Heathkit®

Heathkit®

# FREQUENCY COUNTER

## Model IM-2410

595-2383-10

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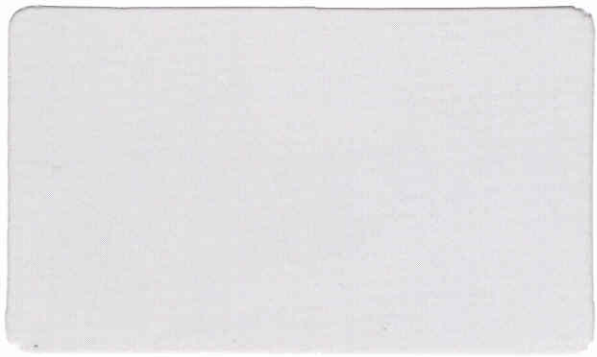
## HEATH COMPANY PHONE DIRECTORY

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

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

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

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



## YOUR HEATHKIT 1 YEAR LIMITED WARRANTY

### Consumer Protection Plan for Heathkit Consumer Products

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

### Heath's Responsibility

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

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

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

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

**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.

10-1-87

# FREQUENCY COUNTER

## Model IM-2410

595-2383-10

**WARNING**

**Do not expose this Frequency Counter to rain or moisture.**

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

# Table of Contents



# INTRODUCTION

The Heathkit Model IM-2410 Digital Frequency Counter is an easy-to-use frequency counter that can accurately measure frequencies from 10 Hz to 225 MHz. The 2-position Frequency Range switch and the dual time Gate switch make this Counter extremely versatile. The 8-digit display always reads out directly in MHz to provide high resolution (10 Hz resolution at 225 MHz).

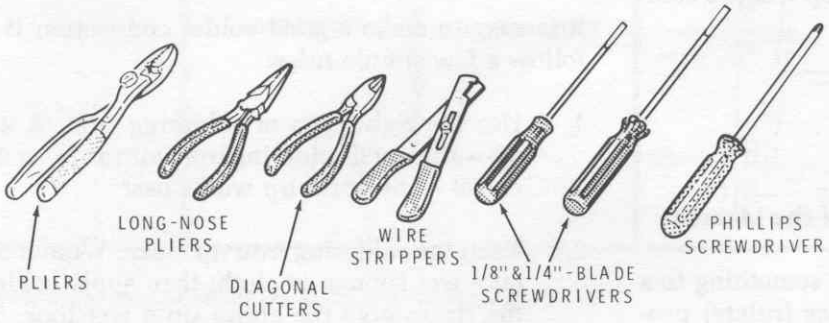
Additional features include a rugged and compact cabinet and a locking swing down bail to elevate the front of the counter for an improved viewing angle.

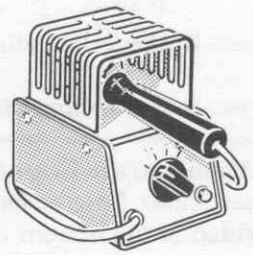
Exceptional accuracy and simplified operation combine to make this Counter a valuable instrument for the engineer, technician, or hobbyist.

# ASSEMBLY NOTES

## TOOLS

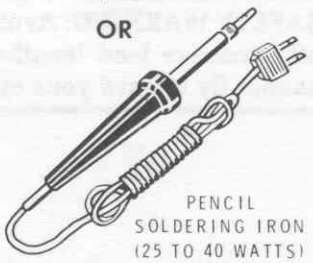
You will need these tools to assemble your kit.



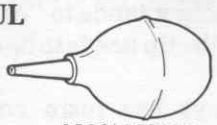
SOLDERING IRON

OR



PENCIL SOLDERING IRON (25 TO 40 WATTS)

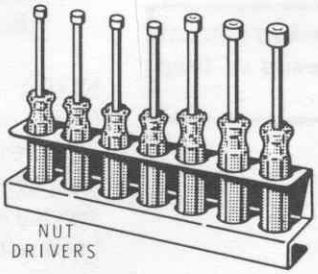
### OTHER HELPFUL TOOLS



DESOLDERING BULB*

NUT STARTER (MAY BE SUPPLIED WITH KIT)

DESOLDERING BRAID*



NUT DRIVERS

*TO REMOVE SOLDER FROM CIRCUIT CONNECTIONS.

## ASSEMBLY

1. Follow the instructions carefully. Read the entire step before you perform each operation.

2. The illustrations in the Manual are called Pictorials and Details. Pictorials show the overall operation for a group of assembly steps; Details generally illustrate a single step. When you are directed to refer to a certain Pictorial "for the following steps," continue using that Pictorial until you are referred to another Pictorial for another group of steps.

3. Most kits use a separate "Illustration Booklet" that contains illustrations (Pictorials, Details, etc.) that are too large for the Assembly Manual. Keep the "Illustration Booklet" with the Assembly Manual. The illustrations in it are arranged in Pictorial number sequence.

4. Position all parts as shown in the Pictorials.

5. Solder a part or a group of parts only when you are instructed to do so.

6. Each circuit part in an electronic kit has its own component number (R2, C4, etc.). Use these numbers when you want to identify the same part in the various sections of the Manual. These numbers, which are especially useful if a part has to be replaced, appear:

   — In the Parts List,

   — At the beginning of each step where a component is installed,

   — In some illustrations,

   — In the Schematic,

   — In the section at the rear of the Manual.

7. When you are instructed to cut something to a particular length, use the scales (rulers) provided at the bottom of the Manual pages.

**SAFETY WARNING: Avoid eye injury when you cut off excessive lead lengths. Hold the leads so they cannot fly toward your eyes.**

## SOLDERING

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

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

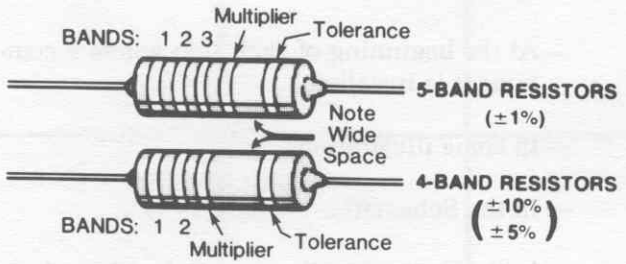
1. Use the right type of soldering iron. A 25 to 40-watt pencil soldering iron with a 1/8" or 3/16" chisel or pyramid tip works best.

2. Keep the soldering iron tip clean. Wipe it often on a wet sponge or cloth; then apply solder to the tip to give the entire tip a wet look. This process is called tinning, and it will protect the tip and enable you to make good connections. When solder tends to "ball" or does not stick to the tip, the tip needs to be cleaned and retinned.

NOTE: Always use rosin core, radio-type solder (60:40 or 50:50 tin-lead content) for all of the soldering in this kit. This is the type we have supplied with the parts. The Warranty will be void and we will not service any kit in which acid core solder or paste has been used.

## RESISTORS

Resistors are identified in Parts Lists and steps by their resistance value in Ω (ohms), kΩ (kilohms), or MΩ (megohms). They are usually identified by a color code of four or five color bands, where each color represents a number. See the "Resistor Color Code" chart. These colors are given in the steps in their proper order (except for the last band, which indicates a resistor's "tolerance"; see the "Resistor Tolerance Chart"). You do not need to memorize the color codes.




Occasionally, a "precision" or "power" resistor may have the value stamped on it. The letter R, K, or M may also be used at times to signify a decimal point, as in: 2R2 = 2.2 Ω
2K2 = 2.2 kΩ, or 2200 Ω
2M2 = 2.2 MΩ

Precision resistors may also be marked as shown in the following examples. The values of the multipliers are shown in the "Multiplier Chart," and the tolerance values are shown in the "Resistor Tolerance" chart.


EXAMPLES: 1009C = 100 × 0.1 = 10 Ω, ±0.25%
1001D = 100 × 10 = 1000 Ω, ±0.5%

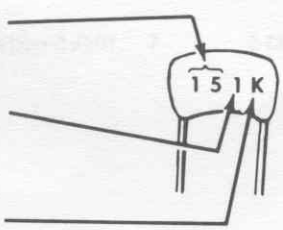
## CAPACITORS

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

First and second digits of capacitor's value: 15

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

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




**RESISTOR COLOR CODE CHART**

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

**RESISTOR TOLERANCE CHART**

| | COLOR OR LETTER | |
|---|---|---|
| ±10% | SILVER | |
| ± 5% | GOLD | J |
| ± 2% | RED | G |
| ± 1% | BROWN | F |
| ±0.5% | GREEN | D |
| ±0.25% | BLUE | C |
| ±0.1% | VIOLET | B |
| ±0.05% | GRAY | |

**MULTIPLIER CHART**

| FOR THE NUMBER: | MULTIPLY BY: | FOR THE NUMBER: | MULTIPLY BY: |
|---|---|---|---|
| 0 | 1 | 4 | 10,000 |
| 1 | 10 | 5 | 100,000 |
| 2 | 100 | 8 | 0.01 |
| 3 | 1000 | 9 | 0.1 |

**CAPACITOR TOLERANCE CHART**

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

EXAMPLES: 151K = 15 × 10 = 150 pF
759 = 75 × 0.1 = 7.5 pF

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

# PARTS LIST

Check each part against the following list. Refer to the illustration in the separate "Illustration Booklet" that corresponds to the key number on the Parts List. The parts may vary slightly from the illustrations. Any part that is individually packaged with a part number on it should be kept in its package after it is identified until you use it.

Some parts are marked with a "171-" or "172-" packaging number. These numbers are used for packaging and do not appear in the Manual "Parts List." Save all packaging material until all parts have been located.

To order a replacement part, always include the PART NUMBER. Use the Parts Order Form furnished with this kit or at the rear of this Manual. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover. Your Warranty is inside the front cover.

Each Circuit Component in this kit has a Circuit Component Number (R2, C4, Q1, etc.). This is a specific number for only that one part in the kit. The purpose of these numbers, which are especially useful if a part ever has to be replaced, is to help you easily identify the same part in each section of the Manual. These numbers will appear:

— In the Parts List.

— At the beginning of each step where a component is installed.

— In some illustrations.

— In the Schematic.

— In the sections at the rear of the Manual.

## RESISTORS

NOTE: The resistors may be packed in more than one envelope. Open all resistor envelopes before you check them against the Parts List.

All resistors have 5% (fourth band gold) tolerance unless they are designated 10% (fourth band silver). All resistors are 1/4 watt unless specified otherwise.

| KEY No. | HEATH Part No. | QTY. | DESCRIPTION | CIRCUIT Comp. No. |
|---|---|---|---|---|
| A1 | 6-100-12 | 2 | 10 Ω (brn-blk-blk) | R3, R19 |
| A1 | 6-560-12 | 1 | 56 Ω (grn-blu-blk) | R25 |
| A1 | 6-101-12 | 2 | 100 Ω (brn-blk-brn) | R5, R26 |
| A1 | 6-121-12 | 1 | 120 Ω (brn-red-brn) | R8 |
| A1 | 6-151-12 | 7 | 150 Ω (brn-grn-brn) | R9, R11, R12, R15, R16, R21, R49 |
| A1 | 6-241-12 | 2 | 240 Ω (red-yel-brn) | R18, R29 |
| A1 | 6-331-12 | 1 | 330 Ω (org-org-brn) | R22 |
| A1 | 6-511-12 | 2 | 510 Ω (grn-brn-brn) | R43, R46 |
| A1 | 6-561-12 | 1 | 560 Ω (grn-blu-brn) | R27 |
| A1 | 6-911-12 | 1 | 910 Ω (wht-brn-brn) | R17 |

## Resistors (cont'd.)

| KEY No. | HEATH Part No. | QTY. | DESCRIPTION | CIRCUIT Comp. No. |
|---|---|---|---|---|
| A1 | 6-102-12 | 11 | 1000 Ω (brn-blk-red) | R4, R6, R7, R13, R14, R24, R31, R38, R44, R45, R48 |
| A1 | 6-182-12 | 1 | 1800 Ω (brn-gry-red) | R28 |
| A1 | 6-562-12 | 1 | 5600 Ω (grn-blu-red) | R23 |
| A1 | 6-202-12 | 2 | 2000 Ω (red-blk-red) | R32, R33 |
| A1 | 6-103-12 | 5 | 10 kΩ (brn-blk-org) | R36, R37, R39, R41, R47 |
| A1 | 6-303-12 | 2 | 30 kΩ (org-blk-org) | R34, R35 |
| A1 | 6-104-12 | 1 | 100 kΩ (brn-blk-yel) | R2 |
| A1 | 6-105-12 | 1 | 1 MΩ (brn-blk-grn) | R1 |
| A1 | 1-88-12 | 1 | 10 MΩ, 10% (brn-blk-blu) | R42 |
| A2 | 6-680 | 1 | 68 Ω 1/2-watt (blu-gry-blk) | R51 |
| A3 | 3-33-5 | 1 | 10 Ω, 5-watt wire-wound | R30 |

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| KEY No. | HEATH Part No. | QTY. | DESCRIPTION | CIRCUIT Comp. No. |
|---|---|---|---|---|
| **CAPACITORS** | | | | |
| **Mica** | | | | |
| B1 | 20-77 | 1 | 24 pF | C15 |
| B1 | 20-100 | 1 | 30 pF | C12 |
| B1 | 20-190 | 1 | 51 pF | C2 |
| B1 | 20-102 | 1 | 100 pF | C5 |
| B1 | 20-103 | 2 | 150 pF | C21, C22 |
| B1 | 20-139 | 2 | 330 pF | C7, C14 |
| **Ceramic** | | | | |
| B2 | 21-759 | 2 | 33 pF | C10, C25 |
| B2 | 21-176 | 9 | .01 µF round | C19, C23, C24, C28, C29, C31, C32, C33, C34 |
| B3 | 21-717 | 8 | .01 µF (103) square | C3, C8, C9, C11, C13, C16, C17, C20 |
| B4 | 21-70 | 1 | .01 µF* large round | C39 |
| **Tantalum** | | | | |
| B5 | 25-220 | 2 | 10 µF (10M) | C18, C41 |
| B5 | 25-281 | 1 | 39 µF | C6 |
| B5 | 25-282 | 1 | 68 µF | C4 |
| **Electrolytic** | | | | |
| B6 | 25-917 | 2 | 10 µF electrolytic | C35, C37 |
| B7 | 25-891 | 1 | 470 µF | C38 |
| B8 | 25-272 | 1 | 6000 µF | C36 |
| **Other Capacitors** | | | | |
| B9 | 21-41 | 1 | 14 pF resin (brn-yel-blk-grn) | C27 |
| B10 | 29-64 | 1 | .15 µF polycarbonate | C1 |
| B11 | 31-67 | 1 | 7-25 pF trimmer | C26 |

| KEY No. | HEATH Part No. | QTY. | DESCRIPTION | CIRCUIT Comp. No. |
|---|---|---|---|---|
| **DIODES** | | | | |
| C1 | 56-56 | 5 | 1N4149 | D3, D4, D7, D8, D9 |
| C1 | 56-86 | 2 | FD777 | D1, D2 |
| C1 | 56-87 | 2 | HP2835 (org-blu); BAT29; 1SS16; or (gry-viol) | D5, D6, |
| C1 | 57-65 | 2 | 1N4002 | D13, D14 |
| C1 | 57-42 | 2 | 3A1 | D11, D12 |

## TRANSISTORS — INTEGRATED CIRCUITS (IC's)

NOTE: Transistors and integrated circuits are marked for identification in one of the following ways:

1. Part number.
2. Type number. (On integrated circuits this refers only to the numbers; the letters may be different or missing.)
3. Part number and type number.
4. Part number with a type number other than the one shown.

| | | | | |
|---|---|---|---|---|
| D1 | 417-293 | 5 | 2N5770 transistor | Q2, Q4, Q5, Q6, Q7 |
| D1 | 417-292 | 1 | 2N5771 transistor | Q3 |
| D1 | 417-828 | 1 | Selected transistor | Q1 |

CAUTION: Any IC that is furnished with its pins pressed into a foam pad can be damaged by static electricity. DO NOT remove it from the foam pad until you are instructed to do so in a step.

| | | | | |
|---|---|---|---|---|
| D2 | 442-644 | 1 | 78L12 IC | U27 |
| D3 | 442-54 | 1 | 7805 IC | U26 |
| D4 | 443-750 | 1 | 5369 IC | U10 |
| D5 | 443-1 | 1 | 7400 IC | U7 |
| D5 | 443-941 | 1 | 7433 or 5433 IC | U11 |
| D6 | 443-16 | 1 | 7476 IC | U5 |
| D5 | 443-34 | 1 | 7492 IC | U8 |
| D6 | 443-940 | 1 | 8647 IC | U2 |
| D6 | 443-694 | 8 | 9368 IC | U18, U19, U20, U21, U22, U23, U24, U25 |

*This part is critical to continued safety. Replace only with a Heath Company part.

| KEY No. | HEATH Part No. | QTY. | DESCRIPTION | CIRCUIT Comp. No. |
|---|---|---|---|---|
| **Transistors — Integrated Circuits (cont'd.)** | | | | |
| D6 | 443-723 | 1 | 10216 IC | U1 |
| D5 | 443-26 | 1 | 74S00 IC | U3 |
| D5 | 443-896 | 1 | 74S02 IC | U4 |
| D5 | 443-628 | 1 | 74196 IC | U13 |
| D6 | 443-727 | 1 | 96L02 IC | U6 |
| D5 | 443-875 | 1 | 74LS32 IC | U12 |
| D5 | 443-813 | 2 | 74LS90 IC | U9, U14 |
| D6 | 443-921 | 3 | 74LS390 IC | U15, U16, U17 |
| **OTHER CIRCUIT COMPONENTS** | | | | |
| | 54-978 | 1 | Power transformer | T1 |
| E1 | 60-70 | 1 | SPST slide switch | SW1 |
| E2 | 60-71 | 2 | DPDT slide switch | SW2, SW3 |
| E3 | 404-238 | 1 | 3579.545 kHz crystal | Y1 |
| E4 | 421-33 | 1 | 1/4-ampere, slow-blow fuse* | F1 |
| E5 | 411-860 | 8 | LED (light emitting diode) | V1, V2, V3, V4, V5, V6, V7, V8 |
| E6 | 475-16 | 2 | Ferrite bead | FB1, FB2 |
| **CLIPS-SHELL-SOCKETS-CONNECTOR** | | | | |
| F1 | 260-65 | 2 | Fuse clip | |
| F2 | 432-866 | 4 | Spring clip (1 extra) | |
| F3 | 432-1080 | 1 | Connector shell | |
| F4 | 434-230 | 1 | 8-pin IC socket | |
| F4 | 434-298 | 17 | 14-pin IC socket | |
| F4 | 434-299 | 15 | 16-pin IC socket | |
| F5 | 432-758 | 1 | BNC connector | |

## HARDWARE

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

### #2 Hardware

| KEY No. | HEATH Part No. | QTY. | DESCRIPTION | CIRCUIT Comp. No. |
|---|---|---|---|---|
| G1 | 250-212 | 2 | #2 × 3/16" self-tapping screw | |
| G2 | 254-26 | 2 | #2 lockwasher | |

*This part is critical to continued safety. Replace only with Heath Company part.

