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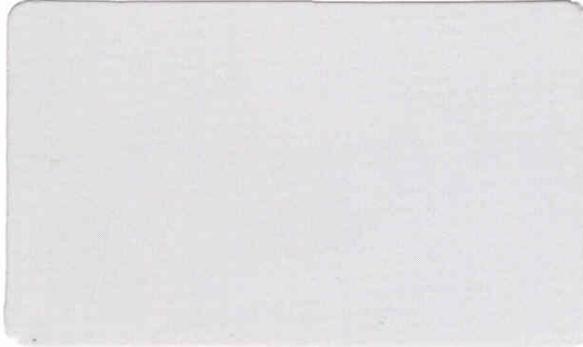
Heathkit[®]

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
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Home Products, Stereo, Security, Telephone,
Marine, Automotive 616-982-3496
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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.

DIGITAL TRAINER

Model ETW-3700

595-3811-02

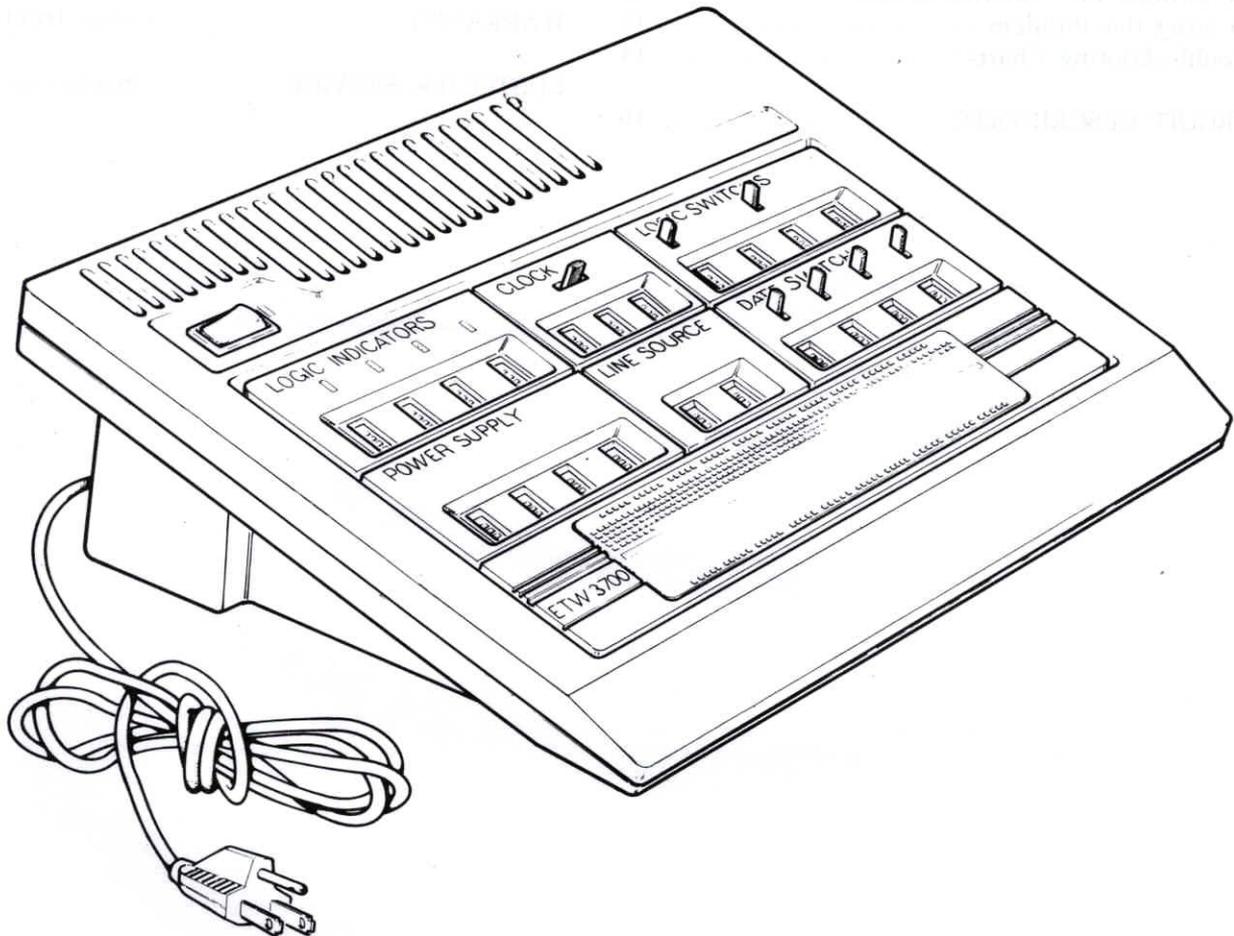


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INTRODUCTION

The Heathkit Model ETW-3700 Digital Trainer is compact and self-contained so you can quickly design and experiment with electronic circuits. The Trainer has the following built-in features:

- Three power supplies to power both digital and linear circuits.
- Four logic Data switches.
- Two “no bounce” logic switches.
- A 3-frequency clock generator.
- Four LED logic-state indicators.
- Internal circuitry compatible with most of today’s commonly-used logic families.
- Removable connector blocks for “solderless” connections between parts and wires.
- A built-in connector to accommodate the Heathkit Model ET/ETW-3567 Accessory Backpack. This Accessory includes programmable positive and negative 15-volt power supplies, a positive 5-volt power supply, and a loudspeaker. In addition, a digital volt-ohm-milliammeter (DVM) is included to allow voltage, current and resistance measurements on experimental circuits without the need for additional test equipment. The Accessory Backpack is designed to hold the experiment circuit boards used in the Heathkit/Zenith Educational courses.

The Trainer is also an excellent learning tool and is a recommended supplement to the individual learning programs of Heathkit/Zenith Educational Systems.

Most of the components are mounted on two easily-accessible circuit boards. The compact size and light weight allow you to move or place the Trainer almost anywhere.

SPECIFICATIONS

POWER SUPPLIES

Output Voltages	+ 12 volts DC at 250 mA. - 12 volts DC at 250 mA. + 5 volts DC at 500 mA.
Load Regulation	+ 5 volts DC supply better than 2%. + 12 and - 12 volt DC supplies better than 1%.
Line Regulation	1%.

DATA SWITCHES

States	+ 5 volts or 0 volts.
Maximum Current	10 mA each switch.
Output	4 terminal blocks, one for each switch.

LOGIC SWITCHES

Type	Momentary contact, spring-loaded.
Circuit	Two flip-flop latches for contact bounce buffering.
Output States	Complementary, + 5 volts and + 0.2 volts.

CLOCK

Frequency Selection	3-position slide switch.
Output Frequency	1 Hz, 1 kHz, 100 kHz; ± 20%.
Duty Cycle	45% to 55%.
Output Voltage	5 volts peak-to-peak.
Output Terminals	Normal and complement.

GENERAL

Logic Indicators	Four green light-emitting diodes (LEDs) with separate input terminals, TTL compatible.
Power Requirements	105 to 132 volts or 210 to 264 volts rms, 50-60 Hz, 35 watts maximum.
Fuse	3/8-ampere slow-blow, for 120 VAC. 3/16-ampere slow-blow, for 220/240 VAC.
Dimensions	12" W × 11-1/4" D × 4-1/4" H (30.5 × 28.7 × 10.8 cm).
Net Weight	5 lbs. (2.3 kg).

The Heath Company reserves the right to discontinue products and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.

OPERATION AND APPLICATIONS

This Digital Trainer not only supplies common DC voltages used in digital electronics, but it also supplies: a line-frequency square wave (60 or 50 Hz); complementary clock signals of 1 Hz, 1 kHz, and 100 kHz; logic and data switches to control input levels; and logic indicators to visually monitor logic states and transitions.

CAUTION: This Trainer is connected to earth ground through the 3-prong line cord plug. DO NOT insert another path to ground through your experimental circuit. Be particularly careful when you use external test equipment that is earth grounded.

Pictorial 1 (fold-out from Page 6) provides you with a brief description of each control function.

