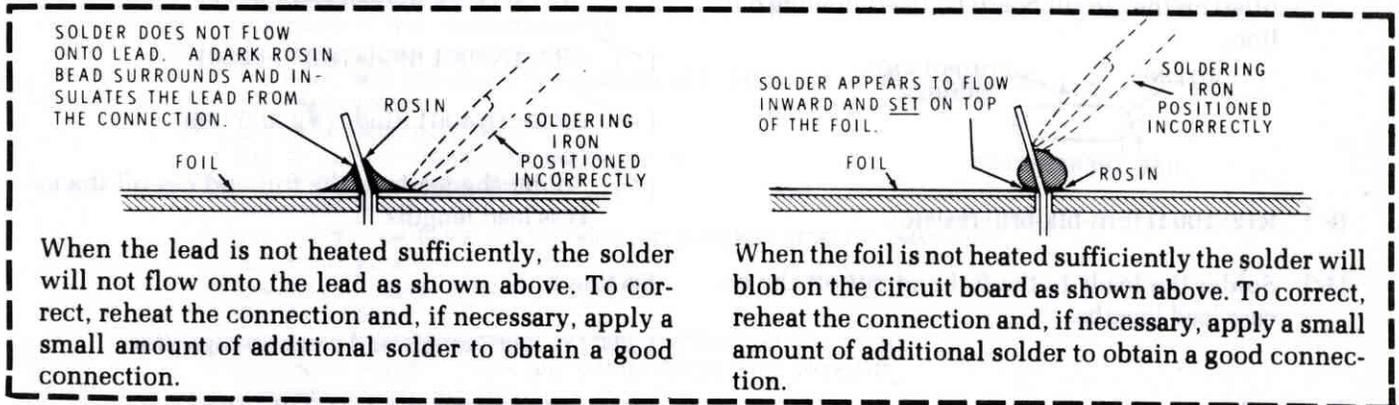


CAUTION: ALWAYS POSITION THE BANDED END OF A DIODE AS SHOWN ON THE CIRCUIT BOARD.

A GOOD SOLDER CONNECTION



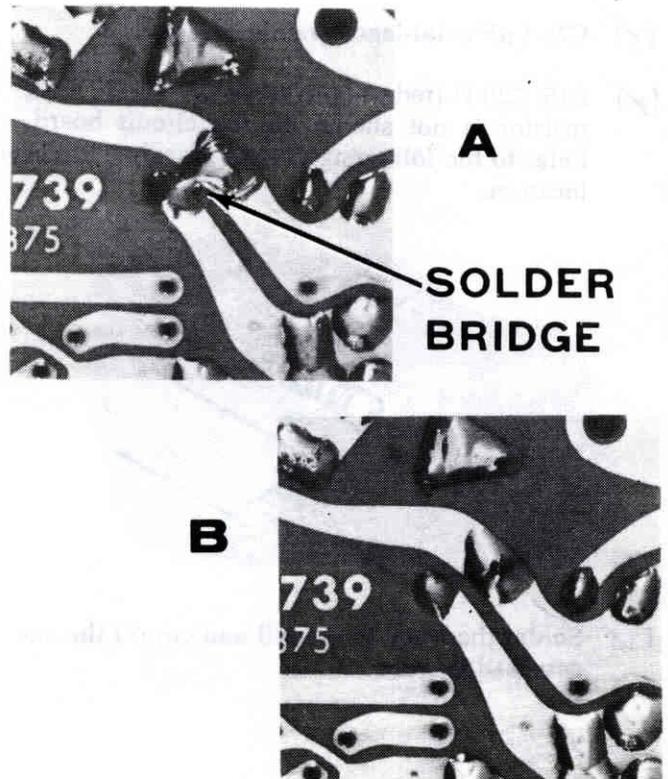
POOR SOLDER CONNECTIONS



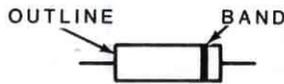
SOLDER BRIDGES

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

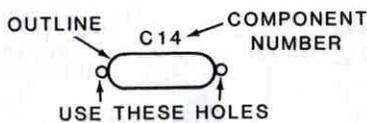
Use only enough solder to make a good connection, and lift the soldering iron straight up from the circuit board. If a solder bridge should develop, turn the circuit board foil-side-down and heat the solder between connections. The excess solder will run onto the tip of the soldering iron, and this will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



- (✓) CR1: 1N4001 diode (#230-5288). NOTE: Diodes are identified on the circuit board by the following outlines:



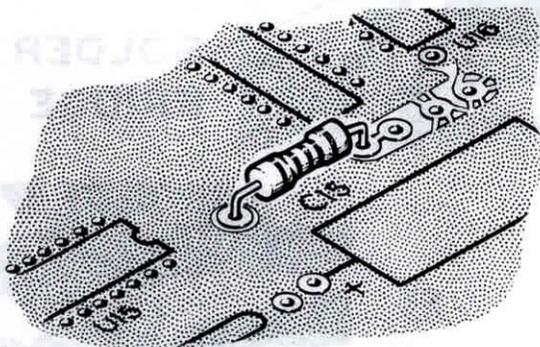
- (✓) R7: 4700 Ω (yel-viol-red) resistor.
 (✓) R13: 100 Ω (brn-blk-brn) resistor.
 (✓) C14: .1 μ F (104) **axial-lead** ceramic capacitor. NOTE: Axial-lead ceramic capacitors are identified on the circuit board by the following outline:



- (✓) R12: 100 Ω (brn-blk-brn) resistor.
 (✓) Solder the leads to the foil and cut off the excess lead lengths.

Section 2

- (✓) C6: .1 μ F **axial-lead** ceramic capacitor.
 (✓) C7: .1 μ F **axial-lead** ceramic capacitor.
 (✓) R15: 220 Ω (red-red-brn) resistor. NOTE: This resistor is not shown on the circuit board. Refer to the following drawing for the correct location.



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

Section 3

- (✓) CR3: 1N4001 diode (#230-5288). Be sure to position the banded end as shown on the circuit board.
 (✓) CR2: 1N4001 diode (#230-5288).
 (✓) CR5: 1N4001 diode (#230-5288).
 (✓) CR4: 1N4001 diode (#230-5288).
 (✓) C4: .1 μ F **axial-lead** ceramic capacitor.
 (✓) CR6: 1N4001 diode (#230-5288).
 (✓) CR7: 1N4001 diode (#230-5288).
 (✓) CR10: 1N4001 diode (#230-5288).
 (✓) Solder the leads to the foil and cut off the excess lead lengths.

