

Heathkit®

**ACCESSORY BACKPACK**

Model ETW-3567

595-3828-03

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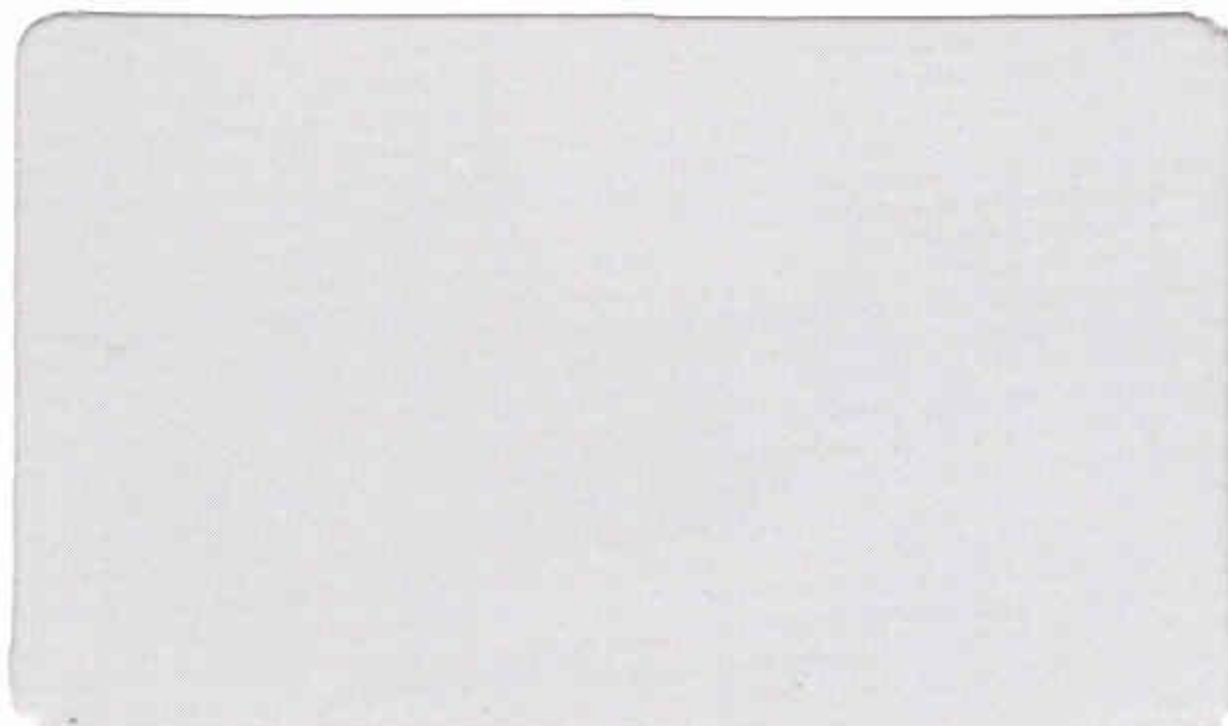
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This warranty covers only Heath products and is not extended to other equipment or components that a customer uses in conjunction with our products.

**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.**

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#### 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.

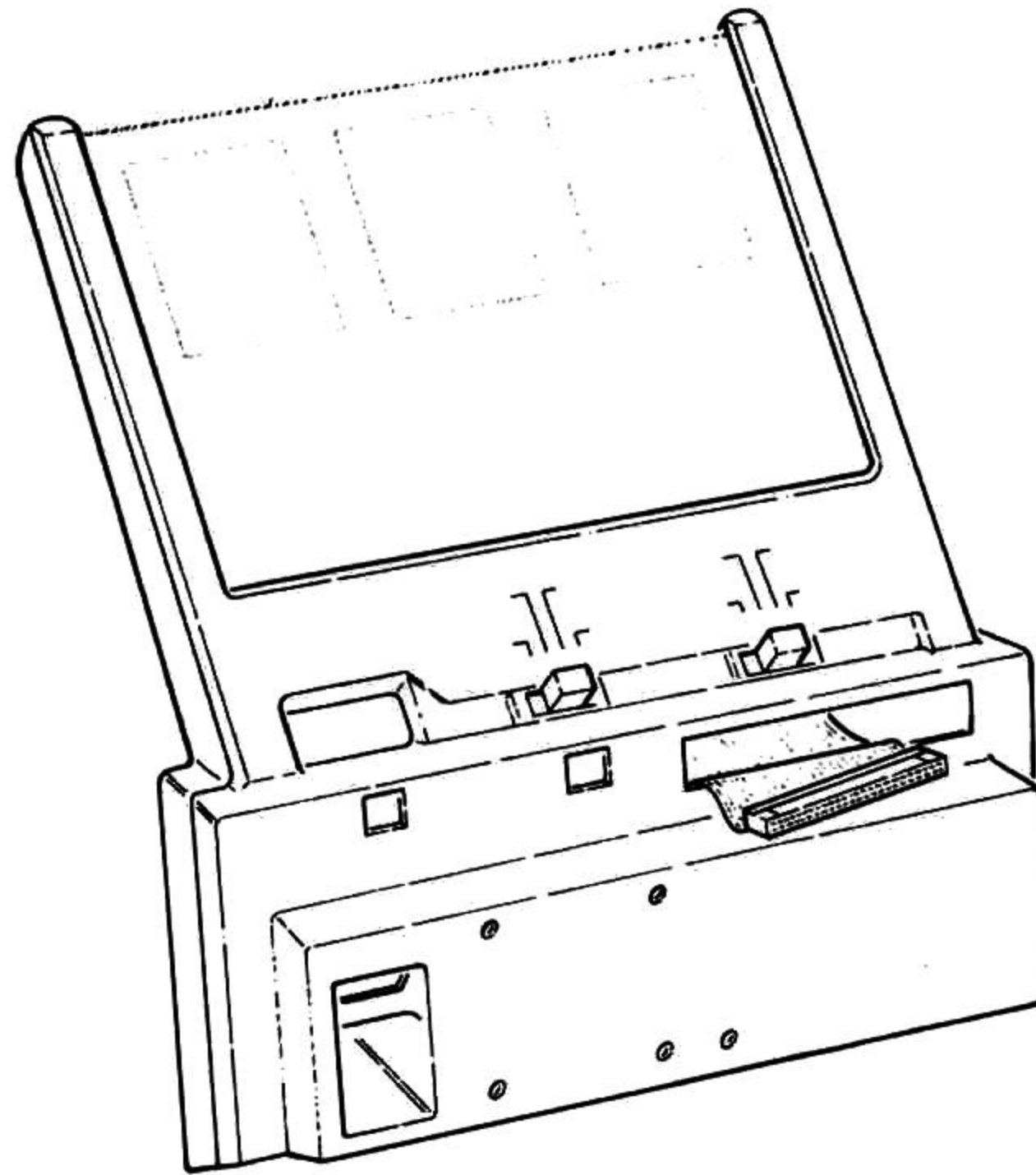
**SHIPPING UNITS** — Follow the packing instructions published in the assembly manuals. Damage due to inadequate packing cannot be repaired under warranty.

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.

# ACCESSORY BACKPACK

## Model ETW-3567

595-3828-03



HEATH COMPANY  
BENTON HARBOR, MICHIGAN 49022

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## WARNING

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

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

- Move the computing device away from the receiver being interfered with.
- Relocate the computing device with respect to the receiver.
- Reorient the receiving antenna.
- Disconnect and remove any experimental connecting leads and/or I/O cables that are not being used. (Unterminated leads and/or I/O cables are a potential source of high RF emission levels.)
- Unplug and remove any experimental circuits that are not being used.
- Obtain results of the experiment as quickly as possible, then turn the computing device off.

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

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# INTRODUCTION

The Heathkit/Zenith Model ETW-3567 Accessory Backpack extends the versatility of your Heathkit/Zenith Electronic Trainer. It mounts directly to the Trainer and provides three regulated voltage sources for experiments. In addition, a 3-1/2 digit digital multimeter allows voltage, current, and resistance measurements on experimental circuits. This eliminates the need for further test equipment to perform most circuit measurements of the Heathkit/Zenith Educational courses.

Other Accessory Backpack features include:

- Programmable, positive and negative 1.2- to 15-volt DC power supplies to power analog, linear, and CMOS circuits.
- A 5-volt DC power supply for TTL logic circuits.
- AC and DC voltage measurements up to 500 volts.
- DC current measurements up to 200 mA.

- Resistance measurements up to 2 Megohms.
- A fused, high-impedance voltmeter input for maximum circuit protection and minimum circuit loading.
- Large, easy-to-read numerals with automatic polarity indication.
- Connectors for accepting experiment circuit boards from Heathkit/Zenith Educational Systems courses.

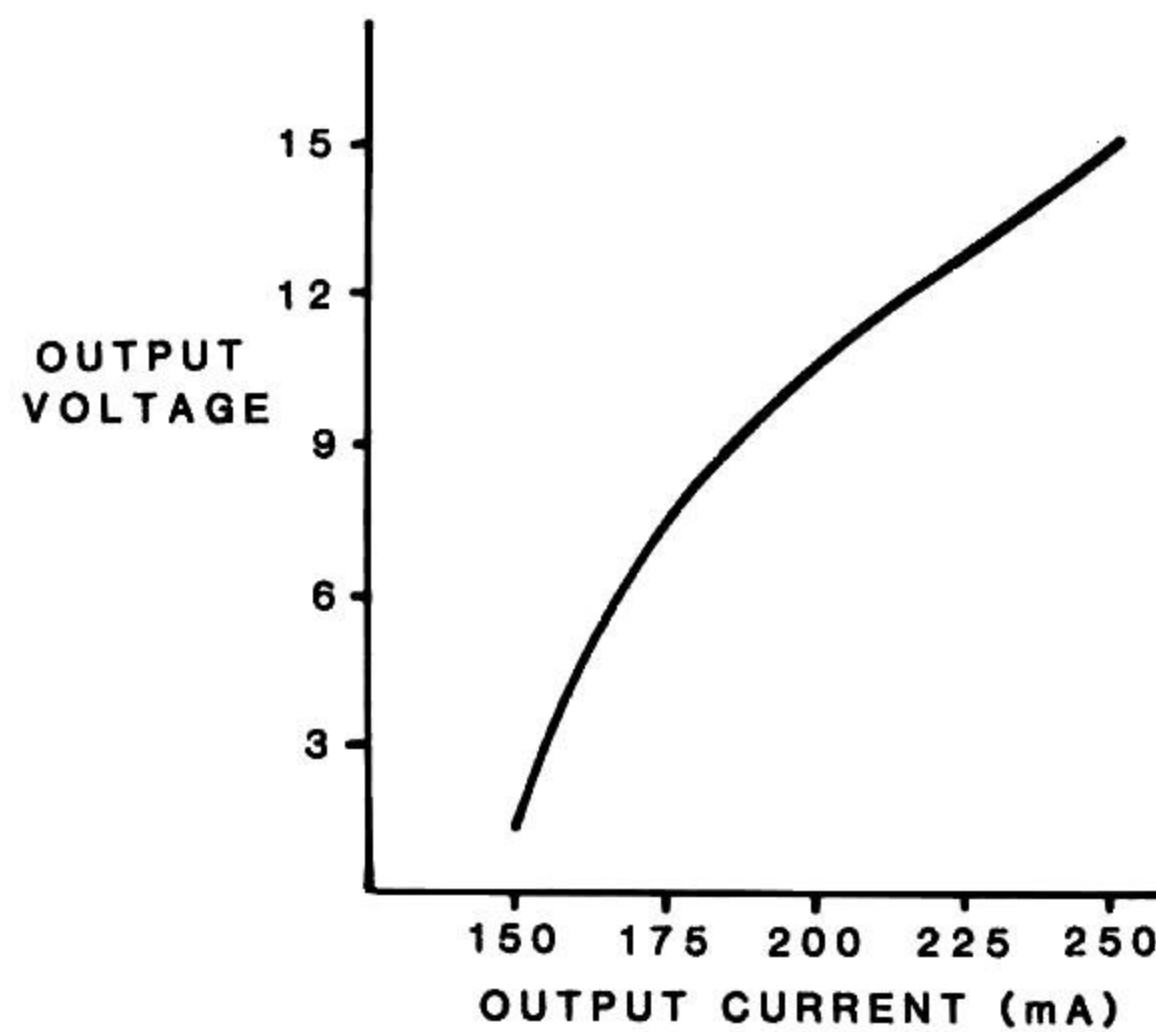
For ease of construction, most components mount on two circuit boards. AC power is coupled through the power switch of the associated Trainer, thus assuring that power for experimental circuits and the DMM is always applied when the Trainer is on.