CONNECTOR BLOCKS

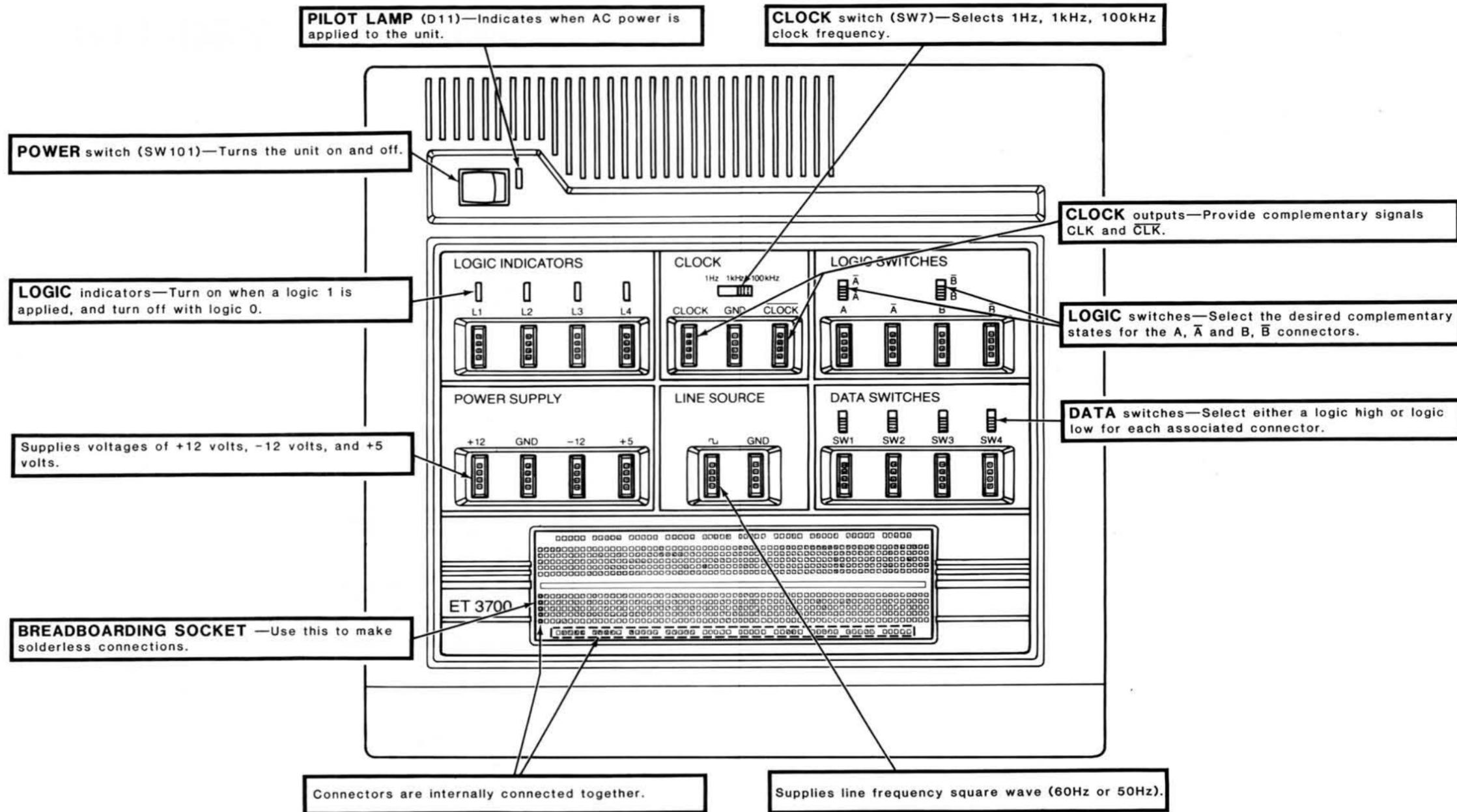
The connector blocks are designed to accept up to #20 (.032") solid wire and most common component leads. The four connectors within a small connector

block are internally connected together. In addition, each vertical row of five connectors in the breadboarding socket are connected together as shown in the Pictorial. You can, therefore, build simple or complex circuits without making solder connections.

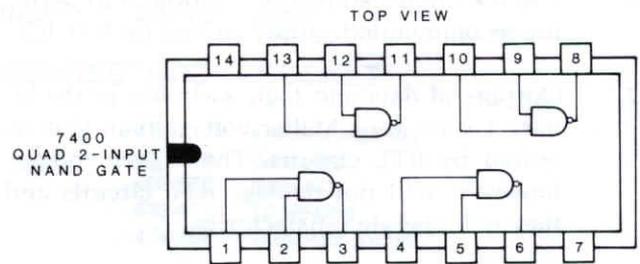
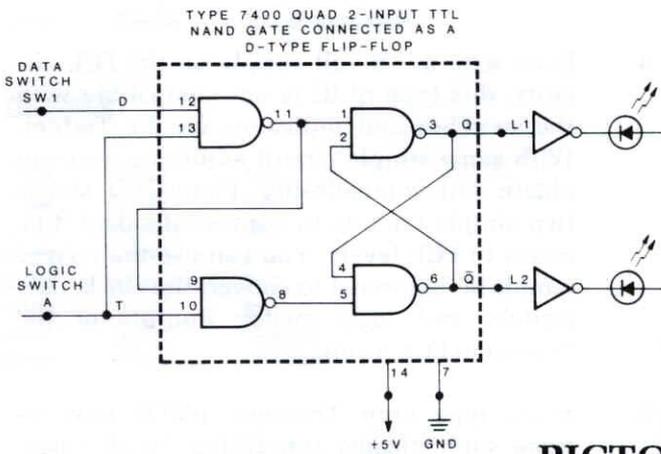
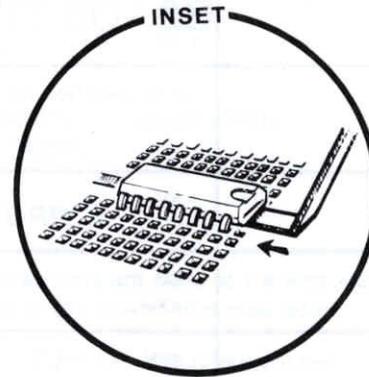
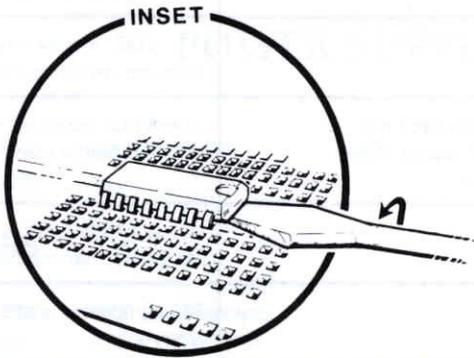
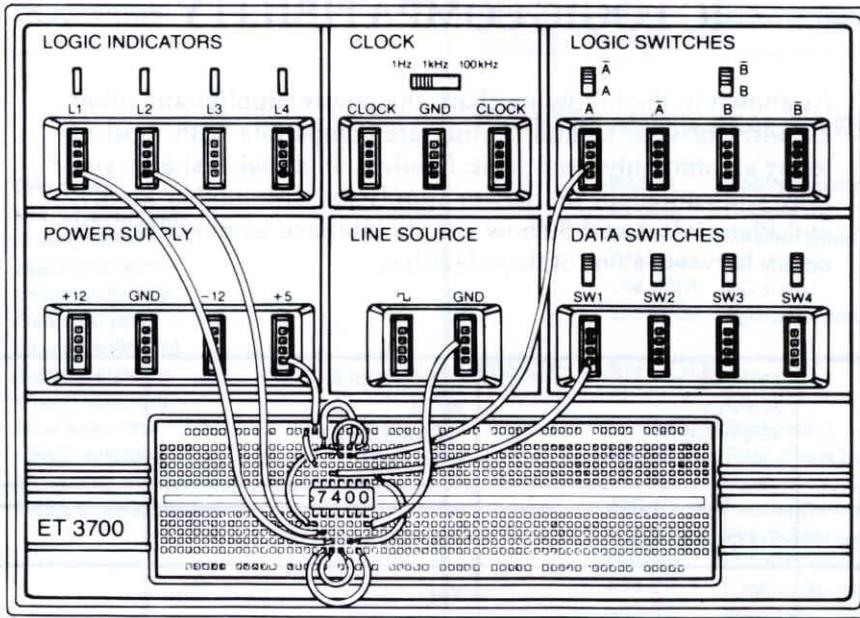
Pictorial 2 shows an example of a typical experiment. The breadboarding socket is designed to accommodate integrated circuits and a small screwdriver blade fits down into the center channel of the socket so you can gently and easily remove an IC (refer to the inset drawing).

ACCESSORY CONNECTORS

Socket S3 and plug P202 are provided for use by the Accessory Backpack.