## Hardware (cont'd.)

### #6 Hardware

| KEY No. | HEATH Part No. | QTY. | DESCRIPTION | CIRCUIT Comp. No. |
|---|---|---|---|---|
| H1 | 250-452 | 16 | 6-32 × 1/4" black screw | |
| H2 | 250-56 | 4 | 6-32 × 1/4" screw | |
| H3 | 250-127 | 6 | #6 × 1/2" self-tapping screw | |
| H4 | 250-1275 | 1 | #6 × 5/8" black self-tapping screw | |
| H5 | 252-77 | 2 | 6-32 nut | |
| H6 | 254-1 | 9 | #6 lockwasher | |
| H7 | 255-21 | 4 | 6-32 tapped spacer | |
| H8 | 259-1 | 1 | #6 solder lug | |

### #8 Hardware

| KEY No. | HEATH Part No. | QTY. | DESCRIPTION | CIRCUIT Comp. No. |
|---|---|---|---|---|
| J1 | 250-1186 | 2 | 8-32 × 3/8" black screw | |
| J2 | 252-78 | 2 | 8-32 nut | |
| J3 | 254-2 | 2 | #8 lockwasher | |

### 3/8" Hardware

| KEY No. | HEATH Part No. | QTY. | DESCRIPTION | CIRCUIT Comp. No. |
|---|---|---|---|---|
| K1 | 252-76 | 1 | 3/8-32 nut | |
| K2 | 254-5 | 1 | 3/8" lockwasher | |
| K3 | 259-27 | 1 | 3/8" solder lug | |

## LINE CORD — WIRE — CABLE — SLEEVING

| HEATH Part No. | QTY. | DESCRIPTION |
|---|---|---|
| 89-54 | 1 | Line cord |
| 344-33 | 24" | Black wire |
| 347-55 | 18" | 8-conductor flat cable |
| 346-60 | 1-1/2" | Clear tubing |

## CABINET PARTS

| KEY No. | HEATH Part No. | QTY. | DESCRIPTION |
|---|---|---|---|
| L1 | 90-1264-1 | 1 | Cabinet top |
| L2 | 200-1373-1 | 1 | Chassis |
| L3 | 203-2026 | 1 | Front panel |
| L4 | 210-89 | 1 | Bezel |
| L5 | 266-1062 | 1 | Bail |

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

## MISCELLANEOUS

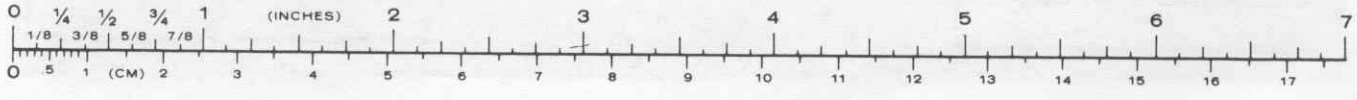
| | | | | |
|---|---|---|---|---|
| | 73-92 | 1 | 5″ foam tape | |
| M1 | 75-52 | 1 | Switch insulator | |
| M2 | 75-754 | 1 | Line cord insulator | |
| | 85-2618-1 | 1 | Display circuit board | |
| | 85-2737-1 | 1 | Main circuit board | |
| | 490-185 | 1 | Solder-Wick** | |
| M3 | 261-32 | 1 | Right front foot | |
| M4 | 261-33 | 1 | Left front foot | |
| M5 | 261-61 | 2 | Rear foot | |
| | 390-1255 | 1 | Fuse label | |
| | | 1 | Blue and white label | |

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

## Miscellaneous (Cont'd.)

| | | | | |
|---|---|---|---|---|
| M6 | 205-778 | 1 | Alignment tool blade | |
| M7 | 205-1854 | 1 | Plate | |
| M8 | 354-7 | 1 | Cable tie | |
| M9 | 490-5 | 1 | Plastic nut starter | |
| M10 | 490-111 | 1 | IC puller | |
| M11 | 352-13 | 1 | Silicone grease | |
| | 597-260 | 1 | Parts Order Form | |
| | | | Solder | |
| | | | Manual (See Page 1 for part number.) | |

**Registered Trademark, Solder Removal Co.



# STEP-BY-STEP ASSEMBLY

## MAIN CIRCUIT BOARD

**START**

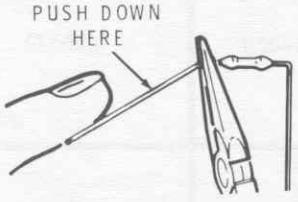
In the following steps, you will be given detailed instructions on how to install and solder the first part on the circuit board. Read and perform each step carefully. Then use the same procedure whenever you install parts on a circuit board.

NOTE: Only a portion of the circuit board is shown in some of the following Pictorials. The small "Identification Drawing" at the top of the page shows the area of the circuit board to be assembled.

( ) Position the circuit board as shown with the printed side up. Note that this circuit board has foil on both sides. DO NOT solder on the printed (component) side. The side of the circuit board opposite the printed side will be referred to as the foil side.

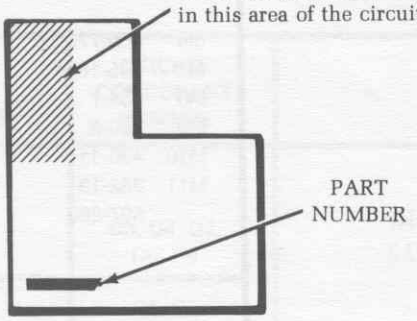
NOTE: When you install a component that has its value printed on it, position the value marking up, so it can be easily read. Diodes should be mounted with their type or part number up, if possible.

( ) Hold a 10 kΩ (brn-blk-org) resistor with long-nose pliers and bend the leads straight down to fit the hole spacing on the circuit board.

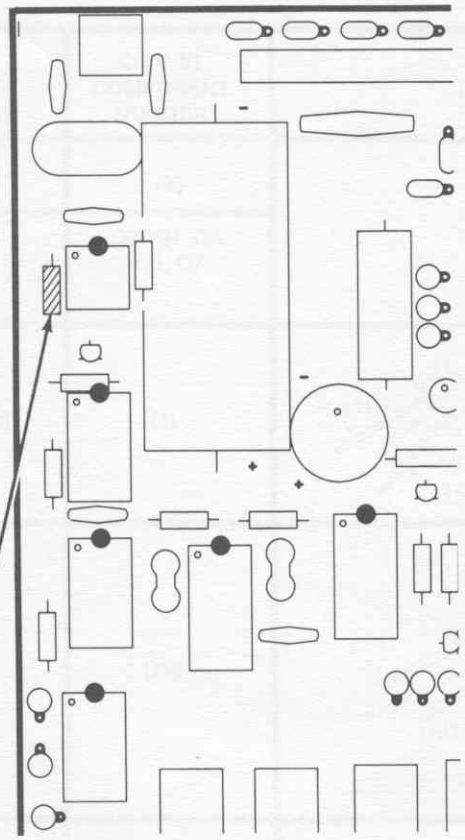



( ) R39: Push the leads through the holes at the indicated location on the circuit board. The end with color bands may be positioned either way.

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




IDENTIFICATION DRAWING

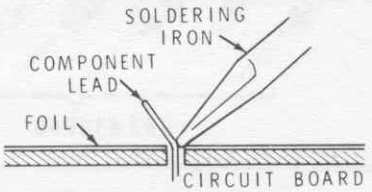


**PICTORIAL 1-1**

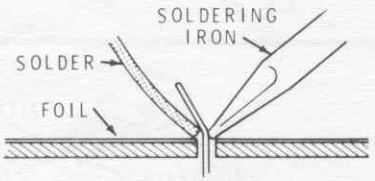
**CONTINUE**

( ) Turn the circuit board over and solder the resistor leads to the foil as follows:

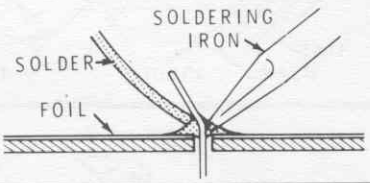
1. Push the soldering iron tip against both the lead and the circuit board foil. Heat **both** for two or three seconds.




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



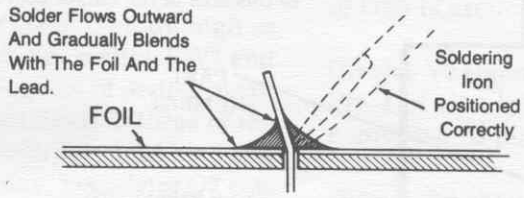

3. As the solder begins to melt, allow it to flow around the connection. Then remove the solder and the iron and let the connection cool.




( ) Cut off the excess lead lengths close to the connection. WARNING: Clip the leads so the ends will not fly toward your eyes.

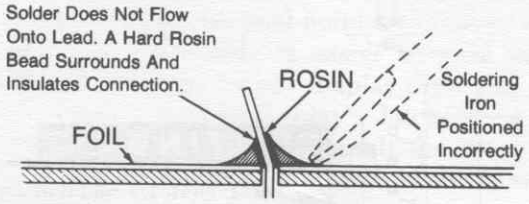
( ) Check each connection. Compare it to the illustrations on Page 11. After you have checked the solder connections, proceed with the assembly on Page 12. Use the same soldering procedure for each connection.

## A GOOD SOLDER CONNECTION

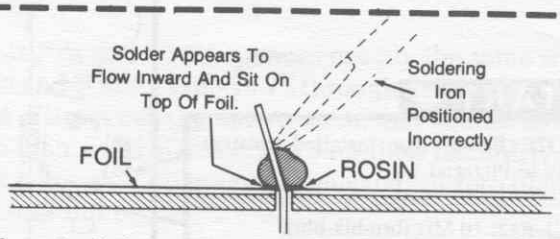



When you heat the lead and the circuit board foil at the same time, the solder will flow evenly onto the lead and the foil. The solder will make a good electrical connection between the lead and the foil.

## POOR SOLDER CONNECTIONS



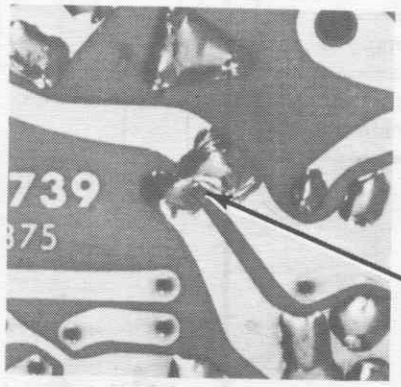

When the lead is not heated sufficiently, the solder will not flow onto the lead as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.




When the foil is not heated sufficiently the solder will blob on the circuit board as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.

## SOLDER BRIDGES

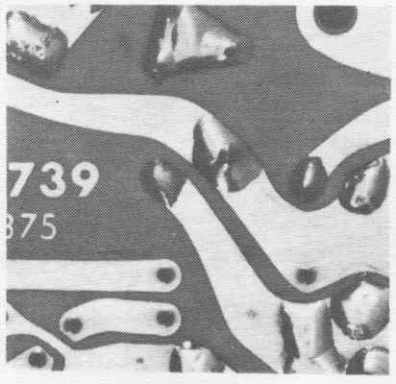
A solder bridge between two adjacent foils is shown in photograph **A**. Photograph **B** shows how the connection should appear. A solder bridge may occur if you accidentally touch an adjacent previously soldered connection, if you use too much solder, or if you "drag" the soldering iron across other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



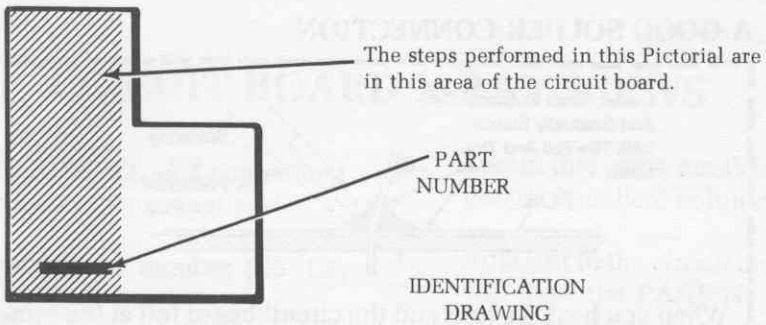

**A**

**SOLDER BRIDGE**

**B**



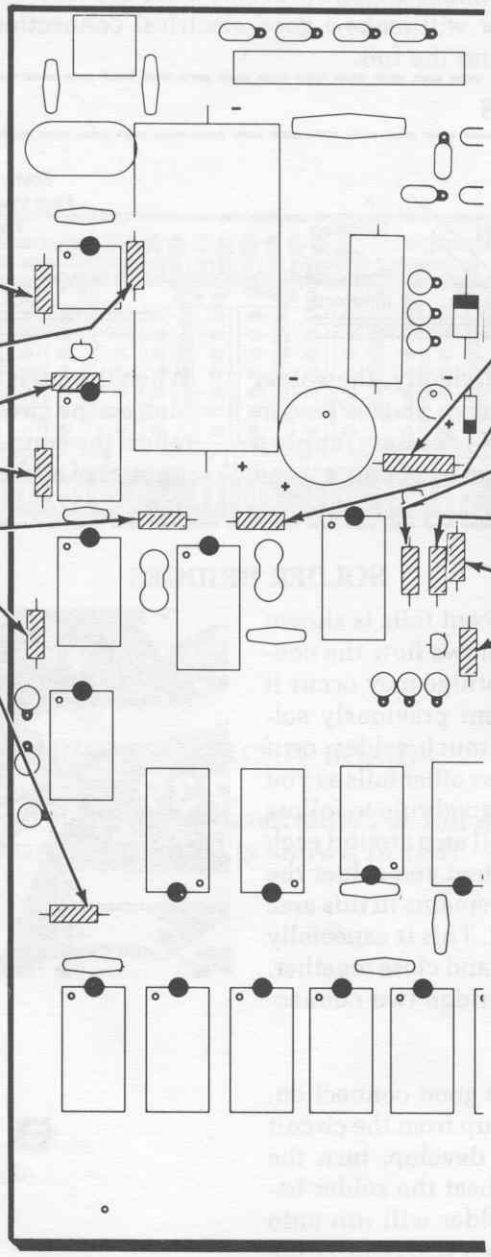

Use only enough solder to make a good connection, and lift the soldering iron straight up from the circuit board. If a solder bridge should develop, turn the circuit board foil-side-down and heat the solder between connections. The excess solder will run onto the tip of the soldering iron, and this will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




**START**

NOTE: Be sure you installed resistor R39 in Pictorial 1-1.

- ( ) R42: 10 MΩ (brn-blk-blu).
- ( ) R41: 10 kΩ (brn-blk-org).
- ( ) R38: 1000 Ω (brn-blk-red).
- ( ) R34: 30 kΩ (org-blk-org).
- ( ) R36: 10 kΩ (brn-blk-org).
- ( ) R37: 10 kΩ (brn-blk-org).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.



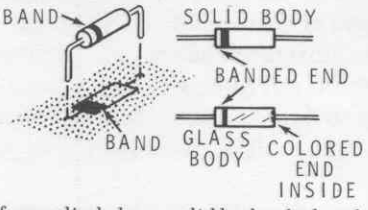
**CONTINUE**

- ( ) R51: 68 Ω, 1/2-watt (blu-gry-blk).
- ( ) R35: 30 kΩ (org-blk-org).
- ( ) R47: 10 kΩ (brn-blk-org).
- ( ) R48: 1000 Ω (brn-blk-red).
- ( ) R46: 510 Ω (grn-brn-brn).
- ( ) R49: 150 Ω (brn-grn-brn).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

**PICTORIAL 1-2**

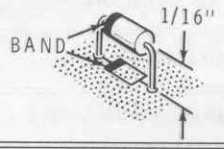
## START

NOTE: When you install a diode, always match the band on the diode with the band mark on the circuit board. THE CIRCUIT WILL NOT WORK PROPERLY IF A DIODE IS INSTALLED BACKWARDS. See Detail 1-3A.