The careful, modern design of the Accessory Backpack will provide long, reliable performance for bench testing, experimenting, or learning with your Heathkit/Zenith Electronic Trainers and educational courses.

# SPECIFICATIONS

## POWER SUPPLIES

Output Voltages ..... (All regulated)	+1.2 to +12 volts, programmable; -1.2 to -12 volts, programmable; (current derated from 250 mA at 12 volts to 150 mA at 1.2 volts; see graph); +5 volts at 500 mA.
Load Regulation .....	± 12 volt supplies better than 1%. 5-volt supply better than 2% ( $I_{out}$ 10mA to Max).
Line Regulation .....	Better than 1% (all supplies).
Ripple and Noise .....	Less than 25 mV.





**DMM (Digital Multimeter)**

Input Impedance .....	10 Megohms.
Display .....	3-1/2 digit, LCD (liquid crystal display).
Functions .....	AC volts, DC volts, DC current, Resistance.
<b>Ranges:</b>	
AC Volts .....	200, 500.
DC Volts .....	2, 20, 200, 500.
DC Current (mA) .....	2, 20, 200.
Resistance (Ohms) .....	2 k, 20 k, 200 k, 2000 k (2 M).
<b>Accuracy:</b>	
AC Volts .....	2% of reading, + 2 counts (referenced to 60 Hz).
DC Volts .....	1.5% of reading, + 2 counts.
DC Current .....	2.5% of reading + 2 counts.
Resistance .....	1% of reading, + 2 counts.
Maximum Inputs .....	AC and DC volts: 500. DC current: 200 mA.
Power Requirements .....	105-130 VAC or 210-260 VAC, 50/60 Hz @ 35 watts.
Dimensions .....	12" wide × 13-1/2" deep × 3-1/2" high. (30.5 × 34.3 × 8.9 cm)
Weight .....	5-1/2 lbs. (2.5 kg.)
Laboratory standard to be used for setting accuracy.	

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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.

# INSTALLATION

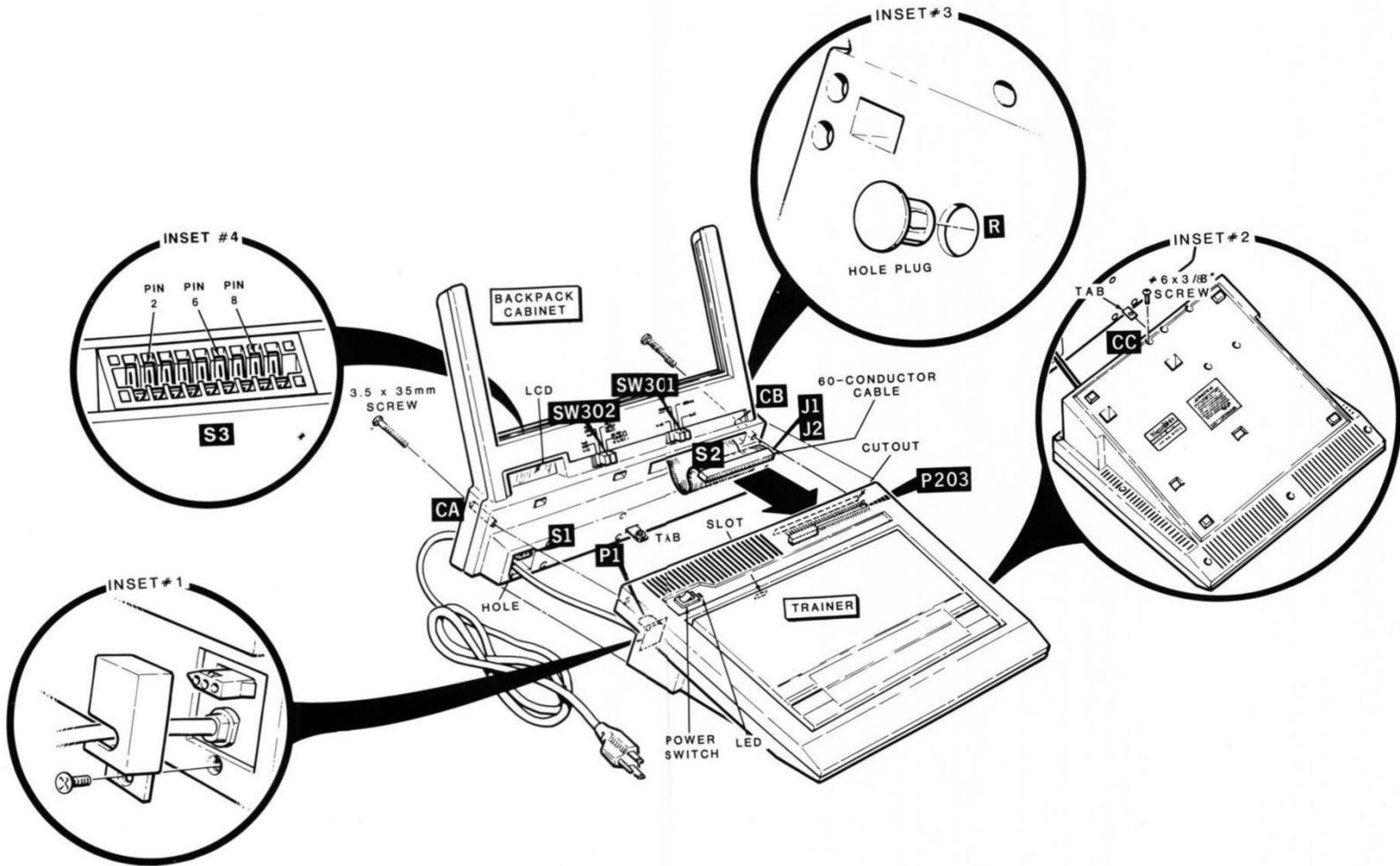
## BACKPACK INSTALLATION

Refer to Pictorial 2 and use the following procedure to attach the Backpack to the rear of your Trainer.

1. Remove the 6-32 × 3/8" flat head screw securing the AC shield to the rear of your Trainer, and the AC shield. Then reinstall the screw.
2. Pass the Trainer line cord through the hole in the Backpack cabinet.
3. Position the Backpack near the rear of the Trainer. Then pass the connector on the end of the 60-conductor cable through the Trainer cabinet cutout and connect it to P203 on the main circuit board of the Trainer.
4. Align power socket S1 with plug P1 on the Trainer. Then press the Backpack onto the Trainer, making sure P1 and S1 mate. Be sure the tab on the mounting bracket enters the slot in the rear of the Trainer. (See inset drawing #2.)
5. Secure the Backpack to the Trainer with two 6-32 × 1-3/8" screws at CA and CB, and a 6-32 × 3/8" screw at CC.

This completes the installation of the Backpack. Proceed to "Operation and Applications."





PICTORIAL 2

# OPERATION AND APPLICATIONS

This section of the Manual provides you with instructions for selecting and using the DMM (Digital Multimeter) functions and ranges. It also tells you how to make voltage, current, and resistance measurements in electronic circuits.

## OPERATION

Refer to Pictorial 3 as you read the following paragraphs.

The ETW-3567 Accessory Backpack is powered directly from the Heathkit/Zenith Electronic Trainer it is attached to, through the Trainer's Power switch. Whenever your Trainer is turned on, the Backpack power supplies and DMM circuits are also turned on and ready to use. The power supplies provide operating voltages and signals for the experiment circuit boards used with the Heathkit/Zenith Educational Systems courses.

### FUNCTION SWITCH (SW301)

This switch selects one of four operating modes for the DMM:

**K $\Omega$**  — In this mode, the DMM becomes an ohmmeter that measures resistances up to 2 Megohms (2,000,000 ohms).

**mA** — This position changes the DMM into an ammeter, allowing measurement of DC currents up to 200 mA (.2 amperes).

**DCV** — This mode converts the DMM into a DC voltmeter that measures DC voltages up to 500 volts.

**ACV** — This mode changes the DMM into an AC voltmeter. However, the voltage being measured is first passed through a rectifier and a filter circuit to convert it into DC. The voltage is then measured as a DC voltage. **IMPORTANT:** This mode will accurately measure AC voltages only in the 200 V and 500 V ranges. Readings made in other ranges will not be accurate.

## RANGE SWITCH (SW302)

The RANGE switch selects the maximum allowable input range for the selected function. When you are making measurements, always start with the Range switch in the highest position, unless you know the voltage, current, or resistance being measured will not exceed a lower range.

The following chart shows the minimum readings and maximum limits for each position of the Range switch. Current measurements are in milliamperes (.001 amperes); resistance measurements are in ohms (k = 1000; M = 1,000,000).

RANGE	MINIMUM	AC VOLTS	DC VOLTS	DC CURRENT	RESISTANCE
2 V	.000	—	1.999 V	1.999 mA	1.999 k $\Omega$
20 V	0.00	—	19.99 V	19.99 mA	19.99 k $\Omega$
200 V	00.0	199.9 V	199.9 V	199.9 mA	199.9 k $\Omega$
500 V	000	499 V	499 V	199.9 mA*	1999 k $\Omega$

\* No decimal point is displayed in the 500 V range. Therefore, the maximum value for DC current will be displayed as "1999" but will be 199.9 mA, as shown on the chart.

## OPERATING CHARACTERISTICS

### Polarity Indication

All voltage readings are implied positive and no polarity sign is displayed for positive values. A minus sign (–) will automatically appear whenever a negative voltage is measured.

### Input Overload

All functions of the DMM are protected against input overloads, either by resistor-diode networks, or through fuse action.

## Overload/Overrange Indication

An overload/overrange condition is indicated when all display digits, except the most significant digit ("1"), are blanked. This does not necessarily mean that the DMM is being exposed to a damaging input condition. For example, when you measure resistance, an open-input (infinite resistance) measurement will cause an overload/overrange condition.

NOTE: When you are measuring resistance, the minus sign (–) may flash momentarily as your DMM recovers from an overload/overrange condition. However, if the minus sign remains on for an in-range measurement, it indicates a voltage is present in the circuit being tested. The voltage may be due to charged capacitors, or to power being applied to the circuit. In either case, the resistance displayed will be incorrect.

### ± 1 Count

It is normal for the right-hand digit of the display to alternate one digit above and below a reading on successive measurements. This is due to the nature of the digital DMM circuitry.

### Fuse Replacement

The DMM circuit is protected in all modes by fuse F1. Replace this fuse ONLY with a 1/4-ampere, 250 V, 3AG regular (**fast-blow**) fuse. Use of a higher-current-rated fuse, or a slow-blow type, may result in damage to the DMM circuitry.

In addition to the DMM input fuse, all of the Accessory Backpack circuitry is protected by AC line fuse F2. This fuse should be replaced only with a 1/4-ampere, 250 V, 3AG **slow-blow** fuse.

## APPLICATIONS

Your Accessory Backpack can be used to power the experimental circuit boards of the Heathkit/Zenith Educational programs, such as the Analog and Digital Electronics courses. The DMM allows you to measure voltages, currents, and resistances of the various circuits on these boards, as well as those of other electronic devices. This section of the Manual gives you general measuring techniques for voltage, current, and resistance measurements using the DMM.

NOTE: In the following paragraphs, UUT refers to the unit (or circuit) under test.

### AC Voltage Measurements

**WARNING:** For any AC voltage measurement, do not connect the common (black) test lead to a voltage that exceeds 350 volts rms, or 500 volts (DC plus peak AC) above earth (power line) ground. This can present a safety hazard or damage the DMM. Also, **NEVER CONNECT THE DMM TO AN AC LINE THAT HAS POWER APPLIED.** ALWAYS remove power from the line being measured first. Then connect the DMM test leads, apply power for your measurement, and, finally, remove the power before you disconnect the DMM leads.