PICTORIAL 1



PICTORIAL 2

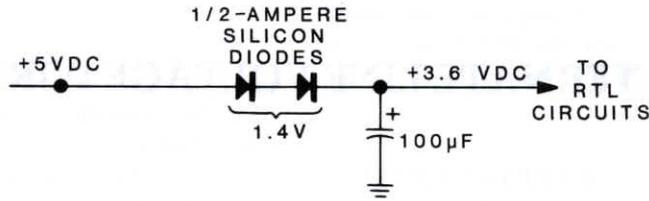
IC LOGIC COMPATIBILITY

As shown in the following chart, the power supplies and other circuitry of your Digital Trainer are compatible with most of today's commonly-used logic families. Pictorial 3 shows you how you can adapt the power supply for still another family, and Pictorials 4 and 5 show simple interface (connecting) circuitry between some of these families.

TYPE OF IC	TYPICAL SUPPLY VOLTAGE	COMPATIBLE WITH INDICATOR AND SWITCHES	COMMENTS
RTL	+ 3.6V (See Note 1.)	Yes (See Note 2.)	
DTL	+ 5V	Yes	
TTL	+ 5V	YES	Also applies to open collector, Schottky, and 3-state types.
CMOS	+ 5V + 12	YES	+ 5 VDC recommended for indicator and switch compatibility.
ECL	+ 5.2V (See Note 3.)	No, when used with + 5 volt supply. (See Note 4.)	Check ECL manufacturer's literature before using.
nMOS	+ 5V	Yes	Not all nMOS uses a + 5 volt supply. Check manufacturer's data.
pMOS (See Note 5.)	+ 5V - 12V	Yes	TTL compatible, static types only
Linear	+ 12V - 12V	Not applicable.	Good for op amps, line drives and receivers, and other linear circuits.

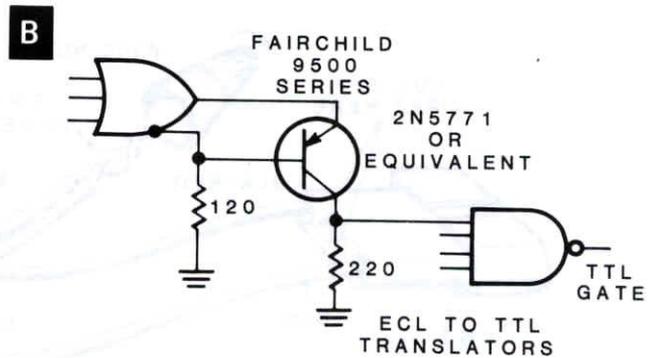
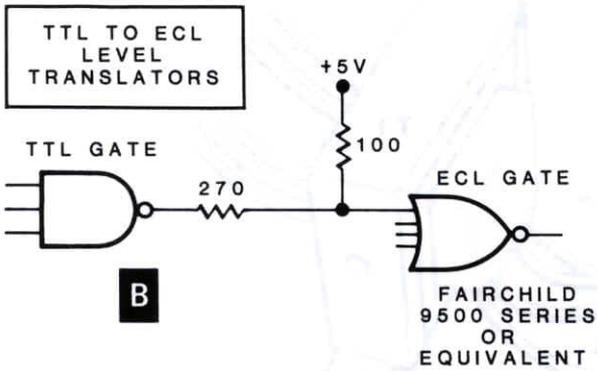
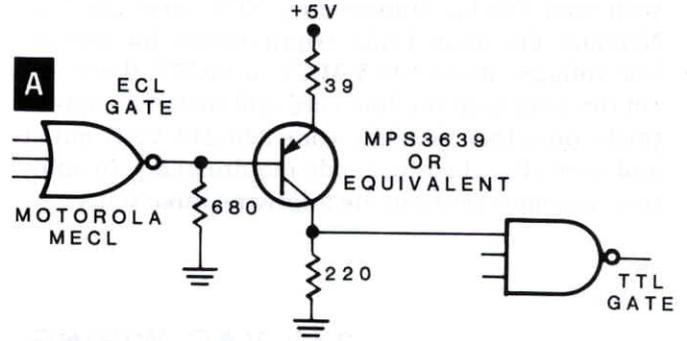
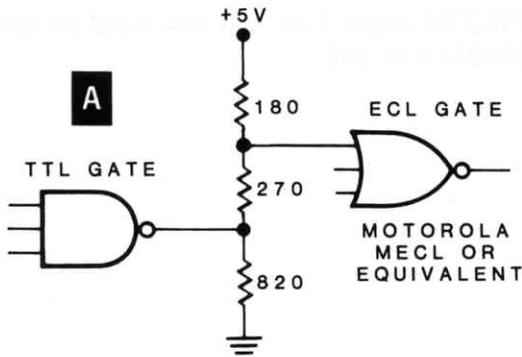
NOTES:

- Use the circuit shown in Pictorial 3 to derive the recommended supply voltage for RTL ICs.
- Outputs of data and logic switches in the binary 1 state are a higher voltage than that required by RTL circuits. The higher voltage, however, will not damage RTL circuits and they will operate satisfactorily.
- The recommended ECL supply voltage is -5.2 VDC. You can, however, reverse the supply voltage connections so that +5 volts from the Digital Trainer can be used. Connect the IC ground to +5 volts and the normal supply input (VEE) to ground. This will produce satisfactory operation for most applications.
- Even with a +5-volt supply on the ECL circuits, this type of IC is not compatible with the switches and indicators on the Trainer. With some simple circuit additions, you can obtain full compatibility. Pictorial 4 shows two simple circuits to convert standard TTL levels to ECL levels. You can use the second circuit in Pictorial 4 to convert the clock, data switch, and logic switch outputs of the Trainer to ECL levels.
- Static type only. Dynamic pMOS requires more sophisticated interfacing. In all cases, check the manufacturer's data sheets.



RECOMMENDED POWER SUPPLY
CIRCUIT FOR RTL IC'S

PICTORIAL 3



PICTORIAL 4

PICTORIAL 5

ALTERNATE LINE VOLTAGE WIRING

Your Digital Trainer has been factory wired for 120 VAC line voltage, which is the most-often-used voltage in the United States. In other countries, however, 220/240 VAC is the most common line voltage. To change the operating line voltage for your Trainer, complete the following steps. **CAUTION:** When you complete these steps, your Trainer will operate **ONLY ON 220/240 VAC**.

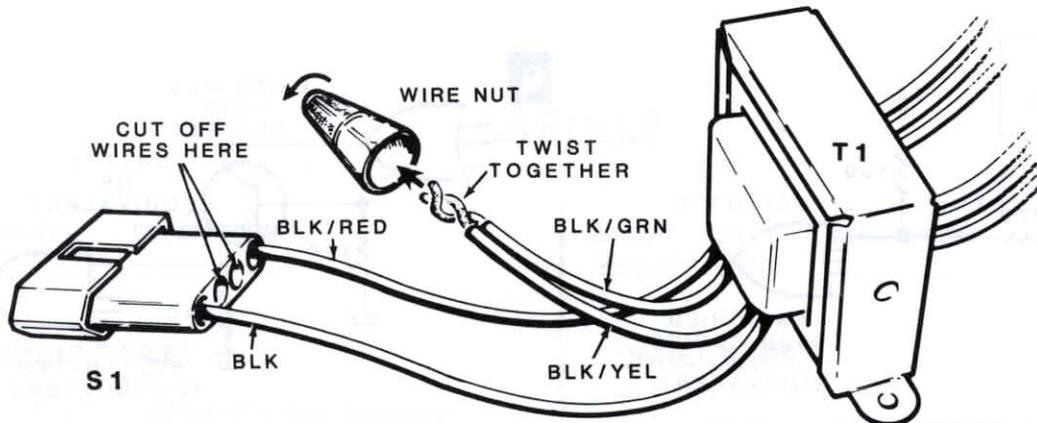
NOTE: These steps should be completed by qualified service personnel only.

IMPORTANT: The plug on the line cord furnished with your Digital Trainer does NOT meet the U.S. National Electrical Code requirements for use on line voltages above 120 VAC. You **MUST**, therefore, cut the plug from the line cord and install an appropriate plug that matches your 220/240 VAC outlet **and** meets the electrical code requirements. In addition, you must perform the following three steps:

1. Cut the black-green and black-yellow wires from pins 2 and 3, respectively, of the 4-pin power transformer socket. Then remove 3/8" of insulation from the end of each wire.
2. Twist together the bare ends of the black-green and black-yellow power transformer wires. Then twist a wire nut (furnished) clockwise over the wire ends as shown in Pictorial 6.
3. Replace line fuse F1 with a 3/16-ampere, slow-blow fuse (not furnished).