Section 4

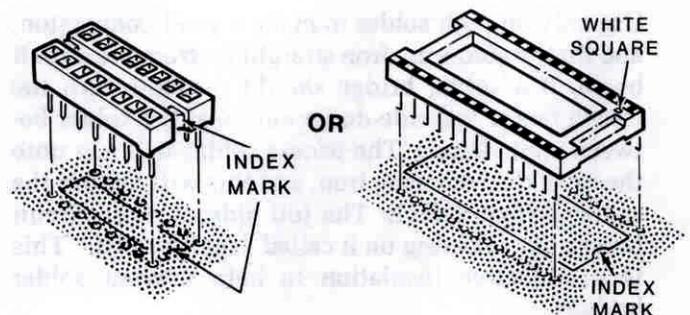
- (✓) C5: .1 μ F **axial-lead** ceramic capacitor.
 (✓) CR8: 1N4001 diode (#230-5288).
 (✓) CR9: 1N4001 diode (#230-5288).
 (✓) Solder the leads to the foil and cut off the excess lead lengths.

Refer to Pictorial 1-2 for the following steps.

Section 1

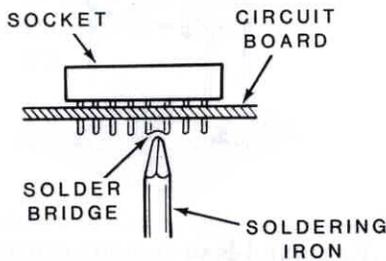
NOTES:

- In the following steps, you will install IC sockets. For each socket, first make sure the pins are straight. Then start the pins into the circuit board holes. Solder the pins to the foil as you install each socket.



2. It is very easy to form a solder bridge between foils when you install an IC socket. After you install each socket, carefully inspect the foil for solder bridges and remove any that you find, as described below. If you suspect that you have a solder bridge but are not positive, you can check your foil pattern against the one shown in the "X-Ray View" (Illustration Booklet, Page 26).

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



- 20-pin IC socket at U1.
- 28-pin IC socket at U2.
- 40-pin IC socket at U3.
- 14-pin IC socket at U15.
- 14-pin IC socket at U20.

Section 2

- 14-pin IC socket at U4.
- 16-pin IC socket at U7.
- 20-pin IC socket at U8.
- 8-pin IC socket at U16.

Section 3

- 8-pin IC socket at U9.
- 8-pin IC socket at U10.
- 8-pin IC socket at U17.
- 8-pin IC socket at U18.
- 20-pin IC socket at U11.

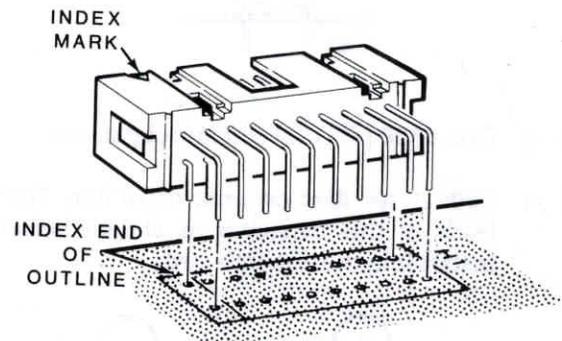
Section 4

- 8-pin IC socket at U5.
- 8-pin IC socket at U6.
- 8-pin IC socket at U12.
- 8-pin IC socket at U13.
- 20-pin IC socket at U14.

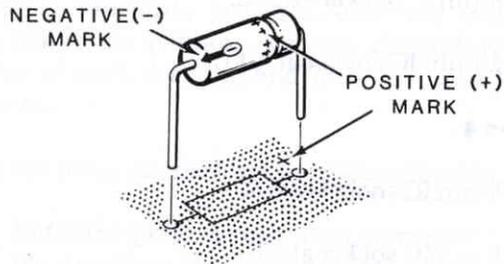
Refer to Pictorial 1-3 for the following steps.

Section 1

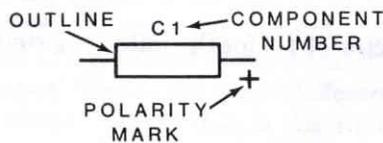
- H1: 20-pin plug. Start the pins on the plug into the circuit board holes so the index mark is toward the indexed end of the circuit board outline. Push the plug down tight against the circuit board. Solder one pin at each end of the plug to the foil, check to make sure the plug is still down tight against the circuit board, and then solder the remaining pins to the foil.



NOTE: In some of the following steps, you will install electrolytic capacitors. Before you install an electrolytic capacitor, look at it and identify 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, or the negative lead in the negative-marked hole.

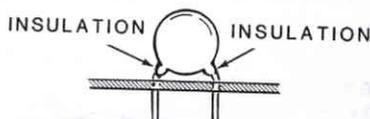


- () C2: 10 μ F electrolytic capacitor. NOTE: Electrolytic capacitors are identified on the circuit board by the following outline:

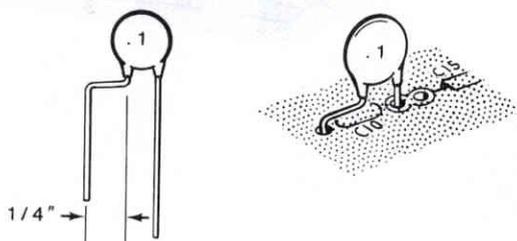


- () C1: 1 μ F electrolytic capacitor.

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



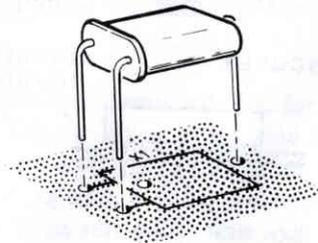
- () C16: 1500 pF (152) ceramic capacitor.
- () C10: .1 μ F **disc** ceramic capacitor. Form the leads of this capacitor as shown before you install it in the circuit board.



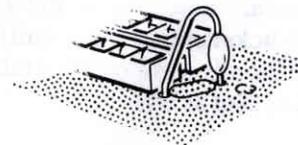
- () C8: 4700 pF (472) ceramic capacitor.
- () Solder the leads to the foil and cut off the excess lead lengths.

Section 2

- () X1: Start the three leads of the 4 MHz crystal (230-5263) into the corresponding circuit board holes as shown. Then push the crystal down against the circuit board, solder the leads to the foil, and cut off the excess lead lengths.



- () C3: .1 μ F **axial-lead** ceramic capacitor. Mount this capacitor vertically as shown.

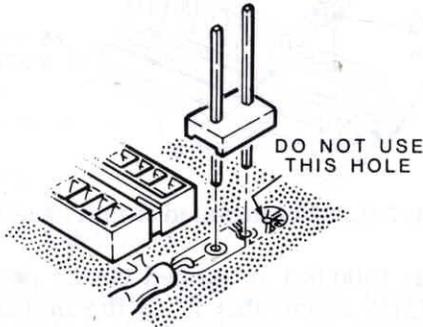


- () R6: 1000 Ω (brn-blk-red) resistor. Mount this resistor vertically over the square outline on the circuit board as shown.



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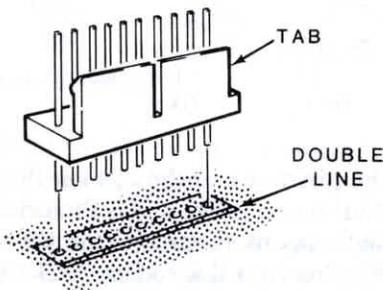
- (✓) H9: 2-pin plug. NOTE: This plug is not shown on the circuit board. Install the plug as shown below and solder the pins to the foil.