#### NOTES:

- A. Any input other than a pure sine wave will cause an error because the AC converter in the DMM circuit is average-sensing and rms (sine wave) calibrated. Square waves, sawtooth waves, etc. can be measured best with an oscilloscope.
- B. Allow several seconds for the DMM to stabilize before you make any AC measurements. This also applies after an overload/overrange condition occurs.
- C. On the two AC voltage ranges (200 and 500 V), the input voltage is AC coupled (capacitive) to the DMM so that DC voltage is blocked.

- D. The DMM may require a few seconds to obtain a stable ( $\pm 1$  count) display.
- E. Use only the 200 V or 500 V range for AC voltage measurements. Other ranges will not provide accurate voltage readings.

1. Turn the Trainer POWER switch on.
2. Set the FUNCTION switch to ACV and the RANGE switch to 500 V.
3. Connect the black test lead to the black jack (J1) and the red test lead to the red jack (J2).
4. Disconnect the line cord of the unit under test (UUT) if measuring voltage on an AC line.
5. Connect the black clip to the chassis and the red clip to the measurement point.
6. Reconnect the AC line cord (if necessary). Then turn the UUT on and observe the DMM display. For readings less than 200 counts (200 VAC), you may select the lower (200 V) range for increased resolution.
7. Turn the power off and disconnect the line cord of the UUT (if necessary) before removing the test leads.

### DC Voltage Measurements

**WARNING:** For any DC voltage measurement, do not connect the common (black) test lead to a voltage that exceeds 350 volts rms, or 500 volts (DC plus peak AC) above earth (power line) ground. This can present a safety hazard or damage the DMM.

**CAUTION:** 500 volts (DC plus peak AC) is the maximum voltage allowable between the test leads.

To prevent possible electric shock when you are measuring voltages that you suspect are above 50 VDC, remove power from the UUT before you connect and disconnect the test leads.

**NOTE:** When you are measuring voltages in circuitry with a relatively high resistance (above 100 k $\Omega$ ), some loading of the circuit will occur when you connect the test leads. This will result in a slightly lower voltage reading than is actually present.

1. Set the Trainer POWER switch to on, the DMM FUNCTION switch to DCV, and the RANGE switch to 500 V or as required for the input voltage level.
2. Connect the test leads to the DMM input jacks (J1 and J2).
3. Connect the black test lead to the chassis or circuit ground of the UUT.
4. Touch the red test lead to the measurement point and observe the display. If necessary, set the RANGE switch to a higher value if an overload/overrange condition appears. For readings less than 200 counts, you may select a lower range for increased resolution

## DC Current Measurements

### WARNINGS:

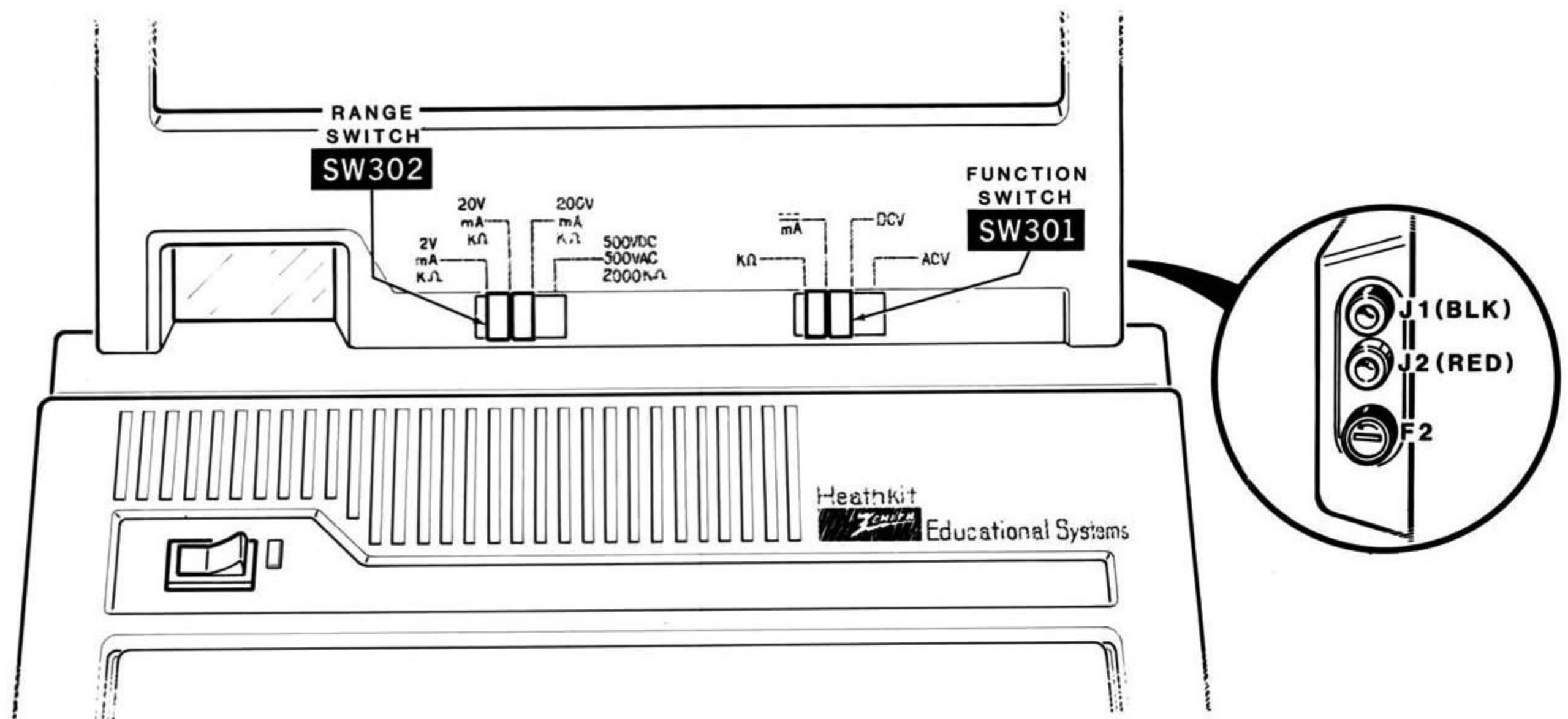
- A. For any DC current measurement, do not connect the common (black) test lead to a voltage that exceeds 350 volts rms, or 500 volts (DC plus peak AC) above earth (power line) ground. This can present a safety hazard or damage the DMM.

- B. Personal injury or DMM damage may result if the fuse opens while you are measuring current in a circuit with an open-circuit voltage greater than 250 V.

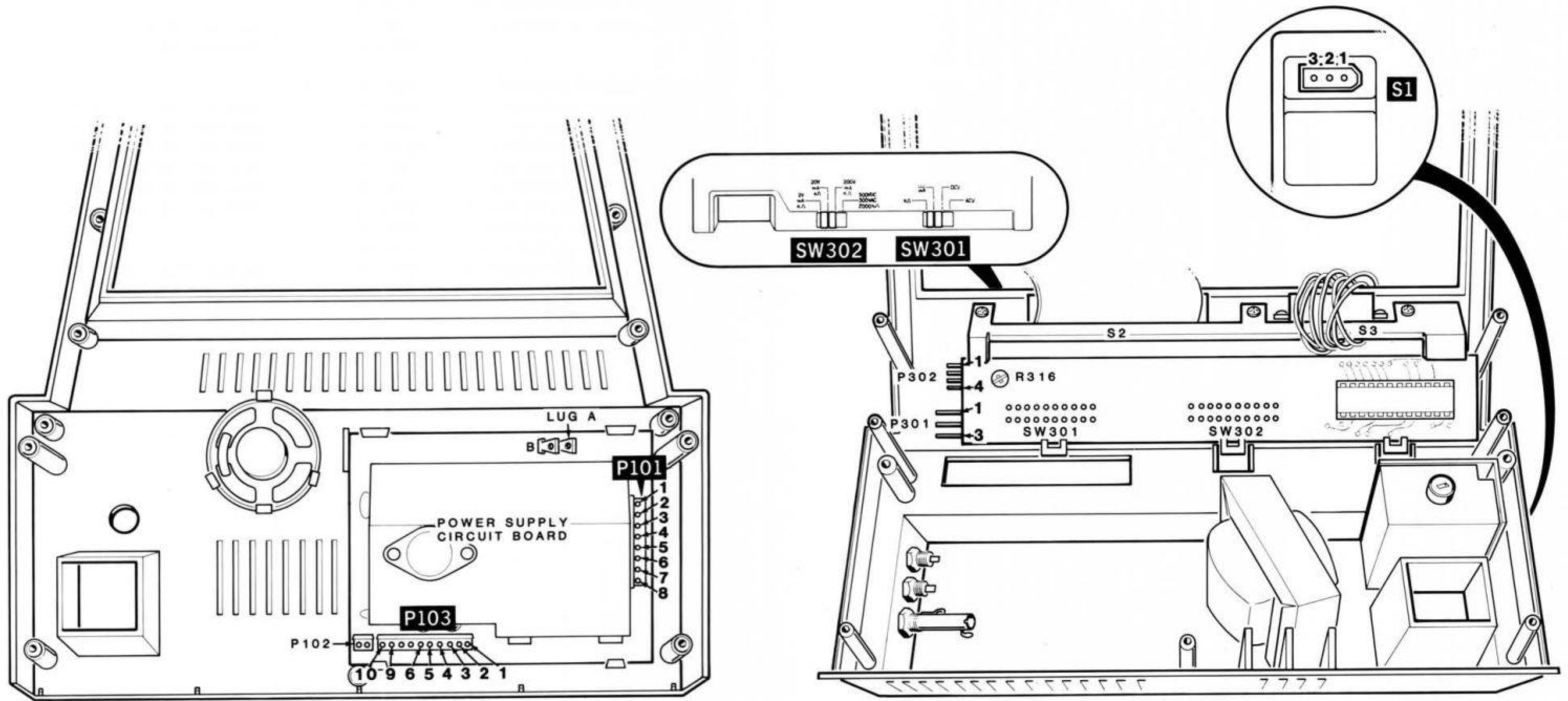
**CAUTION:** The DMM is fuse-protected for a 250 mA maximum DC current on the mA ranges. If this is exceeded, the fuse will open, the display will read zero, and the circuit under test will be opened.

1. Set the Trainer POWER switch to on, the DMM FUNCTION switch to mA, and the RANGE switch to 200 V (200 mA).
2. Turn the power off to the UUT.
3. Connect the test leads to J1 and J2.
4. For current measurements, the DMM is placed in series with the circuit being tested. Therefore, you must open the circuit at its supply voltage point. First, connect the black test lead to the circuit being tested. Then connect the red test lead to the supply voltage source. (The black test lead always goes to the point closest to ground in the opened circuit, and the red lead always goes to the **most positive** point.)
5. Turn the power to the UUT on and observe the DMM display. For readings less than 200 counts, you may select a lower range for increased resolution.
6. Turn the UUT power off, disconnect the test leads, and restore the circuit to its original condition.





**PICTORIAL 3**



PICTORIAL 4

**Resistance Measurements**

**CAUTION:** Before you make in-circuit resistance measurements, make sure you disconnect power to the circuit. Also discharge all capacitors, especially electrolytics.

**NOTES:**

- A. The resistance of the test leads may add an additional .1 to .3 ohms to the total measured resistance.
- B. When you make measurements in the highest range, the test leads may pick up stray line noise, which may result in erratic behavior of the last digit in the display. You can minimize this effect by twisting the test leads together and keeping your hands away from the test leads.
- C. If an overrange occurs while you are making resistance measurements in the highest range, it may take several seconds for the display to show the correct, measured value.
- D. When you make in-circuit resistance measurements in circuits with semiconductors (diodes, transistors, ICs), you may have to reverse the test leads to obtain the most accurate reading. The voltage used for resistance tests is high enough to forward-bias semiconductor junctions, thus causing lower than normal readings. For accurate in-circuit measurements, remove the semiconductor device, or isolate it from the circuit by lifting one or more leads.
- E. You can use the ohmmeter to check diodes and transistors for shorted or open conditions. To do this, connect the test leads across the device and note the reading. Then reverse the lead connections and note the reading. Most diodes will have a forward to reverse resistance ratio of at least 10:1 when measured in the lowest ( $2k\Omega$ ) resistance range. Most transistors will exhibit a higher reverse than forward resistance between their base, emitter and collector leads.