Your ETW-3700 Digital Trainer is now wired for operation on 220/240 VAC **only**.

240 VAC WIRING



PICTORIAL 6

IN CASE OF DIFFICULTY

This part of the Manual will help you locate and correct difficulties which might occur in your Trainer. This information is divided into the "Visual Checks," "Precautions for Troubleshooting," "Locating the Problem," and "Troubleshooting Charts." Use the Visual Checks to locate any difficulties that occur right after you receive the unit.

The "Troubleshooting Charts" call out specific problems that may occur and list one or more conditions or components that could cause each problem. "Circuit Board X-Ray Views" are also provided in the

Page 23 to help you locate the circuit components and compare foils.

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

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

VISUAL CHECKS

1. Examine the cabinet of your Trainer for signs of shipping damage (cracks in the cabinet, parts rattling around inside, etc.). If outside damage is evident, remove the cabinet screws and examine the circuit boards for cracked foils and broken parts. Also check for other damage to the cabinet.

NOTE: If you find damage, save the shipping carton and notify the shipping company as soon as possible.

2. Check the line cord to be sure it is inserted into an AC outlet, and that the outlet has power going to it.
3. Check fuse F1 to be sure it is not open. An open fuse can indicate a shorted connection on your experimental circuit, an overload on

one or more power supplies caused by excess current drawn from your experimental circuit, or a component failure in your circuit or the power supply circuitry inside the Trainer. Determine whether the experimental circuit is the cause by disconnecting all wires from the "POS" and "NEG" connector blocks and replacing the fuse. If the POWER indicator now lights when you apply power, the experimental circuit is the problem.

4. Disconnect the Trainer from the AC outlet and remove the cabinet screws. Check for signs of damaged or burned components on the power supply circuit board. Then read the "Precautions for Troubleshooting" section and perform the "Resistance Tests" and "Voltage Tests" which follow.

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 is applied.

LOCATING THE PROBLEM

RESISTANCE TESTS

If you do not obtain the proper results in any of the following resistance tests, interchange the ohmmeter leads and remeasure the test point. If you still do not obtain the proper indication, refer to the "Troubleshooting Charts" in this section of the Manual.

NOTE: Do not connect the Trainer's line cord to an AC outlet until you are directed to do so in a step.

- () Be sure the POWER switch is in the off position (push down on the left side).
- () Set the ohmmeter to the $R \times 10$ range.
- () Connect either ohmmeter lead to the round (ground) prong of the line cord plug. Then touch the other ohmmeter lead to one of the flat prongs. The meter should indicate infinity (an open circuit).
- () With one ohmmeter lead still connected to the round prong of the line cord plug, touch the other ohmmeter lead to the remaining flat prong. The meter should again indicate infinity.
- () Set the ohmmeter to the $R \times 1$ range.

- () Connect the negative ohmmeter lead to one flat prong of the line cord plug and the positive ohmmeter lead to the other flat prong. The ohmmeter should indicate infinity with the POWER switch off, and between 25 and 70 ohms with the POWER switch on.

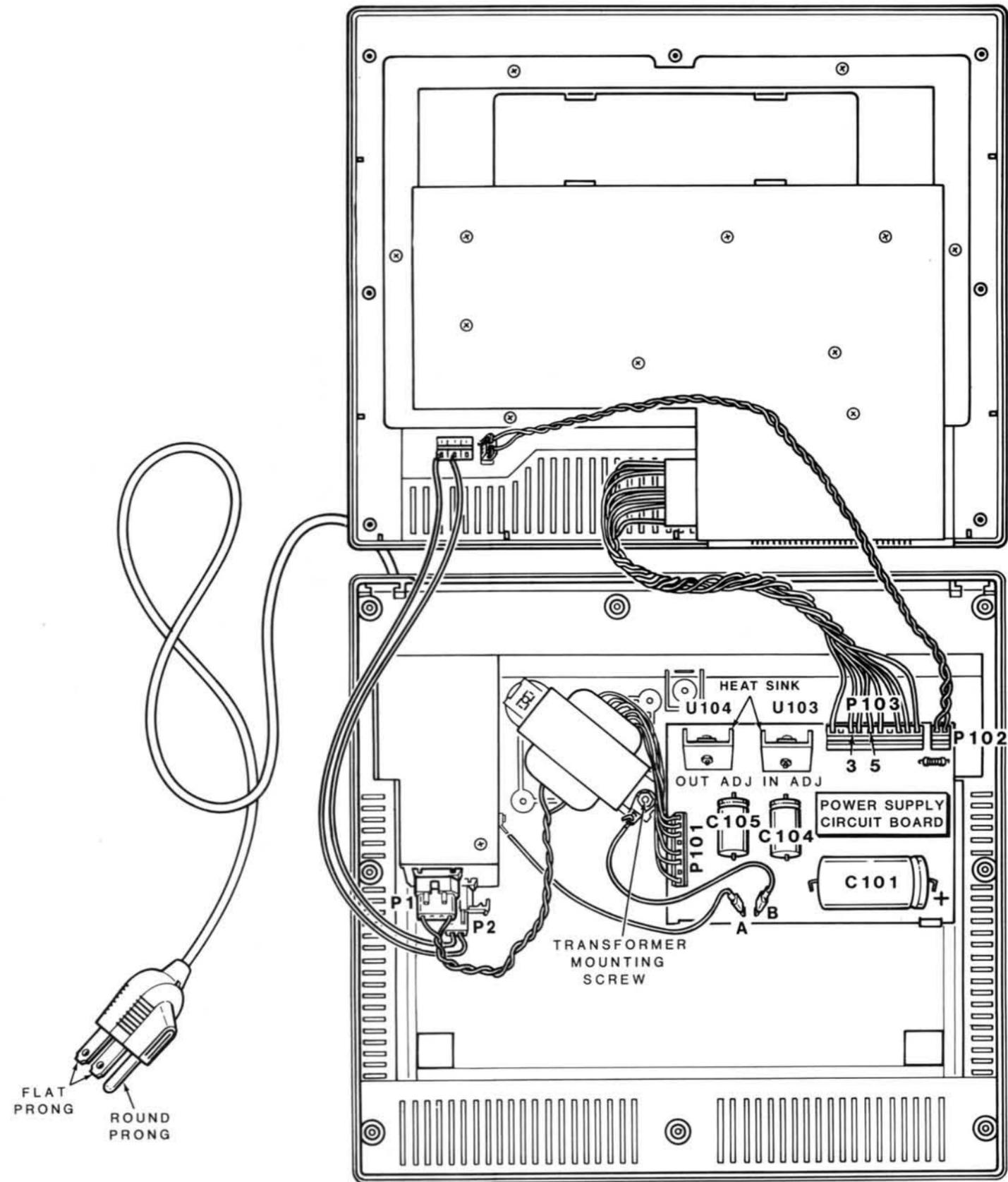
- () Reset the POWER switch to off, if this has not already been done.

Refer to Pictorial 7 (fold-out from Page 12) while you perform the following tests.

NOTE: The following measurements were taken with a VTVM (such as the Heathkit Model IM-5218). If you use a multimeter, your measurements may vary from those shown.

- () Remove the cabinet screws and lift the cabinet top off. Position the top as shown in the Pictorial.
- () Set the ohmmeter to the $R \times 100 \Omega$ range.
- () Connect the negative ohmmeter lead to flat connector lug A on the power supply circuit board. Leave this lead connected to lug A until a step direct you to disconnect it.

NOTE: It may take several seconds for the ohmmeter to reach the indicated readings in some of the following steps. This is due to the charging effect of the capacitors in the circuit.



PICTORIAL 7

- () Touch the positive ohmmeter lead to the OUT lead of U104. The ohmmeter should indicate between 1000 and 1500 ohms.
- () Set the ohmmeter to the $R \times 10$ range.
- () Touch the positive ohmmeter lead to U104's heat sink. The ohmmeter should indicate between 50 and 70 ohms.
- () Set the ohmmeter to the $R \times 100$ range.
- () Touch the positive ohmmeter lead to the ADJ lead of U104. The ohmmeter should indicate between 800 and 1500 ohms.
- () Set the ohmmeter to the $R \times 1000$ range.
- () Touch the positive ohmmeter lead to the IN lead of U103. The ohmmeter should indicate between 10 k Ω and 20 k Ω .
- () Set the ohmmeter to the $R \times 100$ range.
- () Touch the positive ohmmeter lead to U103's heat sink. The ohmmeter should indicate between 1200 and 1800 ohms.
- () Touch the positive ohmmeter lead to the ADJ lead of U103. The ohmmeter should indicate between 1100 and 1500 ohms.
- () Set the ohmmeter to the $R \times 1000$ range.
- () Touch the positive ohmmeter lead to the positive (+) lead of capacitor C101. The ohmmeter should indicate greater than 30k ohms. NOTE: It may take several seconds to reach this indication.
- () Disconnect the ohmmeter leads from the Trainer.

