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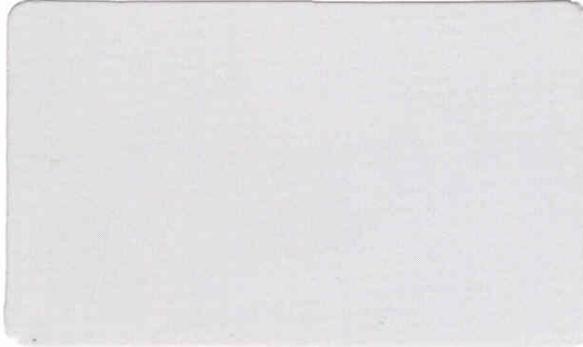
ANALOG TRAINER
Model ET-3600
595-3801-05

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

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

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

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



YOUR HEATHKIT 1 YEAR LIMITED WARRANTY

Consumer Protection Plan for Heathkit Consumer Products

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

Heath's Responsibility

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

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

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

NOT COVERED — The correction of assembly errors, adjustments, calibration, and damage due to misuse, abuse, or negligence are not covered by the warranty. Use of corrosive solder and/or the unauthorized modification of the product or of any furnished component will void this warranty in its 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 FORESEEABLE.

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

ANALOG TRAINER

Model ET-3600

595-3801-05

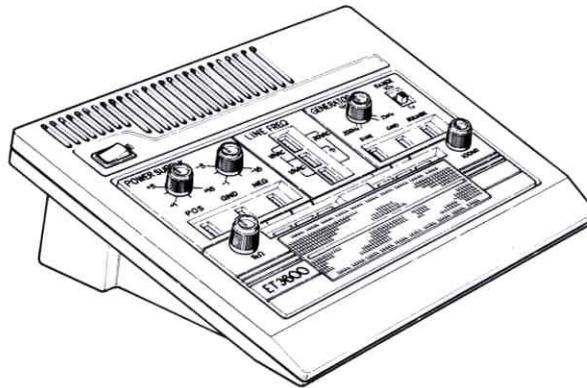


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INTRODUCTION

The Heathkit Model ET-3600 Analog Trainer is a compact, rugged, reliable, and versatile design and learning instrument. Now, you can quickly build and test circuits that you have designed or want to experiment with. Not only is this an excellent learning tool, but it is also a recommended supplement to the individual learning programs of Heathkit Educational Systems.

This Trainer has the following built-in features:

- Variable, regulated positive and negative 15 volt DC power supplies.
- A 200 Hz to 20 kHz frequency generator, with sine wave and square wave outputs.
- Two 60-Hz sine wave signal sources (15 and 30 volts).
- A large removable breadboard designed to hold transistors, ICs, and other standard components.
- A 1000 Ω (1 k Ω) and a 100 k Ω potentiometer for use with experimental circuits.
- A built-in connector to accommodate the Heathkit Model ET-3567 Backpack. This accessory includes programmable positive and negative power supplies and a loudspeaker. In addition, a digital VOM is included to allow voltage, current, and resistance measurements on experimental circuits without the need for additional test equipment. The Backpack is designed to hold the experiment circuit boards used in the Heathkit Educational courses.

Most of the Trainer's components are mounted on two circuit boards. This makes the Trainer easy to assemble. The compact size and light weight allow you to move or place the Trainer almost anywhere.

UNPACKING INSTRUCTIONS

The carton of your Analog Trainer kit contains a "Pack Index Sheet" that shows you the location of Packs #1 and #2. The remaining containers and loose parts make up the "Final Pack."

Each assembly section of the Manual has a Parts List that directs you to open one of the Packs. Each Parts List also includes its own unpacking instructions, which you should read carefully. **DO NOT OPEN MORE THAN ONE PACK AT A TIME.** Packs #1 and

#2 are used to assemble the power supply and main circuit boards, respectively, while the Final Pack contains all of the parts to assemble the cabinet. You will find, however, that one or more of the larger parts, such as the main circuit board, will be included in the Final Pack.

Do not throw away any packing 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" & 1/4"-BLADE
SCREWDRIVERS

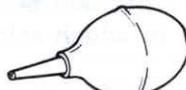


PHILLIPS
SCREWDRIVER

OTHER HELPFUL TOOLS



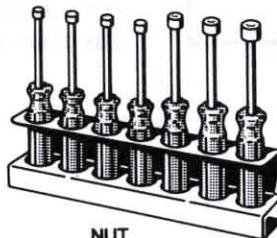
NUT STARTER
(May Be Supplied
With Kit)



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. Most kits use a separate "Illustration Booklet" that contains illustrations (Pictorials, Details, etc.) that are too large for the Assembly Manual. Keep the "Illustration Booklet" with the Assembly Manual. The illustrations in it are arranged in Pictorial number sequence.
4. Position all parts as shown in the Pictorials.
5. Solder 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.

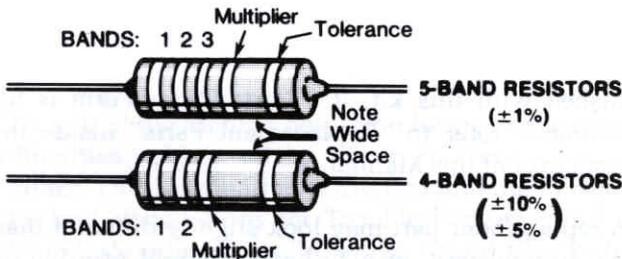
It is easy to make a good solder connection if you follow a few simple rules:

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 re-tinned.

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

RESISTORS

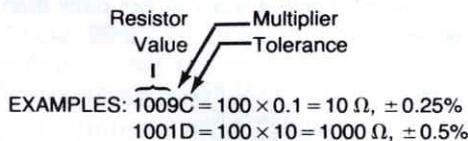
Resistors are identified in Parts Lists and steps by their resistance value in Ω (ohms), $k\Omega$ (kilohms), or $M\Omega$ (megohms). They are usually identified by a color code of four or five color bands, where each color represents a number. See the "Resistor Color Code" chart. These colors are given 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 memorize the color codes.



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

$2R2 = 2.2 \Omega$
 $2K2 = 2.2 k\Omega$, or 2200Ω
 $2M2 = 2.2 M\Omega$

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.



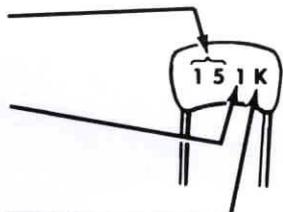
CAPACITORS

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

First and second digits of capacitor's value: 15

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

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



RESISTOR COLOR CODE CHART

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

RESISTOR TOLERANCE CHART

	COLOR OR LETTER	
$\pm 10\%$	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 CHART

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: $2R2 = 2.2 (pF \text{ or } \mu F)$.

POWER SUPPLY 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 "Power Supply 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 fur-

nished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover of this Manual.

A replacement part may look slightly different than the original part, or may have different printing on it. In any case, the performance of the replacement part will meet or exceed the requirements of the original part. For example: A 15-volt capacitor (10 μ F, 15 V) may be replaced with a 25-volt capacitor (10 μ F, 25 V).

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

A1	25-880	2	10 μ F electrolytic	C106, C111
A1	25-885	2	100 μ F electrolytic	C107, C112
A2	25-875	2	1000 μ F electrolytic	C104, C108

DIODES – INTEGRATED CIRCUITS

B1	57-42	4	1N5401 diode	D103, D104 D105, D106
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NOTE: Integrated circuits may be marked for identification in any one of the following four ways:

1. Part number.
2. Type number. (For integrated circuits, this refers only to the numbers and letters in **BOLD** print. Disregard any other numbers or letters on the IC.)

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

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

B2	442-644	1	78L12 IC	U102
B2	442-646	1	79L12 IC	U105
B3	442-708	1	LM317 IC	U103
B3	442-709	1	LM337 IC	U104

CONNECTORS-SOCKET

C1	432-1279	2	Flat connector	
C2	432-943	1	2-pin plug	P102
C3	432-876	1	8-pin plug	P101
C4	432-877	1	10-pin plug	P103

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
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HARDWARE

D1	250-1411	2	3.0 x 6mm screw
D2	252-2	2	3mm nut
D3	254-9	2	3mm lockwasher

NOTE: Heath Company does not stock metric hardware. Therefore, if you order replacement hardware, order complete sets as we will send you standard hardware.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
---------	----------------	------	-------------

MISCELLANEOUS

	230-6124	1	Power supply circuit board (may be marked 85-3191-01)
E1	215-94	2	Heat sink
E2	352-31	1	Thermal compound
	230-6362	1	Caution label*
	597-260	1	Parts Order Form*
		1	Blue and white label*
		1	Assembly Manual (See Page 1 for part number.)
			Solder
	230-6113	4	Preformed bare wire

*These parts may be packed inside the Manual.

TAPED COMPONENTS

The remaining parts are supplied on taped strips. It is not necessary to check them against the following list.

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

The following resistors are rated at 1/4-watt, have a 5% tolerance, and have four color bands (last band gold). The last band (gold) will not be called out.

6-181-12	2	180 Ω (brn-gry-brn)	R102, R104
6-102-12	1	1000 Ω (brn-blk-red)	R101

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

CAPACITORS

F1	21-786	4	.1 μF (104) axial-lead ceramic	C103, C105, C109, C113
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DIODES

	57-65	2	1N4002	D107, D108
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STEP-BY-STEP ASSEMBLY

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

NOTES:

1. In each series of steps, you will install parts in a top-to-bottom, left-to-right sequence. Occasionally, you may be directed to install a part out of sequence.
2. 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.
3. In general, solder instructions are given only at the end of a series of similar steps. You may solder more often if you wish.