## CALIBRATION

Your ETW-3567 Accessory Backpack has been factory calibrated and should not need recalibration when you receive it. This section of the Manual is provided to allow you to recalibrate the DMM circuit should you suspect that the voltage readings are no longer accurate.

The following steps allow you to adjust the accuracy of the DMM circuitry to within 6% using a known reference (the 5-volt power supply). You will also test the polarity indicator using the two programmable 12-volt power supplies. NOTE: For greater accuracy, use a high accuracy (1%) voltage standard with an output voltage between 5.0 and 15.0 VDC.

Refer to Pictorial 2 for the following steps.

- ( ) Set FUNCTION switch SW301 to the DCV position.
  - ( ) Set RANGE switch SW302 to the 20 V range.
  - ( ) Use a small blade-type screwdriver to set control R316 to the center of its range. This control is on the foil side of the DMM circuit board, and is accessible through hole R in the back of the Backpack. NOTE: You will have to remove a small hole plug. Refer to inset drawing #3.
  - ( ) Connect the Trainer line cord to an AC outlet and set the Trainer POWER switch to on. The LED on the Trainer will light, and the LCD on the Backpack should read 0.00,  $\pm 1$  count. NOTE: A negative (-) sign may be present or flashing in front of the first "0" on the display.
  - ( ) Insert the banana plug on the black test lead into jack J1 and the banana plug on the red test lead into jack J2.
  - ( ) Insert a cutoff component lead or 1" length of bare wire into any ground (GND) connector block on the Trainer.
  - ( ) Connect the black clip to the ground wire by pressing on the back of the clip to expose its hooked end, placing the hook over the wire, and then releasing the back of the clip.
  - ( ) Refer to inset drawing #4 and locate power cable socket S3 at the bottom of the slide-in module holder.
  - ( ) Push on the back of the red clip to expose the hooked end and touch the end to S3 pin 2. The display should indicate about 5 volts. Adjust R316 (through hole R) for a reading of 5.00 volts. NOTE: The negative (-) sign should not be showing.
- Alternately, connect the black lead to the negative (-) terminal, and the red lead to the positive (+) terminal of a known voltage standard of between 5 and 12 VDC. Then, carefully adjust R316 until the display reads the exact voltage of the standard.
- ( ) Touch the red clip to S3 pin 6. The display should indicate about -12 volts with the negative (-) sign showing.
  - ( ) Touch the red clip to S3 pin 8. The display should indicate about 12 volts positive (no polarity sign will appear).
  - ( ) Set the FUNCTION switch to the ACV position.
  - ( ) Set the RANGE switch to the 200V position.
  - ( ) Touch the red clip lead to S3 pin 9. The display should indicate about 18 volts (AC).
  - ( ) Disconnect the test leads, turn the Trainer off, and reinstall the small hole plug into hole R.

## IN CASE OF DIFFICULTY

This part of the Manual helps you locate and correct difficulties which might occur in your Accessory Backpack. This information is divided into the "Visual Checks," "Precautions for Troubleshooting," 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" (Pages 26 — 28) are also provided to help you locate the circuit components.

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

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 Backpack 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 power socket to be sure it is inserted into the plug of the Trainer, and that the Trainer is turned on and connected to an outlet that 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 of one or more power supplies caused by excess current draw from your experimental circuit, or a component failure in your circuit or the power supply circuitry inside the Backpack. You can isolate an experimental circuit cause by lifting the experiment circuit board clear of its mating socket on the Backpack, replacing the fuse, and checking to see if the LCD display appears when power is again applied.

4. Disconnect the Trainer from the AC outlet and the Backpack from the Trainer. Then remove the cabinet screws and check for signs of damaged or burned components on the power supply circuit board. Read the "Precautions for Troubleshooting" section and perform the "Resistance Tests" that 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 AC bracket wiring, and is potentially lethal. Be careful to avoid electrical shock when you work on this unit with the Trainer's line cord connected to an AC outlet and power applied.**

### RESISTANCE TESTS

You will need a high-input-impedance (1 M $\Omega$  or greater) VOM (volt-ohm-milliammeter), DVM (digital voltmeter), or VTVM (vacuum tube voltmeter) to make the following resistance tests. If a meter is not available, check U101, U103, and U104 on the power supply circuit board for signs of overheating.

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 of this Manual.

- ( ) Refer to Pictorial 2 and remove the three screws that attach the Backpack to the Trainer. Then pull the line cord through the hole in the Backpack, and lift the Backpack off.
- ( ) Refer to Pictorial 1 and remove the eleven screws that secure the Backpack cabinet front to the back, and lift the back off.

Refer to Pictorial 4 for the following steps.

- ( ) Set the ohmmeter to the R  $\times$  1000  $\Omega$  (1k $\Omega$ ) range.
- ( ) Connect one lead of the ohmmeter to S1 pin 2. Touch the other lead to S1 pin 1. The ohmmeter should indicate infinity (an open circuit).
- ( ) Touch the free lead of the ohmmeter to S1 pin 3. The ohmmeter should indicate infinity.
- ( ) Connect one lead of the ohmmeter to S1 pin 1 and touch the other lead to S1 pin 3. The ohmmeter should indicate a very low resistance (near 0 ohms).
- ( ) Connect the common (-) lead of the ohmmeter to flat connector lug A on 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. Remove any connector installed at the test point, and complete all the tests before reinstalling the connector.

#### NOTES:

1. In the following chart, P101-6 means to touch P101, pin 6, with the free ohmmeter lead; > = greater than.
2. You may have to allow several seconds for capacitors to charge before obtaining the highest reading.

<u>Test Point</u>	<u>Resistance</u>
( ) P101, pins 1 and 3	>20 k $\Omega$
( ) P101-6	0 $\Omega$
( ) P101, pins 7 and 8	>15 k $\Omega$
( ) P103-1	>20 k $\Omega$
( ) P103, pins 3 thru 6	>1 k $\Omega$
( ) P103-10	>4 k $\Omega$

# Heathkit®

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- ( ) Set FUNCTION switch SW301 in the  $K\Omega$  position and RANGE switch SW302 in the 2V position.
- ( ) Connect the negative ohmmeter lead to P301-3. Touch the positive ohmmeter lead to P301-1. The meter should indicate at least 20  $k\Omega$ .
- ( ) Connect the negative ohmmeter lead to P302-1. Touch the positive ohmmeter lead to P302-4. The meter should indicate  $>10 k\Omega$ .
- ( ) Disconnect the ohmmeter leads.
- ( ) Reinstall the cabinet back onto the front with the eleven screws that you removed earlier.
- ( ) Mount the Backpack to the Trainer with the three screws that you removed earlier.

Refer to the "Calibration" section for power supply voltage tests.

## TROUBLESHOOTING CHARTS

The following Troubleshooting Charts list specific difficulties that could occur in your Accessory Backpack. Several possible causes may be listed for each difficulty. Refer to the "Circuit Board X-Ray Views" and the "Schematic Diagrams" to locate and identify the parts listed in this chart.

If a particular part is mentioned (U101 for example) as a possible cause, check that part and other components connected to it.

### RESISTANCE CHART

PROBLEM	POSSIBLE CAUSE
Power socket S1 resistances are low or high.	1. F2 open.
P101 pin 1 or pin 3 measures less than 50 k $\Omega$ .	1. D101 or D102. 2. U101.
P101 pin 7 or pin 8 measures less than 15 k $\Omega$ .	1. D103-D106. 2. U102-U105.
P103-1 measures less than 20 k $\Omega$ .	1. D105 or D106.
P103 pin 3 or pin 4 measures less than 1 k $\Omega$ .	1. D107. 2. R102. 3. U103.
P103 pin 5 or pin 6 measures less than 1 k $\Omega$ .	1. D108. 2. R104. 3. U104.
P103-10 measures less than 4 k $\Omega$ .	1. U101.
Resistance between P301-1 and P301-3 is below 20 k $\Omega$ .	1. U301. 2. U302.
Resistance between P302-1 and P302-4 is below 10 k $\Omega$ .	1. Range or Function switch in wrong position. 2. Q301.

### VOLTAGE CHART

PROBLEM	POSSIBLE CAUSE
No + 5 VDC at S3 pin 2.	1. U101.
R316 will not adjust for a 5.00-volt LCD display.	1. U101. 2. R314, R315, or R317. 3. U302.
No - 12 VDC at S3 pin 6.	1. U104.
No + 12 VDC at S3 pin 8.	1. U103.



## CIRCUIT DESCRIPTION

Refer to the Schematic Diagrams (fold-out from Pages 19-20) 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 Not used.
- 301 – 399 Parts mounted on the DVM circuit board.

### POWER SUPPLIES

AC line voltage is connected through the Power switch of the Trainer the Backpack is mounted on, and fuse F2, to the primary windings of T1. Voltage from one secondary is then fed to the power supply circuit board and supplies the  $\pm$  programmable 15 VDC sources, while a another secondary winding supplies voltage for the +5 VDC supply. Voltage from still another secondary is connected to P301 on the DVM circuit board to provide an independent power supply for the voltmeter circuits.

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 U103 to supply the programmable positive voltage power source. Resistor R102, and a programming resistor located on the experimental circuit board for your particular Heath/Zenith Educational course, determine the output voltage of the regulator. The value of the programming resistor, which is connected through socket S2 pin 5, can be changed to vary the regulated voltage from U103 from +1.2 volts 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 supply operates in the same manner. Voltage from D103 and D105 is applied to the input of U104 to supply the variable negative voltage power source. R104 and the experimental circuit board programming resistor, connected through S2 pin 7, set the negative source output voltage. By changing the value of the programming resistor, you can set the output voltage of U104 to any level from -1.2 volts to -15 volts.

The +5 VDC source operates in a similar manner, except that AC voltage is rectified by D101 and D102, filtered by C101 and C102, and regulated to +5 volts by U101. C103 further filters the regulator output. No output programming resistors are required for U101.

## DMM (Digital Multimeter) CIRCUIT

### DMM Power Supply

AC voltage from one secondary of power transformer T1 is rectified by D301 and filtered by C301. The resulting DC voltage is then regulated to +9 volts by U301. C302 filters the regulated output before it is used to power the DMM circuits and supply a regulated reference voltage for the A/D converter.

### Basic Meter Circuit

The DMM circuit is comprised of an Analog-to-Digital (A/D) converter (U302), a liquid crystal display (LCD301), and a DC voltage reference source (R314-R317). This circuit provides a digital indication for DC voltages between -199.9 millivolts and +199.9 millivolts. MOS/LSI\* integrated circuit U301 contains all of the active analog, digital, timing, and display driver circuits required for the 3-1/2 digit A/D conversion.

The reference voltage across R314-R317 is applied to A/D  $V_{REF HI}$  and  $V_{REF LO}$  inputs in the voltage and current modes of operation. This voltage charges reference capacitor C306 once every conversion cycle (once every .4 seconds). R312 and C306 provide low-pass filtering for the reference voltage, reducing noise effect. When the DMM is operated in the resistance mode, the reference circuit is used as a voltage source for resistance measurements.

C305 and R318 are oscillator components which determine the A/D converter's oscillator frequency of approximately 40 kHz. This frequency provides 2-1/2 conversions per second and helps suppress 50 and 60 Hz noise. The entire conversion timing sequence is controlled by this oscillator.

U302 is powered by the output voltage from U301, which is connected across  $V_{DD}$  and  $V_{SS}$ . An internal regulator in U302 sets  $V_{DD}$  (pin 1) at approximately +2.8 volts with respect to the COM pin (32). The COM pin is used as analog ground.

$V_{IN LO}$  (pin 30) and  $V_{IN HI}$  (pin 31) are the analog signal inputs to the A/D converter. C309 and R313 provide low-pass filtering of the input signal to suppress AC line and noise signals from the input DC signal.