VOLTAGE TESTS

If you do not obtain the correct voltages in any of the following tests, refer to the "Troubleshooting Charts" in this section of the Manual.

WARNING: AC line voltage is present on the lugs of the POWER switch when the line cord is connected to an AC outlet. Be especially careful to avoid this area when you make the following voltage tests.

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

- () Connect the negative voltmeter lead to flat connector lug A on the power supply circuit board. Leave this lead connected to lug A until a step directs you to disconnect it.
- () Unplug the 10-pin socket from P103 on the power supply circuit board.
- () Connect the line cord to an AC outlet.
- () Push the POWER switch to on. The POWER LED should light.
- () Set the voltmeter to measure +15 volts DC. Then touch the positive voltmeter lead to the positive (+) lead of capacitor C101. The voltmeter should indicate +12 volts DC.
- () Touch the positive voltmeter lead to plug P103 pin 10. The voltmeter should indicate +5 volts DC.
- () Set the voltmeter to measure +25 volts DC. Then touch the positive voltmeter lead to the positive (+) lead of capacitor C104. The voltmeter should indicate +20 volts DC.
- () Set the voltmeter to measure +15 volts DC. Then touch the positive voltmeter lead to plug P103 pin 3. The voltmeter should indicate +12 volts DC.
- () Set the voltmeter to measure -25 volts DC. Then touch the positive voltmeter lead to the negative (-) lead of capacitor C108. The voltmeter should indicate -21 volts DC.
- () Set the voltmeter to measure -15 volts DC. Then touch the positive voltmeter lead to plug P103 pin 5. The voltmeter should indicate -12 volts DC.
- () Push the POWER switch to off and unplug the line cord.
- () Disconnect the voltmeter leads from the Trainer.
- () Reconnect the 10-pin plug to P103 on the power supply circuit board.
- () Reinstall the cabinet screws.

TROUBLESHOOTING CHARTS

The following Troubleshooting Charts list specific difficulties that could occur in your Trainer. Several possible causes may be listed for each difficulty. Refer to the "Circuit Board X-Ray Views" and the

"Schematic Diagram" to locate and identify the parts listed in this chart. If a particular part is mentioned (D108 for example) as a possible cause, check that part and other components connected to it.

RESISTANCE CHART

PROBLEM	POSSIBLE CAUSE
Line cord plug resistance (POWER switch on) is high.	<ol style="list-style-type: none"> 1. Fuse F1. 2. Plug P1 or P2.
OUT lead of U104 measures less than 50 ohms.	<ol style="list-style-type: none"> 1. Diode D108. 2. Capacitor C112.
Heat sink of U104 measures less than 50 ohms.	<ol style="list-style-type: none"> 1. Diodes D103 or D105. 2. Capacitor C108 or C109.
ADJ lead of U104 measures less than 800 ohms.	<ol style="list-style-type: none"> 1. Capacitor C111.
IN lead of U103 measures less than 10 k Ω .	<ol style="list-style-type: none"> 1. Diode D104 or D106. 2. Capacitor C104 or C105.
Heatsink of U103 measures less than 1200 ohms.	<ol style="list-style-type: none"> 1. Diode D107. 2. Capacitor C107.
ADJ lead of U103 measures less than 1100 ohms.	<ol style="list-style-type: none"> 1. Capacitor C106.
Positive lead of capacitor C101 measures less than 30k ohms.	<ol style="list-style-type: none"> 1. Capacitor C101 or C102. 2. Integrated circuit U101.

VOLTAGE CHART

PROBLEM	POSSIBLE CAUSE
POWER LED does not light.	<ol style="list-style-type: none"> 1. LED D1. 2. Plug P102.
No + 12 VDC at positive lead of C101.	<ol style="list-style-type: none"> 1. Plug P101, P102, or P103. 2. Diode D101 or D102. 3. Capacitor C102. 4. Integrated circuit U101.
No +5 VDC at P103 pin 10.	<ol style="list-style-type: none"> 1. Integrated circuit U101. 2. Capacitor C103.
No + 20 VDC at positive lead of capacitor C104.	<ol style="list-style-type: none"> 1. Plug P101, P102, or P103. 2. Diodes D103—D106. 3. Capacitor C104 or C105.
No + 12 VDC at P103 pin 3.	<ol style="list-style-type: none"> 1. Integrated circuit U103. 2. Capacitor C107. 3. Diode D107.
No - 20 VDC at negative lead of capacitor C108.	<ol style="list-style-type: none"> 1. Plug P101, P102, or C103. 2. Diodes D103—D106. 3. Capacitor C108 or C109.
No - 12 VDC at P103 pin 5.	<ol style="list-style-type: none"> 1. Integrated circuit U104. 2. Capacitor C112. 3. Diode D108.

OPERATIONAL CHART

PROBLEM	POSSIBLE CAUSE
Pilot lamp does not light.	<ol style="list-style-type: none"> 1. Fuse F1. 2. LED D1. 3. Resistor R101. 4. + 5 volt supply. 5. Coil L51. 6. Switch SW1. 7. Transformer T1.
+ 5 volt supply has incorrect voltage.	<ol style="list-style-type: none"> 1. Integrated circuit U101. 2. Capacitor C101, C102, or C103.
+ 12 volt supply has incorrect voltage.	<ol style="list-style-type: none"> 1. Integrated circuit U103. 2. Capacitor C104, C106, or C107. 3. Diode D107. 4. Resistor R102 or R103.
-12 volt supply has incorrect voltage.	<ol style="list-style-type: none"> 1. Integrated circuit U104. 2. Capacitor C108, C109, C111, or C112. 3. Diode D108. 4. Resistor R104 or R105.
One of the Logic Indicators remains lit with no input.	<ol style="list-style-type: none"> 1. Integrated circuit U202.
Clock will not change frequency.	<ol style="list-style-type: none"> 1. Switch SW207. 2. Integrated circuit U204.

CIRCUIT DESCRIPTION

Refer to the Schematic Diagram while you read this "Circuit Description." The component numbers are arranged in the following groups to help you locate specific parts on the Schematic, circuit boards, and cabinet:

1—49	Parts mounted on the cabinet.
51—99	Parts mounted on the line filter circuit board.
101—199	Parts mounted on the power supply circuit board.
201—299	Parts mounted on the main circuit board.

DATA SWITCHES

These switches select either ground potential or +5 volts DC. Resistor R201 limits the current.

LOGIC SWITCHES

Switch $A-\bar{A}$ (SW205) controls a latching flip-flop made up of U201A and U201B. When switch SW205 is in the \bar{A} position, pins 4 and 5 are low. This produces a high at pins 2 and 6. Because pin 1 is pulled up by R202 at this time, it is also considered to be high. This makes a low at pin 3. When SW205 is in the A position, a low is at pin 1. This forces pins 3 and 4 high. With highs at pins 4 and 5, pins 3 and 6 go low and outputs A and \bar{A} have changed state.

Switch $B-\bar{B}$ (SW206) operates the same as switch $A-\bar{A}$.

LOGIC INDICATORS

With no input to connector L1, U202A and LED D205 are off. When a high is applied to connector L1, U202A turns on. Current then flows through D205 and resistor R219 to light the LED. The other indicators operate in the same manner.

CLOCK

The clock is made up of U204 (a 555 timer) and the RC time frequency control components. These are R229, R231, and C204, C205, or C206. Switch SW207 selects the desired capacitor. The output of U204 (pin 3) is applied to two NAND gates (U203C and U203D) that operate as inverters to produce the CLK and \bar{CLK} outputs.

LINE FREQUENCY SIGNAL

The line frequency signal is coupled from the secondary of transformer T1, through resistor R224, to the base (B) of transistor Q201. Diode D209 half-wave rectifies the signal, which leaves the positive excursions to turn on transistor Q201. Transistor Q201 then drives NAND gate U203A, which is connected as an inverter.