- () Cut the "Taped Component Chart" from the last page in the Illustration Booklet. Make sure you read the instructions at the top of the chart before you use it. The components are listed in the order of assembly.

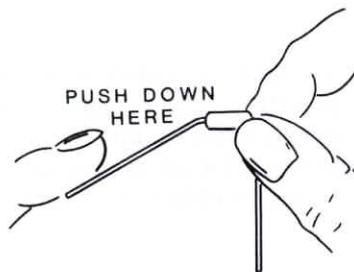
In the following steps, you will be given detailed instructions on how to install and solder the first component on the circuit board. Read and perform each step carefully. Then use the same procedure to install the remaining components on the circuit board.

Note that the circuit board has foil patterns on one side and the other side has outlines of components (parts) shown on it. The "foil" side of the board will be referred to as such, and the side with the outlines will be called the "component" side of the board.

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

- () Cut the first component, a .1 μ F (104) ceramic capacitor, from the Taped Components Chart as outlined in the instructions. Then hold the capacitor by the body as shown and bend the leads straight down with your finger to fit the circuit board hole spacing at C113.

NOTE: This capacitor is followed by a diode on the taped strip.



- () C113: Start the capacitor leads into their circuit board holes at the indicated location. NOTE: Ceramic capacitors are identified by the following outline.

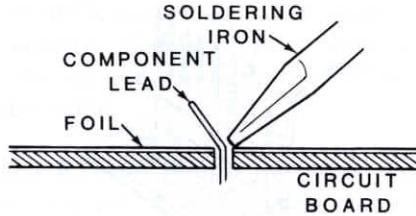


- () Press the capacitor body against the circuit board and bend the leads outward slightly to hold it in place.

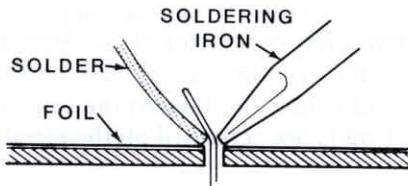


Solder the capacitor leads to the circuit board as follows:

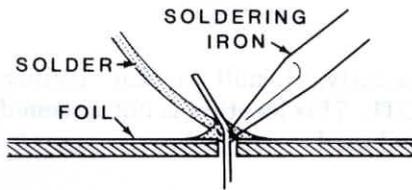
1. Push the soldering iron tip against both the lead and the circuit board foil. Heat **both** for two or three seconds.



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.

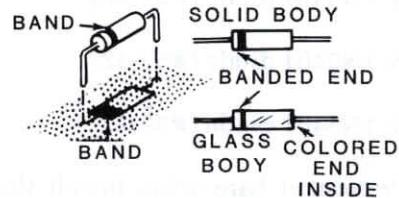
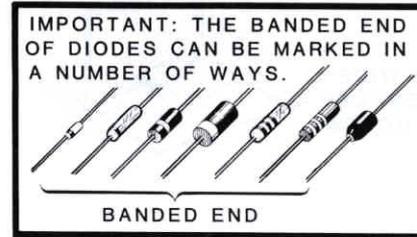


- () Cut off the excess lead lengths close to the connection. **WARNING:** Clip the leads so the ends will not fly toward your eyes.
- () Check each solder connection and compare it to Detail 1-1A. After you have checked the connections, proceed with the assembly. Use the same soldering procedure for each component.

IMPORTANT: Make sure you installed the first component on Page 10 before you proceed.

NOTE: When you install a diode, as in the next step, 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.



- () D108: 1N4002 diode (#57-65).
- () R104: 180 Ω (brn-gry-blk-blk) resistor.

NOTE: No part will be installed at R105.

- () C109: .1 μF (104) ceramic capacitor.
- () R102: 180 Ω (brn-gry-blk-blk) resistor.

NOTE: No part will be installed at R103.

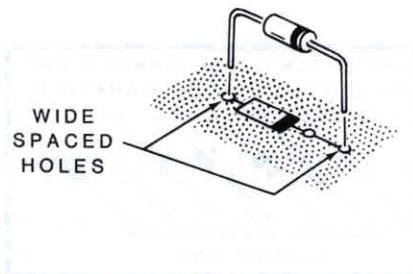
- () C105: .1 μF (104) ceramic capacitor.
- () D107: 1N4002 diode (#57-65).
- () R101: 1000 Ω (brn-blk-red) resistor.
- () C103: .1 μF (104) ceramic capacitor.

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

Refer to Pictorial 1-2 for the following steps.

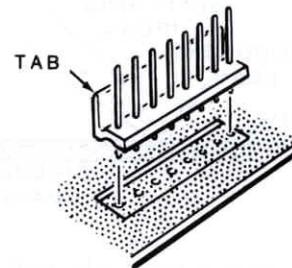
- () J4: Preformed bare wire. Insert the leads of the wire into the circuit board holes. Press the wire flat against the board; then bend the leads out slightly to hold the wire in place.

NOTE: When you install the following four diodes, use the wider-spaced holes.

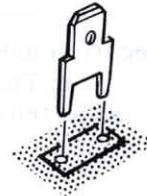


- () D105: 1N5401 diode (#57-42).
- () D103: 1N5401 diode (#57-42).
- () D106: 1N5401 diode (#57-42).
- () D104: 1N5401 diode (#57-42).
- () J1: Preformed bare wire. Install this wire in the same manner as you did J4 earlier.
- () J2: Preformed bare wire. Similarly, install a wire at J2.
- () J3: Preformed bare wire. Similarly, install a wire at J3.
- () Solder the leads to the foil and cut off the excess lead lengths.

- () P101: 8-pin plug. To install a plug, position the tab side of the plug over the double line of the circuit board outline. Then insert the short pins into the holes, push the plug tight against the circuit board, and solder the pins to the foil.



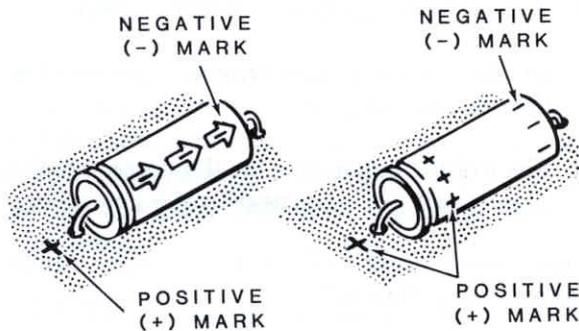
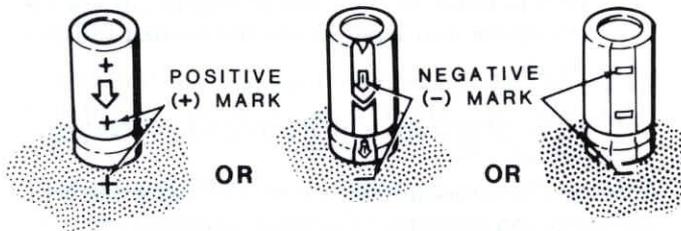
- () P103: 10-pin plug.
- () P102: 2-pin plug.
- () Install a flat connector at A. Push the connector as far into the circuit board holes as possible and solder the lugs to the foil. NOTE: This location is not screened on the circuit board.



- () Similarly, install a flat connector at B. NOTE: This location is not screened on the circuit board.

Refer to Pictorial 1-3 for the following steps.

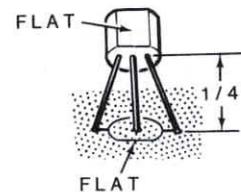
NOTE: When you install an electrolytic capacitor, always identify the markings near the leads. One lead will have a positive (+) mark or a negative (-) mark near it. Be sure to install the positive lead in the positive-marked hole or the negative lead in the negative-marked hole. Be careful; only the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



- () C108: 1000 μF electrolytic capacitor. NOTE: When you install this capacitor, use the circuit board hole near the positive (+) mark that best matches the length of the capacitor.
- () C104: 1000 μF electrolytic capacitor. NOTE: When you install this capacitor, use the circuit board hole near the negative (-) mark that best matches the length of the capacitor.
- () C106: 10 μF electrolytic capacitor.
- () C107: 100 μF electrolytic capacitor.
- () C112: 100 μF electrolytic capacitor.
- () C111: 10 μF electrolytic capacitor.
- () Solder the leads to the foil and cut off the excess lead lengths.

NOTES:

1. Components in the following steps have very similar identification numbers. Be sure you have the correct part before you install it.
2. When you install integrated circuits in the following steps, position them so the flat side is over the flat of the outline on the circuit board, as shown. Then insert the leads into their corresponding circuit board holes and position the bottom of the case 1/4" above the board. Bend each IC's leads out slightly on the foil side of the board to hold it in place. Solder the leads to the foil and cut off the excess lead lengths.

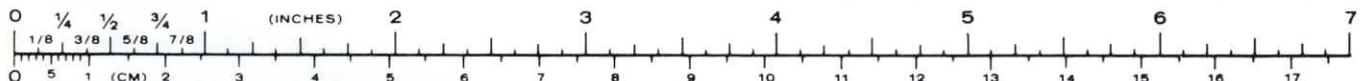


- () U105: **79L12** IC (#442-646).
- () U102: **78L12** IC (#442-644).

WARNING: You will be using thermal heat sink compound in the following steps. Although the compound is not caustic, it may cause temporary discomfort if it gets into your eyes. If this happens, rinse your eyes with warm water. If the compound gets into your clothing, the clothing may require professional cleaning. The compound contains Zinc oxide, ZnO_2 . Always wash your hands after you finish using the compound. Keep this and all chemicals out of the reach of children.