If your diode has a solid body, the band is clearly defined. If your diode has a glass body, do not mistake the colored end inside the diode for the banded end. Look for a band painted on the outside of the glass.

NOTE: When you install the next two diodes, space them approximately 1/16" above the circuit board as shown.




( ) D11: 3A1 diode (#57-42).

( ) D12: 3A1 diode (#57-42).

( ) D14: 1N4002 diode (#57-65).

( ) D13: 1N4002 diode (#57-65).

( ) D9: 1N4149 diode (#56-56).

( ) D8: 1N4149 diode (#56-56).

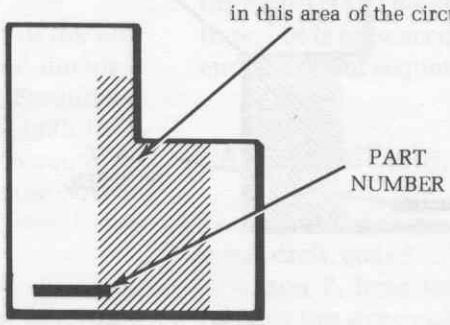
( ) R44: 1000 Ω (brn-blk-red).

( ) R45: 1000 Ω (brn-blk-red).

( ) R43: 510 Ω (grn-brn-brn).

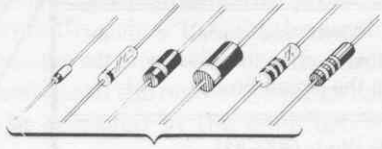
( ) Solder the leads to the foil and cut off the excess lead lengths.

The steps performed in this Pictorial are in this area of the circuit board.

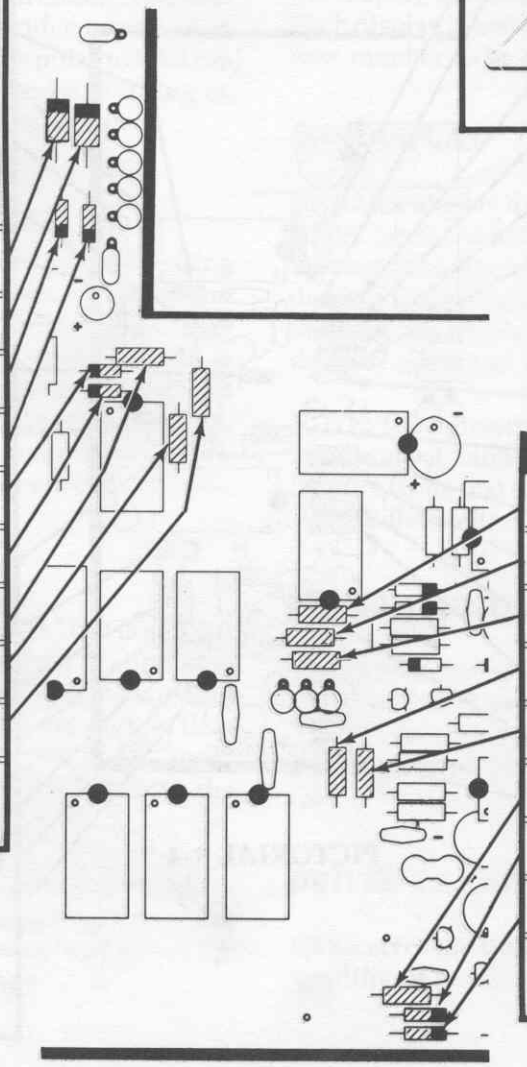



IDENTIFICATION DRAWING

IMPORTANT: THE BANDED END OF DIODES CAN BE MARKED IN A NUMBER OF WAYS.




**Detail 1-3A**



## CONTINUE

( ) R21: 150 Ω (brn-grn-brn).

( ) R32: 2000 Ω (red-blk-red).

( ) R33: 2000 Ω (red-blk-red).

( ) R19: 10 Ω (brn-blk-blk).

( ) R18: 240 Ω (red-yel-brn).

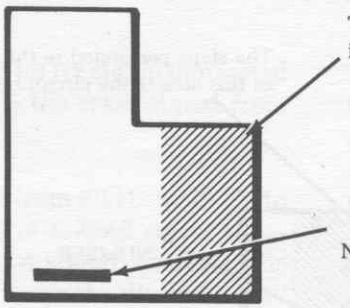
( ) R3: 10 Ω (brn-blk-blk).

( ) D2: FD777 diode (#56-86).

( ) D1: FD777 diode (#56-86).

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

**PICTORIAL 1-3**




IDENTIFICATION DRAWING

**START**

( ) R27: 560 Ω (grn-blu-brn).

( ) R28: 1800 Ω (brn-gry-red).

NOTE: When you install a diode, match the band on the diode with the band on the circuit board.

( ) D5: Diode (#56-87).

( ) D6: Diode (#56-87).

( ) R26: 100 Ω (brn-blk-brn).

( ) R17: 910 Ω (wht-brn-brn).

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

( ) D4: 1N4149 diode (#56-56).

( ) R14: 1000 Ω (brn-blk-red).

( ) R15: 150 Ω (brn-grn-brn).

( ) R16: 150 Ω (brn-grn-brn).

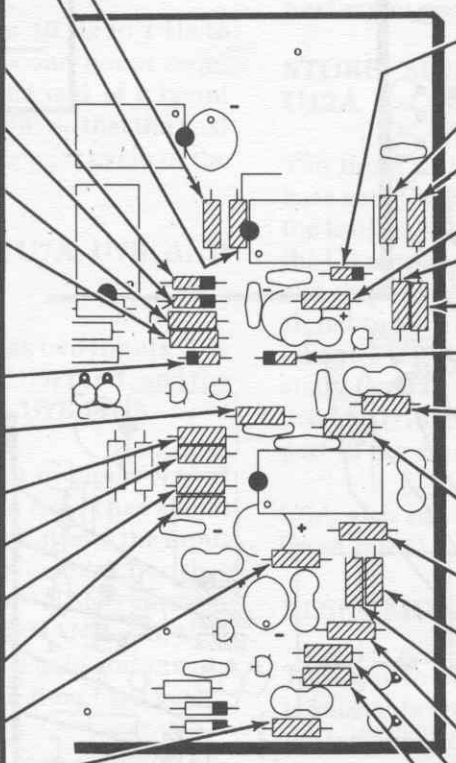
( ) R8: 120 Ω (brn-red-brn).

( ) R9: 150 Ω (brn-grn-brn).

( ) R7: 1000 Ω (brn-blk-red).

( ) R1: 1 MΩ (brn-blk-grn).

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



**PICTORIAL 1-4**

**CONTINUE**

( ) D7: 1N4149 diode (#56-56).

( ) R31: 1000 Ω (brn-blk-red).

( ) R22: 330 Ω (org-org-brn).

( ) R29: 240 Ω (red-yel-brn).

( ) R24: 1000 Ω (brn-blk-red).

( ) R23: 5600 Ω (grn-blu-red).

( ) D3: 1N4149 diode (#56-56).

( ) R25: 56 Ω (grn-blu-blk).

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

( ) R13: 1000 Ω (brn-blk-red).

( ) R6: 1000 Ω (brn-blk-red).

( ) R12: 150 Ω (brn-grn-brn).

( ) R11: 150 Ω (brn-grn-brn).

( ) R5: 100 Ω (brn-blk-brn).

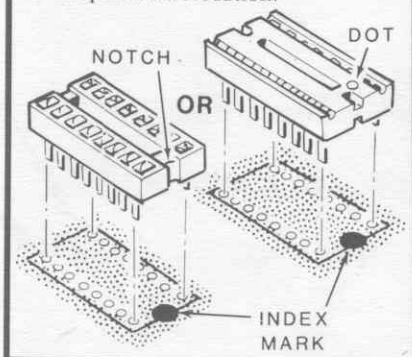
( ) R4: 1000 Ω (brn-blk-red).

( ) R2: 100 kΩ (brn-blk-yel).

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

**START**

NOTE: Before you install an IC socket, make sure the pins are straight. If there is any kind of identification mark (notch, dot, arrowhead, etc.) at or near one end of the socket, place this marked end toward the index mark on the circuit board (this index mark should still be visible after you install the socket). Then start the pins into the circuit board holes and solder them to the foil. DO NOT install a 14-pin socket at a 16-pin socket location.




( ) 8-pin IC socket at U10.

( ) 14-pin IC socket at U8.

( ) 14-pin IC socket at U9.

( ) 16-pin IC socket at U6.

( ) 16-pin IC socket at U5.

( ) 14-pin IC socket at U7.

( ) 16-pin IC socket at U17.

( ) 16-pin IC socket at U16.

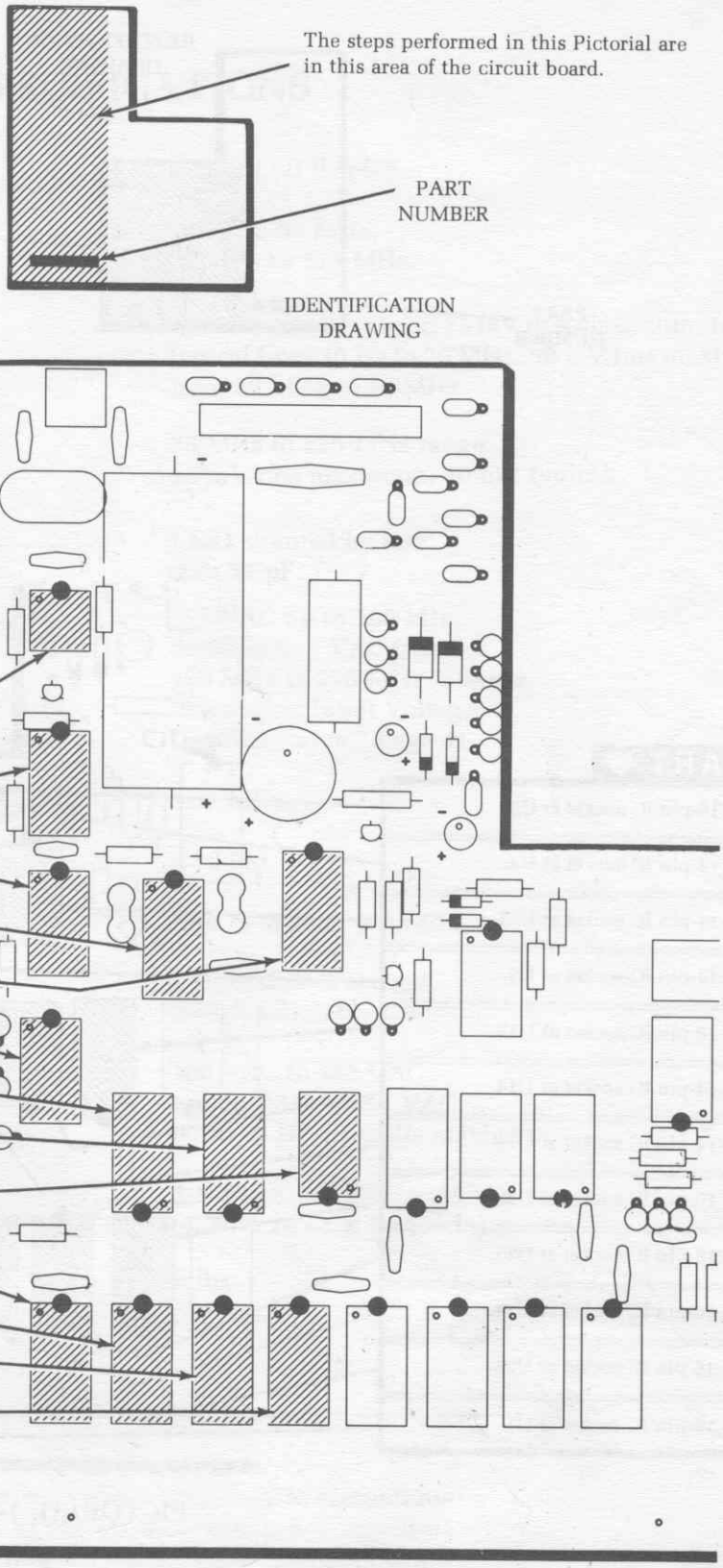
( ) 14-pin IC socket at U12.

( ) 16-pin IC socket at U18.

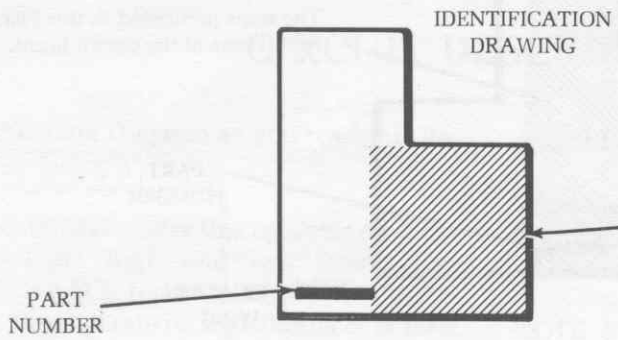
( ) 16-pin IC socket at U19.

( ) 16-pin IC socket at U20.

( ) 16-pin IC socket at U21.




**PICTORIAL 1-5**




START

( ) 16-pin IC socket at U2.

( ) 14-pin IC socket at U4.

( ) 14-pin IC socket at U11.

( ) 14-pin IC socket at U3.

( ) 16-pin IC socket at U15.

( ) 14-pin IC socket at U14.

( ) 14-pin IC socket at U13.

( ) 16-pin IC socket at U22.

( ) 16-pin IC socket at U23.

( ) 16-pin IC socket at U24.

( ) 16-pin IC socket at U25.

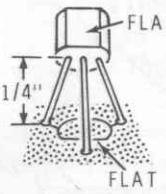
( ) 16-pin IC socket at U1.

**PICTORIAL 1-6**

HEATHKIT®

## START

NOTE: When you install a transistor or integrated circuit (IC) in each of the following steps, align its flat with the flat on the board. Insert the leads into their correct holes. Position the transistor or IC 1/4" above the board. Then solder the leads to the foil and cut off the excess lead lengths.




( ) Q6: 2N5770 transistor (#417-293).

( ) U27: 78L12 IC (#442-644).

( ) Q7: 2N5770 transistor (#417-293).

Perform the following steps in area B.

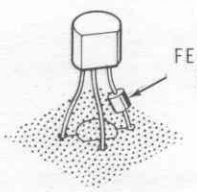
( ) Q5: 2N5770 transistor (#417-293).

( ) Q3: 2N5771 transistor (#417-292).

( ) Q4: 2N5770 transistor (#417-293).

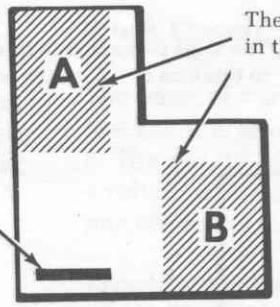
( ) Q2: 2N5770 transistor (#417-293).

( ) Q1/FB1: Selected transistor (#417-828). Place a ferrite bead on the gate (G) lead of this transistor before you install it.

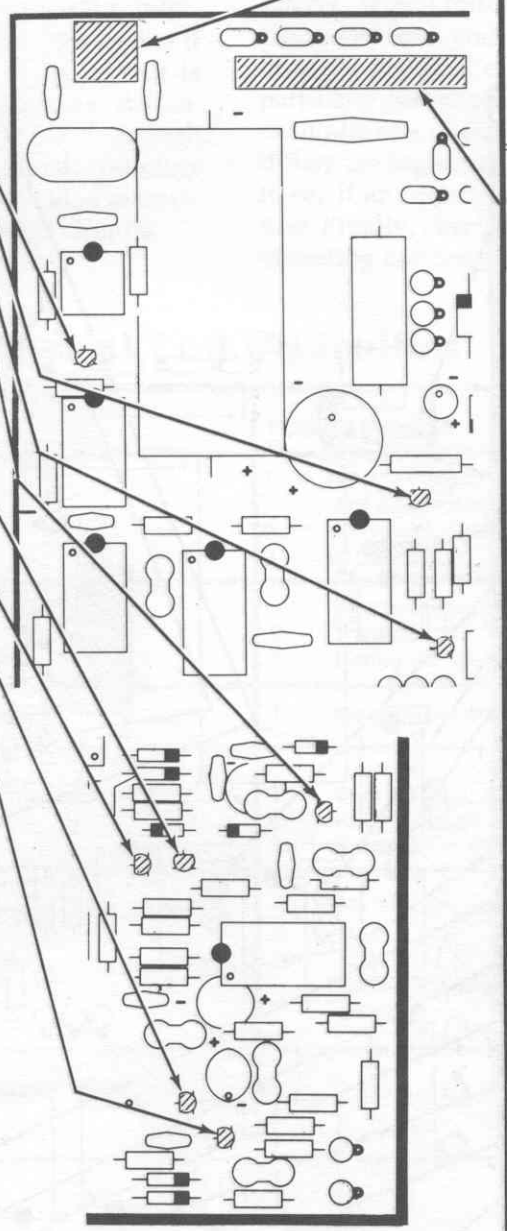



IDENTIFICATION DRAWING

PART NUMBER




The steps performed in this Pictorial are in this area of the circuit board.