+ 5 VOLT SUPPLY

Diodes D101 and D102 rectify the voltage coming from one secondary winding of transformer T1. Capacitors C101 filters the resulting voltage before it is regulated to +5 volts by U101. Bypass capacitors C102 and C103 prevent oscillations from occurring through U101.

+ 12 VOLT SUPPLY

Diodes D103, D104, D105, and D106 rectify the voltage coming from the remaining secondary winding of transformer T1. Capacitor C104 filters this voltage before it is applied to regulator U103.

Regulator U103 provides the + 12 volt power source. R102 and R103 set the output voltage of the regulator. C106 prevents U103 from oscillating.

- 12 VOLT SUPPLY

The negative 12-volt supply consists of D103, D105, C108, C109, U104, C111, D108, R104, C112, and R105. This circuit operation is similar to the positive 12-volt supply, but produces a regulated - 12 volts.

REPLACEMENT PARTS LIST

NOTES:

1. Component values and circuit component numbers are referenced to the Schematic Diagram, to the "Circuit Board X-Ray Views," and in related Pictorials.
2. If a circuit component is not listed in the following list (such as R105), that component is not used in this model.
3. To order a replacement part, always include the PART NUMBER. Use the Parts Order Form furnished with your Trainer. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover of this Manual.
4. 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).

CABINET

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

C51	27-127	.047 μ F (474) Mylar @ capacitor
C52	21-71	.001 μ F (1000 pF) ceramic capacitor (may be marked 102)
C53	21-71	.001 μ F (1000 pF) ceramic capacitor (may be marked 102)
D1	412-634	LED (light-emitting diode)
F1	421-42	3/8-ampere, slow-blow fuse
L51	45-615	RF choke
SW1	61-58	Rocker switch
T1	54-1054	Power transformer

CIRCUIT Comp. No.	HEATH Part No.	DESCRIPTION
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CONNECTORS

432-66	Push-on connector
432-861	Male connector pin
432-873	Female connector pin
432-196	2-pin plug shell
432-907	2-pin socket shell
432-722	3-pin plug shell
432-156	4-pin plug shell
432-1279	Flat connector lug
432-1610	Breadboard

CIRCUIT Comp. No.	HEATH Part No.	DESCRIPTION
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WIRE — CABLE

89-54		Line cord
134-1693		LED (2-wire) cable
134-1692		Power cable
344-50		Black solid wire
344-51		Brown solid wire
344-52		Red solid wire
344-53		Orange solid wire
344-54		Yellow solid wire
344-55		Green solid wire
344-56		Blue solid wire
344-207		Green stranded wire
344-210		Black stranded wire
344-219		White stranded wire

CIRCUIT Comp. No.	HEATH Part No.	DESCRIPTION
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PLASTIC AND METAL PARTS

92-879		Cabinet bottom
92-880		Cabinet top
94-669		Cabinet insert
204-3001		AC chassis
204-3066		AC shield
205-2005		Backpack mounting plate

MISCELLANEOUS

75-736		Strain relief
85-2789-1		Filter circuit board
261-49		Foot
423-16		Fuseholder body
423-18		Fuseholder cap
423-19		Fuseholder nut
423-21		Fuseholder washer
432-67		Wire nut

POWER SUPPLY CIRCUIT BOARD

CIRCUIT Comp. No.	HEATH Part No.	DESCRIPTION
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CAPACITORS

C101	25-903	6800 μ F electrolytic
C102	27-145	.22 μ F (224) Mylar
C103	27-145	.22 μ F (224) Mylar
C104	25-875	1000 μ F electrolytic
C105	21-786	.1 μ F (104) axial-lead ceramic
C106	25-880	10 μ F electrolytic
C107	25-885	100 μ F electrolytic
C108	25-875	1000 μ F electrolytic
C109	21-786	.1 μ F (104) axial-lead ceramic
C111	25-880	10 μ F electrolytic
C112	25-885	100 μ F electrolytic

DIODES

D101	57-42	3A1
D102	57-42	3A1
D103	57-42	3A1
D104	57-42	3A1
D105	57-42	3A1
D106	57-42	3A1
D107	57-65	1N4002
D108	57-65	1N4002

CIRCUIT Comp. No.	HEATH Part No.	DESCRIPTION
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RESISTORS

NOTE: All resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise listed.

R101	6-271-12	270 Ω (red-viol-brn)
R102	6-1500-12	150 Ω , 1% (brn-grn-blk-blk)
R103	6-1301-12	1300 Ω , 1% (brn-org-blk-brn)
R104	6-1500-12	150 Ω , 1% (brn-grn-blk-blk)

INTEGRATED CIRCUITS

U101	442-30	UA309
U102	442-708	LM317
U103	442-709	LM337

CONNECTORS — SOCKET

432-1279		Flat connector lug
432-943		2-pin plug
432-876		8-pin plug
432-877		10-pin plug
434-189		Transistor socket

MISCELLANEOUS

85-3191-1		Power supply circuit board
215-94		Vertical heat sink
215-658		Flat heat sink
352-31		Thermal compound

MAIN CIRCUIT BOARD

CIRCUIT Comp. No.	HEATH Part No.	DESCRIPTION
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CAPACITORS

C201	21-786	.1 μ F (104) axial-lead ceramic
C202	21-786	.1 μ F (104) axial-lead ceramic
C203	21-786	.1 μ F (104) axial-lead ceramic
C204	20-109	62 pF (620) mica
C205	27-161	.01 μ F (103) Mylar
C206	25-864	10 μ F electrolytic

DIODES — LIGHT-EMITTING DIODES (LEDs)

D205	412-657	LED
D206	412-657	LED
D207	412-657	LED
D208	412-657	LED
D209	56-56	1N4149 diode

RESISTORS

NOTE: All resistors are rated at 1/4-watt and have a 5% tolerance unless otherwise listed.

R201	6-471-12	470 Ω (yel-viol-brn)
R202	6-103-12	10 k Ω (brn-blk-org)
R203	6-103-12	10 k Ω (brn-blk-org)
R204	6-103-12	10 k Ω (brn-blk-org)
R205	6-103-12	10 k Ω (brn-blk-org)
R206	6-102-12	1000 Ω (brn-blk-red)
R207	6-102-12	1000 Ω (brn-blk-red)
R208	6-102-12	1000 Ω (brn-blk-red)
R209	6-102-12	1000 Ω (brn-blk-red)
R211	6-561-12	560 Ω (grn-blu-brn)
R212	6-103-12	10 k Ω (brn-blk-org)
R213	6-561-12	560 Ω (grn-blu-brn)
R214	6-103-12	10 k Ω (brn-blk-org)
R215	6-561-12	560 Ω (grn-blu-brn)
R216	6-103-12	10 k Ω (brn-blk-org)
R217	6-561-12	560 Ω (grn-blu-brn)
R218	6-103-12	10 k Ω (brn-blk-org)
R219	6-101-12	100 Ω (brn-blk-brn)

CIRCUIT Comp. No.	HEATH Part No.	DESCRIPTION
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Resistors (Cont'd.)

R221	6-101-12	100 Ω (brn-blk-brn)
R222	6-101-12	100 Ω (brn-blk-brn)
R223	6-101-12	100 Ω (brn-blk-brn)
R224	6-103-12	10 k Ω (brn-blk-org)
R225	6-103-12	10 k Ω (brn-blk-org)
R226	6-472-12	4700 Ω (yel-viol-red)
R227	6-102-12	1000 Ω (brn-blk-red)
R228	6-102-12	1000 Ω (brn-blk-red)
R229	6-153-12	15 k Ω (brn-grn-org)
R231	6-683-12	68 k Ω (blu-gry-org)

TRANSISTORS — INTEGRATED CIRCUITS (ICs)

Q201	417-801	MPSA20 transistor
U201	443-728	74LS00 IC
U202	443-1602	74ACT00
U203	443-54	7403
U204	442-53	NE555 IC

CONNECTORS — SOCKETS

432-1609	Connector block
432-1064	10-pin plug
432-1641	60-pin plug
434-230	8-pin IC socket
434-298	14-pin IC socket

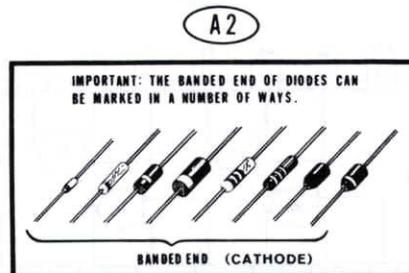
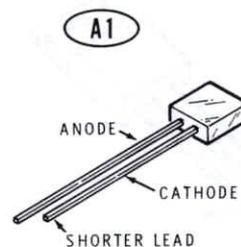
MISCELLANEOUS