- () U104: Refer to Detail 1-3A and mount an **LM337** IC (#442-709) to a heat sink and install the assembly at U104 as follows:

1. Straighten the leads of the IC to fit the circuit board holes, if necessary.
2. Refer to the inset drawing and open the thermal compound. Then spread a small amount of it on the metal back of the IC.
3. Secure the IC to the heat sink with a 3.0 x 6mm screw, a 3mm lockwasher, and a 3mm nut, as shown. Make sure the wide space between the mounting hole and the edge of the heat sink is pointing up.



4. Insert the IC leads into their respective holes.
 5. Solder the IC leads to the foil and cut off the excess lead lengths.
- () U103: In the same manner, mount an **LM317** IC (#442-708) to a heat sink and install the assembly at U103.

NOTE: No components should be installed at C101, C102, D101, D102, R103, R105, or U101.

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following possible problems:

- () Unsoldered connections.
- () Poor solder connections.
- () Solder bridges between foil patterns.
NOTE: Refer to the "X-Ray Views" if you are uncertain and want to see the correct foil patterns.
- () Protruding leads which could touch together.

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

- () 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 (-) markings.

Set the power supply circuit board aside. Proceed to "Main Circuit Board."

MAIN 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 "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.

A replacement part may look slightly different than the original part, or may have different printing on it. In any case, the performance of the replacement part will meet or exceed the requirements of the original part. For example: A 15-volt capacitor (10 μ F, 15 V) may be replaced with a 25-volt capacitor (10 μ F, 25 V).

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

A1	20-173	1	10 (100) pF mica	C201
A2	27-227	1	.0056 μ F (562) Mylar®	C208
A2	27-172	1	.056 μ F (563) Mylar®	C207
A3	25-862	2	2.2 μ F electrolytic	C206, C209
A3	25-870	1	2 μ F electrolytic	C204

CONTROLS

B1	230-6138	1	1000 Ω	R216
B1	230-6139	2	2000 Ω	R217, R218
B1	230-6140	1	100 k Ω linear	R215
B1	230-6141	1	100 k Ω audio	R213
B2	10-393	1	5 M Ω	R214

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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CONNECTORS — SOCKETS

C1	432-1609	15	Connector block	
C2	230-6465	1	3-pin plug	P202
C3	432-1064	1	10-pin plug	P201
C4	230-6241	1	60-pin plug	P203
C5	434-230	1	8-pin IC socket	
C6	434-299	1	16-pin IC socket	

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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INTEGRATED CIRCUITS — DIODES

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

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

D1	442-39	1	LM301	U201
D1	442-710	1	XR2206	U202
D2	57-65	2	Diode	D201, D202

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

E1	230-6294	1	Slide switch	SW201
E2	3-15-5	2	75 Ω , wire wound	R219, R220
E2	(See note below)	1	180 Ω , wire wound	R223*
	6-222	2	2200 Ω (red-red-red), 1/2-watt, 5%	R221, R222
	230-6113	5	Preformed bare wire	

FROM THE FINAL PACK

	230-6152	1	Main circuit board (may be marked 85-3189)	
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* NOTE: You may receive a 175 Ω wire wound resistor (Heath part number 3-16-5) in place if the 180 Ω resistor for R223.

TAPED COMPONENTS

The remaining parts are supplied on taped strips. It is not necessary to check them against the following list.

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

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

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

All resistors are rated at 1/4-watt.

6-201-12	1	200 Ω (red-blk-brn)	R205
6-102-12	1	1000 Ω (brn-blk-red)	R207
6-512-12	2	5100 Ω (grn-brn-red)	R208, R209
6-8451-12	1	8450 Ω (gry-yel-grn-brn), 1%	R212
6-103-12	1	10 k Ω (brn-blk-org)	R206
6-333-12	2	33 k Ω (org-org-org)	R203, R204
6-273-12	1	27 k Ω (red-viol-org)	R211
6-104-12	1	100 k Ω (brn-blk-yel)	R202
6-334-12	1	330 k Ω (org-org-yel)	R201

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
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AXIAL-LEAD CAPACITORS

	21-786	3	.1 μ F (104) ceramic	C202, C203, C205
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STEP-BY-STEP ASSEMBLY

Refer to Pictorial 2-1 as you read the following notes and steps.

NOTES:

- The circuit board shown in Pictorial 2-1 is divided into three sections. You will be working on each of these sections in a specific series of steps.
 - In each series of steps, you will install parts in a top-to-bottom, left-to-right sequence. Occasionally, you may be directed to install a part out of sequence.
- () Cut the "Taped Component Chart" from the last page in the Illustration Booklet. Note that it is divided into numbered sections which correspond to the numbered sections on the circuit board pictorial. The components are listed in the order of assembly.

Section 1

- () R201: 330 k Ω (org-org-yel) resistor.
- () C203: .1 μ F (104) ceramic capacitor.
- () J201: Preformed bare wire. Insert the leads of the wire into the circuit board holes. Press the wire flat against the board; then bend the leads out slightly to hold the wire in place.
- () J203: Preformed bare wire. Install this wire in the same manner as you did J201 previously.
- () C202: .1 μ F (104) ceramic capacitor.
- () R204: 33 k Ω (org-org-org) resistor.
- () R203: 33 k Ω (org-org-org) resistor.
- () R209: 5100 Ω (grn-brn-red) resistor.
- () R211: 27 k Ω (red-red-org) resistor.

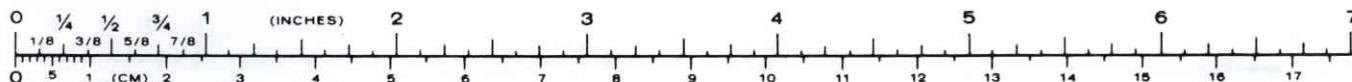
- () R208: 5100 Ω (grn-brn-red) resistor.
- () R202: 100 k Ω (brn-blk-yel) resistor.
- () Solder the leads to the foil and cut off the excess lead lengths.

Section 2

- () J202: Preformed bare wire. Install this wire in the same manner as you did J201 earlier.
- () R205: 200 Ω (red-blk-brn) resistor.
- () C205: .1 μ F (104) ceramic capacitor.
- () R206: 10 k Ω (brn-blk-org) resistor.
- () R207: 1000 Ω (brn-blk-red) resistor.
- () R212: 8450 Ω , 1% (gry-yel-grn-brn) resistor.
- () R222: 2200 Ω , 1/2-watt, 5% (red-red-red) resistor.
- () Solder the leads to the foil and cut off the excess lead lengths.

Section 3

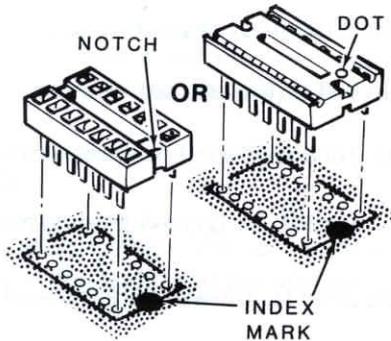
- () J204: Preformed bare wire. Install this wire in the same manner as you did J201 earlier.
- () J205: Preformed bare wire. Install this wire in the same manner as you did J201 earlier.
- () R223: 180 Ω wire wound resistor. NOTE: You may receive a 175 Ω wire wound resistor instead of a 180 Ω resistor. Use either resistor for R223.
- () R219: 75 Ω (wire wound) resistor.



- () R220: 75 Ω (wire wound) resistor.
- () R221: 2200 Ω , 1/2 watt, 5% (red-red-red) resistor.
- () Solder the leads to the foil and cut off the excess lead lengths.

Refer to Pictorial 2-2 for the following steps.

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 may have formed. To remove a solder bridge, hold the circuit board foil-side-down as shown below, 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.

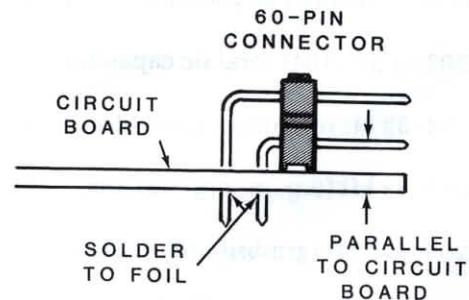
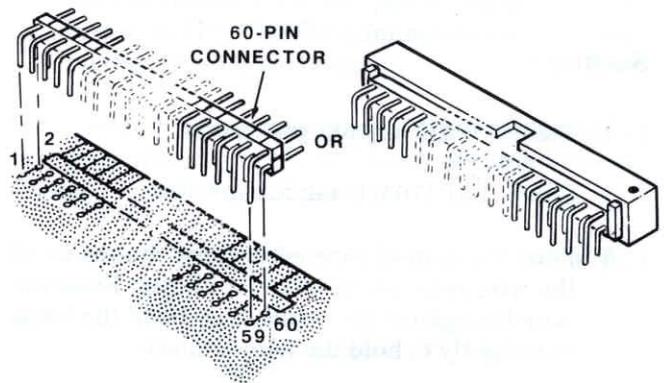
- () Install an 8-pin IC socket at U201.
- () Install a 16-pin IC socket at U202.

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 information in Detail 2-2A before you install the ICs.

- () U201: LM301 IC (#442-39).
- () U202: XR2206 IC (#442-710).