- () C15: 470 μ F electrolytic capacitor. Be sure to observe the correct polarity.
- (✓) Solder the leads to the foil and cut off the excess lead lengths.

Section 3

- (✓) H2: Start the shorter pins of an 8-pin plug into the circuit board holes at H2. Be sure to position the plug so the tab is toward the double line of the circuit board outline. Push the plug down tight against the circuit board. Then solder the pins to the foil.

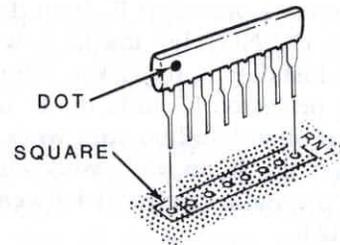


- (✓) H5: 8-pin plug at H5. Push the plug down tight against the circuit board and solder the pins to the foil.

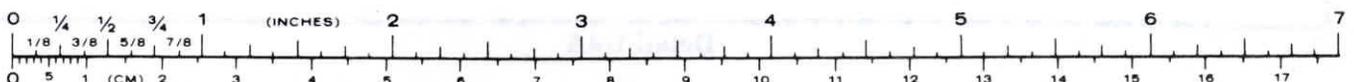
- (✓) C9: .1 μ F disc ceramic capacitor. Solder the leads to the foil and cut off the excess lead lengths.
- (✓) H8: 3-pin plug at PEN SOL. Be sure to position the plug so the tab is toward the double line of the circuit board outline. Then solder the pins to the foil.

Section 4

- (✓) RN1: Resistor network (#230-5280). Start the leads of the resistor network into the circuit board holes so the dot-marked end is toward the square outline on the circuit board. Then push the network down against the circuit board and solder the leads to the foil. Cut off any excess lead lengths.



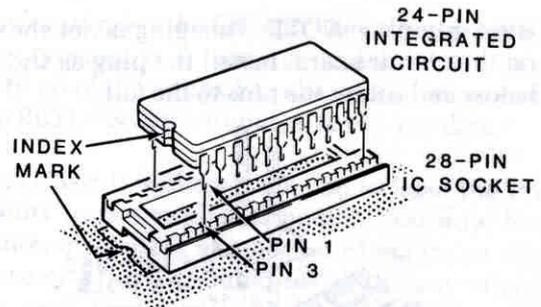
- (✓) H3: 8-pin plug. Be sure to position the plug properly on the circuit board. Solder the pins to the foil.
- (✓) H7: 3-pin plug at LIMIT. Solder the pins to the foil.
- (✓) H6: 3-pin plug at XFMR. Solder the pins to the foil.
- (✓) C11: .1 μ F disc ceramic capacitor. Solder the leads to the foil and cut off the excess lead lengths.



Refer to Pictorial 1-4 for the following steps.

Section 1

NOTE: Many of the ICs used in this kit are CMOS (complementary metal-oxide semiconductor) devices. These are rugged and reliable components when they are installed, but they can be damaged by static electricity during installation. The other ICs are of a type that is not susceptible to static electricity. Nevertheless, you should treat these ICs as if they were CMOS types, since it will avoid all possible confusion between ICs and provide protection in all cases. Use the procedure shown in Detail 1-4A whenever you are directed to install ICs.



- (✓) U1: 74LS374 integrated circuit (#230-5293).
- (✓) U2: 150008-1 integrated circuit (#230-5297). **NOTE:** Install this IC in the indicated holes of the socket. Do not use socket holes 1, 2, 27, and 28.

Once you remove a protected IC from its protective foam packing, **DO NOT** lay the IC down or let go of it until it is installed in its socket. When you bend the leads of a protected IC, hold the IC in one hand and place your other hand on your work surface before you touch the IC to your work surface. This will equalize the static electricity between the work surface and the IC.

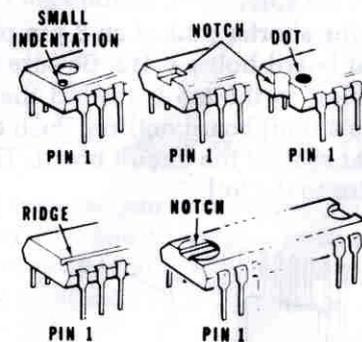
The pins on the ICs may be bent out at an angle, so they do not line up with the holes in the IC socket. **DO NOT** try to install an IC without first bending the pins as described below. To do so may damage the IC pins or the socket, causing intermittent contact.



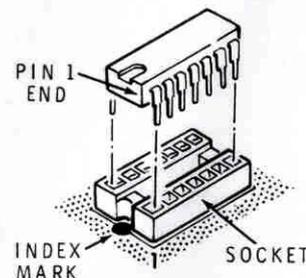
Before you install an IC, lay it down on its side as shown below and very carefully roll it toward the pins to bend the lower pins into line. Then turn the IC over and bend the pins on the other side in the same manner.



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



Position the pin 1 end of the IC over the index mark on the circuit board (refer to the Pictorial if you cannot find the index mark on your circuit board). Then start the IC pins into the socket. Make sure that all of the pins are started into the socket. Then push the IC firmly into the socket. **NOTE:** An IC pin can become bent under the IC and it will appear as though it is correctly installed in the socket.



Detail 1-4A

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- () U3: 46802 integrated circuit (#230-5296).
- () U15: 74LS74 integrated circuit (#230-5266).
- () U20: 74LS00 integrated circuit (#230-5292).

Section 2

- () U4: 74LS05 integrated circuit (#230-5267).
- () U7: 74LS138 integrated circuit (#230-5264).
- () U8: 74LS273 integrated circuit (#230-5269).
- () U16: 75452 integrated circuit (#230-5268).

Section 3

- () U9: 75452 integrated circuit (#230-5268).
- () U10: 75452 integrated circuit (#230-5268).
- () U17: 75452 integrated circuit (#230-5268).
- () U18: 75452 integrated circuit (#230-5268).
- () U11: 74LS273 integrated circuit (#230-5269).

Section 4

- () U5: 75452 integrated circuit (#230-5268).
- () U6: 75452 integrated circuit (#230-5268).
- () U12: 75452 integrated circuit (#230-5268).
- () U13: 75452 integrated circuit (#230-5268).
- () U14: 74LS240 integrated circuit (#230-5265).

Refer to Pictorial 1-5 for the following steps.

Section 1

NOTE: Mount the following resistors vertically over the square part of the circuit board outline.

- () R4: 68 Ω , 2-watt (blu-gry-blk) resistor.

- () R5: 68 Ω , 2-watt (blu-gry-blk) resistor.
- () R10: 68 Ω , 2-watt (blu-gry-blk) resistor.
- () R11: 68 Ω , 2-watt (blu-gry-blk) resistor.
- () R14: 68 Ω , 2-watt (blu-gry-blk) resistor.

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

Section 2

- () R2: 68 Ω , 2-watt (blu-gry-blk) resistor.
- () R3: 68 Ω , 2-watt (blu-gry-blk) resistor.
- () R8: 68 Ω , 2-watt (blu-gry-blk) resistor.
- () R9: 68 Ω , 2-watt (blu-gry-blk) resistor.