60-672	2-position slide switch
60-673	3-position slide switch
60-674	Spring-return slide switch
85-3190-1	Main circuit board
255-848	LED spacer

SEMICONDUCTOR IDENTIFICATION

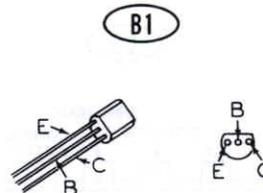
DIODES

<u>CIRCUIT COMPONENT NUMBER</u>	<u>HEATH PART NUMBER</u>	<u>MAY BE REPLACED WITH</u>	<u>KEY NUMBER</u>
D1	412-634	Red LED	A1
D101	57-42	1N5401	A2
D102	57-42	1N5401	A2
D103	57-42	1N5401	A2
D104	57-42	1N5401	A2
D105	57-42	1N5401	A2
D106	57-42	1N5401	A2
D107	57-65	1N4002	A2
D108	57-65	1N4002	A2
D205	412-657	Green LED	A1
D206	412-657	Green LED	A1
D207	412-657	Green LED	A1
D208	412-657	Green LED	A1
D209	56-56	1N4149	A2



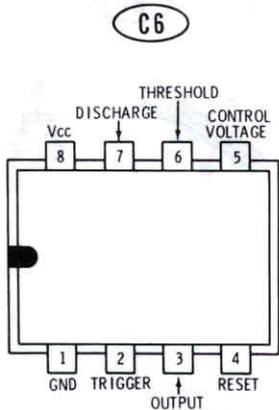
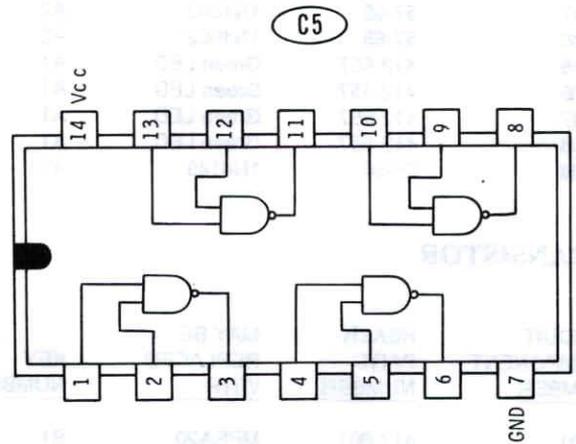
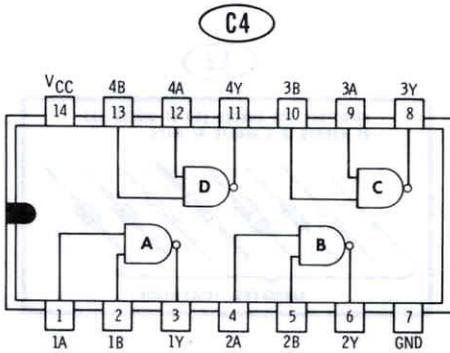
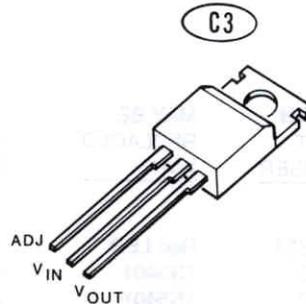
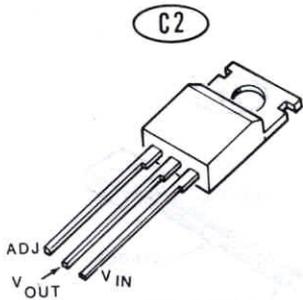
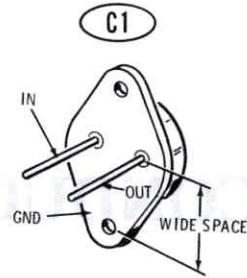
TRANSISTOR

<u>CIRCUIT COMPONENT NUMBER</u>	<u>HEATH PART NUMBER</u>	<u>MAY BE REPLACED WITH</u>	<u>KEY NUMBER</u>
Q201	417-801	MPSA20	B1



INTEGRATED CIRCUITS

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	KEY NUMBER
U101	442-30	UA309	C1
U103	442-708	LM317	C2
U104	442-709	LM337	C3
U201	443-728	74LS00	C4
U202	443-1602	74ACT00	C5
U203	443-54	7403	C4
U204	442-53	555	C6

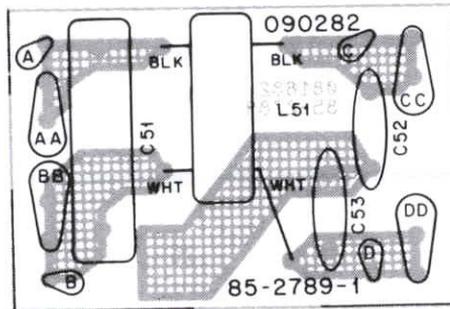


CIRCUIT BOARD X-RAY VIEWS

NOTE: To find the PART NUMBER of a component for the purpose of ordering a replacement part:

- A. Find the circuit component number (R1, C1, etc.) on one of the x-ray views.
- B. Locate this same number in the "Circuit Component Number" column of the "Parts List."
- C. Adjacent to the circuit component number, you will find the PART NUMBER and DESCRIPTION, which you must supply when you order a replacement part.

Also see the X-Ray Views on the fold-out from this page.



FILTER CIRCUIT BOARD
(Shown from the component side.)

CIRCUIT BOARD X-RAY VIEWS

OPERATION AND APPLICATIONS

Adjustment on the circuit components, such as the 100K potentiometer, is required for the 100K potentiometer and the 100K potentiometer.

The circuit board is shown in the figure below.