C308 is charged by internally generated voltages to compensate for offset voltages in the analog circuitry of U302. This "automatic zeroing" ensures that the digital display will be zero for a zero voltage input to the converter input.

Integrating capacitor C307 and integrating resistor R319 are used in conjunction with the internal circuitry of U302 to integrate the analog input voltage over a fixed time interval. After integration, the voltage across the reference capacitor is used to return the integrator output to zero. The time required for the output to return to zero is proportional to the analog input signal.

### Resistance Measuring Circuit

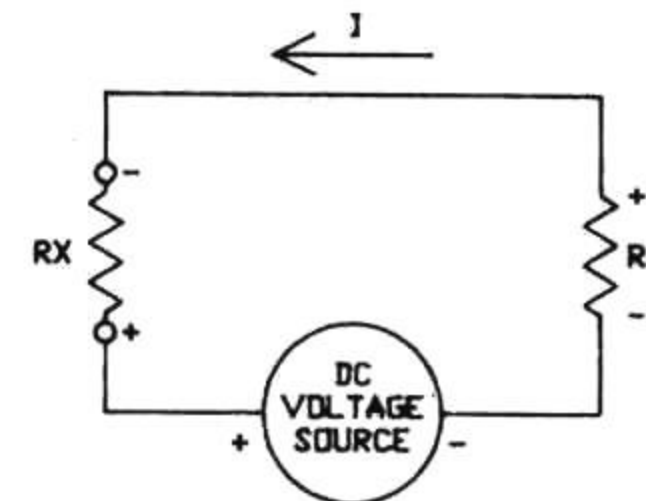


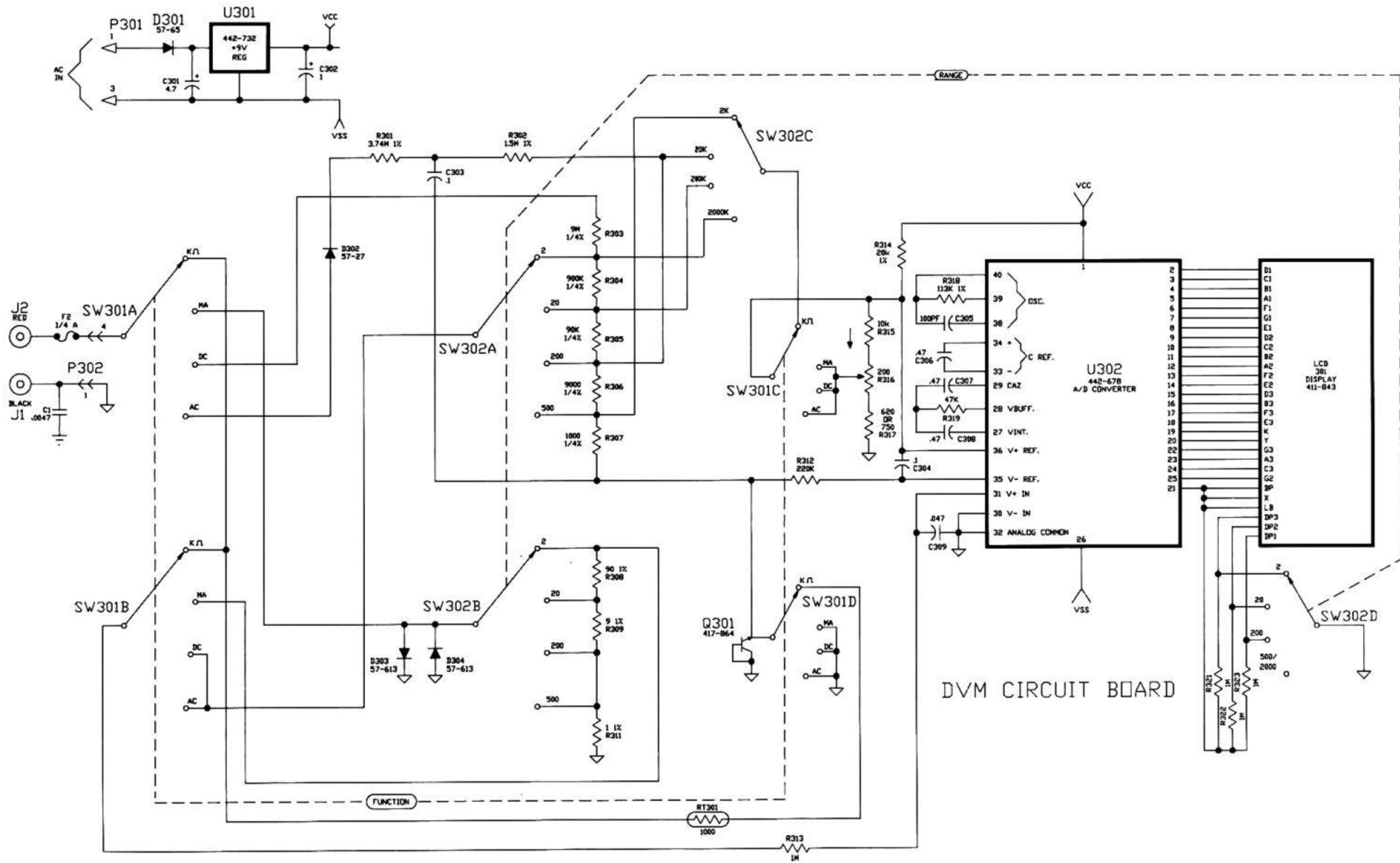
FIGURE 1

Resistance measurements are accomplished with a ratiometric technique which compares the voltage across standard resistor  $R_s$  with the voltage across unknown resistor  $R_x$  (see Figure 1). This is possible since the converter produces a display that is proportional to the ratio of the analog input voltage ( $V_{in}$ ) to the reference input voltage ( $V_{ref}$ ). Specifically, the digital value displayed is:

$$1000 \left( \frac{V_{in}}{V_{ref}} \right).$$

Therefore, if these two voltages were equal, the value 1000 would be displayed.

\*Metal Oxide Semiconductor/Large Scale Integration



DVM CIRCUIT BOARD

In the Pictorial, the DC voltage source forces the same current to pass through the standard and unknown resistors. This produces a voltage drop ( $R \times I$ ) that, when substituted in the above equation, reduces to:

$$1000 \left( \frac{R_x}{R_s} \right).$$

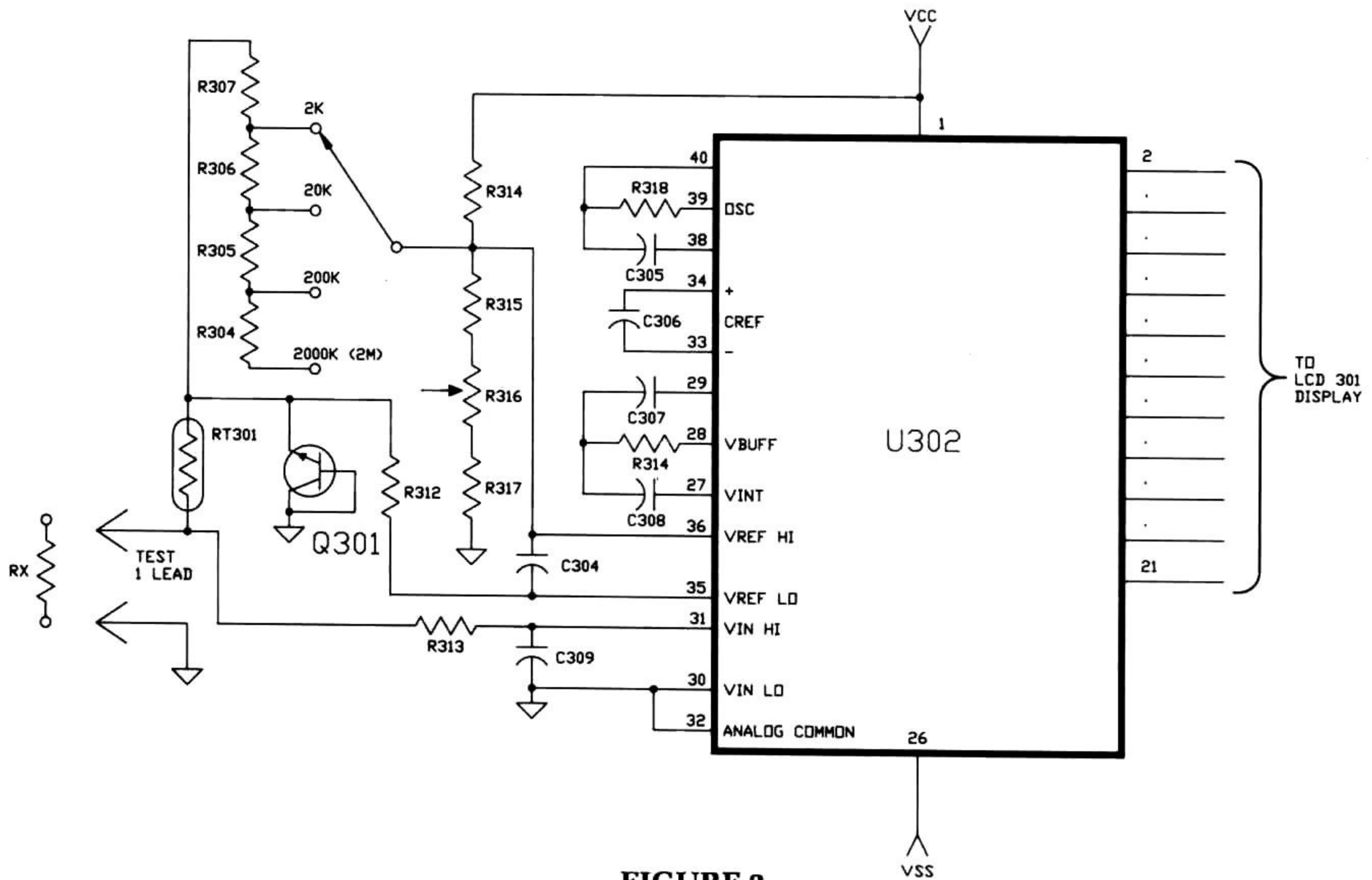
Since the value of standard resistor  $R_s$  is chosen to be some power of 10, the displayed value is equal to the unknown resistance times a power of 10 scaling factor.

Figure 2 shows that the voltage across unknown resistor  $R_x$  is applied to A/D converter inputs  $V_{IN HI}$  and  $V_{IN LO}$  through a low-pass filter and protection circuitry. The voltage across standard resistor  $R_s$  ( $R_{304}$ - $R_{307}$ ) is applied to converter inputs  $V_{REF HI}$  and  $V_{REF LO}$  through a low-pass filter made up of  $R_{312}$  and  $C_{306}$ . Transistor  $Q_{301}$  is connected as a zener diode; therefore, its emitter-collector voltage is limited to approximately 9 volts when the "diode" is reverse-biased by a positive overload voltage.

When the "diode" is forward-biased by a negative overload voltage, the emitter-collector voltage of  $Q_{301}$  is approximately  $-0.7$  volts. In either case, a current path exists through  $Q_{301}$ ,  $RT_{301}$ ,  $R_{313}$ , and the source of the overload.  $RT_{301}$  acts as a linear resistor until the current through it exceeds 12 mA. Above this value its resistance increases rapidly in a nonlinear manner, limiting the current to some value less than 12 mA. This provides protection for the reference inputs as well as for the DC voltage source.

**Decimal Point Circuit**

The proper decimal point is determined by section D of Range switch  $SW_{302}$ . Pull-up resistors  $R_{321}$ ,  $R_{322}$ , and  $R_{323}$  normally keep their respective decimal points turned off. When  $SW_{302}$  is placed in the 2 V range,  $R_{321}$  is connected to ground, removing the voltage from decimal point element  $DP_3$ , causing it to appear on the display. In the 20 V range,  $DP_2$  turns on when  $R_{322}$  is grounded, and  $DP_1$  appears when  $R_{323}$  is grounded in the 200 V range.