- () CR11: 1N5401 diode (#230-5287). Position this diode over the square part of the circuit board outline so the banded end is **down** as shown.



- () CR12: 1N5401 diode (230-5287). Position this diode over the square part of the circuit board outline so the banded end is down.
- () Solder the leads to the foil and cut off the excess lead lengths.

Section 3

- () C13: 10,000 μ F electrolytic capacitor. Be sure to observe the correct polarity. At the positive end of the capacitor, use the circuit board hole that best matches the capacitor you received.
- () Solder the leads to the foil and cut off the excess lead lengths.

Refer to Pictorial 1-6 for the following steps.

- () Position the circuit board with the component side down as shown in the Pictorial.
- () Refer to Detail 1-6A and mount a 6-32 × 1/4" hex stud to the circuit board at AA. Use a #6 lockwasher and a 6-32 nut. Push this stud toward the nearby edge of the circuit board before you tighten the hardware.
- () Similarly, mount 6-32 × 1/4" hex studs to the circuit board at AB, AC, and AD. ** See below*
- () U19: Refer to Detail 1-6B and use the following procedure to install a 7805 integrated circuit (#230-5262) to the circuit board:
 1. Use long-nose pliers to bend the leads 90° at a point 1/4" away from the IC body as shown in Part A of the Detail.
 2. Start the IC leads into the corresponding circuit board holes (the outline of this part is shown on the component side of the circuit board). Then temporarily use a 6-32 × 1/4" screw to secure the IC to the hex stud at AB.
 3. Solder the IC leads to the foil on the **component side** of the circuit board and cut off any excess lead lengths.
 4. Remove the screw from the hex stud at AB and set it aside for use later.

CIRCUIT BOARD CHECKOUT

Carefully inspect the foil side of the circuit board for the following most commonly made errors:

- () Unsoldered connections.
- () Poor solder connections.
- () Solder bridges between foil patterns (refer to the "X-Ray View" in the Illustration Booklet on Page 26).
- () Protruding leads which could touch each other or the chassis when the circuit board is mounted later.

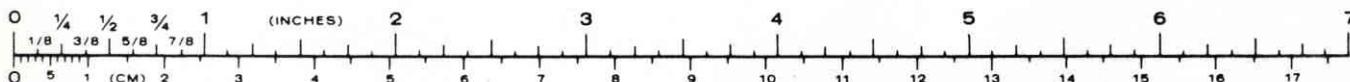
Refer to the illustrations where parts were installed as you make the following visual checks:

- () Diodes for the proper **type** and **installation**.
- () Integrated circuits for the proper **type** and **installation**.
- () Electrolytic capacitors for the correct position of the positive (+) or negative (-) marked lead.

This completes the assembly of the circuit board. Set it aside until it is called for in a step.

Page 24 — Left column. Add the following Note to the third step:

NOTE: It is not necessary to push these studs toward the edge of the circuit board before you tighten the hardware.



Page 25 — Left column, under "Electronic Components." Add an asterisk next to the fifth item (230-5257).

— Add the following Note near the bottom of the Manual page:

*NOTE: Use the LED attached to the "Important Notice" instead of the one supplied with the kit.

CHASSIS

PARTS LIST

Unpack the remainder of the kit. Then check each part against the following list. The key numbers correspond to the numbers on the "Chassis Parts Pictorial." Return any part that is packed in an individual envelope, with the part number on it, back into its envelope until that part is called for in a step. Do not throw away any packing material until you account for all of 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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ELECTRONIC COMPONENTS

A1	230-5206	1	Keypad assembly	
A2	230-5223	1	Solenoid assembly	
A3	230-5226	1	Limit switch	S1
A4	230-5252	2	Stepping motor	M1, M2
A5	230-5257	1	LED (light-emitting diode)	CR13
A6	230-5259	1	Power transformer	T1
A7	230-5298	1	Rocker switch	S2
A8	230-5301	1	630 mA fuse	F1

HARDWARE

NOTE: Hardware packets are marked to show the size of the hardware they contain (HDW#2 & #4, or HDW#6, etc.). You may have to open more than one packet to locate all of the hardware of any one size (#6, for example).

#2 & #4 Hardware

B1	230-5240	2	2-56 × 5/8" screw
B2	230-5239	2	2-56 nut
B3	230-5208	2	#2 × 17/64" spacer
B4	230-5250	1	4-40 × 1/8" setscrew

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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#2 & #4 Hardware (Cont'd.)

B5	230-5244	2	4-40 × 3/16" screw
B6	230-5242	2	4-40 × 3/8" screw
B7	230-5245	1	4-40 × 1/2" screw
B8	230-5246	4	#4 external-tooth lockwasher
B9	230-5251	1	#4 flat washer
B10	230-5241	1	4-40 locknut
B11	230-5233	2	4-40 × 1-3/16" tapped spacer
B12	230-5213	2	"E" ring

Other Hardware

C1	250-1325	2	6-32 × 1/4" screw
C2	230-5243	15	6-32 × 3/8" screw
C3	254-1	1	#6 lockwasher
C4	230-5255	11	6-32 locknut
C5	230-5305	1	#6 solder lug
C6	230-5207	1	Fiber washer

PLUGS - SOCKETS

D1	230-5205	1	8-pin socket
D2	230-5224	2	3-pin socket

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

E1	230-5236	1	Platen
E2	230-5248	1	Left side bracket
E3	230-5249	1	Right side bracket
E4	230-5307	1	Chassis

PLASTIC PARTS

F1	230-5211	2	Pinch wheel arm
F2	230-5216	1	Pen holder
F3	230-5217	1	Pen holder support
F4	230-5218	1	Carriage
F5	230-5219	1	Right penlift arm
F6	230-5220	1	Left penlift arm
F7	230-5203	1	Case
F8	230-5229	1	Limit switch stop tab
F9	230-5237	1	Antistatic pad
F10	230-5247	2	Grommet strip
F11	230-5302	1	Strain relief

SHAFTS – PINS

G1	230-5212	2	Retaining pin
G2	230-5215	1	Carriage shaft
G3	230-5221	1	Lift shaft
G4	230-5234	1	Grit wheel shaft

PINCH WHEELS

H1	230-5214	2	Pinch wheel
H2	230-5230	1	Shaft bearing
H3	230-5232	1	Pulley
H4	230-5254	1	Belt drive pulley

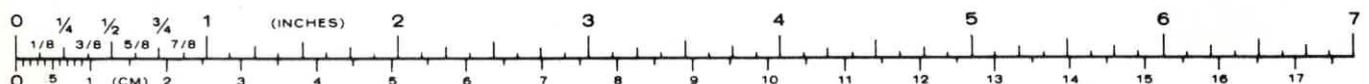
KEY No.	HEATH Part No.	QTY.	DESCRIPTION
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WIRE – SLEEVING – HARNESS – LINE CORD