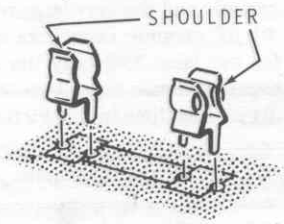


## CONTINUE

Perform the following steps in area A.

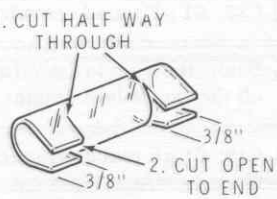
( ) C27: 7-25 pF trimmer. Solder the lugs to the foil.

( ) Install two fuse clips in the circuit board as shown. Position each clip so its shoulders are away from the other clip. Then solder the clips to the foil.

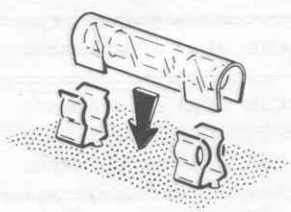


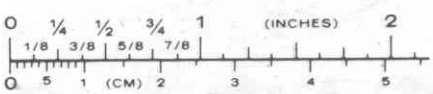

( ) Locate the clear tubing and cut off a 1-1/2" length.

( ) Flatten the tubing and cut each end as shown.



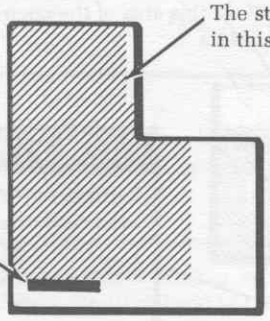

( ) F1: Locate the 1/4-ampere fuse and insert it into the prepared tubing. Then install the fuse into the fuse clips.






**PICTORIAL 1-7**

IDENTIFICATION DRAWING




## START

NOTE: In the following steps, install each capacitor down tight against the circuit board.

( ) C27: 14 pF resin (brn-yel-blk-grn).

( ) Set the seven square .01 μF (103) ceramic and the very large round .01 μF ceramic capacitors aside for use later. Use only the nine round ceramic capacitors at the .01 μF locations in this Pictorial.

( ) C24: .01 μF round ceramic.

( ) C25: 33 pF ceramic.

( ) C22: 150 pF mica.

( ) C21: 150 pF mica.

( ) C23: .01 μF round ceramic.

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

( ) C19: .01 μF round ceramic.

( ) C28: .01 μF round ceramic.

( ) C34: .01 μF round ceramic.

( ) C29: .01 μF round ceramic.

( ) C31: .01 μF round ceramic.

( ) C33: .01 μF round ceramic.

( ) C32: .01 μF round ceramic.

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

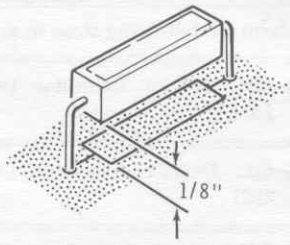
## CONTINUE

NOTE: When you install an electrolytic capacitor, be sure to match the plus (+) mark on the capacitor with the plus (+) mark on the circuit board, or match the minus (−) mark on the capacitor with the minus mark on the circuit board.


( ) C37: 10 μF electrolytic.

( ) C35: 10 μF electrolytic.

( ) R30: 10 Ω, 5-watt wire-wound resistor. Position the body of the resistor 1/8" above the circuit board. Solder the leads to the foil and cut off the excess lead lengths.

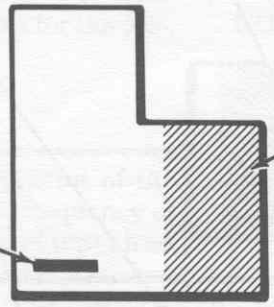



( ) Solder the leads to the foil and cut off the excess lead lengths.



**PICTORIAL 1-8**

IDENTIFICATION DRAWING

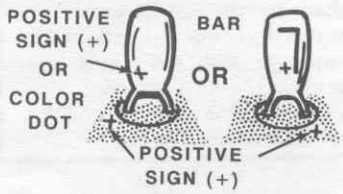




**Detail 1-9A**

## START

NOTE: When you install a tantalum capacitor, install the lead marked with the positive (+) mark or color dot or bar on the capacitor in the positive (+) marked hole on the board.




( ) C41: 10 μF tantalum.

NOTE: Use only the square ceramic capacitors at the eight .01 μF (103) locations on this Pictorial. The large .01 μF round capacitor will be installed later.

( ) C16: .01 μF (103) ceramic.

( ) C11: .01 μF (103) ceramic.

( ) C9: .01 μF (103) ceramic.

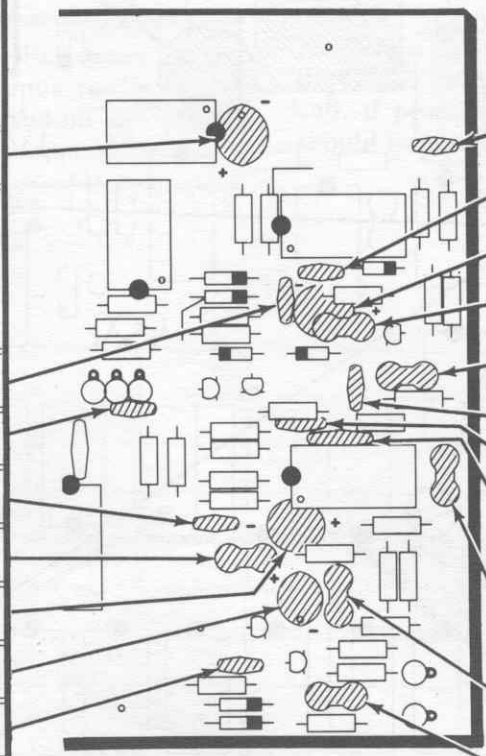
( ) C7: 330 pF mica.

( ) C6: 39 μF tantalum.

( ) C4: 68 μF tantalum.

( ) C3: .01 μF (103) ceramic.

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



**PICTORIAL 1-9**

## CONTINUE

( ) C13: .01 μF (103) ceramic.

( ) C17: .01 μF (103) ceramic.

( ) C18: 10 μF tantalum.

( ) C14: 330 pF mica.

( ) C15: 24 pF mica.

( ) C8: .01 μF (103) ceramic.

( ) C20: .01 μF (103) ceramic.

( ) C10/FB2: 33 pF ceramic with a ferrite bead on the indicated lead. See Detail 1-9A above.

( ) C12: 30 pF mica.

( ) C5: 100 pF mica.

( ) C2: 51 pF mica.

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

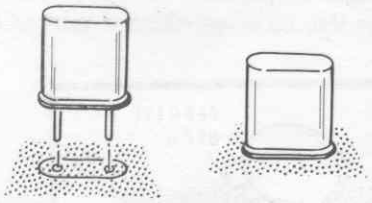
IDENTIFICATION DRAWING

The steps performed in this Pictorial are in this area of the circuit board.

PART NUMBER

## START

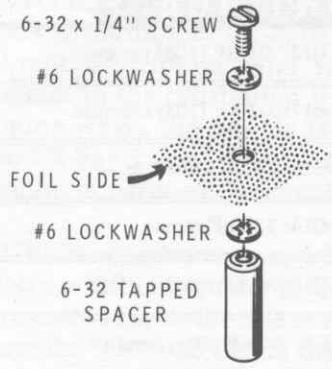
( ) Y1: 3579.545 kHz crystal. Solder the leads to the foil and cut off the excess lead lengths.



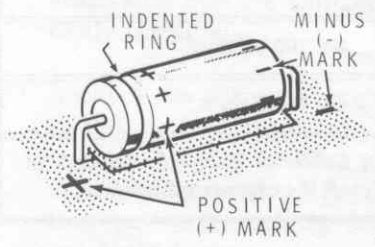
( ) C39: .01 μF large round ceramic.

NOTE: Use the black screws only when they are called for in a step.

( ) Install 6-32 tapped spacers at the four indicated locations on the **foil** side of the circuit board. Use 6-32 × 1/4" screws and #6 lockwashers.



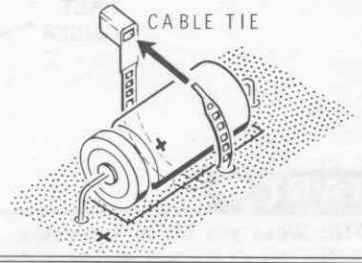

NOTE: When you install electrolytic capacitors, be sure to match the plus (+) mark on the capacitor with the plus (+) mark on the circuit board, or match the minus (−) mark on the capacitor with the minus mark on the circuit board.




## CONTINUE

( ) C36: 6000 μF electrolytic. Solder the leads to the foil and cut off the excess lead lengths.

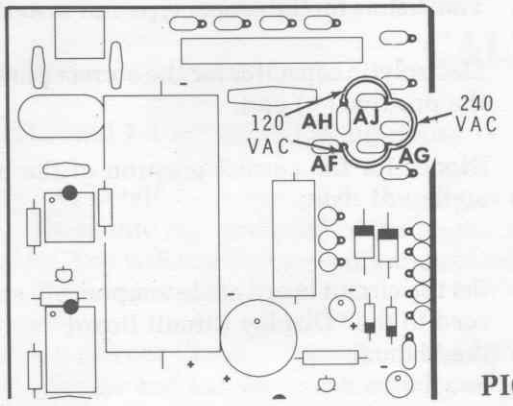
( ) Secure C36 to the circuit board with a cable tie as shown (with the rough side of the cable tie on the inside). Cut off the excess length.

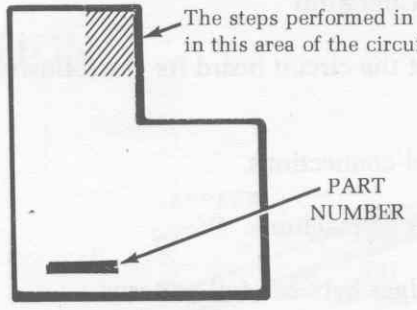



( ) C38: 470 μF electrolytic. Match the positive (+) mark on the capacitor with the positive (+) mark on the circuit board, or match the minus (−) mark on the capacitor with the minus (−) mark on the circuit board. Solder the leads to the foil and cut off the excess lead lengths.



**PICTORIAL 1-10**




**PICTORIAL 1-11**

## ALTERNATE LINE VOLTAGE

Two sets of line voltage wiring instructions are given below, one for 120 VAC and one for 240 VAC. In the U.S.A., 120 VAC is most often used, while in other countries 240 VAC is more common. USE ONLY THE INSTRUCTIONS THAT AGREE WITH THE LINE VOLTAGE IN YOUR AREA.

NOTE: When you are instructed to prepare a wire, remove a 1/4" length of insulation from each end of the indicated length of wire. If necessary, tightly twist together the fine wire strands at each end; then melt a small amount of solder on them to hold them together.

Refer to Pictorial 1-11 for the following steps.

### 120 VAC Line Voltage

( ) Prepare two 1-1/4" lengths of black wire.

( ) Install one wire between circuit board holes AH and AJ.

( ) Install the other wire between circuit board holes AF and AG.

( ) Solder the wires to the foil and cut off the excess wire lengths.

( ) Write "1/4 A. 3 AG slow-blow" on the fuse label and set the label aside.

### 240 VAC Line Voltage

( ) Prepare a 1-1/4" length of black wire.

( ) Install this wire between circuit board holes AJ and AG.

( ) Solder the wire to the foils and cut off the excess wire lengths.

( ) Replace the fuse at F1 with a 1/8 ampere 3 AG slow-blow fuse (not furnished).

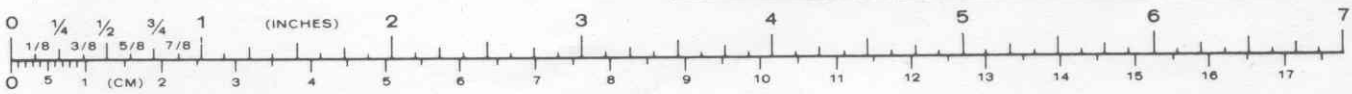
( ) Write "1/8 A. 3 AG slow-blow" on the fuse label and set the label aside.

CAUTION

The plug on the power cord for this kit is for standard 120 VAC outlets. For 240 VAC operation in the U.S.A., cut off and replace this plug with a permanent plug that matches your 240 VAC receptacle in a manner such that your power connection conforms with section 210-21 (b) of the National Electric Code, which reads, in part:

> "Receptacles connected to circuits having different voltages, frequencies, or types of current (AC or DC) on the same premises shall be of such design that attachment plugs used on such circuits are not interchangeable."

**When you install a new plug, make sure it is connected according to your local electrical code. Units employing three-wire line cords must always have the green wire connected to chassis ground.**



## Circuit Board Checkout

Carefully inspect the circuit board for the following conditions.

( ) Unsoldered connections.

( ) Poor solder connections.

( ) Solder bridges between foil patterns.

( ) Protruding leads which could touch together.

( ) Transistors for the proper type and installation.

( ) Electrolytic capacitor for the correct position of the positive (+) end.

( ) Diodes for the correct position of the banded end.

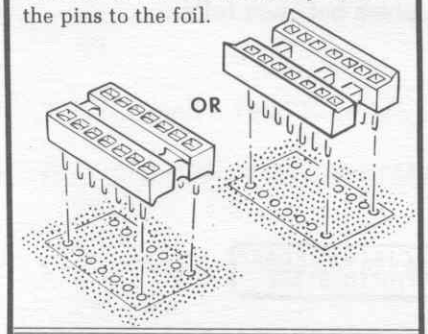
( ) Set the circuit board aside temporarily and proceed to the "Display Circuit Board" section of the Manual.

## DISPLAY CIRCUIT BOARD

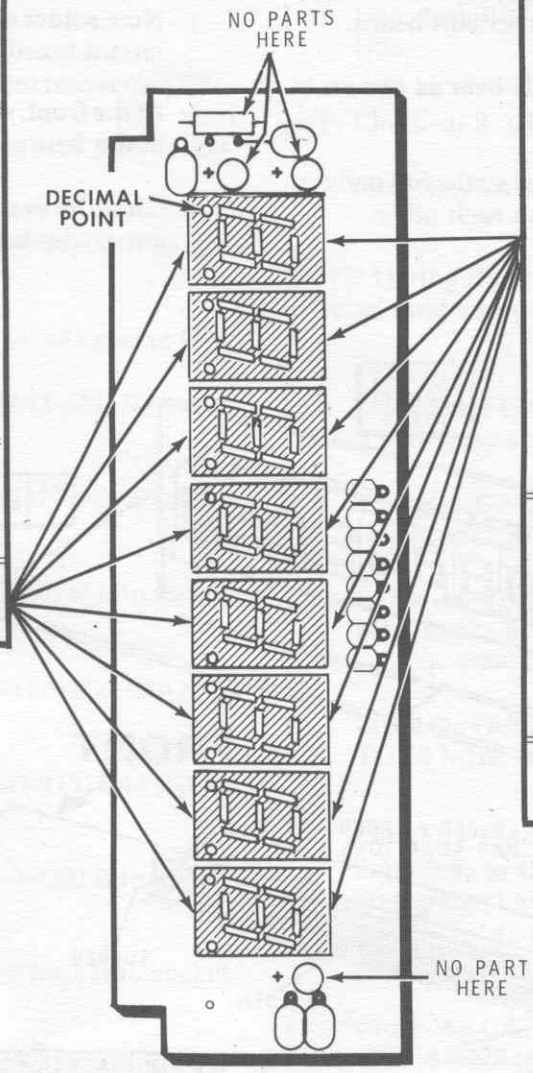
**START**

( ) Position the circuit board on your work area so the side with the component outlines is up, as shown.

NOTE: To install a 14-pin IC socket, be sure the socket pins are straight. Insert the socket pins into the holes. The sockets can be installed either way. Solder the pins to the foil.

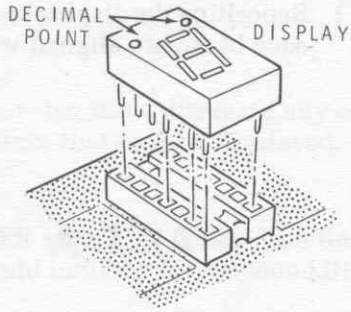



( ) Install eight 14-pin IC sockets at locations V1 through V8.




**CONTINUE**

( ) V1-V8: Install a light-emitting diode (LED) display in each of the IC sockets. Position the decimal points of each display as shown. Press each display firmly into its socket.




### CIRCUIT BOARD CHECK

Carefully inspect the circuit board for the following conditions.

( ) Unsoldered connections.
( ) Poor solder connections.
( ) Solder bridges between foils.
( ) LED's for proper installation.

No parts are installed at the outlines at both ends of the board.

**PICTORIAL 2-1**

## WIRING

Refer to Pictorial 3-1 for the following steps.

( ) Position the main circuit board printed side up on your work surface as shown in Part A of Pictorial 3-1.

( ) Fit the bottom edge of the display circuit board into the groove of the main circuit board.

( ) Turn the two circuit boards over as shown in Part B of Pictorial 3-1.

( ) Reposition the display board so the foil pads on each board are aligned with each other.