**FIGURE 2**

**Voltage Divider/Standard Resistors**

R303-R306 form a decade resistive divider network for attenuating input voltages and determining the value of the reference resistor for resistance measurements. Range switch SW302A selects the proper tap in the divider network for voltages. SW302C selects the proper tap for resistances.

**Current Shunts**

R308, R309, and R311 are used as current shunts for DC current measurements. D303 and D304 are voltage clamps which protect the shunts from voltage and current overloads.

**AC Voltage Measurements**

AC voltages are rectified by D302 and filtered by R301, R302, and C303. The resulting DC voltage is then applied to one tap of the divider network at R306 and R307. It is then measured and displayed as a DC voltage.

# REPLACEMENT PARTS LIST

## NOTES:

- Component values and circuit component numbers are those referred to on the Schematic Diagram, on the Circuit Board X-Ray View, and in related Pictorials.
- If a circuit component number is not listed in the Parts List (such as R105), that component is not used in the circuit.
- 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  $\mu$ F, 15 V) may be replaced with a 25-volt capacitor (10  $\mu$ F, 25 V).

## CABINET

<u>CIRCUIT</u> <u>Comp. No.</u>	<u>HEATH</u> <u>Part No.</u>	<u>DESCRIPTION</u>
------------------------------------	---------------------------------	--------------------

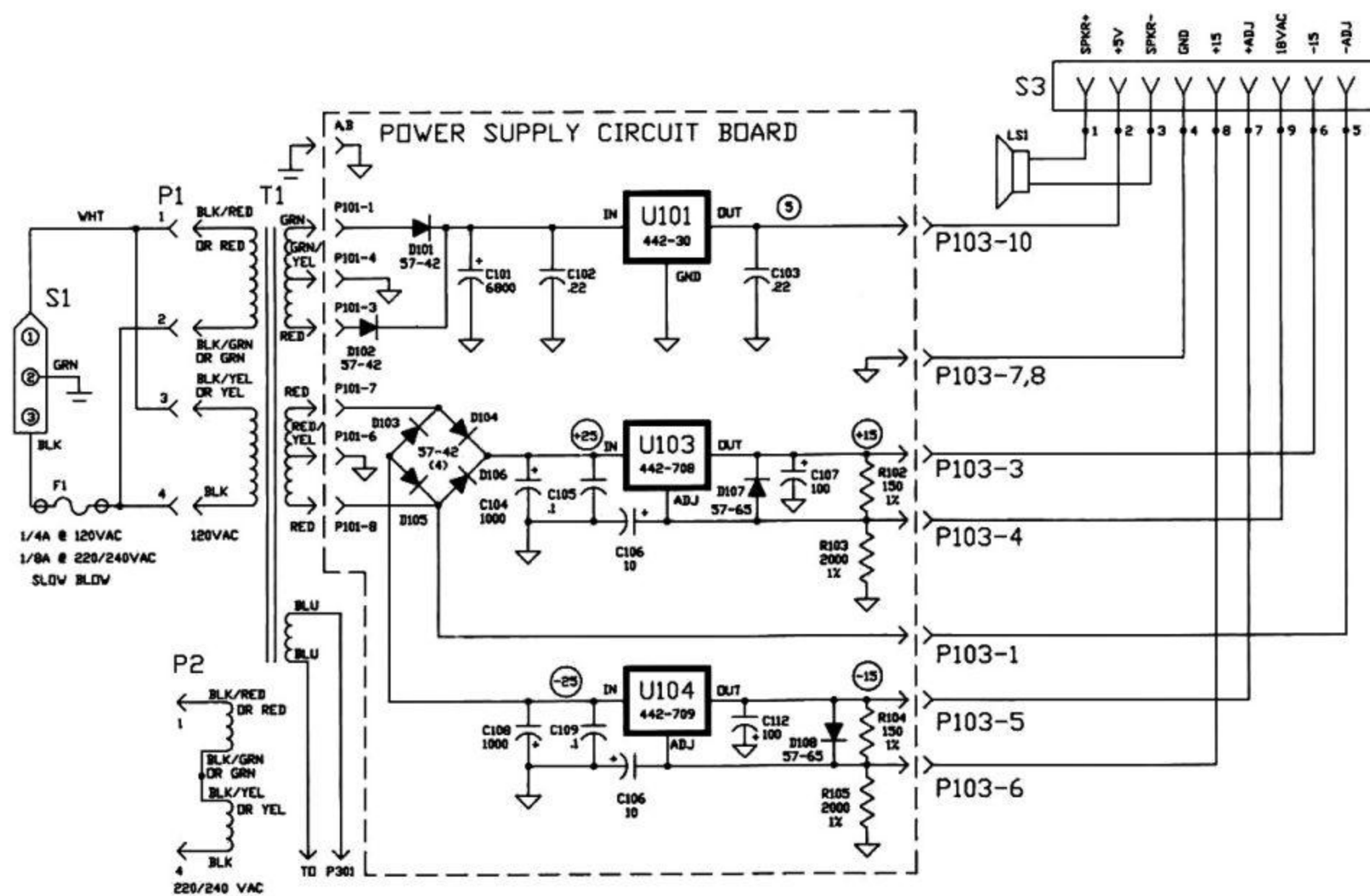
<u>CIRCUIT</u> <u>Comp. No.</u>	<u>HEATH</u> <u>Part No.</u>	<u>DESCRIPTION</u>
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### ELECTRONIC PARTS

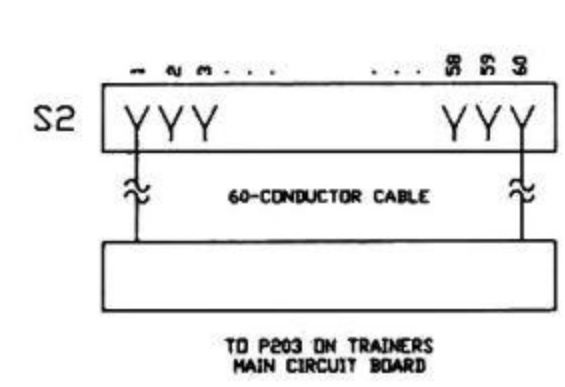
T1	54-1055	Power transformer
LS1	401-176	Speaker
F2	421-19	1/4-ampere, regular (fast-blow) fuse
F1	421-33	1/4-ampere, slow-blow fuse

### MISCELLANEOUS

	70-10	Black insulator
	70-11	Red insulator
	95-676	Cabinet front
	95-677	Cabinet back
	204-3045	Connector bracket
	204-3046	Mounting bracket
	204-3047	AC bracket
	260-97	Black clip
	260-96	Red clip
	390-2090-17	FCC label
J1	436-22	Black jack
J2	436-11	Red jack
	438-47	Banana Plug







POWER SUPPLY  
CIRCUIT BOARD



**Schematic of the  
Heathkit®  
Accessory Backpack  
Model ETW-3567**

NOTES:

1. Refer to the "Circuit Board X-Ray Views" for the physical location of parts.
2. Refer to the component identification section for the tolerance and rating of parts shown on the schematic.
3. Resistor values are in ohms (k = 1000, M = 1,000,000); tolerances are 5% unless otherwise specified.
4. Capacitor values are in  $\mu\text{F}$  (microfarads) unless otherwise specified.
5. The Range switch is shown in the "2 V" position; the Mode switch is shown in the resistance ("K $\Omega$ ") position.
6.  Indicates circuit ground.
7.  Indicates a DC voltage measured from the indicated point with respect to input ground (J1).
8.  Indicates a connection.
9.  Indicates no connection.

## DVM CIRCUIT BOARD

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

Resistors with 5% or 1% tolerance (6-series part numbers) are rated at 1/4-watt and have four or five color bands (last band gold), respectively. The last color band will not be called out.

Precision resistors (2-series part numbers) are rated at 1/2-watt and have a tolerance of .25% unless otherwise indicated. The numbers in parentheses, for each precision resistor, are a code for the resistor's value. Only the numbers and letters in **BOLD** print may be stamped on the resistor.

R301	6-3744-12	3.74 MΩ (org-viol-yel-yel), 1%
R302	6-155-12	1.5 MΩ (brn-grn-grn), 5%
R303	2-393	9 MΩ ( <b>9M</b> or <b>9004C</b> ), .5%
R304	2-392	900 kΩ ( <b>900k</b> or <b>9003C</b> ), .5%
R305	2-391	90 kΩ ( <b>90k</b> or <b>9002C</b> ), .5%
R306	2-390	9000 Ω ( <b>9k</b> , <b>9000</b> , or <b>9001C</b> ), .5%
R307	2-385	1000 Ω ( <b>1k</b> , <b>1000</b> , or <b>1001C</b> ), .5%
R308	2-366	90 Ω ( <b>90</b> or <b>9009C</b> ), .5%
R309	2-374	9 Ω ( <b>9</b> , <b>909C</b> , or <b>9008F</b> ), .5%
R311	2-388	1 Ω ( <b>1</b> or <b>109C</b> ), .5%
R312	6-224-12	220 kΩ (red-red-yel), 5%
R313	6-105-12	1 MΩ (brn-blk-grn), 5%
R314	6-2002-12	20k Ω (red-blk-blk-red), 1%
R315	6-103-12	10 kΩ (brn-blk-org), 5%
R316	10-1155	200 Ω control
R317	6-6190-12	619 Ω (blu-brn-wht-blk), 1%
R318	6-1133-12	113 kΩ (brn-brn-org-org), 1%
R319	6-473-12	47 kΩ (yel-viol-org), 5%
R321	6-105-12	1 MΩ (brn-blk-grn), 5%
R322	6-105-12	1 MΩ (brn-blk-grn), 5%
R323	6-105-12	1 MΩ (brn-blk-grn), 5%

### CAPACITORS

C301	25-924	2.2 μF electrolytic
C302	25-900	1 μF electrolytic
C303	27-77	.1 μF (104) MylarR
C304	27-77	.1 μF (104) Mylar
C305	20-102	100 pF (100 or 101) mica
C306	27-220	.47 μF (474) Mylar
C307	27-220	.47 μF (474) Mylar
C308	27-220	.47 μF (474) Mylar
C309	27-161	.01 μF (103) Mylar

CIRCUIT Comp. No.	HEATH Part No.	DESCRIPTION
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### DIODES-TRANSISTOR-INTEGRATED CIRCUITS

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

1. Part number.
2. Type number. (For integrated circuits, this refers only to the numbers and letters 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.

D301	57-65	1N4002 diode
D302	57-27	1N5397 diode
D303	57-613	1N5402 diode
D304	57-613	1N5402 diode
Q301	417-864	MPSA05 transistor
U301	442-732	<b>78L09</b> IC
U302	442-678	<b>7106</b> IC

### CONNECTORS-SOCKETS

	100-1875	LCD socket assembly consisting of:  (2) Elastomeric contact strips (1) LCD holder
P301	432-1554	3-pin connector
P302	432-1231	4-pin connector
	434-253	IC socket

### MISCELLANEOUS

RT301	9-95	Thermistor
SW301	60-675	Slide switch
SW302	60-675	Slide switch
	85-3192-1	Circuit board
LCD301	411-843	LCD (liquid crystal display)
	446-725	1 Display window



## POWER SUPPLY CIRCUIT BOARD

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

The following resistors have five color bands (last band brown). This last band will not be called out.

All resistors have a tolerance of 1% and are rated at 1/4-watt.

R102	6-1500-12	150 $\Omega$ (brn-grn-blk-blk)
R103	6-2001-12	2000 $\Omega$ (red-blk-blk-brn)
R104	6-1500-12	150 $\Omega$ (brn-grn-blk-blk)
R105	6-2001-12	2000 $\Omega$ (red-blk-blk-brn)

### CAPACITORS

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

### DIODES

D101	57-42	1N5401
D102	57-42	1N5401
D103	57-42	1N5401
D104	57-42	1N5401
D105	57-42	1N5401
D106	57-42	1N5401
D107	57-65	1N4002
D108	57-65	1N4002

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

### INTEGRATED CIRCUITS

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.