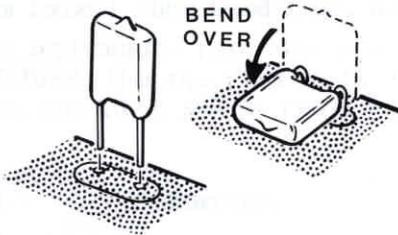
NOTE: To install a plug, position its tab side over the double line of the circuit board outline. Then insert the short pins into the holes, push the plug tight against the circuit board, and solder the pins to the foil.

- () P201: 10-pin plug.
- () P202: 3-pin plug.
- () P203: 60-pin plug. **IMPORTANT:** Be sure the pins are parallel to the circuit board.



NOTE: When you install an electrolytic capacitor, always 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 or the negative lead in the negative-marked hole. Be careful; only the negative lead may have a mark near it.

- () C206: 2.2 μ F electrolytic capacitor.
- () C209: 2.2 μ F electrolytic capacitor.
- () C201: 10 pF (100) mica capacitor.
- () C204: 1 μ F electrolytic capacitor.
- () Solder the leads to the foil and cut off the excess lead lengths.
- () C207: .056 μ F (563) Mylar capacitor. Push this capacitor flat against the circuit board. Then solder the leads to the foil and cut off the excess lead lengths.



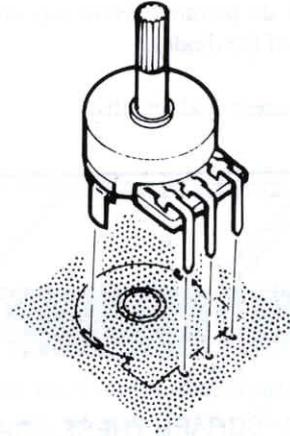
- () C208: .0056 μ F (562) Mylar capacitor. Push this capacitor flat against the circuit board. Then solder the leads to the foil and cut off the excess lead lengths.

Refer to Detail 2-2B and install connector blocks at the following 15 locations. NOTE: The connector blocks may be installed either way.

- () AA, AB, and AC.
- () AD, AE, and AF.
- () AG, AH, and AJ.
- () AK, AL, and AM.
- () AN, AP, and AR.

Refer to Pictorial 2-3 for the following steps.

NOTE: To install a control, as in the next step, insert the control lugs into their respective holes. Then push the control flat against the circuit board and solder the lugs to the foil.

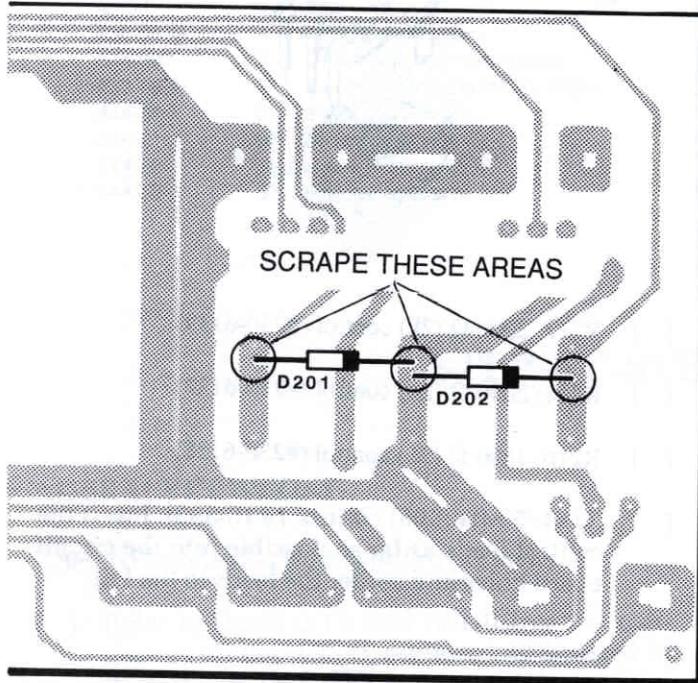


- () R217: 2000 Ω (2k) control (#230-6139).
- () R218: 2000 Ω (2k) control (#230-6139).
- () R216: 1000 Ω (2k) control (#230-6138).
- () R214: 5 M Ω (505) control (#10-393). Insert the control leads as far as possible into the circuit board holes and solder the leads to the foil.



- () R213: Small 100 k Ω , **audio** control (#230-6141).
- () SW201: Slide switch. Insert the switch leads into the circuit board holes; then solder the leads to the foil.
- () R215: Large 100 k Ω , **linear** control (#230-6140).

- () Turn the circuit board over so that the foil side is facing up.
- () Use a sharp knife and carefully scrape away the green "solder-resist" coating from the indicated areas.
- () Solder the leads of D201 and D202 (#57-65) to the circuit board as pictured. Note the direction of the banded ends of the diodes.
- () Cut off any excess lead lengths.



CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following possible problems:

- () Unsoldered connections.
- () Poor solder connections.
- () Solder bridges between foil patterns. NOTE: Refer to the "X-Ray Views" if you are uncertain and want to see the correct foil patterns.
- () Protruding leads which could touch together.

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

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

Set the main circuit board aside. Proceed to "Cabinet Assembly."

CABINET ASSEMBLY

PARTS LIST

Remove the parts from the Final Pack and check each part against the following list. The key numbers correspond to the numbers on the "Cabinet Parts Pictorial." 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.

A replacement part may look slightly different than the original part, or may have different printing on it. In any case, the performance of the replacement part will meet or exceed the requirements of the original part. For example: A 15-volt capacitor (10 μ F, 15 V) may be replaced with a 25-volt capacitor (10 μ F, 25 V).

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

A1	230-6161	1	Power Transformer	T1
A2	230-6162	1	Power switch	SW1
A3	412-634	1	LED (light-emitting-diode)	LED1
	421-42	1	Fuse, 3/8-ampere slow blow	F1
	230-6208	2	162 Ω (brn-blu-red-blk) resistor	

HARDWARE

NOTES:

1. You may have to open more than one packet to locate all of the hardware.
2. Hardware is shown full size in the Parts Pictorial so you can place any screw, nut, etc., you are uncertain about over the illustration.

B1	250-1434	22	3.5 x 10mm self-tapping screw
B2	250-1420	1	3.5 x 10mm flat head screw
B3	250-1325	3	3.0 x 8mm screw
B4	250-1425	2	4.0 x 8mm screw

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
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Hardware (Cont'd.)

B5	252-3	2	3mm nut
B6	252-22	2	4mm nut
B7	254-1	6	3mm lockwasher
B8	259-1	2	4mm lockwasher

CONNECTORS

With Wires

C1	230-6177	1	2-pin plug
C2	230-6178	1	2-pin socket
C3	230-6179	1	3-pin plug
C4	230-6180	1	4-pin plug

Without Wires

C5	230-6181	1	Breadboard
C6	432-1279	5	Flat connectors

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
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PLASTIC AND METAL PARTS

D1	230-6347	1	Cabinet bottom
D2	230-6183	1	Cabinet top
D3	230-6189	1	Cabinet insert
D4	230-6350	1	AC bracket
D5	230-6351	1	AC shield
D6	230-6352	2	Mounting plate

CABLES — LINE CORD — WIRES

89-54	1	Line cord
230-6335	1	LED (2-wire) cable
344-207	2	Green wire with connectors
230-6336	1	10-pin (8-wire) connector cable
344-50	3'	Black solid wire
344-51	3'	Brown solid wire
344-52	3'	Red solid wire
344-53	3'	Orange solid wire

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
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CABLES — LINE CORD — WIRES (Cont'd.)

344-54	3'	Yellow solid wire
344-55	3'	Green solid wire
344-56	3'	Blue solid wire
344-59	1'	White solid wire

MISCELLANEOUS

E1	75-736	1	Strain relief
	230-6176	1	AC circuit board (may be marked 85-2789-1)
E2	261-49	4	Foot
E3	230-6356	1	Fuseholder
E4	490-111	1	IC lifter
	230-6196	5	Knob
	230-6355	1	Insulator
	73-142	1	Foam cushion
	346-20	2	Large sleeving
	346-35	2	Small sleeving

STEP-BY-STEP ASSEMBLY**AC BRACKET WIRING**

Refer to Pictorial 3-1 for the following steps.

- () Refer to Detail 3-1A and install five flat connectors on the AC circuit board as directed in the following three steps.

1. Position the AC circuit board as shown.
2. Insert a flat connector at one of the indicated AA location and solder the pins to the foil.
3. Similarly, install flat connectors at the remaining AA location and at the three indicated BB locations.

NOTE: No other components will be installed on the circuit board.

- () Position the AC bracket as shown in Pictorial 3-1.
- () Carefully peel away the backing paper from the paper insulator. Then press the insulator onto the AC bracket as shown.

- () Carefully peel away the backing paper from the foam cushion. Then press the cushion onto the paper insulator as shown.

- () Refer to Detail 3-1B Part A and mount a fuseholder at F1. Use the hardware supplied with the holder. Position the lugs as shown. Do not overtighten the hardware or the fuseholder may break.

- () Refer to Part B of Detail 3-1B and bend lug 2 of fuseholder F1 out slightly as shown. Be careful that you do not apply pressure to the lug where it emerges from the fuseholder. The fuse will be installed later. NOTE: If the fuseholder cap is not already installed, you may wish to install it now so that it does not become lost. Do not overtighten the cap.

- () Refer to Detail 3-1C and insert the tab on the AC circuit board into the slot in the AC bracket. Then secure the circuit board to the AC bracket with a 3.0 × 8mm screw.

- () Refer to Detail 3-1D and install a 3-pin plug (with wires) at S1. Position the pointed end of the connector to the left, as shown.