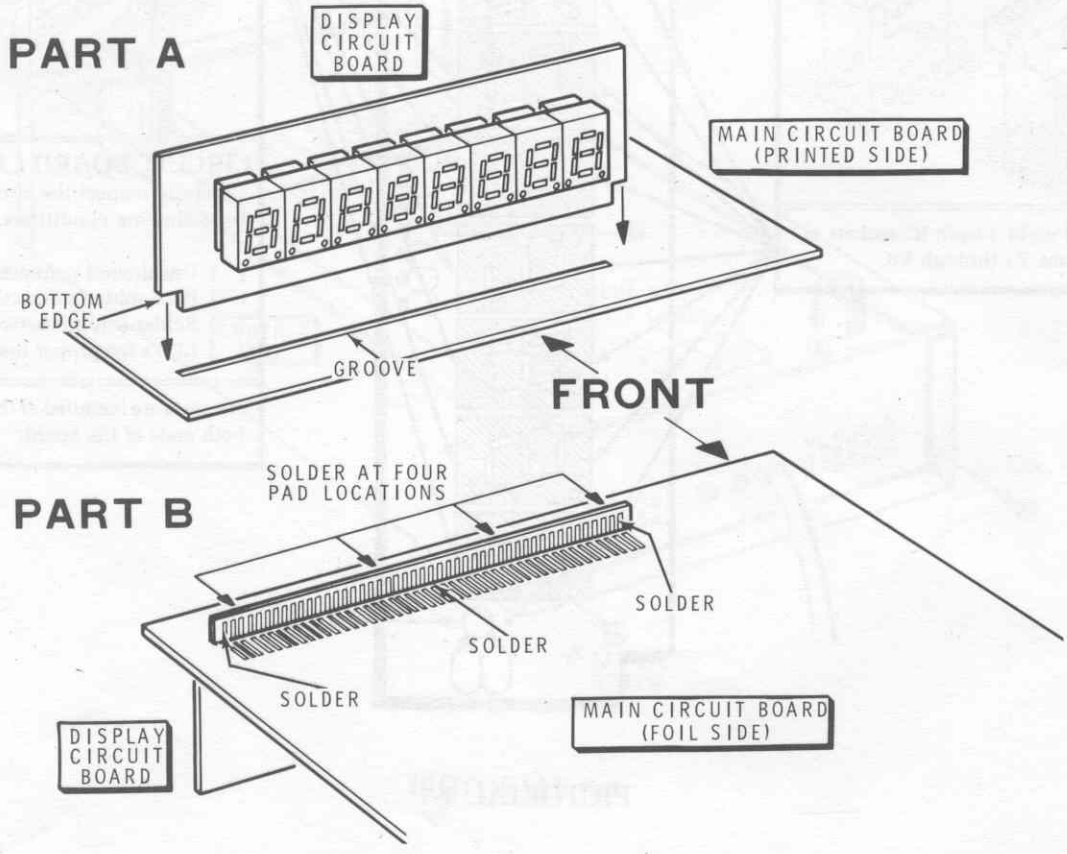
( ) With the display board perpendicular to the main board, solder the two end pads and a pad near the center of both boards together.

( ) Check to see that the display board is still perpendicular to and tight against the main circuit board. If not, heat the soldered connections and reposition the display circuit board as required.

( ) Now solder all the remaining foil pads of each circuit board to each other.

( ) **At the front, solder the two board foils together at the four pad locations.**

( ) Carefully examine the solder joints, and correct any solder bridges between foils.




**PICTORIAL 3-1**

Refer to Pictorial 3-2 (Illustration Booklet, Page 3) for the following steps.

( ) Position the main circuit board with the **foil** side up as shown in the Pictorial.

( ) Locate the 18" length of 8-conductor flat cable and cut it in half to provide two 9" lengths of 8-conductor flat cables.

NOTE: In the following steps, you will separate the 8-conductor flat cables to produce four 3-conductor cables. To separate these conductors, allow the sharp edges of your cutters to seat in the grooves between the conductors and then cut the conductors apart at just one end. See Detail 3-2A. Be careful not to cut the insulation and expose the fine wires.

( ) At one end of one of the 8-conductor flat cables, separate the conductors between the blue and green conductors.

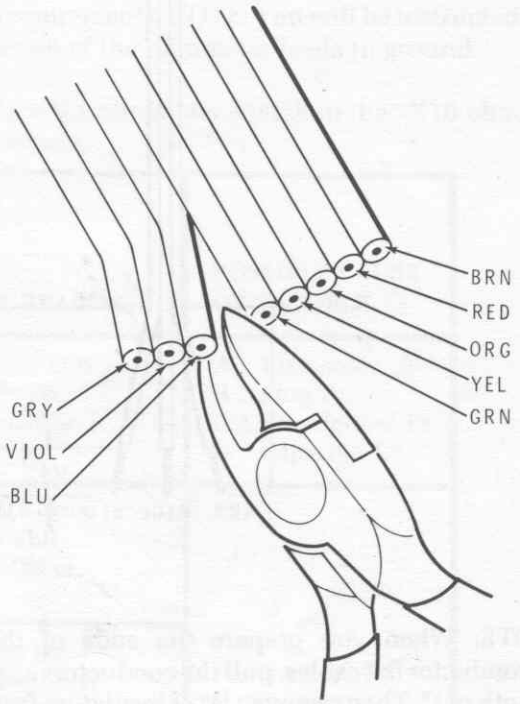
( ) Completely separate the gray, violet, and blue 3-conductor flat cable from the other conductors. Set this 3-conductor cable aside temporarily.

( ) In the same manner, separate the green, yellow, and orange 3-conductor cable from the other conductors. Save this three conductor cable and discard the red and brown conductors.

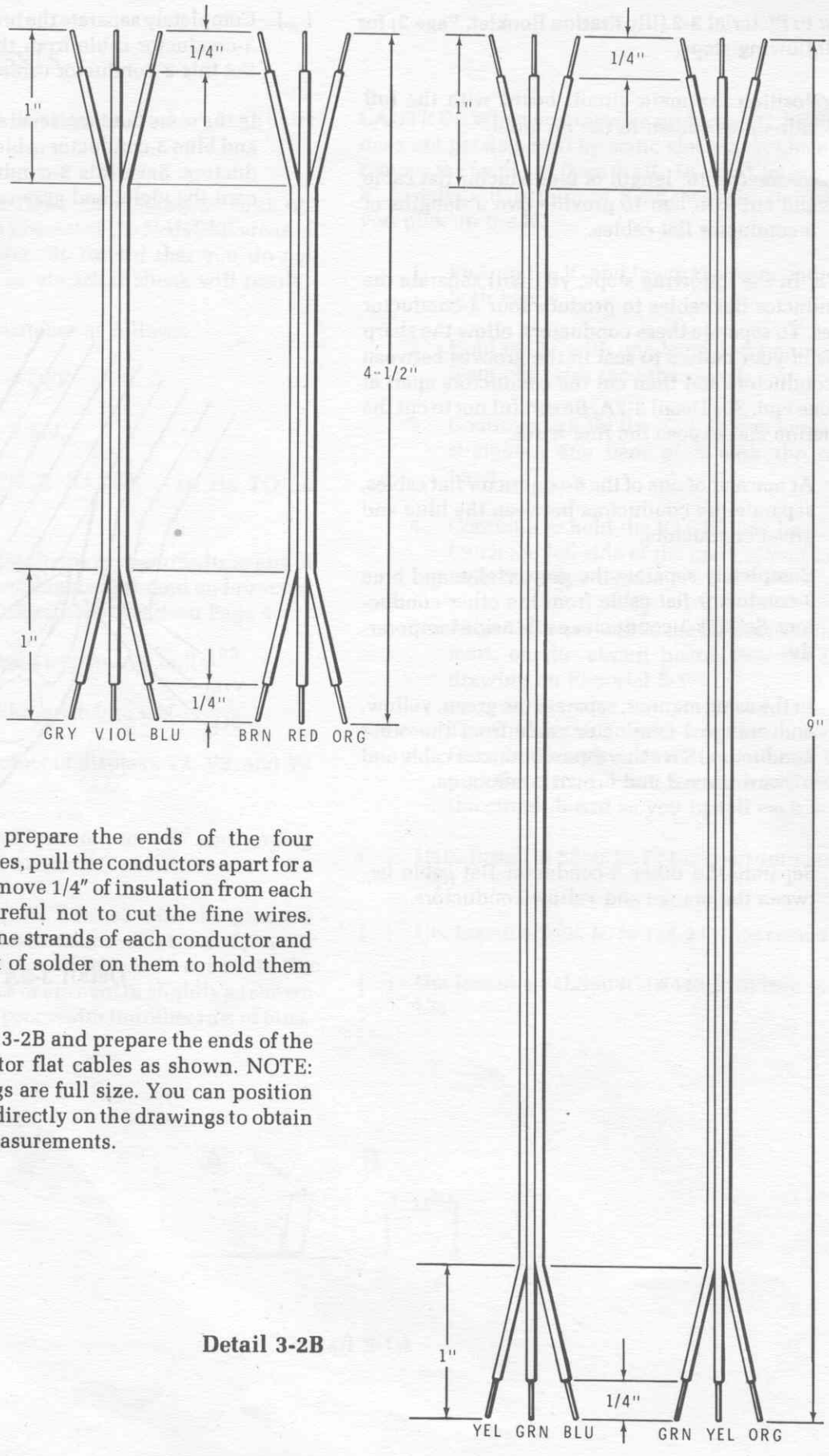
( ) Separate the other 8-conductor flat cable between the orange and yellow conductors.

( ) Completely separate the brown, red, and orange 3-conductor cable from the other conductors. Set this 3-conductor cable aside temporarily.

( ) In the same manner, separate the yellow, green, and blue 3-conductor cable from the other conductors. Save this 3-conductor cable and discard the violet and gray conductors.



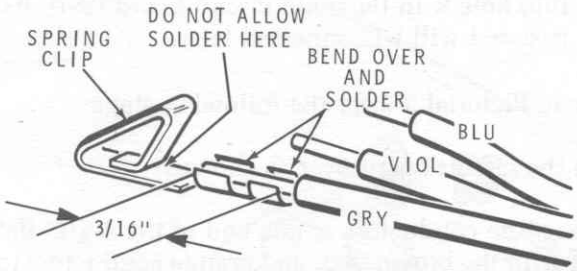

**Detail 3-2A**




NOTE: When you prepare the ends of the four 3-conductor flat cables, pull the conductors apart for a length of 1". Then remove 1/4" of insulation from each conductor, being careful not to cut the fine wires. Twist together the fine strands of each conductor and melt a small amount of solder on them to hold them together.

( ) Refer to Detail 3-2B and prepare the ends of the four 3-conductor flat cables as shown. NOTE: These drawings are full size. You can position the flat cables directly on the drawings to obtain the correct measurements.

**Detail 3-2B**




**Detail 3-2C**

( ) Locate the 4-1/2", 3-conductor cable with the blue, violet, and gray conductors. At the indicated end of this cable, cut the exposed bared end to 3/16" as shown in Detail 3-2C.

( ) Refer to Detail 3-2C and install a spring connector on each of these shortened conductors.

( ) Refer to Detail 3-2D and push the spring connectors on this 3-conductor cable into the connector shell. Be sure the connector shell is positioned with its slots up. Push on the cable until the locking tabs on the spring connectors snap into place.

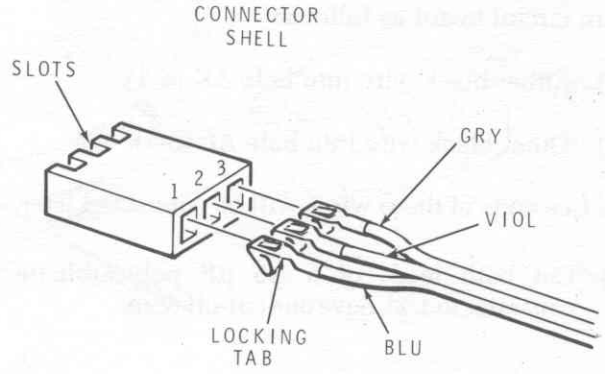
NOTES:

1. When you connect conductors or wires to the foil side (not the printed side) of the circuit board, as in the following steps, keep the insulation 1/8" above the board so you get a good solder connection. The circuit board hole callouts are on the printed side of the circuit board.

2. In the following steps, (NS) means not to solder because other wires will be added later. "S-" with a number, such as (S-3), means to solder the connection. The number following the "S" tells how many wires are at the connection. Cut off any excess wire end after you solder a connection.

Connect the conductors at the free end of the flat cable with the connector shell on it to the **foil** side of the main circuit board as follows.

( ) Blue conductor into hole S (S-1).




**Detail 3-2D**

( ) Violet conductor into hole T (S-1).

( ) Gray conductor into hole U (S-1).

The connector shell will be connected later.

Connect the conductors at one end of the 9" flat cable with the green, yellow, and orange conductors to the main circuit board as follows:

( ) Green conductor into hole R (S-1).

( ) Orange conductor into hole P (S-1).

( ) Yellow conductor into hole Q (S-1).

The free end of this cable will be connected later.

Connect the conductors at one end of the 9" flat cable with the blue, green, and yellow conductors to the main circuit board as follows:

( ) Blue conductor into hole N (S-1).

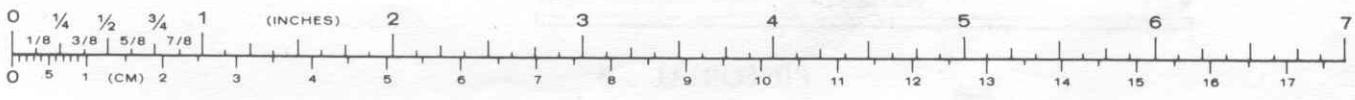
( ) Green conductor into hole M (S-1).

( ) Yellow conductor into hole L (S-1).

The free end of this cable will be connected later.

( ) Prepare the ends of two 10" black wires.

( ) Twist these two black wires together to form a twisted pair.



Connect the wires at one end of this twisted pair to the main circuit board as follows:

( ) Either black wire into hole AK (S-1).

( ) Other black wire into hole AL (S-1).

The free ends of these wires will be connected later.

( ) Cut both leads of a .15 µF polycarbinate capacitor to 1/2". Save one cut-off wire.

( ) C1: Connect one lead of this .15 µF capacitor into hole J in the main circuit board (S-1). Position the capacitor next to the board as shown in Pictorial 3-2. The other lead of the capacitor will be connected later.

( ) Connect one end of the cut-off capacitor lead into hole K in the main circuit board (S-1). Its free end will be connected later.

Refer to Pictorial 3-3 for the following steps.

Turn the circuit board over as shown.

Connect the conductors at one end of the 4-1/2" flat cable with the brown, red, and orange conductors to the **printed** side of the main circuit board as follows:

( ) Brown conductor into hole B (S-1).

( ) Red conductor into hole C (S-1).

( ) Orange conductor into hole D (S-1).

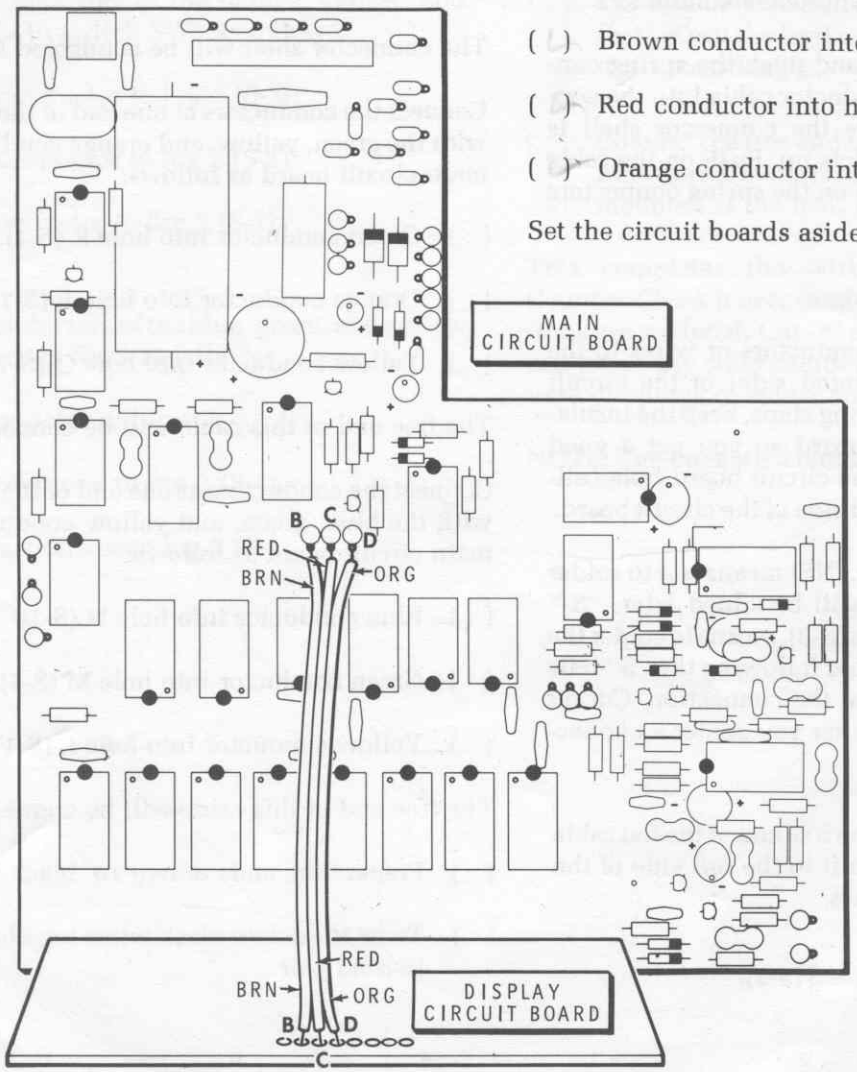
Connect the conductors at the free end of this cable to the display circuit board as follows:

( ) Brown conductor into hole B (S-1).