	230-5256	1	Black stranded wire (3-1/2" long)
	230-5258	1	Line cord
J1	230-5260	1	LED harness
	346-35	5-1/2"	Small heat-shrinkable sleeving
	230-5303	4"	Large heat-shrinkable sleeving
	344-51	17"	Brown solid wire
	344-56	17"	Blue solid wire
	344-91	9"	Brown stranded wire
	344-92	9"	Red stranded wire
	344-93	9"	Orange stranded wire
	344-94	9"	Yellow stranded wire
	344-95	9"	Green stranded wire
	344-96	9"	Blue stranded wire
	344-97	9"	Violet stranded wire

MISCELLANEOUS

K1	230-5201	4	Cable tie
	74-15	1	Roll of double-stick tape
K2	230-5209	2	Grit pad
K3	230-5228	1	Pen spring
K4	230-5231	2	Extension spring
K5	230-5235	1	Timing belt
K6	230-5299	1	Fuseholder
K7	230-5300	1	Fuseholder insert
K8	230-5304	4	Foot
K9	490-227	1	Large allen wrench (1.5 mm)
K9	490-23	1	Small allen wrench (.049")
K10	230-5204	2	Plastic tape strip (3/8" x 1")
	406-684	1	Pen



STEP-BY-STEP ASSEMBLY

CHASSIS ASSEMBLY

Refer to Pictorial 2-1 for the following steps.

- () Position the chassis as shown in the Pictorial.
- () Carefully peel away the backing paper from two feet. Then press a foot onto the bottom of the chassis near each rear corner as shown. Be sure each foot is 1/2" from the rear edge and 1" from the side edge as shown.
- () Similarly press a foot onto the bottom of the chassis near each front corner as shown. Be sure each foot is 3/4" from the front edge and 1/2" from the side edge as shown.
- () S2: Position the rocker switch near hole S2 in the chassis as shown so the two lugs are toward the left. Then press the switch into the hole until it locks into place.
- () Mount the fuseholder to the chassis at F1. Match the flats on the fuseholder with the flats in the sides of the chassis hole. Also be sure lug 2 faces upward. Then use the nut supplied with the fuseholder to secure the fuseholder into place. Do not overtighten this nut.

NOTE: When a step calls for hardware, only the screw size is given. If a step calls for "6-32 x 3/8" hardware", for example, it means you should use a 6-32 x 3/8" screw and a 6-32 locknut.

- () Mount a #6 solder lug onto the chassis at CA. Use a 6-32 x 3/8" screw and a 6-32 locknut. Be sure to position the solder lug as shown in the Pictorial before you tighten the hardware.
- () Bend solder lug CA away from the chassis so you can connect a wire to it in a later step.

- () Cut the black leads coming from the power transformer to the indicated lengths. Measure the leads from the point where they exit the transformer. Remove 3/8" of insulation from the end of each lead. Tightly twist together the wires at the end of each lead. Then melt a small amount of solder on these ends to hold the fine strands together.
- () T1: Mount the power transformer to the chassis at T1 as shown. Use two sets of 6-32 x 3/8" hardware. Be sure to position the transformer so the leads extend from the right side as shown. Push the transformer as far as possible toward the left side of the chassis before you tighten the hardware.
- () Mount the circuit board (assembled earlier) to the chassis as shown. Use a 6-32 x 1/4" screw and a #6 lockwasher to mount it and integrated circuit U19 to the chassis at CB. Use only 6-32 x 1/4" screws at CC and CD (the hex stud at CA will not be secured to the chassis). Be sure to position the board so plug H1 is toward the rear of the chassis as shown. NOTE: If the circuit board studs do not line up with the chassis holes, loosen the hardware on top of the board, reposition the studs, and tighten all hardware.
- () M1: Remove the two indicated screws (the longer two) from a stepping motor. Then use these screws to mount the motor onto the chassis at M1. Be sure to position the motor so the leads are toward the rear of the chassis as shown.
- () Slide the belt drive pulley onto the shaft of motor M1 so the setscrew lines up with the flat on the shaft. Then push the pulley onto the shaft until it is 1/4" above the body of the motor. Use the large allen wrench to tighten the setscrew.

*CF
see
below*

Page 27 — Right column, third step. Change the sixth line of the step to read:

.... at CF will not be secured to the chassis). Be

() Refer to Detail 2-1A and use the following procedure to prepare the end of the line cord:

1. Remove enough outer insulation from the line cord so the exposed brown wire is 4" long.
2. Cut the blue wire to 2" and the green-yellow wire to 4".
3. Remove 3/8" of insulation from the end of each lead. Tightly twist together the wires at the end of each lead. Then melt a small amount of solder on these ends to hold the fine strands together.

() Refer to Detail 2-1B and use a strain relief to secure the line cord in chassis hole CE.

Refer to Pictorial 2-2 for the following steps.

NOTES:

1. Refer to the inset drawing on the Pictorial when a step directs you to "make a mechanically secure connection".
2. In the following steps, (NS) means not to solder the connection because you will add other wires later. "S-" with a number, such as (S-2), means to solder the connection. The number following the "S-" tells you how many wires should be at the connection. This helps you check your work for errors as you go.

() Connect the free end of the green-yellow line cord lead to solder lug CA (S-1). Make a mechanically secure connection. NOTE: Do not shorten this wire even though it appears to be too long.

() Cut five 3/4" lengths of **large** heat-shrinkable sleeving. Use these lengths of sleeving in the following steps.

() Slide a 3/4" length of sleeving onto the brown line cord lead. Then connect the free end of the brown line cord lead to fuseholder F1 lug 1 (S-1). Make a mechanically secure connection. After the connection cools, slide the sleeving down onto the fuseholder lug so it completely covers the connection. Then refer to Detail 2-2A and use the heat from a match or candle to shrink the sleeving against the connection.

() Slide a 3/4" length of sleeving onto the longer black lead coming from the power transformer. Then connect the free end of the lead to switch S2 lug 1 (S-1). Make a mechanically secure connections. After the connection cools, slide the sleeving over the connection and use heat to shrink it into place.

() Slide a 3/4" length of sleeving onto the remaining black lead coming from the power transformer.

() Refer to Detail 2-2B and use the following procedure to connect the black power transformer lead and the blue line cord lead together:

1. Form a hook in the free ends of the transformer lead and the blue line cord lead.
2. Hook the two leads together and crimp the hooks to make a mechanically secure connection. Then solder the connection.
3. After the connection cools, slide the sleeving so it completely covers the connection. Then use heat to shrink the sleeving into place.

NOTE: When a step directs you to prepare a stranded wire, as in the next step, first cut the wire to the indicated length. Then remove 1/4" of insulation from each end. Tightly twist together the wires at each end of the wire. Then melt a small amount of solder on these ends to hold the fine strands together.

() Locate the length of black stranded wire. Then prepare the ends. Do not shorten this wire.

() Connect one end of the prepared black wire to switch S2 lug 2 (S-1). Make a mechanically secure connection. After the connection cools, slide a 3/4" length of sleeving onto the wire so it covers the connection. Then use heat to shrink the sleeving into place.