- () Similarly, install a 4-pin plug (with wires) at S2. Position the pointed end of the connector to the left, as shown.
- () Install a 2-pin plug (with wires) at S3. Position the pointed end of the connector to the left, as shown.

NOTES:

1. When you are directed to make a mechanically secure connection, as in the next step, form a hook in the bare end of the lead or wire as shown in the inset drawing. Then hook the bare end through the lug and crimp it securely in place.

2. In the following steps, (NS) means not to solder because other wires will be added later. "S-" with a number following it, such as (S-3), means to solder the connection. The number "-3" tells you that there are three wires and/or leads in the connection. This will allow you to check your work as you go.

() Push the connector at the free end of the white wire coming from S1 hole 1 onto the AC circuit board flat connector BB nearest S1.

() Push the connector at the free end of the two white wires coming from S2 holes 1 and 3 onto the AC circuit board flat connector BB nearest S2.

() Slide a piece of large sleeving as far as possible over the free ends of the black wire coming from S1 hole 3 and the black wire without a connector coming from S3. Then connect the free ends of these two wires to fuseholder F1 lug 1 (S-2). Make a mechanically secure connection. After the connection cools, slide the sleeving over the connection and use a heat source to shrink the sleeving.

() Slide a piece of large sleeving as far as possible over the free ends of the black wire coming from S2 hole 2 and the black wire coming from

S2 hole 4. Then connect the free ends of these two wires to fuseholder F1 lug 2 (S-2). Make a mechanically secure connection. After the connection cools, slide the sleeving over the connection and use a heat source to shrink the sleeving. **NOTE:** Bend lug 1 away from the side of the AC bracket, if necessary, to keep bare wires from touching the metal bracket.

() Push the connector at the free end of the black wire with a connector coming from S3 onto the AC circuit board flat connector AA nearest F1.

() Refer to Detail 3-1E and mount the prepared end of the line cord with a strain relief at AC.

() Push the connectors at the end of the line cord leads onto the AC circuit board flat connectors as follows:

Black lead to flat connector AA nearest S1.

White lead to the middle flat connector BB.

() Secure the solder lug at the end of the green line cord lead to the AC bracket at hole A. Use a 3.0 × 8mm screw, three 3mm lockwashers and a 3mm nut.

() Locate a green wire with a push-on connector on one end and a solder lug on the other end. Use this wire in the next step.

() Secure the solder lug on the end of a green wire, and the solder lug on the free end of the green wire coming from S1 hole 2 to the AC bracket at B. Use a 3.0 × 8mm screw, three 3mm lockwashers and a 3mm nut. Position the wires as shown in the Pictorial. The push-on connector will be installed later.

() Carefully check the wiring of the AC bracket to be sure no wires are touching the metal bracket and all wires are soldered to their proper lugs.

Set the AC bracket aside temporarily.



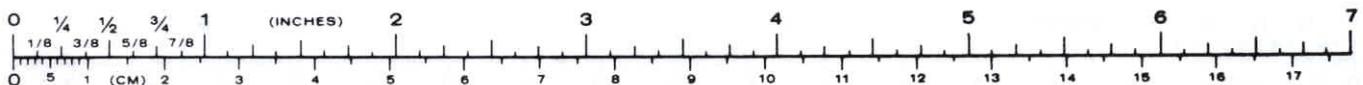
CABINET BOTTOM ASSEMBLY

Refer to Pictorial 3-2 for the following steps.

- () Refer to the inset drawing and position the cabinet bottom upside down.
- () Remove the paper backing from a foot and press it into a recessed area, as shown.
- () Similarly, install a foot at each of the three remaining locations.
- () Carefully peel the paper backing from the blue and white label. Then press the label onto the bottom of the cabinet in the area shown. Do not cover any holes in the cabinet bottom with the label.
- () Carefully peel the paper backing from the caution label. Then press the label onto the bottom of the cabinet in the area shown.
- () Reposition the cabinet bottom as shown in the Pictorial.
- () T1: Refer to Detail 3-2A and scrape any varnish from the indicated transformer mounting flange.
- () Locate a green wire with a solder lug on one end and a push-on connector on the other end. Use this wire in the next step.
- () Again refer to Detail 3-2A and mount the transformer to the cabinet bottom at BB and BC with two 4.0 × 8mm screws, two 4mm lock-washers, and two 4mm nuts. Install the solder lug at one end of a green wire at BC and position the transformer as shown in the Pictorial.
- () Feed the free end of the line cord coming from the AC bracket through cutout BA from the inside of the cabinet bottom. Then position the AC bracket as shown and secure it to the cabinet bottom with a 3.5 × 10mm self-tapping screw.
- () Position the AC shield over the line cord and connector S1 as shown. Then mount the shield to the cabinet and AC bracket with a 3.5 × 10mm flat head screw.
- () Position the power supply circuit board over the cabinet bottom as shown. Then slide the rear edge of the circuit board under the two rear mounting tabs as far as possible, and press the front edge of the board down onto the front tabs until it snaps into place.
- () Push the push-on connector at the end of the green wire coming from the AC bracket onto flat connector A on the power supply circuit board. NOTE: The flat connector is not labeled on the circuit board screen.
- () Push the push-on connector at the end of the green wire coming from solder lug BC onto flat connector B on the power supply circuit board. NOTE: The flat connector is not labeled on the circuit board screen.

If you intend to operate your Trainer on 220/240 VAC line voltage, proceed to "Alternate Line Voltage Wiring."

If you intend to operate your Trainer on 120 VAC, proceed to "Cabinet Top Assembly."



ALTERNATE LINE VOLTAGE WIRING

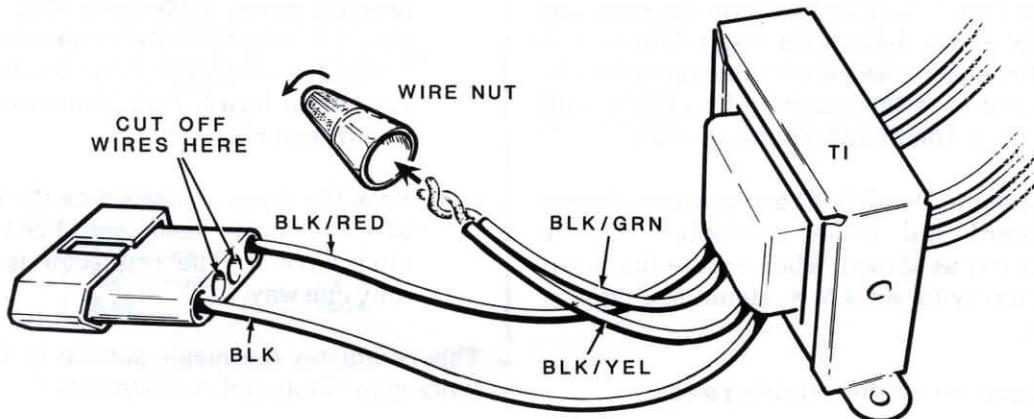
Your Analog Trainer is wired for 120 VAC line voltage, the most often used voltage in the U.S.A. However, in other countries, 240 VAC is most common. **COMPLETE THE FOLLOWING TWO STEPS ONLY IF YOU WILL OPERATE YOUR ET-3600 ANALOG TRAINER ON 220/240 VAC.**

IMPORTANT: The plug on the line cord furnished with your ET-3600 Analog Trainer does not meet the U.S. National Electrical Code requirements for use on line voltages above 120 VAC. Therefore, you must cut the plug from the line cord and install an appropriate plug that matches your 220/240 VAC outlet **and** meets electrical code requirements. In addition, you must perform the following two steps:

- () 1. Cut the yellow and green wires from pins 2 and 3, respectively, of the 4-pin transformer connector. Then remove 3/8" of insulation from the end of each wire.
- () 2. Twist the bare ends of the yellow and green transformer leads together. Then twist a wire nut (not supplied) clockwise over the wire ends as shown below.

NOTE: Wire nuts may be obtained from a local hardware or electrical supply store.

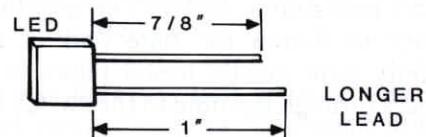
Your ET-3600 Analog Trainer is now wired for use on 220 VAC **ONLY**.



CABINET TOP ASSEMBLY

Refer to Pictorial 3-3 for the following steps.

- () Place a soft cloth on your work surface to prevent scratching the cabinet top.
- () Position the cabinet top as shown in the Pictorial.
- () SW1: Refer to Detail 3-3A and install the power switch at SW1. Position the switch lugs toward the top as shown and push the switch into the cutout until it snaps into place.
- () Cut the shorter lead of an LED to 7/8" and the longer lead to 1".

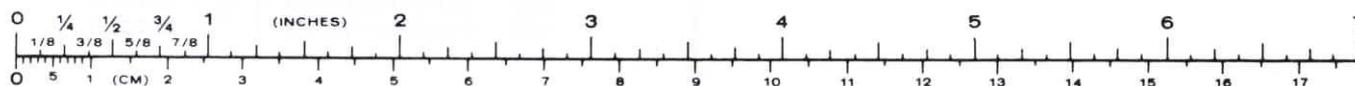


- () LED1: Refer to Detail 3-3A and insert the **longer** lead of an LED into the small hole nearest the top edge, and the shorter lead into the remaining hole, at the bottom of the cabinet top slot at LED1. Then push the LED into the slot as far as possible. The LED should be flush with the top surface.