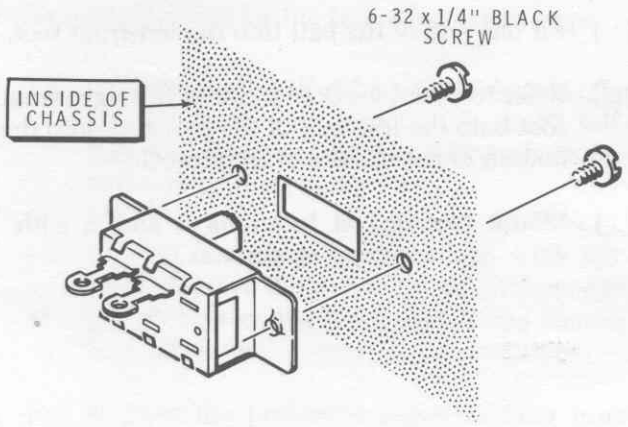
( ) Red conductor into hole C (S-1).

( ) Orange conductor into hole D (S-1).

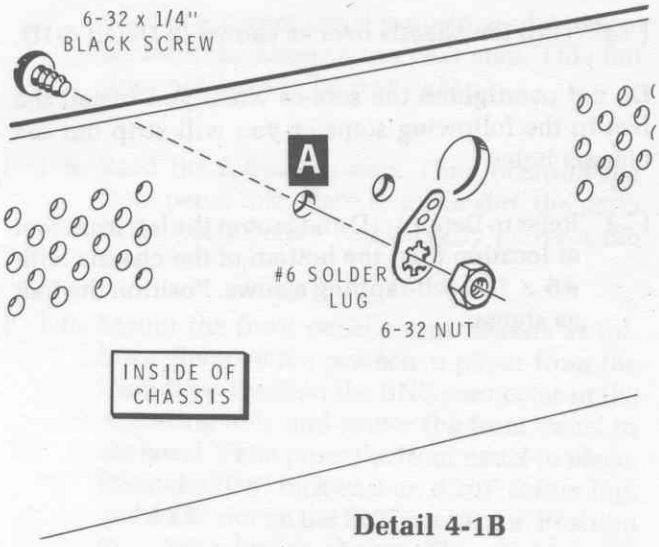
Set the circuit boards aside temporarily.




**PICTORIAL 3-3**




**Detail 4-1A**




**Detail 4-1B**

## CHASSIS

Refer to Pictorial 4-1 (Illustration Booklet, Page 3) for the following steps.

( ) SW1: Refer to Detail 4-1A and mount an SPST slide switch at location SW1 on the chassis with 6-32 × 1/4" **black** screws. Use the **black** screws only when they are called for in a step. Position the switch so its lugs are located as shown in Pictorial 4-1.

( ) SW2: In a similar manner, mount a DPDT slide switch at location SW2. The switch can be positioned either way.

( ) SW3: Mount the remaining DPDT slide switch at SW3.

NOTE: The term "hardware" in the following steps refers to the screws, nuts, and lockwashers you will use to mount parts. The phrase "Use 6-32 × 1/4" hardware," for example means to use a 6-32 × 1/4" screw, one or more #6 lockwashers and a 6-32 nut at each mounting hole. Refer to the Detail called out in the step for the correct number of lockwashers to use and the correct way to install the hardware. Use the plastic nut starter furnished with the kit to pick up #4 and #6 nuts and start them on screws.

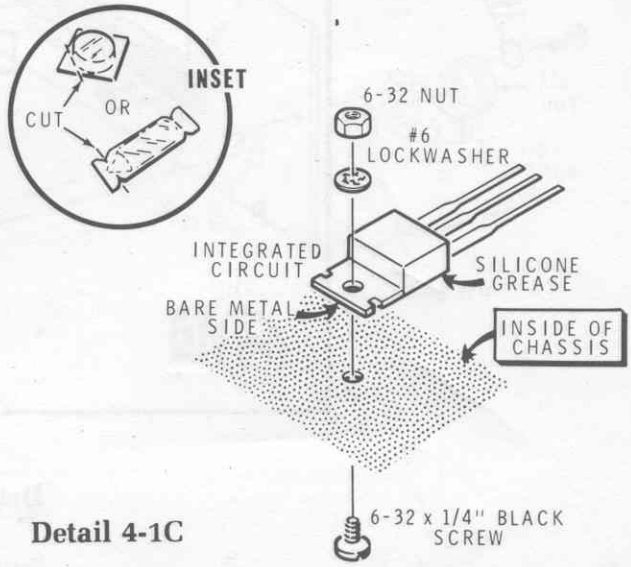
( ) Refer to Detail 4-1B and install a #6 solder lug at location A at the rear chassis. Position the lug as shown. Use a 6-32 × 1/4" **black** screw and a 6-32 nut. No lockwasher is used.

( ) Locate the fuse label you set aside earlier. Peel off its backing paper and press the label into place on the inside rear of the chassis. Avoid covering the ventilation holes with the label.

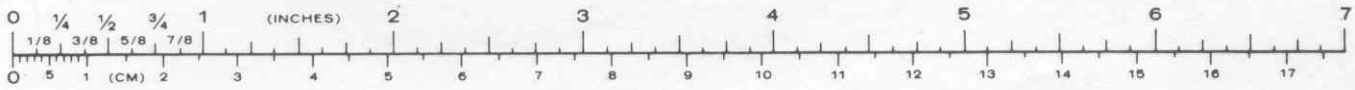
WARNING: The silicone grease you will use in the following step helps transfer heat from the IC to the chassis. The grease is not caustic, but make sure you do not get it into your eyes, ears, nose, mouth, or clothing. Always wash your hands after you use the grease. Keep this and all chemicals out of the reach of children.

( ) Apply a thin layer of silicone grease on the metal side of a 7805 IC (#442-54). Discard the remaining silicone grease.

( ) U26. Refer to Detail 4-1C and mount the 7805 IC (#442-54) at location U26 on the chassis with a 6-32 × 1/4" **black** hardware. Position the IC so its lugs are located as shown in Pictorial 4-1.




**Detail 4-1C**



( ) Turn the chassis over as shown in Detail 4-1D.

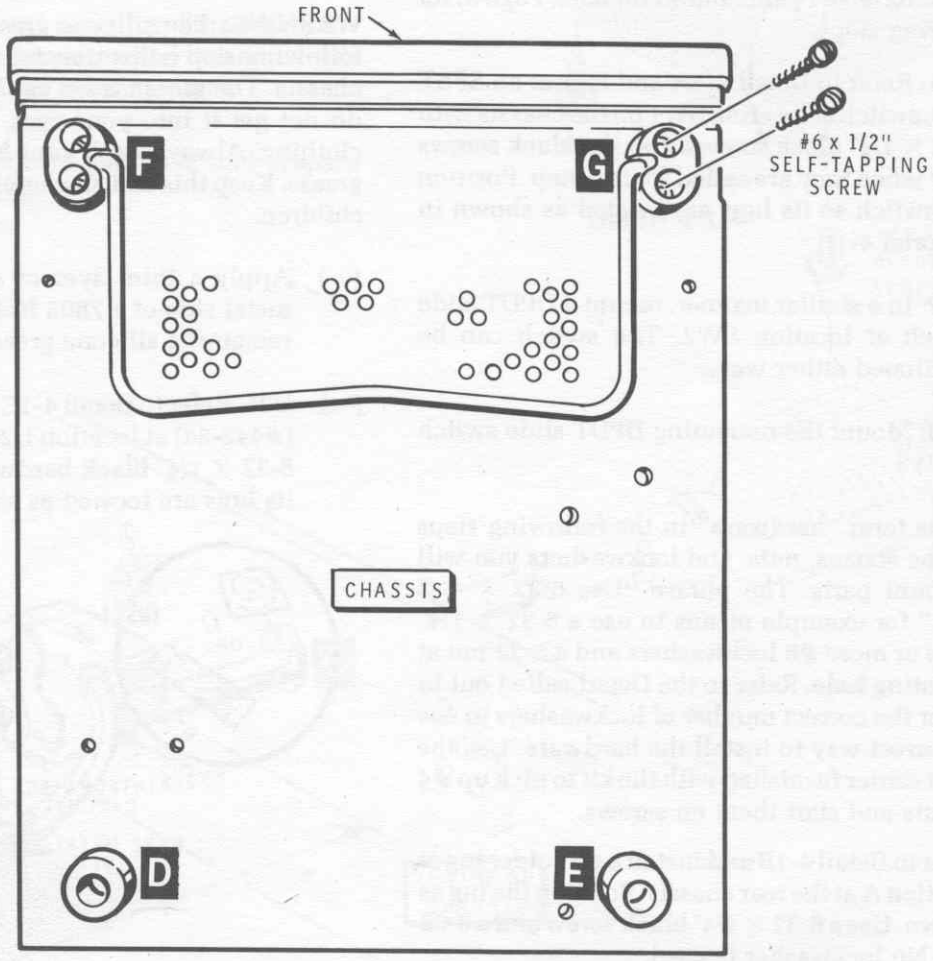
Do not overtighten the screws when you install the feet in the following steps or you will strip out the chassis holes.

( ) Refer to Detail 4-1D and mount the left front foot at location F on the bottom of the chassis with #6 × 1/2" self-tapping screws. Position the foot as shown.

( ) Fit one end of the bail into the left-front foot.

( ) Refer to Detail 4-1D and mount the right front foot onto the free end of the bail and onto the bottom of the chassis at location G.

( ) Mount rear feet at locations D and E with #6 × 1/2" self-tapping screws.




**Detail 4-1D**

Refer to Detail 4-1E for the following seven steps.

( ) 1. Refer to Detail 4-1E and mount the bezel to the chassis front with two #2 × 3/16″ self-tapping screws and two #2 lockwashers. Position the cutout as shown.

( ) 2. Cut the foam tape lengthwise so it is 3/8″ wide. Remove the protective paper from one side and press the foam tape to the chassis front as shown.

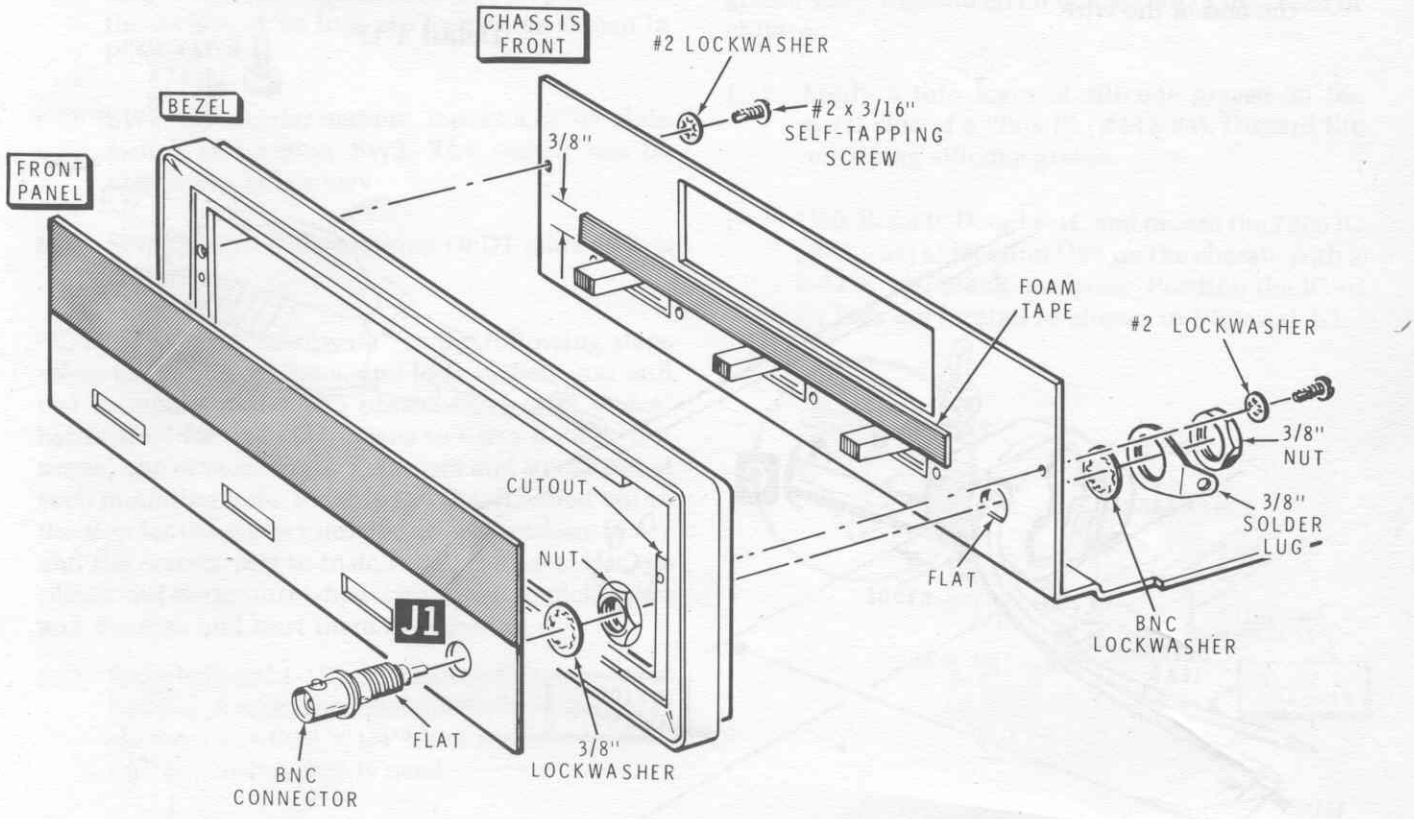
( ) 3. Remove the protective paper backing from the front panel. (There may be backing on both sides.)

( ) 4. Mount the BNC connector to the front panel with a 3/8″ lockwasher and nut. (Do not use lockwasher supplied with the BNC connector. It will be used later.) Position the flat (on the BNC connector) down as shown. Also, be sure the flat on the nut closest to the bottom edge of the front panel is positioned down so it clears the bezel in the next step. This nut does not have to be real tight.

( ) 5. Read the following step. Then position the front panel into place to make sure the parts fit properly before you actually perform the step.

( ) 6. Mount the front panel to the chassis as follows: Remove the protective paper from the foam tape. Position the BNC connector in the mounting hole and center the front panel in the bezel. Then press the front panel in place. Place the BNC lockwasher, a 3/8″ solder lug, and a 3/8″ nut on the BNC connector. Position the solder lug as shown. Then tighten the hardware.

( ) 7. Bend the solder lug away from the front panel at about a 30° angle.




**Detail 4-1E**

Refer to Pictorial 4-1 for the following steps.

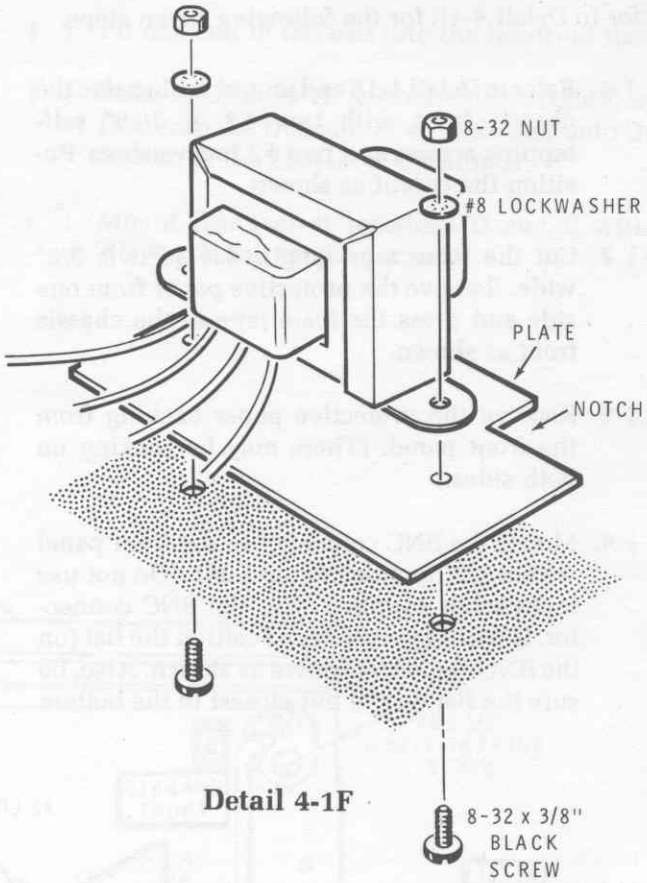
( ) T1: Refer to Detail 4-1F and position the plate with the notch as shown. Align the mounting holes of the plate with the mounting holes in the chassis at T1. Then mount the power transformer over the plate with 8-32 × 3/8″ **black** hardware. Position the transformer so the correct number of leads extend from the sides, as shown in Pictorial 4-1.

( ) Pass the end of the line cord opposite the plug through hole C from the rear of the chassis.