U101	442-30	UA309 IC
U103	442-708	LM317 IC
U104	442-709	LM337 IC

### CONNECTORS-SOCKET

	432-1279	Flat connector
P101	432-876	8-pin plug
P103	432-877	10-pin plug
	230-6496	Transistor socket

### WIRE-CABLES

	230-6500	Power cable
	230-6501	Signal cable
	341-9	Black (flexible) test lead
	341-7	Red (flexible) test lead

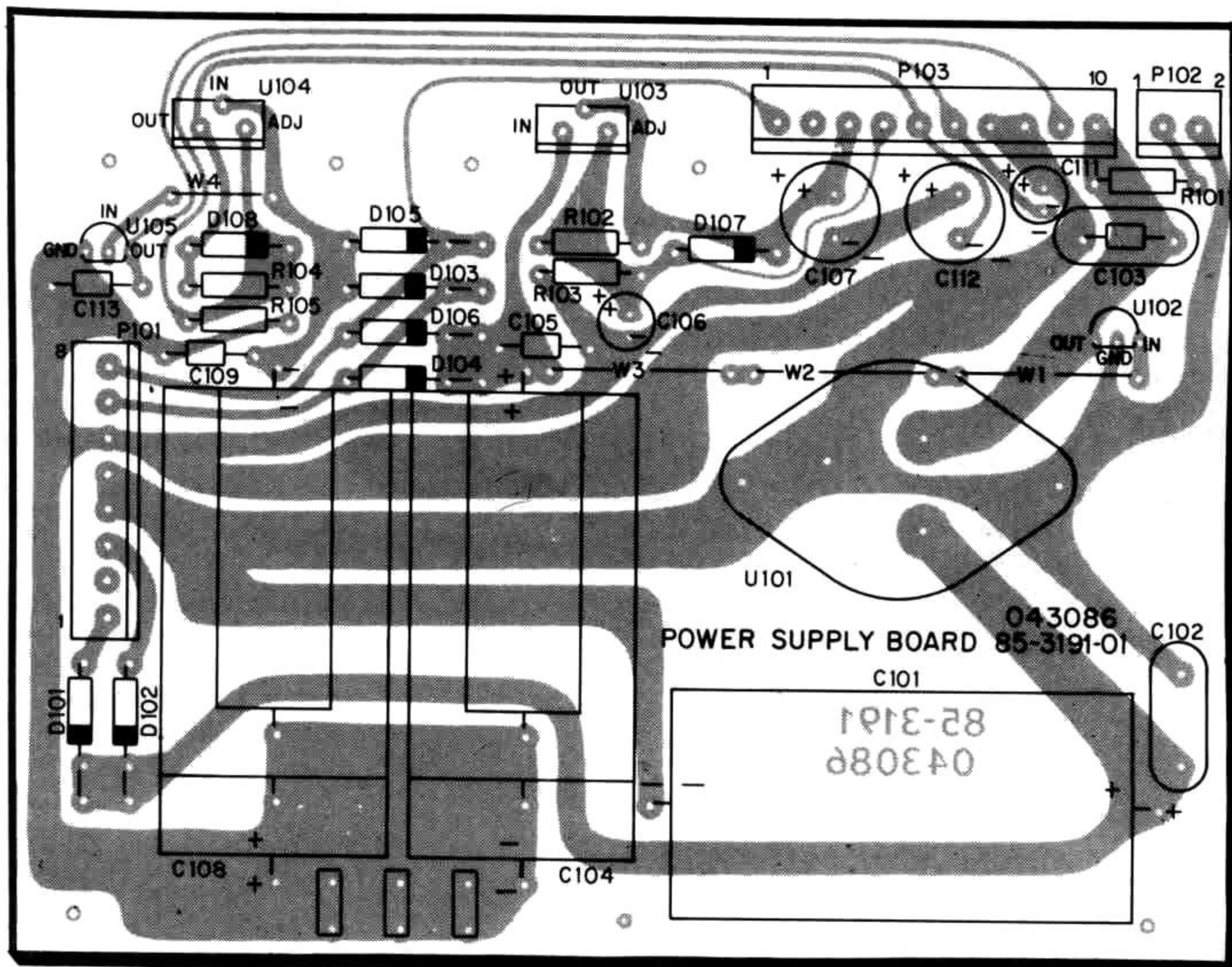
### MISCELLANEOUS

	75-139	Transistor insulator
	230-6510	Power supply circuit board
	352-31	Thermal compound
	230-6499	Small heat sink
	230-6509	Large heat sink

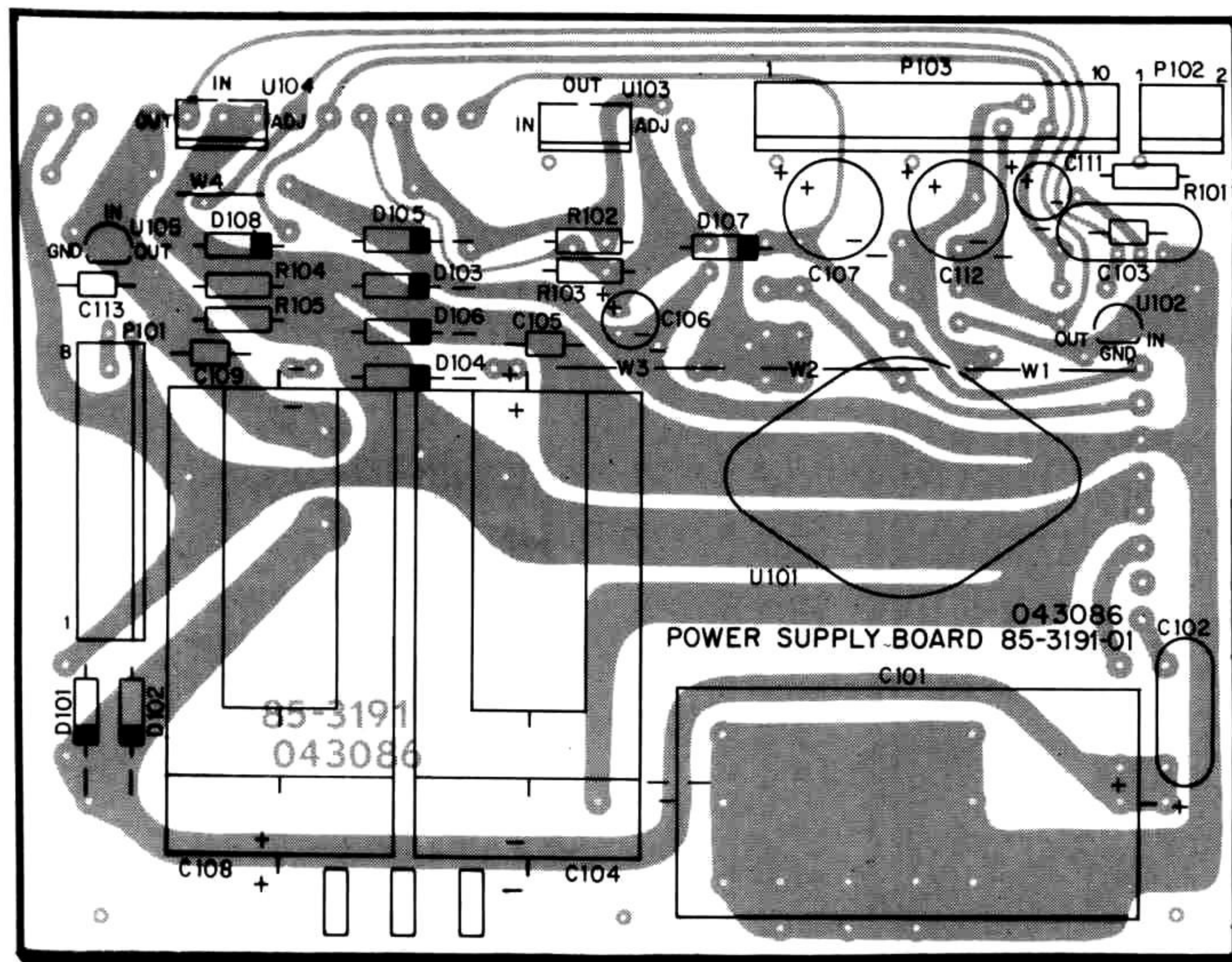
# CIRCUIT BOARD X-RAY VIEWS

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

- A. Find the circuit component part number on the appropriate X-Ray View.
- B. Locate the same number in the "Circuit Component Number" column of the "Replacement 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.



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

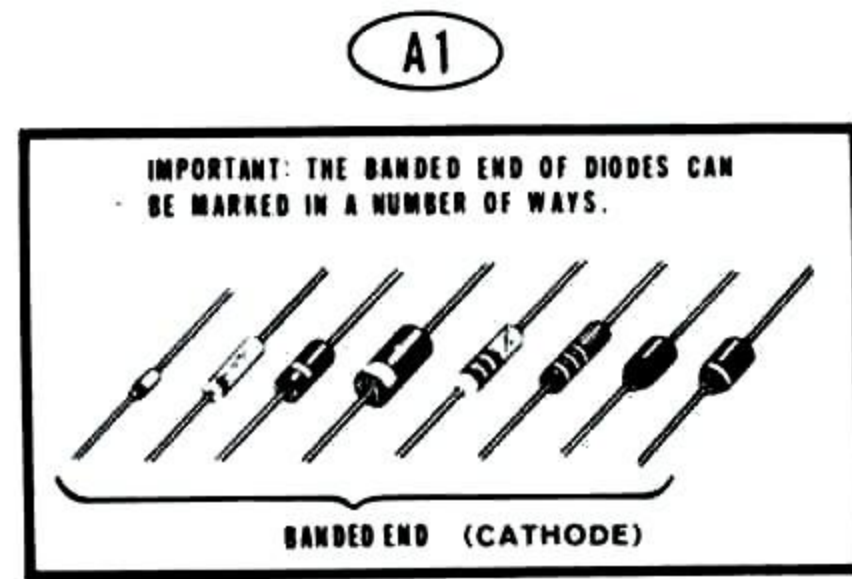


**POWER SUPPLY CIRCUIT BOARD**  
(Shown from the foil side.)

# SEMICONDUCTOR IDENTIFICATION

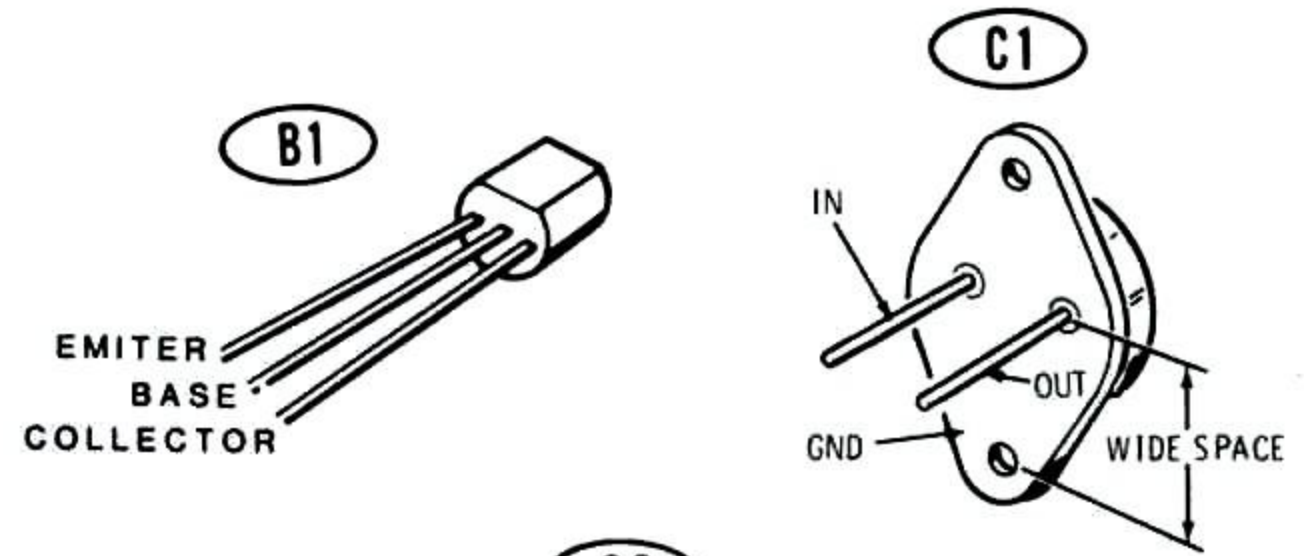
## DIODES

COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	KEY NUMBER
D302	57-27	1N5397	A1
D101-D106	57-42	3A1 or 1N5401	A1
D107, D108, D108, D301	57-65	1N4002	A1
D303, D304	57-613	1N5624	A1