() Slide the remaining length of sleeving onto the free end of the black wire. Then connect the end of the wire to fuseholder F1 lug 2 (S-1). Make a mechanically secure connection. After the connection cools, slide the sleeving over the connection. Then use heat to shrink the sleeving into place.

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- () Route the cable coming from power transformer T1 as shown. Then push the socket on the end of this cable onto circuit board plug XFMR. Position the socket so the slots are toward the left as shown.
- () Route the cable coming from motor M1 as shown. Then push the socket on the end of this cable onto circuit board plug H2. Make sure you position the socket so the red wire is at plug pin 1.

Set the chassis assembly aside until it is called for in a step.

PAPER MOVER ASSEMBLY

Refer to Pictorial 3-1 for the following steps.

- () Locate the two grit pads and the grit wheel shaft.

NOTE: The back (smooth) side of the grit pads have an adhesive coating on them which must be activated before they become sticky. In the next step, you will use acetone (lacquer thinner or fingernail polish remover) to activate this coating. Use only enough to moisten the pads. This ensures that the adhesive will setup quickly.

- () Use acetone to clean the indicated surfaces of the grit wheel shaft (to remove any dust or grease).
- () Use acetone to moisten the back (smooth) side of a grit pad. Then tightly wrap the pad around the grit wheel shaft as shown. Keep one edge of the pad flush with one edge of the surface. Use a rubber band, or something similar, to hold the pad into place while the adhesive sets.
- () Similarly moisten the back of the remaining grit pad. Then wrap the pad around the other end of the grit wheel shaft as shown.
- () Start a 4-40 × 1/8" setscrew into either hole at the larger end of the grit wheel shaft.
- () Set the grit wheel shaft aside until it is called for in a step.

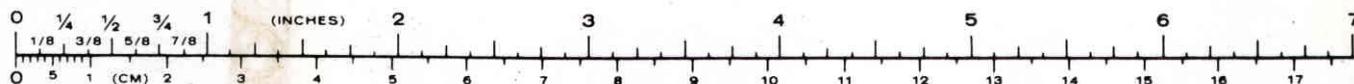
Refer to Pictorial 3-2 for the following steps.

- () Position the antistatic pad as shown in Detail 3-2A so the shiny side is up. Also note that the cutouts in the shorter sides of the pad are closer to one longer side than they are to the other.
- () Cut an 8-1/2" length of double-stick tape. Then press the sticky side of the tape onto the indicated edge of the antistatic pad.
- () Similarly cut lengths of double-stick tape and press them onto the antistatic pad as shown in the Detail.
- () Carefully peel the backing paper from the lengths of tape to expose the remaining sticky side.
- () Carefully align the cutouts in the antistatic pad with the cutouts in the platen. Then press the pad onto the platen. Be sure the longer edges of the pad are flush with the longer edges of the platen. Also be sure you do not have any air bubbles between the pad and the platen.
- () Carefully peel away the backing paper from the paper line label. Align the indicated side of the label with the rear edge of the cutouts in the antistatic pad. Then press the label onto the pad. **NOTE:** You may find it easier to use a straightedge to keep the label lined up with the cutouts.
- () Set the platen assembly aside until it is called for in a step.

Refer to Pictorial 3-3 for the following steps.

NOTE: If you find the bearing hard to install in the next step, you may find it easier to use a vise to start the bearing into the hole. Once you have the bearing started, you should be able to press it the rest of the way with your fingers.

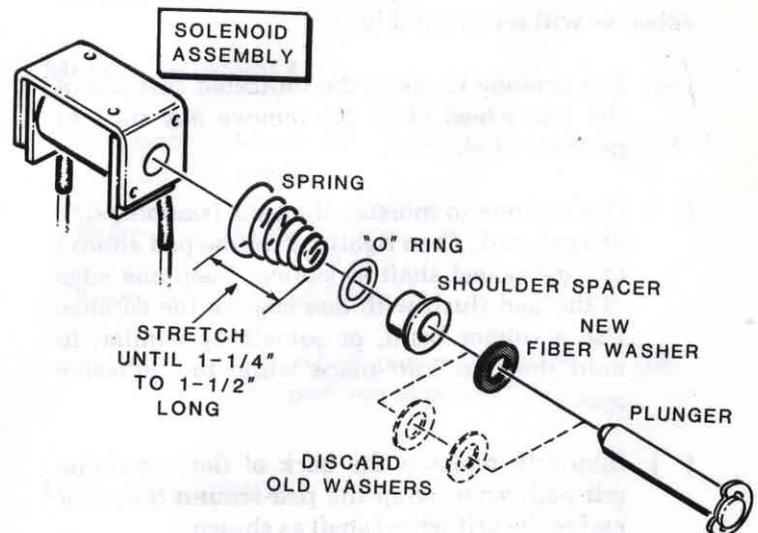
- () Position the left side bracket and the shaft bearing as shown. Then press the shaft bearing into the hole BA of the bracket. Be sure to insert the bearing from the correct side of the bracket as shown.



- () Carefully peel the backing paper from a plastic tape strip. Then press the tape strip onto the left side bracket in the area shown.
- () Use 4-40 × 1/2" hardware and a #4 flat washer to mount the pulley onto the left side bracket at BB. Slide the pulley away from the side bracket as shown; then tighten the hardware finger tight.
- () Set the left side bracket aside temporarily.
- () Carefully peel the backing paper from the remaining plastic tape strip. Then press the tape strip onto the right side bracket in the area shown.
- () M2: Turn two 4-40 × 1-3/16" tapped spacers onto the indicated screws of the remaining stepper motor. Then use two 4-40 × 3/8" screws and two #4 external-tooth lockwashers to mount the motor onto the indicated side of the right side bracket. Be sure the wires extend from the indicated side of the motor.
- () Use 6-32 × 3/8" hardware to mount the left side bracket to the indicated side of the platen. Leave the hardware loose at this time.
- () Remove the rubber bands from the grit wheel shaft (that you used to hold the grit pads in place while the adhesive set). Then start the smaller end of the shaft into the shaft bearing in the left side bracket.
- () Position the right side bracket near the platen and start the larger end of the grit wheel shaft onto the shaft of motor M2. Then use 6-32 × 3/8" hardware to mount the right side bracket onto the platen.
- () Tighten the hardware that secures the side brackets to the platen. Position the grit wheel shaft so the grit pads are evenly centered centered in the two openings in the platen. Then use the small allen wrench to tighten the setscrew against the motor shaft.
- () Bend the two grommet strips 90° at a point three links from one end as shown in the Pictorial. Then slide a grommet strip onto each side bracket as shown in the inset drawing.

Refer to Pictorial 3-4 for the following steps.