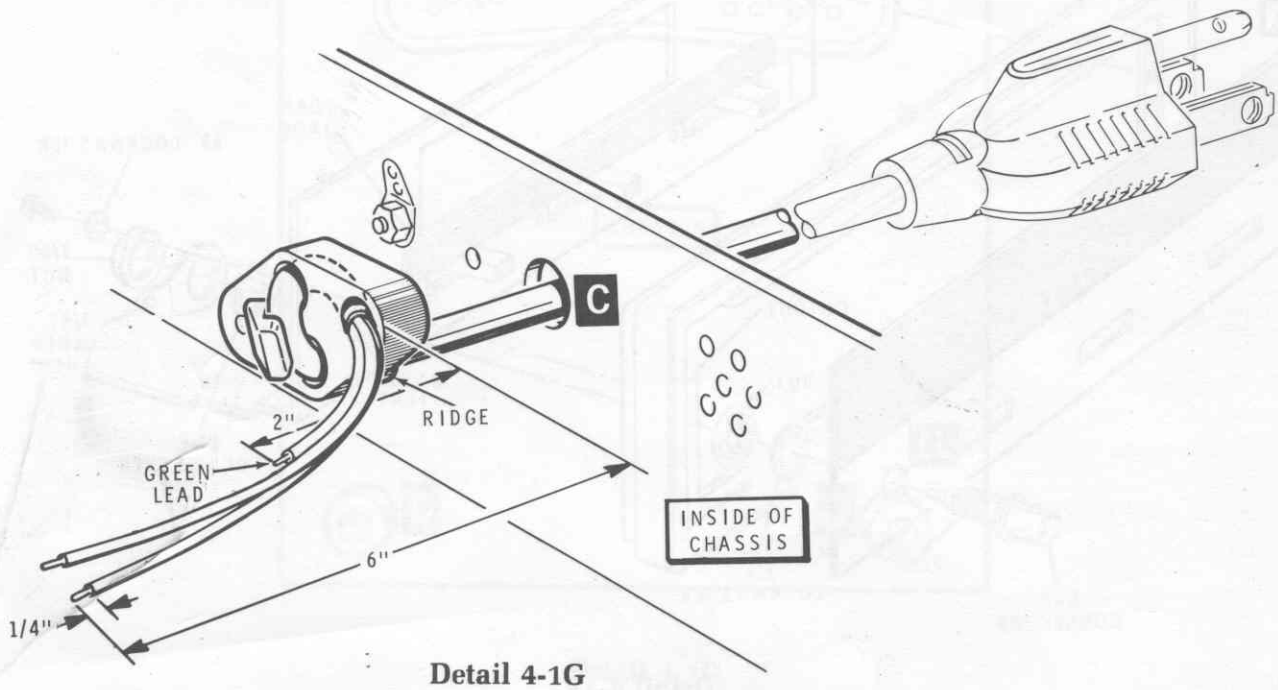
( ) Refer to Detail 4-1G and install the line cord insulator on the line cord.

( ) Carefully remove the outer insulation from the line cord up to the insulator. The line cord leads and insulator will be installed later.

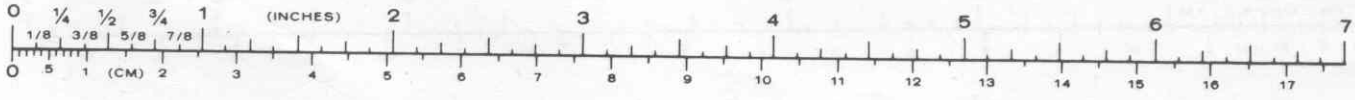
( ) Cut the green line cord lead to 2″ and prepare the end of the wire.

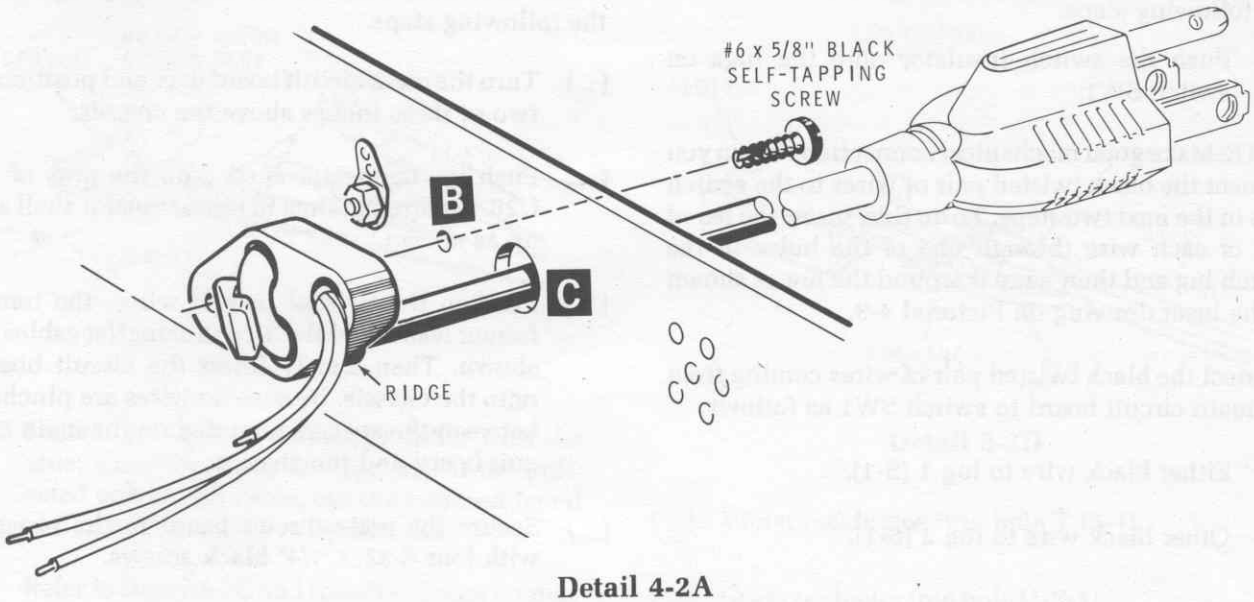



**Detail 4-1F**




**Detail 4-1G**






**Detail 4-2A**

Refer to Pictorial 4-2 (Illustration Booklet, Page 4) for the following steps.

( ) Refer to Detail 4-2A and mount the line cord insulator on the inside rear of the chassis . Fit the ridge of the insulator into hole C. Secure the line cord insulator with a #6 × 5/8" black self-tapping screw.

( ) Connect the line cord green lead to solder lug A (S-1).

Connect the leads coming from power transformer T1 to the main circuit board as follows:

( ) Black-red lead into hole AE (S-1).

( ) Black-yellow lead into hole AC (S-1).

( ) Black-green lead into hole AD (S-1).

( ) Black lead into hole AB (S-1).

( ) Blue-yellow lead into hole W (S-1).

( ) Either blue lead into hole V (S-1).

( ) Other blue lead into hole X (S-1).

( ) Red-yellow lead into hole Z (S-1).

( ) Either red lead into hole Y (S-1).

( ) Other red lead into hole AA (S-1).

Connect the remaining line cord leads to the main circuit board as follows:

( ) White lead into hole AN (S-1).

( ) Black lead into hole AM (S-1).

( ) Cut off any excess line cord and power transformer lead lengths on the foil side of the circuit board.

Refer to Pictorial 4-3 (Illustration Booklet, Page 4) for the following steps.

( ) Push the switch insulator onto the lugs on switch SW1.

NOTE: Make good mechanical connections when you connect the black twisted pair of wires to the switch lugs in the next two steps. To do this, insert the bared end of each wire through one of the holes in the switch lug and then wrap it around the lug as shown in the inset drawing on Pictorial 4-3.

Connect the black twisted pair of wires coming from the main circuit board to switch SW1 as follows:

( ) Either black wire to lug 1 (S-1).

( ) Other black wire to lug 2 (S-1).

Connect the conductors of the orange, yellow, and green flat cable to switch SW2 as follows:

( ) Orange conductor to lug 1 (S-1).

( ) Yellow conductor to lug 2 (S-1).

( ) Green conductor to lug 3 (S-1).

Connect the conductors of the blue, green, and yellow flat cable to switch SW3 as follows:

( ) Blue conductor to lug 1 (S-1).

( ) Green conductor to lug 2 (S-1).

( ) Yellow conductor to lug 3 (S-1).

Refer to Pictorial 4-4 (Illustration Booklet, Page 4) for the following steps.

( ) Turn the main circuit board over and position it two or three inches above the chassis.

( ) Push the connector shell onto the pins of IC U26. Be sure the slots in the connector shell are up as shown.

( ) Position the twisted pair of wires, the transformer leads, and the 3-conductor flat cables as shown. Then slowly lower the circuit board onto the chassis. Be sure no wires are pinched between the spacers mounted on the main circuit board and the chassis.

( ) Secure the main circuit board to the chassis with four 6-32 × 1/4" **black** screws.

( ) Connect the free lead of C1 to BNC connector J1 (S-1). Keep the lead as short as possible. Cut off any excess length.

( ) Connect the free end of the bare wire extending from hole K in the circuit board to the solder lug mounted at the BNC connector (S-1).

This completes the wiring of your Frequency Counter. Check it over carefully to see that all connections are soldered. Cut off any protruding wires that can touch any other component leads. Shake out any wire clippings or solder splashes.

NOTE: The integrated circuits will be installed later.

# INITIAL TESTS

## PRIMARY WIRING TESTS

A wiring error in the primary wiring circuit (line cord, ON-Off switch, etc.) of your kit could cause you to receive a severe electrical shock. These "Primary Wiring Tests" will assure you that no such wiring errors exist.

( ) Be sure the power cord is not plugged in.

( ) Turn the POWER switch to OFF.

( ) If you do not have an ohmmeter, carefully check the line cord fuse, ON-OFF switch, and transformer wiring with that shown in Pictorial 4-2 and Pictorial 4-3. Make sure there are no fine strands of wire or solder blobs touching adjacent terminals or the chassis. Then proceed to the "Operational Tests."

If you have an ohmmeter, perform the following resistance measurements. NOTE: You will be instructed to connect one of the ohmmeter leads to ground.

( ) Place the ohmmeter switch in the "X10 ohms" position.

| METER CONNECTIONS | | METER READING | POSSIBLE CAUSE OF TROUBLE |
|---|---|---|---|
| RED LEAD | BLACK LEAD | | |
| 1. Either flat prong of the line cord plug. | Ground | INFINITE with the POWER switch ON or OFF. | A. Line cord.<br>B. Fuse F1.<br>C. Transformer T1.<br>D. Capacitor C1. |
| 2. Other flat prong of the line cord plug | Ground | INFINITE with the POWER switch ON or OFF. | |
| 3. Round prong of the line cord plug. | Ground | 0 Ω with the POWER switch ON or OFF. | |
| 4. Either flat prong. | Other flat prong. | 1M or higher. | |
| ( ) Turn the POWER switch ON. | | | |
| 5. Either flat prong. | Other flat prong. | 15 to 50 ohms for 120 VAC wiring<br>--or--<br>40 to 100 ohms for 240 VAC wiring. | See A, B, C, & D above |

( ) Move the POWER switch to OFF.

This completes the "Primary Wiring Tests". If all tests were satisfactory, proceed to the "Operational Tests." If any of the tests were not correct, you must make the corrections necessary to obtain the correct readings before you continue.

## OPERATIONAL TESTS

Refer to Pictorial 5-1 (Illustration Booklet, Page 5) for the following steps.

WARNING: When the line cord is connected to an AC outlet, line voltage is present at the DANGER areas of the Frequency Counter. Be careful that you do not touch these areas or an electrical shock will result.

Set the front panel switches as follows:

( ) SW1: POWER — OFF

( ) SW2: GATE — 1 SEC

( ) SW3: FREQUENCY RANGE — 10 Hz TO 50 MHz

NOTE: If you do not obtain the proper results in any of the following steps, unplug the line cord and proceed to the "Initial Test Difficulties" chart on Page 43.

( ) Plug the line cord into an AC outlet.

( ) Move the POWER switch to ON.

( ) The decimal points of displays V2, V3, and V4 should light.

( ) Move the POWER switch to OFF and unplug the line cord from the AC outlet.

Before you install an IC, first be sure the pins are straight. Then lay it down on one of its rows of pins, as shown below, in Part A, and roll the IC over until the pins are at right angles or are bent in slightly as shown in Part B. Repeat this process for the other row of pins.

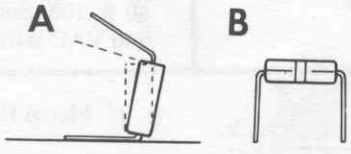
CAUTION: When you install a protected IC, be sure it does not get damaged by static electricity. Once you remove the foam pad from the IC, DO NOT let go of the IC. Install the IC as follows. Read the entire step before you pick up the IC.

1. Pick up the IC and touch the foam pad with both hands.
2. Hold the IC with one hand and remove the foam pad with the other hand.
3. Continue to hold the IC with one hand and straighten any bent pins with the other hand.
4. Continue to hold the IC with one hand and touch the foil side of the main circuit board with the other hand.
5. Align the pin 1 end of the IC with the index mark on the circuit board. See the inset drawing on Pictorial 5-1.
6. Then push the IC pins into the IC socket. Once in the socket, the IC is protected. Support the circuit board from the foil side of the circuit board as you install each IC.

( ) U10: Install a 5369 IC (#443-750) into socket U10.

( ) U8: Install a 7492 IC (#443-34) into socket U8.

( ) U9: Install a 74LS90 IC (#443-813) into socket U9.




**Detail 5-1A**

( ) U6: Install a 96L02 IC (#443-727) into socket U6.

( ) U5: Install a 7476 IC (#443-16) into socket U5.

( ) U11: Install a 7433 IC (#443-941) into socket U11.

( ) U4: Install a 74S02 IC (#443-896) into socket U4.

( ) U3: Install a 74S00 IC (#443-26) into socket U3.

( ) U2: Install an 8647 IC (#443-940) into socket U2.

( ) U1: Install a 10216 IC (#443-723) into socket U1.

( ) U7: Install a 7400 IC (#443-1) into socket U7.

( ) U17: Install a 74LS390 IC (#443-921) into socket U17.

( ) U16: Install a 74LS390 IC (#443-921) into socket U16.

( ) U12: Install a 74LS32 IC (#443-875) into socket U12.

( ) U15: Install a 74LS390 IC (#443-921) into socket U15.

( ) U14: Install a 74LS90 IC (#443-813) into socket U14.

( ) U13: Install a 74196 IC (#443-628) into socket U13.

( ) U18: Install a 9368 IC (#443-694) into socket U18.

( ) U19: Install a 9368 IC (#443-694) into socket U19.

( ) U20: Install a 9368 IC (#443-694) into socket U20.

( ) U21: Install a 9368 IC (#443-694) into socket U21.

( ) U22: Install a 9368 IC (#443-694) into socket U22.

( ) U23: Install a 9368 IC (#443-694) into socket U23.

( ) U24: Install a 9368 IC (#443-694) into socket U24.

( ) U25: Install a 9368 IC (#443-694) into socket U25.

( ) Check all IC's for correct type and installation.

( ) Plug the line cord into an AC outlet.

NOTE: During the following tests, disregard any occasional random numbers that may be displayed.

( ) Move the POWER switch to its ON position. The display should indicate _ _ . 000000 MHz.

( ) Move the GATE switch to .1 SEC. The display should indicate _ _ _ . 00000 MHz.

( ) Move the FREQUENCY RANGE switch to 20 MHz to 225 MHz. The display should indicate _ _ _ _ . 0000 MHz.

( ) Move the FREQUENCY RANGE switch to 10 Hz TO 50 MHz.

( ) Carefully touch one end of a test lead (not supplied) to the center connection of INPUT connector J1 and touch the other end to IC U10 pin 7. The display should indicate _ _ 3.57954 MHz.

( ) Move the GATE switch to 1 SEC. The display should indicate _ 3.579540 MHz.

( ) Disconnect the test lead from the Frequency Counter.

( ) Move the POWER switch to OFF and unplug the line cord from the AC outlet.