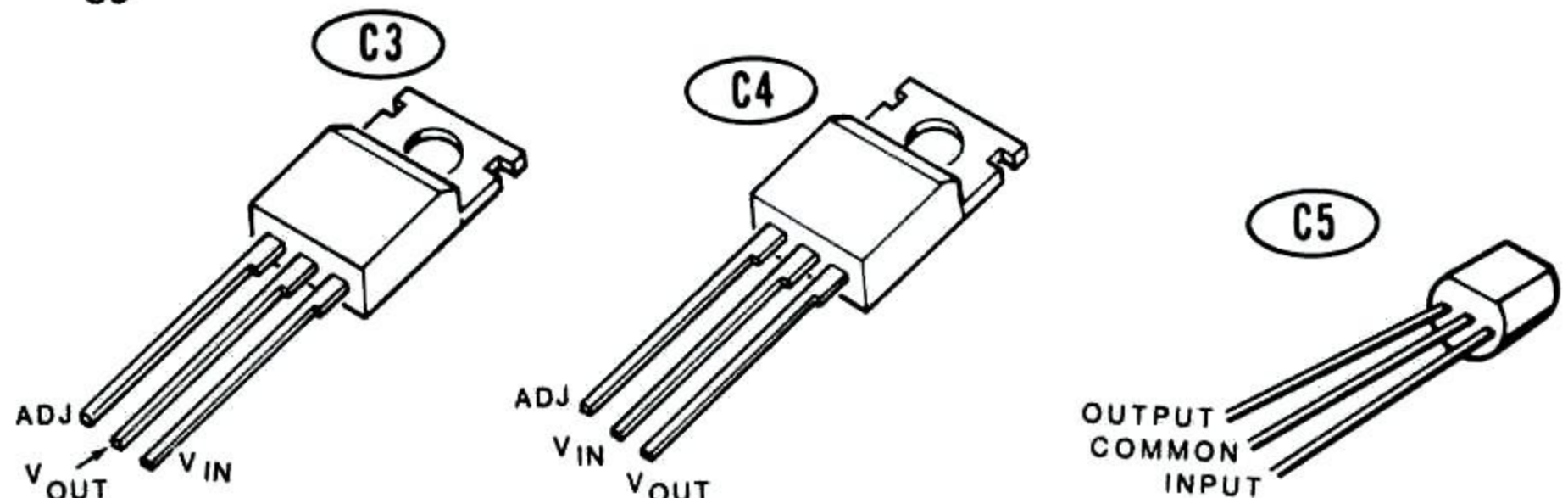
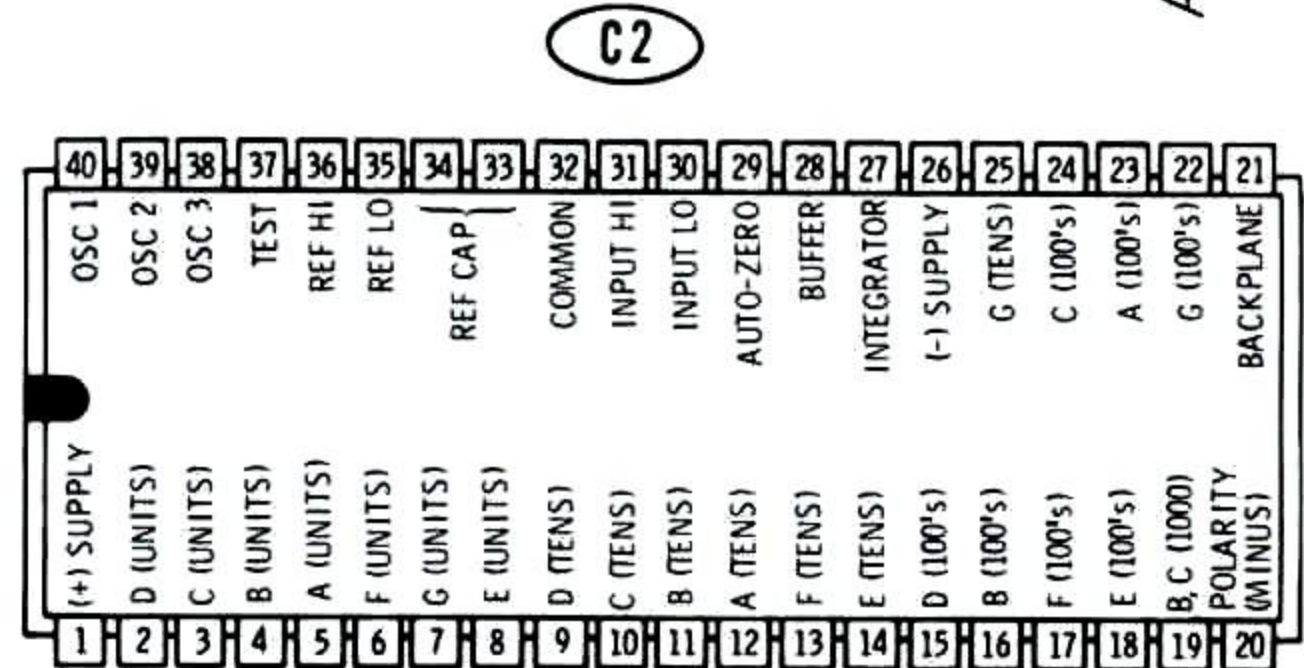
## TRANSISTOR

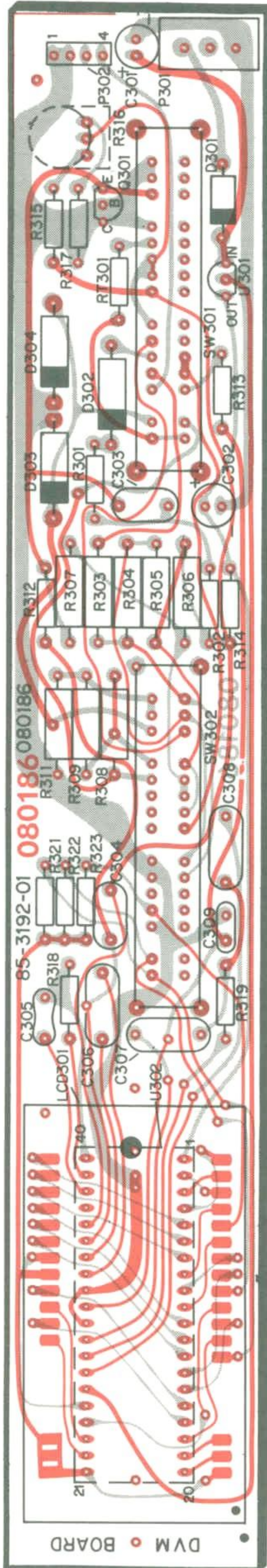
Q301	417-864	MPSA05	B1
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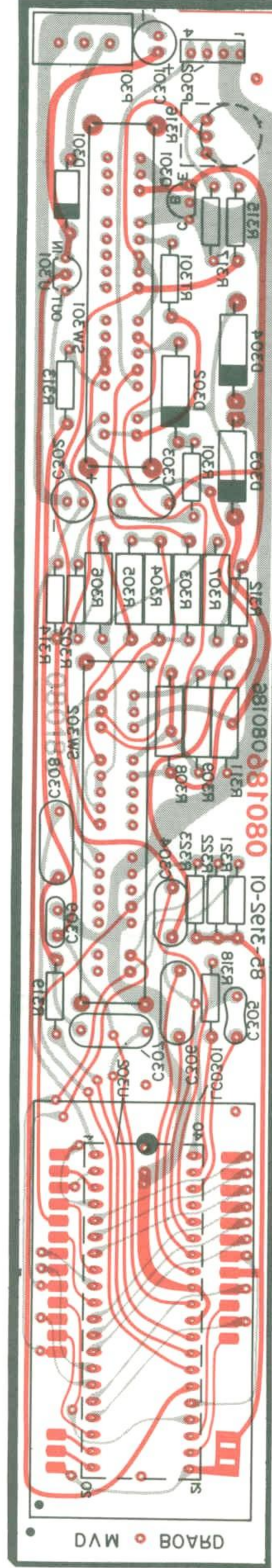
## INTEGRATED CIRCUITS

U101	442-30	LM309K	C1
U302	442-678	7106	C2
U103	442-708	LM317	C3
U104	442-709	LM337	C4
U301	442-732	78L09	C5





**DVM CIRCUIT BOARD**  
 (Shown from the component side. The component side foils are shown in red.)



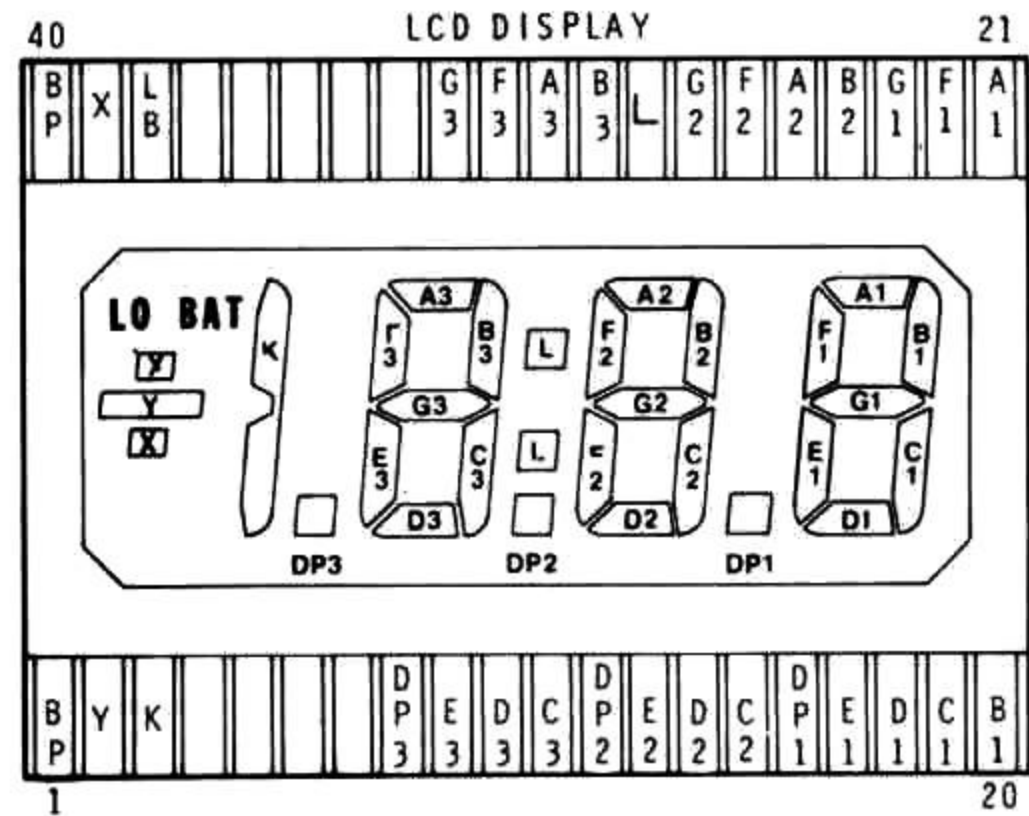
**DVM CIRCUIT BOARD**  
 (Shown from the foil side. The component side foils are shown in red.)

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

**DISPLAY**

LCD301	411-843	AND FE0203 or BECKMAN 739-02050 or HAMLIN 3933-363-159	D1
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**D1**



# 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

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**Free Manual**

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**PLEASE REPORT VOILATIONS TO  
[WWW.TECH-SYSTEMS-LABS.COM](http://WWW.TECH-SYSTEMS-LABS.COM)**