- () Turn the cabinet top upside down on your work surface. If necessary, use a piece of tape (not furnished) to hold the LED in place when turning the top over.
- () Refer to inset drawing #1 and position the **smaller** connector at one end of the LED (2-wire) cable over the leads of LED1 so that the red wire is over the longer LED lead. Then push the connector onto the LED leads and bend each lead over the connector to hold the LED and connector in place.
- () Slide a piece of small sleeving over the free end of the black stranded wire of the 2-pin socket. Then connect the wire to SW1 lug 1 (S-1). Make a mechanically secure connection. After the connection cools, slide the sleeving over the connection and shrink the sleeving with a heat source. NOTE: You may find it necessary to flatten the bare end of the wire slightly with needle nosed pliers to allow it to pass through the hole in the switch lug.
- () Similarly, slide a piece of small sleeving over the free end of the white stranded wire of the 2-pin socket. Then connect the wire to SW1 lug 2 (S-1). Make a mechanically secure connection. After the connection cools, slide the sleeving over the connection and shrink the sleeving with a heat source.
- () Refer to the Pictorial and cut off the mounting tabs on a 2-pin socket shell if this has not already been done.
- () Refer to Detail 3-3B and position the main circuit board over the cabinet insert. Line up the holes for each control shaft; then press the circuit board onto the insert and secure it with seven 3.5 × 10mm self-tapping screws.
- () Again refer to Detail 3-3B and position the circuit board and insert assembly over the cabinet top as shown. Then secure the insert to the top with six 3.5 × 10mm self-tapping screws.
- () Position the cabinet top and cabinet bottom as shown in the Pictorial.
- () Push the 2-pin connector on the wires coming from SW1 onto connector S3 on the AC bracket.
- () Push the 4-pin connector on the end of one group of transformer wires onto connector S2 on the AC bracket.
- () Remove the fuseholder cap and install a 3/8-ampere fuse for 120 VAC, OR, a 3/16-ampere fuse (not furnished) for 220 VAC, into fuseholder F1. Then reinstall the fuseholder cap. Do not overtighten the cap.
- () Refer to the inset drawing and turn the shafts of the five controls on the main circuit board fully counterclockwise.
- () Refer to the inset drawing and set POWER switch SW1 to its off position (press down on the side away from LED1).
- () Push the 8-pin connector on the end of the red and yellow transformer wires onto P101 on the power supply circuit board. The connector is keyed to fit only one way.
- () Push the 2-pin connector on the free end of the LED cable onto P102 on the power supply circuit board. The connector is keyed to fit only one way.
- () Push the 10-pin connector on one end of the (8-wire) power cable onto P202 on the main circuit board. Push the connector at the other end of the cable onto P103 on the power supply circuit board. Each connector is keyed to fit only one way.
- () Push the 3-pin connector on the blue and yellow transformer leads onto P201 on the main circuit board. The connector is keyed to fit only one way.

Refer to Pictorial 3-4 for the following steps.

This completes the major portion of the assembly. Proceed to "Tests and Adjustments."



TESTS AND ADJUSTMENTS

RESISTANCE TESTS

You will need a high-input-impedance (1 MΩ or greater) VOM (volt-ohm-milliammeter), DVM (digital voltmeter), or VTVM (vacuum tube voltmeter) to make the following resistance and voltage tests. If a meter is not available, recheck the connections to P101, P102, and P103 on the power supply circuit board, and P201 and P202 on the main circuit board. Then proceed to "Power Test."

The following tests will help you find a serious problem in your Trainer before you apply power to it. The resistance tests will identify a short circuit that could damage components in your Trainer. Watch for readings that are lower than those indicated. Generally, higher resistance readings are better.

NOTE: The following tests assume that a VOM or VTVM will be used. If you use a DMM (digital multimeter), set the meter for an appropriate maximum value. Most DMMs will not display any indication on some of the resistance checks. This is because the circuit resistance is higher than the range that your meter is set to. To check your meter, touch the two leads together; the meter should indicate zero.

If you do not obtain the proper results from any of the following resistance tests, reverse the ohmmeter leads and remeasure the test point. If you still do not obtain the proper reading, refer to the "In Case of Difficulty" section in this Manual.

NOTE: Do not connect the Trainer to an AC outlet until you are instructed to do so in a step.

Refer to Pictorial 4-1 for the following steps.

- () Set the ohmmeter to the R × 100 range.
- () Connect either ohmmeter lead to the round (ground) pin of the line cord plug.

- () Touch the free meter lead to either flat pin of the line cord plug. The meter should indicate infinity (an open circuit).
- () Touch the free ohmmeter lead to the other flat pin. The meter should indicate infinity.
- () Set the ohmmeter to the R × 1 range.
- () Connect the negative (–) ohmmeter lead to one flat pin and touch the other lead to the remaining flat pin. The ohmmeter should indicate infinity with the POWER switch off, and about 10 Ω to 30 Ω with the switch on. Reset the POWER switch to off.
- () Set the ohmmeter to the R × 1000 Ω (1kΩ) range.
- () Connect the negative (–) lead of the ohmmeter to flat connector A on the power supply circuit board.
- () Disconnect the connectors at P101, P102, and P103 from the power supply circuit board.
- () Touch the other ohmmeter lead to each test point in the following chart. The meter should read the resistance indicated. NOTE: In the following chart, P101-6 means to touch P101, pin 6, with the free ohmmeter lead. The > symbol means 'greater than'.

	Test Point	Resistance
()	P101-6	0 Ω
()	P101, pins 7 and 8	> 15 kΩ
()	P102-1	> 3 kΩ
()	P102-1	0 Ω
()	P103-1	> 20 kΩ
()	P103, pins 3 thru 6	> 20 kΩ
()	P103-9	> 4 kΩ
()	P103-10	> 5 kΩ

- () Reconnect the connectors at P101, P102, and P103.

- () Set the ohmmeter to the $R \times 10k$ range.
- () Connect one ohmmeter lead to TP1 and the other lead to TP2 on the main circuit board.
- () Adjust control R214 (through the small hole) for a reading between $77\text{ k}\Omega$ and $90\text{ k}\Omega$. Set the control as close to $90\text{ k}\Omega$ as possible. This will calibrate the frequency generator circuit to within 12% of its ranges. If the ohmmeter does not reach $77\text{ k}\Omega$, be sure the controls on the main circuit board are all set to their full counterclockwise position. Then reverse the ohmmeter leads and readjust the control.

NOTE: If a frequency counter or oscilloscope is available, you can set the frequency of the generator. See "Frequency Generator Calibration."

- () Disconnect the ohmmeter leads.

POWER TEST

WARNING: AC line voltage will be present on the lugs of POWER switch SW1 when the line cord is connected to an AC outlet. Be especially careful to avoid this area when you are making voltage tests in the following steps.

- () Connect the line cord to an AC outlet.
- () Set the POWER switch to on. LED1 should light.

If a voltmeter is available, proceed to "Voltage Tests." Otherwise, turn the POWER switch off, disconnect the line cord, and proceed to "Final Assembly."

VOLTAGE TESTS

If you do not obtain the proper results or voltages during the following tests, refer to the "In Case Of Difficulty" section of this Manual.

NOTE: All voltages are $\pm 10\%$.

- () Disconnect the power cable from P103 on the power supply circuit board.
- () Connect the common voltmeter lead to flat connector A on the power supply circuit board.
- () Set the voltmeter to measure +30 VDC and touch the free lead to each of the following points:
 - () U103 heat sink. Measure +25 VDC.
 - () P103-10. Measure +12 VDC.
- () Set the voltmeter to measure -30 VDC and touch the free lead to each of the following points:
 - () U104 heat sink. Measure -25 VDC.
 - () P103-9. Measure -12 VDC.
- () Set the POWER switch to off and disconnect the line cord from the AC outlet.
- () Disconnect the voltmeter leads.
- () Reconnect the power cable to P103 on the power supply circuit board.

If a frequency counter or oscilloscope is available, proceed to "Frequency Generator Calibration." Otherwise, proceed to "Final Assembly."

FREQUENCY GENERATOR CALIBRATION

- () Connect the input lead of an oscilloscope to the "SQUARE" connector block on the main circuit board, and the ground or shield lead to a ground connector block. Connect the input lead of a frequency counter to the "SINE" connector block, and the ground or shield lead to a ground connector block.
- () If you are using an oscilloscope, set its time base to 1 ms/division and its input range to 2 V/division.

- () Turn the GENERATOR control (R213) shaft fully counterclockwise.
- () Be sure the RANGE switch (SW201) is in the "1x" position.
- () Connect the line cord to an AC outlet and turn the POWER switch on. LED1 should light and the counter should show a reading of about 200 Hz, or the oscilloscope should display a square wave.
- () Adjust R214 (through the small hole in the main circuit board) until the frequency counter reads 200 Hz, or until one complete waveform on the oscilloscope display occupies exactly 5 divisions (5 milliseconds). NOTE: The signal level from the SQUARE connector block may cause some frequency counters to multiply the frequency reading. Therefore, be sure the frequency counter is connected to the "SINE" block.
- () Set the RANGE switch to the "10K" position. The oscilloscope display should change to show 10 complete cycles in five divisions, and the frequency counter should read 2 kHz (2000 Hz).
- () Set the POWER switch to off and disconnect the line cord from the AC outlet.
- () Disconnect the frequency counter or oscilloscope.

Proceed to "Final Assembly."

FINAL ASSEMBLY

Refer to Pictorial 5-1 for the following steps.