- () Refer to Detail 3-4A and use the following procedure to prepare the solenoid assembly:
 1. Temporarily remove the rubber band from the solenoid. Then remove the plunger.
 2. Pull the spring, "O" ring, shoulder spacer, and two washers from the plunger. Discard the two washers.
 3. Stretch the spring until it is 1-1/4" to 1-1/2" long.
 4. Slide the fiber washer supplied with the kit onto the plunger. Then reinstall the shoulder spacer, "O" ring, and spring as shown.
 5. Push the end of the plunger into the solenoid and use the rubber band (removed earlier) to hold the plunger in place.
- () Use two 4-40 × 3/16" screws and two #4 external-tooth lockwashers to mount the solenoid assembly onto the left side bracket as shown. Slide the solenoid as far as possible toward the front of the platen before you tighten the hardware.



Detail 3-4A

- () S1: Use the following procedure to mount the limit switch onto the right side panel:
 1. Insert 2-56 × 5/8" screws into holes BC and BD in the right side bracket as shown.

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2. Hold the screws at BC and BD in place while you slide a #2 × 17/64" spacer onto each screw.
3. Position the timing belt between spacers BC and BD on the right side bracket and around pulley BB on the left side bracket as shown.
4. Slide the limit switch onto the screws at BC and BD so the actuator is positioned as shown. Then use two 2-56 nuts to secure the switch.
3. Drive the penlift arm onto the lift shaft until the knurled area is completely covered. Continue to drive the arm onto the shaft until 1/16" of the shaft is exposed as shown in the Pictorial.
4. Position the lift shaft on a flat surface so the indicated side of the left penlift arm is flat against the surface as shown.
5. Start the indicated side of the right penlift arm onto the free end of the lift shaft as shown. Be sure the indicated side of the penlift arm is flat against the surface as shown.

Refer to Pictorial 3-5 for the following steps.

() Refer to Detail 3-5A and use the following procedure to prepare a pinch wheel assembly:

1. Push an "E" ring onto the grooved end of the retaining pin.
2. Look at both sides of a pinch wheel. Note that the plastic insert is larger on one side of the wheel than it is on the other.
3. Slide the pinch wheel onto the retaining pin so the smaller side of the insert is toward the "E" ring as shown.

4. Push the end of the retaining pin as far as possible into a pinch wheel arm. Do not push the retaining pin so far that the wheel cannot still rotate freely.

() Similarly prepare another pinch wheel assembly.

() Set the two pinch wheel assemblies aside temporarily.

() Refer to Detail 3-5B and use the following procedure to prepare the lift shaft:

1. Look at the lift shaft and note that the knurled area on one end of the shaft is closer to the end of the shaft than it is at the other end.
2. Start the shorter end of the shaft into the indicated hole in the left penlift arm. Be sure to position the penlift arm as shown. Also be sure to start the shaft into the correct hole.

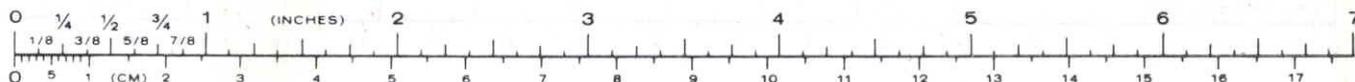
6. Make sure the indicated sides of both penlift arms are still flat against the surface. Then drive the right penlift arm part way onto the lift shaft.

7. Make sure the two penlift arms are still flat against the surface. This will ensure that the penlift arms are in proper alignment. Then drive the right penlift arm onto the shaft until it completely covers the knurled area. Check the alignment several times to make sure it is still correct as you perform this step. NOTE: You may find it easier to use a nut driver, or similar object, as shown to drive this penlift arm onto the shaft.

() Position the lift shaft assembly as shown in Detail 3-5C. Then push one end of the carriage shaft into the remaining hole in the right penlift arm. Position the carriage onto the carriage shaft as shown. Then push the end of the shaft into the remaining hole in the left penlift arm. Be sure the carriage is positioned properly on the carriage shaft and fits around the lift shaft as shown.

() Push one of the prepared pinch wheel assemblies onto each end of the carriage shaft as shown in the Pictorial. Be sure to position each pinch wheel assembly so it engages with the penlift arm as shown.

() Position the carriage assembly above the platen assembly as shown in the Pictorial. Then drop the carriage shaft into the cutouts in the left and right side brackets as shown.



Refer to Pictorial 3-6 for the following steps.

- () Locate one of the extension springs. Then refer to Detail 3-6A and use the following procedure to install the spring on the right side of the assembly:

1. Hold the carriage assembly in place with one hand while you use the other hand to hook the spring around the indicated tab on the right side bracket (behind motor M2).
2. Route the free end of the spring upward between the motor and the side panel. Then hook the end of the spring around the boss on the right pinch wheel arm.

- () Similarly install an extension spring on the other side of the assembly.

- () Refer to Detail 3-6B and use the following procedure to install the pen spring on the **right** side of the assembly:

1. Slide the larger loop of the spring onto the right pinch wheel arm as shown. Be sure to install the spring exactly as shown so the small hook extends toward the left from above the pinch wheel arm.
2. Position the small hook of the spring around the boss on the right pinch wheel arm. Then position the loop on the remaining end of the spring onto the end of the lift shaft.
3. Use a drop of glue (not supplied) or a 1/8" × 1/8" piece of double-stick tape to secure the loop on the end of the spring to the lift shaft. NOTE: This helps ensure that the spring will stay on the shaft during normal operation.

- () Carefully remove the rubber band from the solenoid plunger.

- () Straighten the two wires coming from the solenoid. Then loosely twist together (approximately one-turn-per inch) the wires.

NOTE: When you push the wires into the socket in the next step, it is not necessary to remove insulation from the wire ends. The tabs inside the socket will bite through the insulation and make contact with the wires. Use the blade of a small screwdriver to push the wires into the socket.

- () Position a 3-pin socket as shown in Detail 3-6C (note the position of the side with the locking tabs). Then push the wires coming from the solenoid into slots 2 and 3 as shown (disregard any numbers that may be stamped into the socket). NOTE: Either wire can go into either slot.

- () Cut a 15" length of brown **solid** wire and a 15" length of blue **solid** wire. Then remove 1/4" of insulation from **one end** of each wire. Use these wires in the next two steps.

- () Connect the bare end of the brown solid wire to limit switch S1 lug 1 (S-1).

- () Connect the bare end of the blue solid wire to limit switch S1 lug 2 (S-1).

- () Loosely twist together the wires coming from limit switch S1.

- () Position a 3-pin socket as shown in Detail 3-6D. Then push the wires coming from limit switch S1 into the slots as follows:

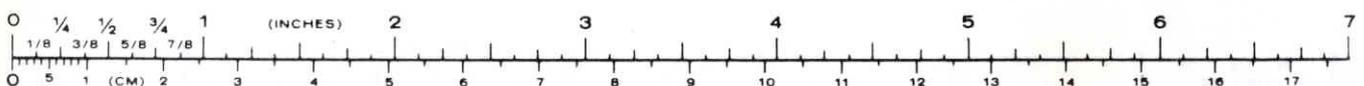
Brown wire into slot 1

Blue wire into slot 2

Refer to Pictorial 3-7 for the following steps.

- () Locate the insulator paper. Then refer to Detail 3-7A and use the following procedure to prepare the insulator:

1. Carefully peel away and discard the backing paper from the insulator.
2. Fold the insulator paper as shown (sticky side in) and press together the two indicated tabs.