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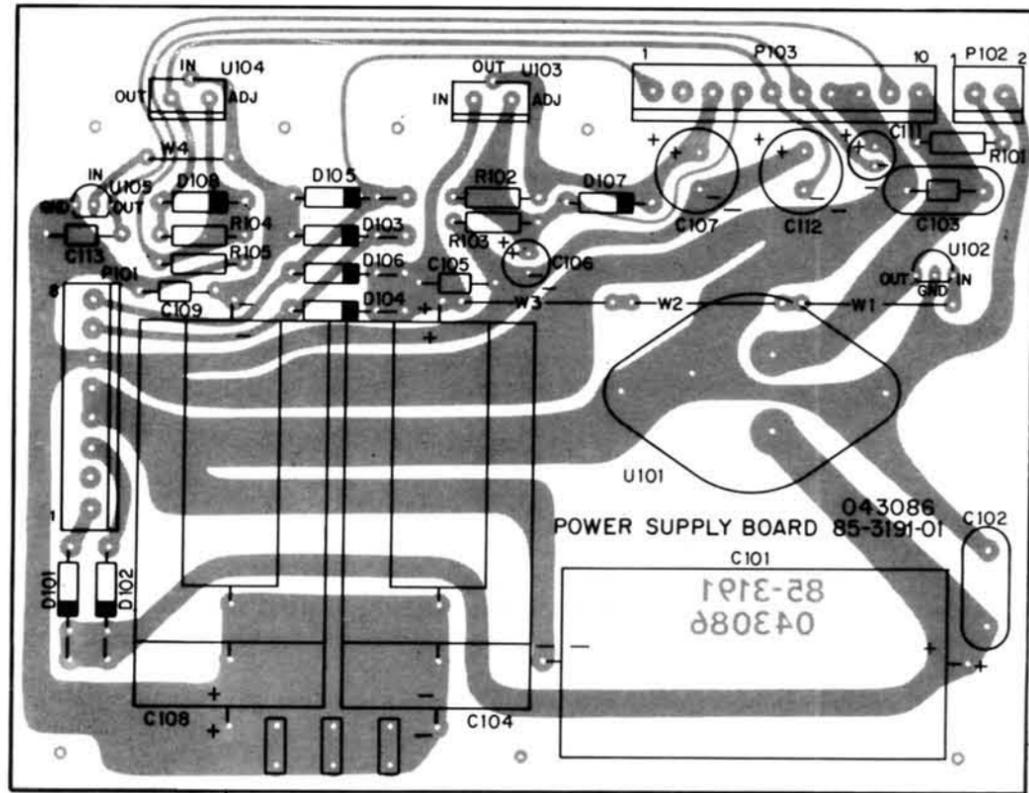
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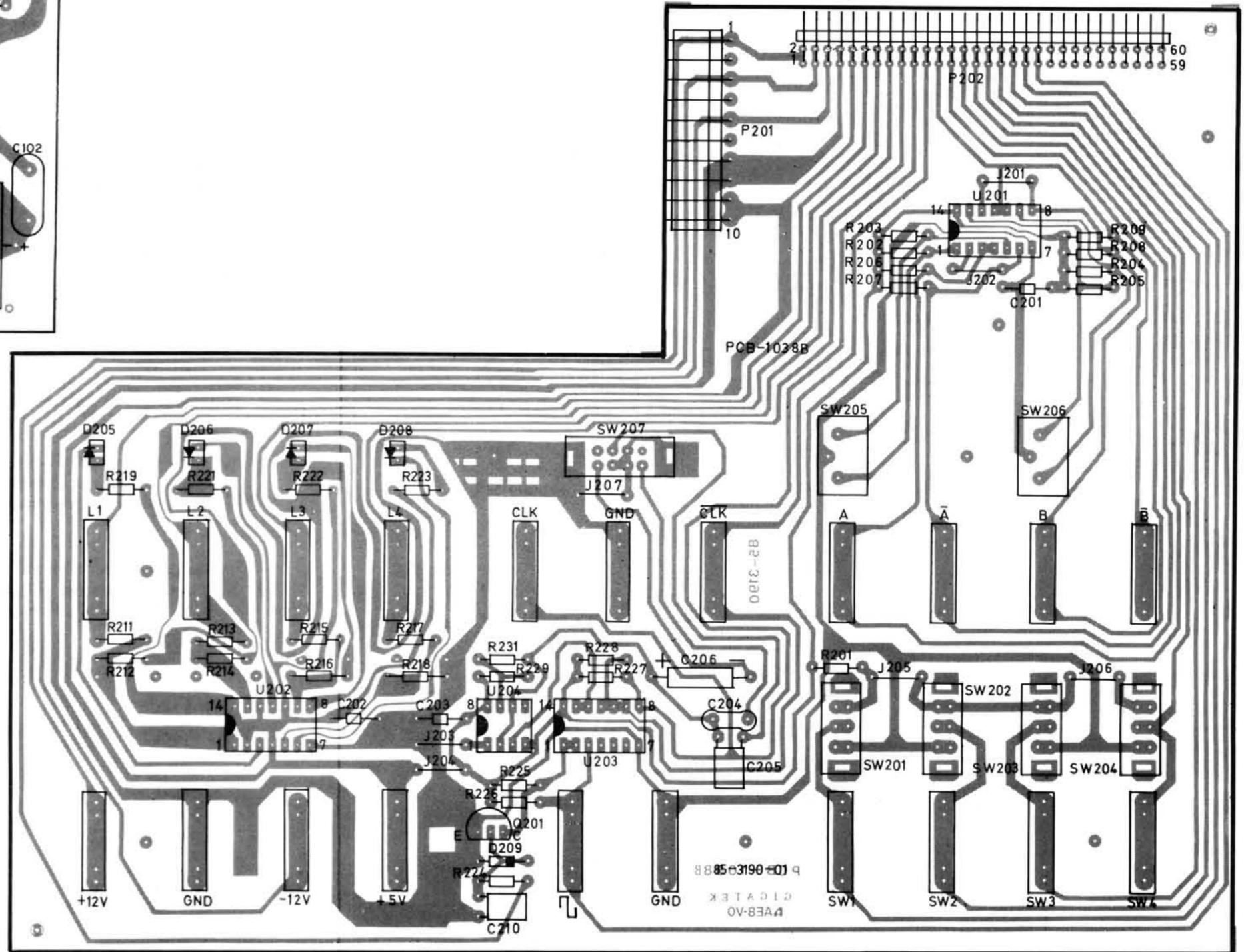


ALL THE CIRCUIT BOARD (shown from the component side)

The circuit board is shown in the figure below. The circuit board is shown in the figure below.

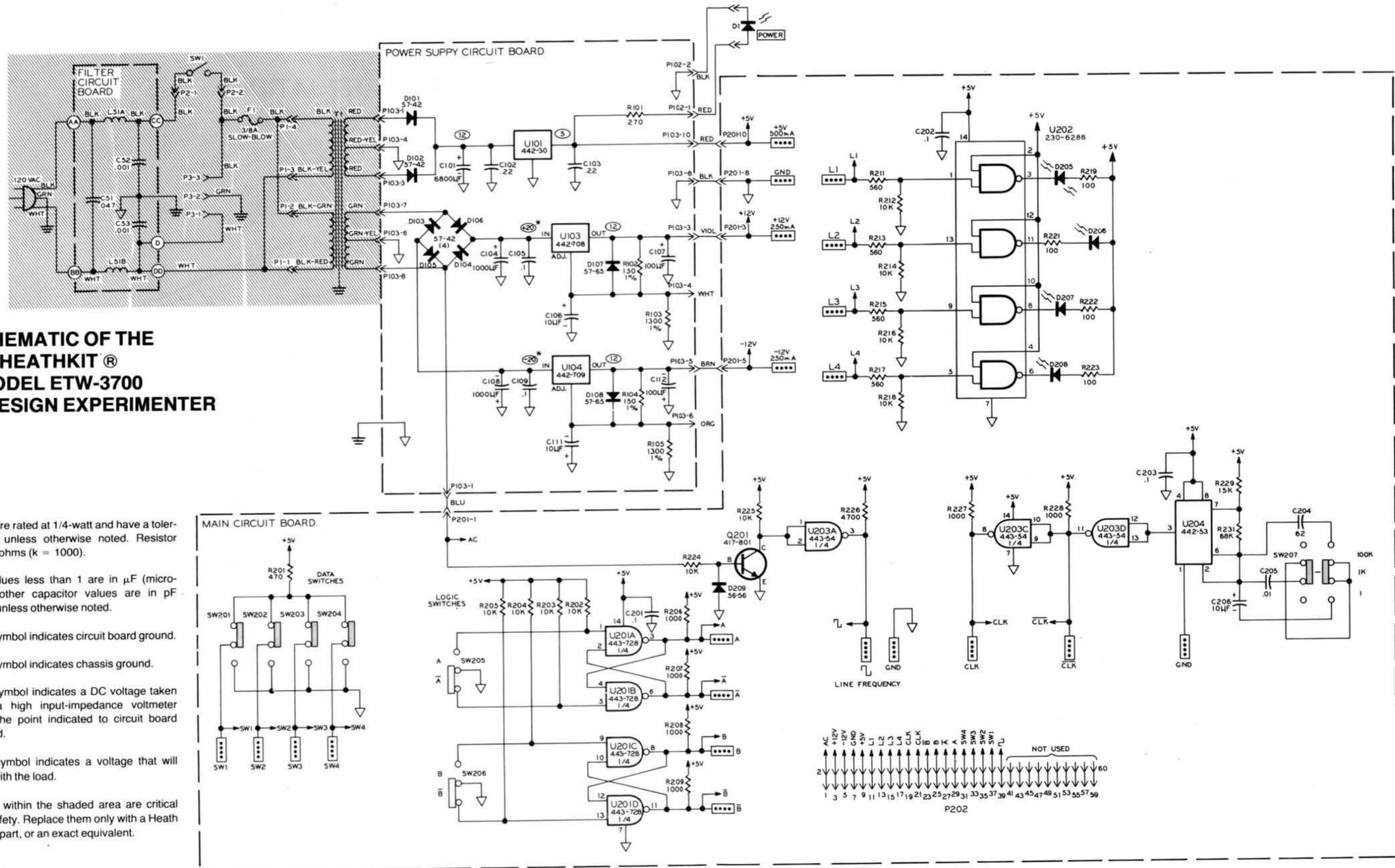


POWER SUPPLY CIRCUIT BOARD
(Shown from the component side.)



MAIN CIRCUIT BOARD
(Shown from the component side.)

SCHEMATIC OF THE HEATHKIT® MODEL ETW-3700 DIGITAL DESIGN EXPERIMENTER



NOTES:

1. All resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise noted. Resistor values are in ohms (k = 1000).
2. Capacitor values less than 1 are in μ F (microfarads). All other capacitor values are in pF (picofarads) unless otherwise noted.
3. This symbol indicates circuit board ground.
4. This symbol indicates chassis ground.
5. This symbol indicates a DC voltage taken with a high input-impedance voltmeter from the point indicated to circuit board ground.
6. * This symbol indicates a voltage that will vary with the load.
7. Components within the shaded area are critical to product safety. Replace them only with a Heath replacement part, or an exact equivalent.

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