- () Insert a mounting plate into the cabinet slot at CA.
- () Similarly, insert a mounting plate into the slot at CB.
- () Position all of the wires behind the power supply circuit board heat sinks and away from the power transformer. Then place the cabinet top onto the cabinet bottom.
- () Refer to inset drawing #1 and turn the Trainer over. Then secure the top to the bottom with eight 3.5 × 10mm self-tapping screws. Do not overtighten the screws.
- () Reposition the Trainer upright on your work area.
- () Refer to inset drawing #2 and be sure the shafts of each control are fully counterclockwise. Then align the pointer on a knob with the indicated mark on the cabinet insert at R217 and press the knob onto the shaft.
- () Similarly install knobs on the shafts of R218, R216, R213, and R215.
- () Press the breadboard into the large recess in the cabinet insert.

OPERATIONAL TESTS

The following steps will test the operation of the +15 and -15 volt variable power supplies and the frequency generator.

Refer to Pictorial 5-2 for the following steps.

- () Connect the line cord to an AC outlet.
- () Prepare two 2" lengths of small white (solid) wire.
- () Insert one end of a 2" solid white wire into one of the connector blocks marked GND. Connect the common lead of your voltmeter to this lead.
- () Insert one end of another 2" solid white wire into the connector block marked "POS."
- () Set the voltmeter to read +30 VDC.

- () Press the POWER switch to on. LED1 should light.
 - () Touch the free voltmeter lead to the wire inserted in the connector block marked "POS." The voltmeter should indicate +1.2 volts with R217 fully counterclockwise, and at least +15 volts with R217 fully clockwise.
 - () Set the voltmeter to read - 30 VDC.
 - () Move the wire to the connector block marked "NEG."
 - () Touch the free voltmeter lead to the wire inserted in the connector block marked "NEG." The voltmeter should indicate - 1.2 volts with R218 fully counterclockwise, and at least - 15 volts with R218 fully clockwise.
 - () Move the wire to the "SINE" connector block.
 - () Touch the free voltmeter lead to the wire. The voltmeter should indicate >4 VAC.
 - () Move the wire to the "SQUARE" connector block.
 - () Touch the free voltmeter lead to the wire. The voltmeter should indicate >4 VAC.
 - () Move the wire to either connector block marked "15 VAC."
 - () Touch the free voltmeter lead to the wire. The voltmeter should indicate 15 volts.
 - () Move the wire to the other connector block marked "15 VAC."
 - () Touch the free voltmeter lead to the wire. The voltmeter should indicate 15 volts.
 - () Disconnect the voltmeter leads.
 - () Set the POWER switch to off and disconnect the line cord from the AC outlet.
- NOTE: In the preceding tests, if either 15-volt power supply does not reach a maximum of 15 volts, replace the following resistor(s) on the power supply circuit board with a 162 Ω (brn-blu-red-blk), 1% resistor (supplied) and remeasure the voltages(s).
- For + 15-volt supply, replace R102.
For - 15-volt supply, replace R104.
- () Set the voltmeter to read 15 VAC.

This completes the assembly of your ET-3600 Analog Trainer. You can use the remaining solid wire for your experiments. Proceed to "Operation and Applications."

OPERATION AND APPLICATIONS

Refer to Pictorial 6-1 for a brief description of each control function.

CONNECTOR BLOCKS AND BREADBOARD

The connector blocks and the breadboard are designed to accept up to #20 (.032") solid wire and most common-sized component leads. The four connectors in each small connector block are internally connected together. Also, each vertical row of five connectors in the breadboard are connected together as shown in Pictorial 6-1. Thus, you can build simple or complex circuits without making solder connections. All of the connectors in the two outer horizontal rows of the breadboard are internally connected together. Thus, the outer rows can be used for a common (ground) bus and a power bus.

The Trainer not only supplies positive (+) and negative (-) DC voltages, but also 15 and 30 volts AC, and both sine and square wave signals from 200 Hz to 20 kHz. You can use the 1 k Ω and 100 k Ω controls whenever you need variable resistors or voltage dividers.

Experiments #1 and #2 (Illustration Booklet, Pages 19 and 20) are two examples of typical experiments. The first uses transistors, and the second uses an integrated circuit (these parts are not supplied). The breadboard is designed to accommodate all types of electronic components with leads of .032" diameter or less, including integrated circuits. The IC lifter supplied in your kit makes it easier to remove ICs from the breadboard. The shorter (pointed) end of the IC lifter fits down into the center channel of the breadboard, under the IC. It is then used as a lever to gently and easily lift an IC out when your experiment is completed. For larger ICs, use the IC lifter under each end of the IC to free all of the IC pins.

IN CASE OF DIFFICULTY

This part of the Manual helps you locate and correct difficulties which might occur in your Analog Trainer. This information is divided into the "Visual Checks," "Precautions for Troubleshooting," and a "Troubleshooting Chart." Use the Visual Checks to locate any difficulties that occur right after you assemble the unit.

The "Troubleshooting Chart" calls out specific problems that may occur and lists one or more conditions or components that could cause each problem. "Circuit Board X-Ray Views" are also provided in the Illustration Booklet on Pages 21-22 to help you lo-

cate the circuit components, and compare foil patterns in case you suspect that a solder bridge exists between the foils.

NOTE: Be sure you read the "Precaution for Troubleshooting" before you use a voltmeter or do any power-on testing on this Analog Trainer.

In an extreme case where you are unable to resolve a difficulty, you may call or write our technical consultants. Our phone lines are especially busy at the beginning of the week and in the afternoons.

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 the "Soldering" instructions for the first part on Page 6. Reheat any doubtful connections.
2. Check the circuit board to be sure there are no solder bridges between adjacent connections. Check the "X-Ray Views" for any questions you may have concerning the foil patterns.
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. Be sure the correct diode is installed at each diode location, and that the banded end is positioned correctly.
5. 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.
6. Check all component leads connected to the circuit board. Make sure that none of the leads make contact with other connections or components.

PRECAUTIONS FOR TROUBLESHOOTING

1. Be cautious when you test solid-state circuits. Although semiconductor devices have almost unlimited life when used properly, they are much more vulnerable to damage from excessive voltage or current than other circuit components.
2. Be sure you do not short any terminals to ground when you make voltage measurements. If the probe should slip, for example, and short out a voltage source, you could damage one or more components.
3. Do not remove components while the unit is plugged in.

WARNING: The full AC line voltage is present at the POWER switch lugs and the AC bracket wiring, and is potentially lethal. Be careful to avoid personal shock when you work on this unit with the line cord connected to an AC outlet and power applied.

TROUBLESHOOTING CHART

The following Troubleshooting Chart lists specific difficulties that could occur in your Analog Trainer. Several possible causes may be listed for each difficulty. Refer to the "Circuit Board X-Ray Views" and the "Schematic Diagram(s)" to locate and identify the parts listed in this chart.

If a particular part is mentioned (R101 for example) as a possible cause, check that part and other components connected to it (compare them to the assembly instructions) 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

PROBLEM	POSSIBLE CAUSE
Line cord plug resistances are low or high.	<ol style="list-style-type: none"> 1. Wiring of F1 or S1 on the AC bracket. 2. F1 open or missing. 3. T1 open.
P101 pin 7 or pin 8 measures less than 15 k Ω .	<ol style="list-style-type: none"> 1. P101 still connected. 2. D103-D106 installed wrong. 3. U102-U105 installed wrong.
P102-1 measures less than 3 k Ω .	<ol style="list-style-type: none"> 1. P102 still connected. 2. U102 installed wrong.
P103-1 measures less than 20 k Ω .	<ol style="list-style-type: none"> 1. P101 still connected. 2. D105 or D106 installed wrong.
P103 pin 3 or pin 4 measures less than 20 k Ω .	<ol style="list-style-type: none"> 1. D107 installed wrong. 2. R102 wrong value. 3. U103 installed wrong or bad.
P103 pin 5 or pin 6 measures less than 20 k Ω .	<ol style="list-style-type: none"> 1. D108 installed wrong. 2. R104 wrong value. 3. U104 installed wrong or bad.
P103-9 measures less than 4 k Ω .	<ol style="list-style-type: none"> 1. U105 installed wrong or bad.
P103-10 measures less than 5 k Ω .	<ol style="list-style-type: none"> 1. U102 installed wrong or bad.
R214 cannot be adjusted to between 77 k Ω and 90 k Ω .	<ol style="list-style-type: none"> 1. Ohmmeter leads should be reversed.