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- (/) Refer to Detail 3-7B and press the insulator paper against the sides and top of the power transformer as shown. Be sure to route the transformer leads against the transformer and out from under the insulator paper as shown in the Pictorial.
 - (/) Position the platen/paper drive assembly near the chassis assembly as shown in the Pictorial.
 - (/) Push the socket on the end of the cable coming from motor M2 onto circuit board plug H5. Be sure the red wire is at plug pin 1.
 - (/) Push the socket on the end of the twisted pair coming from limit switch S1 onto circuit board plug LIMIT. Be sure the brown wire is closest to the nearby edge of the circuit board.
 - (/) Push the socket on the end of the twisted pair coming from the solenoid onto circuit board plug PEN SOL. Be sure the wires extend from the indicated side of the socket.
 - (/) Push the **larger** socket on one end of the LED harness onto the indicated circuit board plug. Be sure to position the socket so the slots are toward the left as shown.
 - (/) Set the chassis assembly aside temporarily.
- (/) Cut the following lengths of **stranded** wire. Then prepare **one end** of each wire.
- | | |
|-----------|-----------|
| 9" brown | 9" yellow |
| 9" orange | 9" violet |
| 9" red | 9" blue |
| 9" green | |
- (/) Form a small hook in the bared end of the 9" brown wire. Hook the wire onto the hook in wire #2 coming from the keyboard assembly and crimp the connection. Then solder the connection.

Use the same procedure to connect the remaining prepared wires to the keyboard wires as follows:

- (/) Orange wire to wire #4 (S-1).
 - (/) Red wire to wire #5 (S-1).
 - (/) Green wire to wire #6 (S-1).
 - (/) Yellow wire to wire #7 (S-1).
 - (/) Violet wire to wire #8 (S-1).
 - (/) Blue wire to wire #9 (S-1).
 - (/) Cut seven 3/4" lengths of **small** heat-shrinkable sleeving. Slide a length of sleeving onto the free end of each wire coming from the keyboard assembly so it completely covers the solder connection and all but 1/8" of the bare portion of the keyboard wire. Then use heat to shrink the sleeving into place.
 - (/) Loosely twist together the wires coming from the keyboard assembly.
- ## CASE PREPARATION
- Refer to Pictorial 3-8 for the following steps.
- (/) Position the keyboard assembly as shown so the side with the 12 dimples is down.
 - (/) Cut wire #1 off close to the keyboard.
 - (/) Cut wire #3 off close to the keyboard.
 - (/) Cut the remaining seven wires off 1/2" away from the point where they exit the keyboard assembly. Then form a small hook in the end of each lead.

Position the 8-pin socket as shown. Then push the free ends of the wires into the slots of the socket as follows:

- Brown wire into slot 2. Be sure to skip slot 1.
- Red wire into slot 3.
- Orange wire into slot 4.
- Yellow wire into slot 5.
- Green wire into slot 6.
- Blue wire into slot 7.
- Violet wire into slot 8.
- Set the keyboard aside temporarily.

Refer to Pictorial 3-9 for the following steps.

- Position the case as shown in the Pictorial.
- Position the LED as shown in the Pictorial. Note that one LED lead is **shorter** than the other. Cut off the shorter lead to a length of $3/8$ ". Cut off the other LED lead to $1/2$ ".
- CR13: Position the LED above the case so the longer lead is toward the left. Then start the leads into their corresponding case top holes and push the LED as far as possible into hole CR13. NOTE: The LED will fit tightly in the hole.

- Cut four $1-3/4$ " lengths and one $1-1/8$ " length of double-stick tape. Press the tape onto the case top in the indicated areas. Then remove the backing paper from the lengths of tape to expose the sticky side.

- Locate the keyboard assembly. Then use the following procedure to mount the keyboard onto the case:

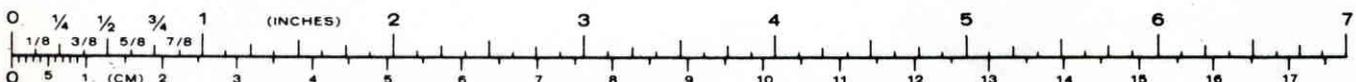
1. Position the keyboard assembly below the case. Then push the keyboard **up** through the indicated slot in the case as shown. Be sure the blue wire is toward the left.
2. Press the keyboard into its recess in the case top so it sticks to the double-stick tape.

- Locate the top label set. Then carefully peel away the backing paper from the labels and press the labels onto the case as shown. Be sure to line up the labels with their corresponding recesses in the case top. The labels are difficult to remove once they are installed.

- Locate the rear label. Then carefully peel away the backing paper from the label and press the label onto the rear of the case as shown.

- Set the case aside until it is called for in a step.

Except for completing the installation of the timing belt, which will be done later, this completes the assembly of the chassis. Proceed to "Initial Tests."



INITIAL TESTS

The following tests will help verify that you have assembled your Plotter correctly. These tests require a VTVM (vacuum tube voltmeter) or a high-input-impedance VOM (volt ohmmeter). If you do not have one of these meters, try to borrow one, or have a friend who has one make these tests.

Refer to Pictorial 4-1 for the following steps.

- () F1: Push the fuse into the fuseholder insert as shown in the inset drawing on the Pictorial. Then push the fuse and insert into the fuseholder. Use a screwdriver blade to push the insert into the fuseholder while you turn the insert 1/4-turn clockwise. This should lock the fuse and insert into the fuseholder.

PRIMARY WIRING TESTS

A wiring error in the primary wiring circuit (line cord, Power switch, etc.) of your kit could cause you to receive a severe electrical shock. These "Primary Wiring Tests" will help you eliminate any such wiring errors that may exist.

- () Be sure the line cord is not plugged in.
- () Push the POWER switch on the rear panel to OFF (push down on the right side of switch S2, as viewed from the rear of the chassis).

If you do not have access to an ohmmeter, carefully check the line cord, fuseholder, Power switch, and power transformer wiring against that shown in Pictorial 2-2 (Illustration Booklet, Page 8). Make sure there are no fine strands of wire or solder globs touching adjacent lugs or the chassis. Also make sure the connections on Power switch S2 and fuseholder F1 are completely covered with sleeving. Then proceed to "Voltage Tests."

If you have an ohmmeter, perform the following resistance measurements.

- () Set the ohmmeter to the $R \times 10$ range.

NOTE: If you do not obtain the proper results in each of the following steps, check the wiring of the primary wiring circuit as instructed above. Correct any errors so you obtain the correct results before you proceed to the next step.

- () Connect the negative (-) or common lead of the ohmmeter to solder lug CA. Leave this lead connected to the chassis until you are directed to disconnect it.
- () Touch the ohmmeter probe to either flat prong of the line cord plug. The ohmmeter should indicate infinity with Power switch S2 in either position.
- () Touch the ohmmeter probe to the other flat prong of the line cord. The ohmmeter should indicate infinity with Power switch S2 in either position.