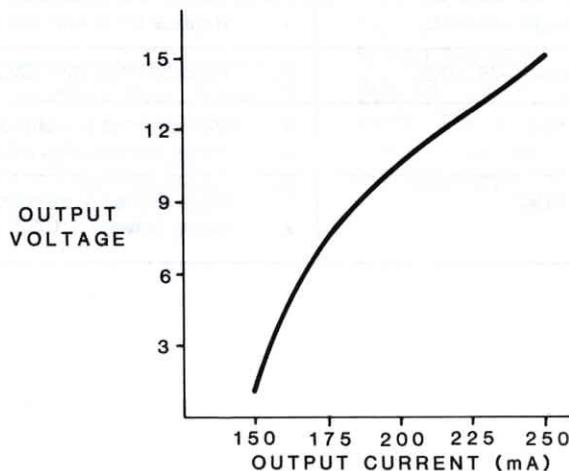
VOLTAGE CHART

PROBLEM	POSSIBLE CAUSE
LED1 does not light.	<ol style="list-style-type: none"> 1. LED1 installed wrong or bad. 2. 2-pin connector at LED1 installed wrong. 3. Check for +12 VDC at P103-10. 4. R101 installed wrong. Check soldering.
No +25 VDC at U103 heat sink.	<ol style="list-style-type: none"> 1. P101 installed wrong. 2. D104 or D106 open or installed wrong. 3. C104 installed wrong. 4. T1 bad.
No +12 VDC at P103-10.	<ol style="list-style-type: none"> 1. U102 installed wrong or interchanged with U105.
No -25 VDC at U104 heat sink.	<ol style="list-style-type: none"> 1. D103 or D105. 2. C108 installed wrong. 3. T1 bad.
No -12 VDC at P103-9.	<ol style="list-style-type: none"> 1. U105 installed wrong or interchanged with U102.
Voltage at "POS" connector block measures +25 VDC and does not vary with R217.	<ol style="list-style-type: none"> 1. U103 installed wrong or interchanged with U104. 2. P202 installed wrong. 3. R217 wrong value or defective.
Voltage at "NEG" connector block measures -25 VDC and does not vary with R218.	<ol style="list-style-type: none"> 1. U104 installed wrong or interchanged with U103. 2. P202 installed wrong. 3. R218 wrong value or defective.
Voltage at "POS" connector block will not reach +15 VDC.	<ol style="list-style-type: none"> 1. Replace R102 with 162 Ω resistor.
Voltage at "NEG" connector block will not reach -15 VDC.	<ol style="list-style-type: none"> 1. Replace R104 with 162 Ω resistor.
Voltage at "POS" connector block reads 0 VDC.	<ol style="list-style-type: none"> 1. D201 shorted or installed wrong. 2. Wiring between P103-3 and P202-3.
Voltage at "NEG" connector block reads 0 VDC.	<ol style="list-style-type: none"> 1. D202 shorted or installed wrong. 2. Wiring between P103-5 and P202-5.

SPECIFICATIONS

POWER SUPPLIES

Output Voltages	+ 1.2 to + 15 volts, variable.
(All regulated)	- 1.2 to - 15 volts, variable.
	(Current derated from 250 mA at 15 volts to 150 mA at 1.2 volts; see graph).
Load Regulation	Better than 2% (from 5 to 15 volts).
Line Regulation	1%.



FREQUENCY GENERATOR

Range Selector Switch	LOW: 200-2000 Hz, continuously variable.
	HIGH: 2000-20 kHz, continuously variable.
Frequency Calibration	12% of maximum range.
Sine Wave Output	5 volts rms at less than 4% distortion.
Square Wave Output	15 volts peak-peak (+ 15 volts maximum; rise time less than 1μs; nominal duty cycle of 50%).

CIRCUIT DESCRIPTION

Refer to the Schematic Diagram (Illustration Booklet, Pages 23 and 24) while you read the following Circuit Description. The component numbers are arranged in the following groups to help you locate specific parts on the Schematic and circuit boards.

- 1 – 99 Parts mounted on the cabinet.
- 101 – 199 Parts mounted on the power supply circuit board.
- 201 – 299 Parts mounted on the main circuit board.

POWER SUPPLIES

AC line voltage is connected through POWER switch SW1 and fuse F1 to the primary windings of T1. Voltage from one secondary is then fed to the power supply circuit board and supplies the \pm variable and ± 12 VDC sources. Voltage from another secondary is connected to P201 on the main circuit board to provide 15 or 30 VAC. Switched AC is also connected to S1 to provide power for the optional ET-3567 Backpack Accessory.

The operation of the positive and negative voltage circuits on the power supply circuit board is identical, except for the polarity of the outputs. Therefore, only the positive voltage sources will be discussed in detail.

Voltage from one center-tapped secondary of T1 (red and red/yellow leads) is rectified by D104 and D106, and filtered by C104 and C105. The resulting positive DC voltage is coupled to the input terminals of voltage regulator U102 to become the +12 volt source. R101 reduces the voltage to power the power-on indicator, LED1.

The voltage from D104 and D106 is also coupled to variable voltage regulator U103 to supply the variable positive voltage power source. Resistor R102 and control R217 determine the output voltage of the regulator. R217 varies the voltage from +1.2 to +15 volts. D107 limits the minimum voltage, and C107 filters the output of the regulator. C106 filters the ADJust input to U103 to prevent oscillation.

The negative voltage supplies operate in the same manner. Voltage from D103 and D105 is applied to the inputs of U104 and U105 to supply -12 volts and the variable negative voltage power source. Control R218 varies the negative source from -1.2 to -15 volts. The +12 and -12 volt sources are only used for U201 and U202 on the main circuit board. The variable voltage sources are available for use in experimental circuits.

FREQUENCY GENERATOR

Frequency generator U202 creates the sine and square wave output signals. An internal VCO (voltage-controlled oscillator), a multiplier and shaper, and a buffer amplifier circuit allow U202 to provide both signal waveforms simultaneously. R205 shapes the sine wave output, and R208, R209, and R211 set the sine wave output amplitude. R206 and R207 set the output level for the square wave signal. The output frequency is determined by capacitors C207 and C208, resistor R212, and controls R213 and

R214. C204 blocks any DC voltage and couples the sine wave output to amplifier U201, and C209 provides filtering for internal voltage regulators.

U201 amplifies the sine wave signal from U202. R202 sets the input level to U201. R203 and R204 set the output voltage reference of U201 to zero, while R201 sets the gain to approximately 6. C201 limits the bandwidth of the amplifier, and C202 and C203 filter the -12 volt and +12 volt power lines, respectively.

SEMICONDUCTOR IDENTIFICATION

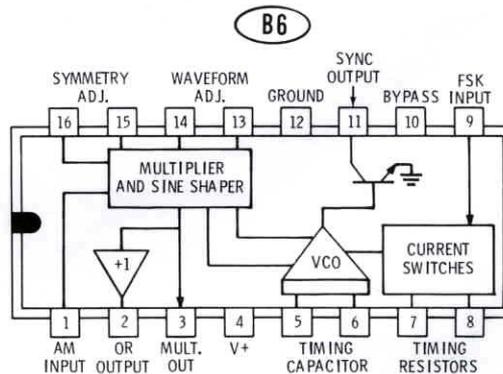
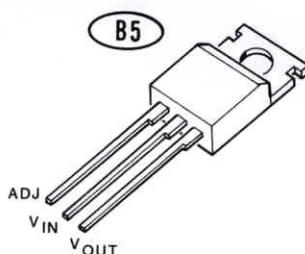
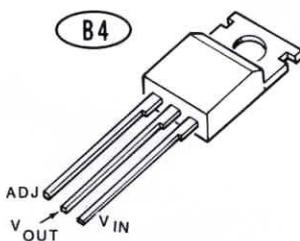
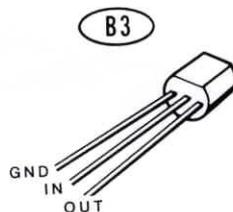
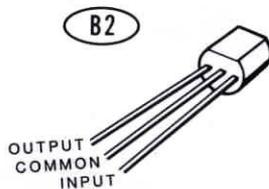
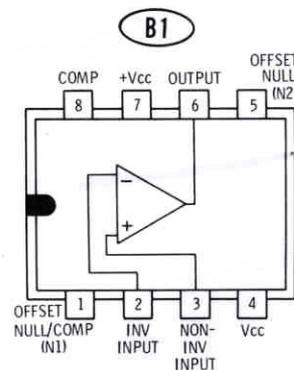
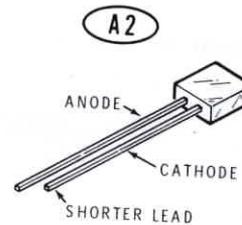
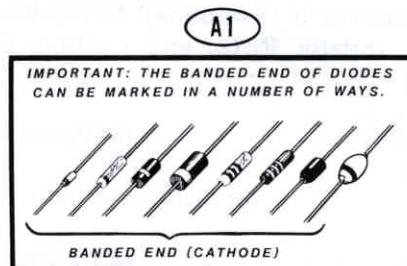
<u>COMPONENT NUMBER</u>	<u>HEATH PART NUMBER</u>	<u>MAY BE REPLACED WITH</u>	<u>KEY NUMBER</u>
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DIODES-LED

D103-D106	57-42	1N5401 or 3A1	A1
D107, D108 D201, D202	57-65	1N4002	A1
LED1	412-634	HLMP-0501	A2

INTEGRATED CIRCUITS

U201	442-39	LM301	B1
U102	442-644	78L12	B2
U105	442-646	79L12	B3
U103	442-708	LM317	B4
U104	442-709	LM337	B5
U202	442-710	XR2206	B6



CUSTOMER SERVICE

REPLACEMENT PARTS

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

ORDERING FROM THE FACTORY

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

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

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

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

OBTAINING REPLACEMENTS FROM HEATH/ZENITH COMPUTER AND ELECTRONICS CENTERS

For your convenience, "over the counter" replacement parts are available from the Heath/Zenith Computer and Electronics centers listed in your catalog. Be sure to bring in the original part and purchase invoice when you request a warranty replacement from a Heath/Zenith Computer and Electronics center.

TECHNICAL CONSULTATION

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

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

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

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

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

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

Heath/Zenith Computer and Electronics center facilities are also available for telephone or "walk-in" personal assistance.

REPAIR SERVICE

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

If it is convenient, personally deliver your kit to a Heath/Zenith Computers and Electronics center. For warranty parts replacement, supply a copy of the invoice or sales slip.

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

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

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

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

Heath Company
Service Department
Benton Harbor, Michigan 49022

Heath Company
Benton Harbor, Michigan