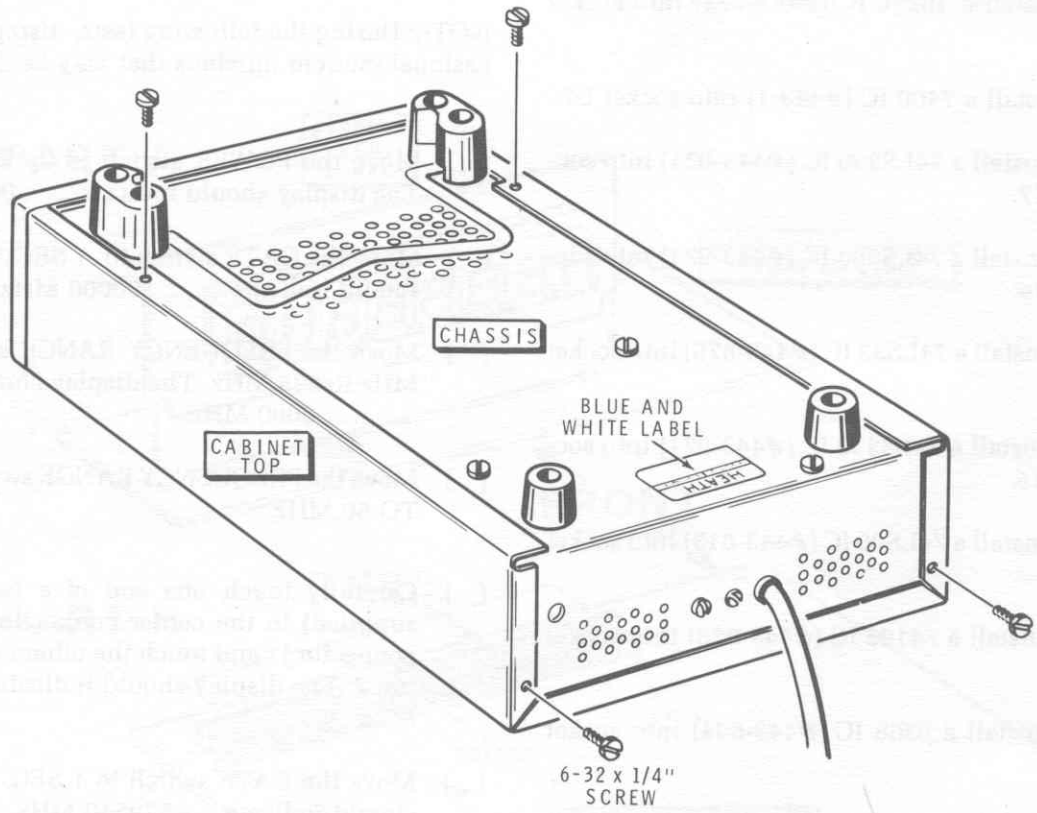
# FINAL ASSEMBLY

Refer to Pictorial 6-1 for the following steps.

( ) Position the cabinet top upside down on your work area.

( ) Slide the counter into the cabinet top and secure the cabinet in place with four 6-32 × 1/4" **black** screws.

( ) Carefully peel the backing paper from the blue and white identification label. Then press the label onto the chassis. Be sure to refer to the model and series numbers on this label in any communications you have with the Heath Company about this kit.




**PICTORIAL 6-1**

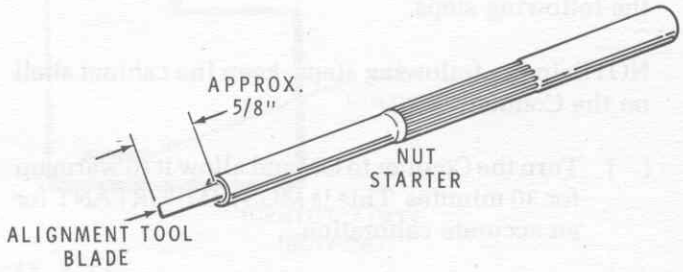
# CALIBRATION

Refer to Pictorial 7-1 for the following steps.

( ) Refer to Detail 7-1A and push the alignment tool blade into the small end of the plastic nut starter. You will use this as an alignment tool in the following steps.

The accuracy of your Counter depends to a great extent upon the care and accuracy with which you perform the following steps. If at any time you do not obtain the results called for in a step, refer to the "In Case of Difficulty" section on Page 42 to correct the problem.

This section of the Manual contains two calibration procedures. If you have access to a reliable frequency counter and/or an accurate frequency generator, proceed to the "With Instruments" procedures on Page 40. If these instruments are not available, proceed to the following "Without Instruments" procedure.



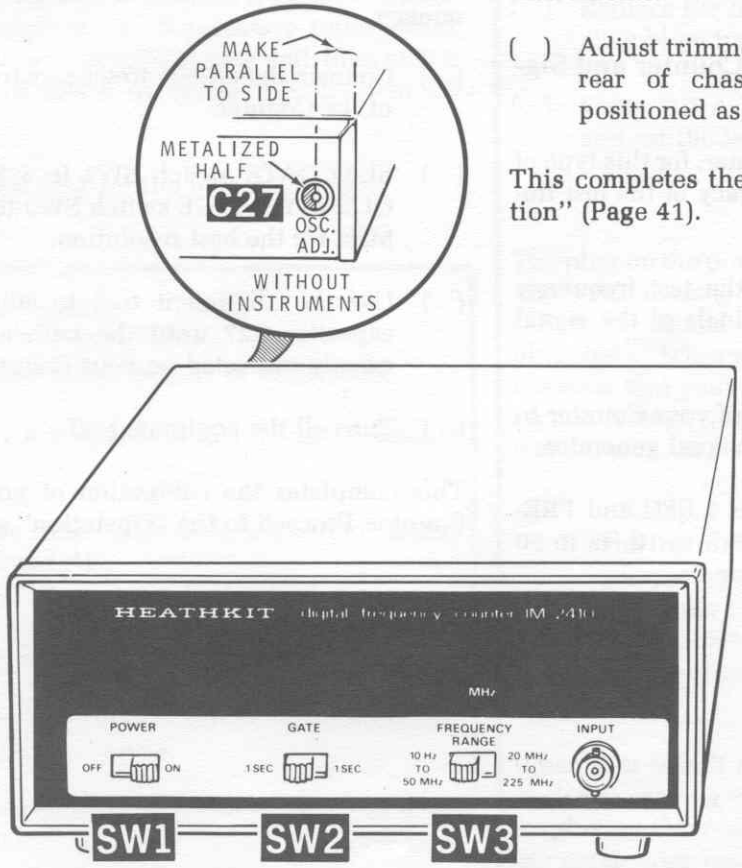

**Detail 7-1A**

## WITHOUT INSTRUMENTS

IMPORTANT: The calibration described below is performed without the use of instruments; therefore, the accuracy of your Counter may vary ±50 PPM maximum. If this is not accurate enough for your purposes, you will have to calibrate the Counter with instruments.

( ) Adjust trimmer capacitor C27 (through hole in rear of chassis) so the metalized half is positioned as shown in Pictorial 7-1.

This completes the calibration. Proceed to "Operation" (Page 41).




**PICTORIAL 7-1**

## WITH INSTRUMENTS

Refer to Pictorial 7-2 (Illustration Booklet, Page 6) for the following steps.

NOTE: In the following steps, keep the cabinet shell on the Counter.

( ) Turn the Counter to ON and allow it to warm up for 30 minutes. This is MOST IMPORTANT for an accurate calibration.

You will need precision equipment to calibrate the clock of your Counter in the following steps.

This calibration can be performed with either a frequency counter and a signal generator (capable of a 1-50 MHz at 250 mV output) or with a known, stable, laboratory standard frequency. Determine which of these methods you will use. Then complete the steps under the appropriate heading. If at any time you do not obtain the results called for in a step, refer to the "In Case of Difficulty" section on Page 42 to correct the problem.

### Calibration With a Frequency Counter and Signal Generator

NOTE: The accuracy of your Counter, for this type of calibration, depends on the accuracy of the test frequency counter.

( ) Connect the test leads of the test frequency counter to the output terminals of the signal generator.

( ) Also connect the test leads of your Counter to the output terminals of the signal generator.

( ) Slide GATE switch SW2 to 1 SEC and FREQUENCY RANGE switch SW3 to 10 Hz to 50 MHz for maximum resolution.

( ) Set the signal generator to any convenient frequency between 1 MHz and 50 MHz at 250 mV output.

( ) Use the alignment tool to adjust OSC ADJ capacitor C27 until your Counter indicates exactly the same frequency as the test frequency counter.

( ) Disconnect the test leads.

This completes the calibration of your Frequency Counter. Proceed to the "Operation" section.

### Calibration With a Known Laboratory Standard Frequency

( ) Turn the Counter to ON and allow it to warm up for 30 minutes. This is MOST IMPORTANT for an accurate calibration.

NOTE: It is essential that the known frequency source (frequency of your choice between 1-50 MHz) be absolutely stable. The accuracy of this type of calibration depends entirely on the accuracy of this known frequency.

( ) Connect the known frequency to the test cable of the Counter.

( ) Slide GATE switch SW2 to 1 SEC and FREQUENCY RANGE switch SW3 to 10 Hz TO 50 MHz for the best resolution.

( ) Use the alignment tool to adjust OSC ADJ capacitor C27 until the known frequency is exactly indicated on your Counter.

( ) Turn all the equipment off.

This completes the calibration of your Frequency Counter. Proceed to the "Operation" section.

# OPERATION

Refer to Pictorial 8-1 (Illustration Booklet, Page 7) for a description of the display and controls for the Frequency Counter.

## INPUT PROBES AND CABLES

CAUTION: Use ONLY the center conductor of the input lead of your Counter to check the frequency of an AC line voltage. Connecting the ground input lead to the "hot" (ungrounded) side of an AC line may result in a blown fuse and/or damage to your counter.

Any standard oscilloscope cables or 10 megohm probe can be used with this Counter. However, the input sensitivity will be lowered.

When you connect your Counter to a transmission line, make sure that the line is properly terminated (low standing wave ratio) to avoid possible damage to the equipment under test and incorrect readings.

## USING THE COUNTER

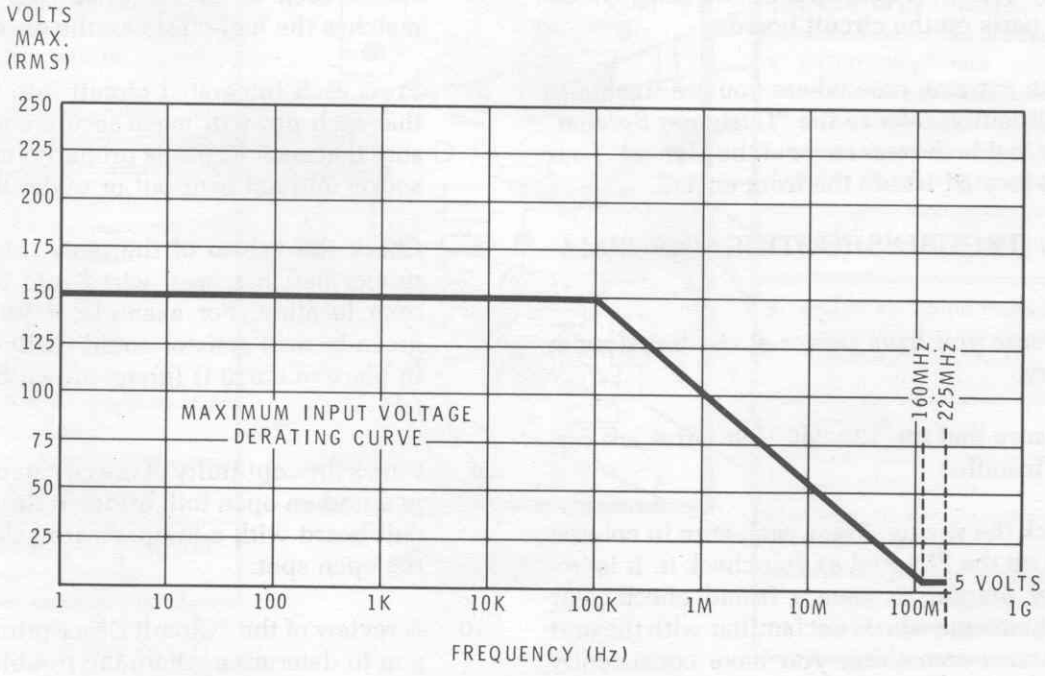
CAUTION: Avoid any excessive voltages that could damage your Counter. Refer to the maximum input voltage derating curve for the maximum safe input voltages for the counter at various frequencies.

## COUNTER RESOLUTION

The display always reads the measured frequency in megahertz. The following table shows the resolution obtained when the GATE and FREQUENCY RANGE switches are in their different positions.

| Gate Switch | Frequency Range Switch | Resolution |
|---|---|---|
| 1 Sec. | 10 Hz--50 MHz | ±1 Hz |
| .1 Sec. | 10 Hz--50 MHz | ±10 Hz |
| 1 Sec. | 20 MHz--225 MHz | ±10 Hz |
| .1 Sec. | 20 MHz--225 MHz | ±100 Hz |

The above chart shows that, for the best resolution, the GATE switch should be in the "1 Sec" position and, if possible, the FREQUENCY RANGE switch should be in the "10 Hz to 50 MHz" position.




**Maximum Voltage Derating Curve**

### UNKNOWN FREQUENCIES

When you are measuring a signal whose frequency is unknown, begin with the GATE switch in the 1 SEC position and the FREQUENCY RANGE switch in the 10 Hz TO 50 MHZ position. Then apply the unknown frequency to the Counter input. If the display changes randomly, or gives a reading and then returns to zero, then either the frequency is out of the 10 HZ TO 50 MHZ range or the input signal level is too low (Counter sensitivity is 25 mV rms).

Change the FREQUENCY RANGE switch to the 20 MHZ TO 225 MHZ position. If the display changes randomly, or gives a reading and then returns to zero, then either the frequency is out of the 20 MHZ TO 225 MHZ range or the input signal level is too low (Counter sensitivity is 25 mV rms).

## IN CASE OF DIFFICULTY

This section gives you suggestions for locating and resolving difficulties. The "General Troubleshooting Information," deals with the type of problems that exist when you have just completed the assembly of your kit. This information primarily covers soldering and assembly problems. The "Troubleshooting Charts" list specific difficulties and likely causes.

If the checks in these areas do not help you locate the problem, the difficulty may be a component. Read the "Circuit Description" and refer to the Schematic Diagram in the Illustration Booklet to help you determine where the trouble is. Refer to the "Circuit Board X-Ray Views" (Pages 50 & 51) for the physical location of parts on the circuit boards.

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

### GENERAL TROUBLESHOOTING INFORMATION

1. Make sure you have power at the transformer primary.

2. Make sure that the 120-240 Volt wires are correctly installed.

3. Recheck the wiring. Trace each wire in colored pencil on the Pictorial as you check it. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something you have consistently overlooked.

4. About 90% of the kits that are returned for repair do not function properly due to poor connections and soldering. Therefore, you can eliminate many troubles by carefully inspecting the connections to make sure they are soldered properly. Reheat any doubtful connections and be sure all the wires are soldered at places where several wires are connected.

5. Make sure that the proper transistor has been installed at each location and that each lead is in the proper hole.

6. Check each IC to make sure its index mark matches the half-circle on the circuit board.

7. Press each integrated circuit into its socket so that each pin will make secure connection. Be sure that each IC pin is properly installed in its socket and not bent out or under the IC.

8. Check the values of the parts. Make sure the proper part has been wired into the circuit at each location. For example, a 150 Ω (brown-green-brown) resistor could easily be installed in place of a 510 Ω (green-brown-brown) resistor.

9. Check the continuity of the circuit board foils. If you find an open foil, bridge it through the circuit board with a jumper wire soldered across the open spot.

10. A review of the "Circuit Description" may help you to determine where the trouble is.

### Substitution

If you want to verify that component is operating properly, you can interchange it with another component that has the same part number. For example, you can interchange any components within the following groups:

V1 through V8;
U15, U16, and U17;
U18 through U25.

If one display unit shows a digit incorrectly, interchange it with one of the other units to determine if the display or the circuit is faulty. If the circuit is faulty and there are no solder bridges on the associated foil, interchange the decoder/driver IC with one of the others. You can use this method with other single digit problems, and it can be extended to interchanging the decade counter integrated circuits.

### Clock Circuit

The heart of the Counter is the clock circuit. Verify that there is proper voltage (+12 volts) at U10 pin 8. The output of U10 pin 1 should be 60 Hz, about 4 volts rms. If the clock circuit is operating correctly, proceed to the troubleshooting chart.

### Troubleshooting Procedures

The "Initial Test Difficulties" and "Troubleshooting Charts" which follow, list problems that may be encountered with your Counter. Each problem has one or more possible causes listed across from it. If a particular part or parts are mentioned (U10 or Q1, for example) as a possible cause, check these parts to see if they are improperly wired or installed. Also check to see if an improper part was installed at that location. Finally, check the component to verify that it is operating correctly.

## Initial Test Difficulties

| TROUBLE | POSSIBLE CAUSE |
|---|---|
| Decimal points do not light. | 1. Refer to Pictorial 3-1B (Page 24) and make sure the four foils on the front of the display board are soldered.<br>2. No +5 volt supply.<br>3. IC U26 or U27. |
| Wrong, or less than three decimal points lit. | 1. Incorrect wiring at holes B, C, or D on either circuit board.<br>2. Transistor Q7.<br>3. Display V2, V3, or V4. |
| Displays do not light after IC's are installed. | 1. Incorrect IC installation. |
| Incorrect number of blanked or lighted displays, decimal points, or display segments. | 1. Switch SW2 or SW3 wiring.<br>2. IC U11 through U25.<br>3. Display V1 through V8. |
| Display does not indicate _ 3.579540 MHz with SW2 at 1 SEC and SW3 at 10 Hz TO 50 MHz. | 1. No +12 volt supply.<br>2. U27.<br>3. U10.<br>4. Q1 through Q4.<br>5. U3 or U4. |
| Display does not indicate _ _ 3.57954 MHz with SW2 at .1 SEC and SW3 at 10 MHz TO 50 MHz. | 1. U5, U6, or U7. |

# Troubleshooting Chart

| PROBLEM | POSSIBLE CAUSE |
|---|---|
| Crystal oscillator circuit does not calibrate, or shows excessive drift. | 1. U10.<br>2. Y1.<br>3. U27 (Check the 12 volt supply). |
| Counter has poor sensitivity (random count or no count) or does not operate at 50 MHz in the 10 Hz to 50 MHz frequency range. | 1. U27 (Check the 12 volt supply).<br>2. Q1, Q2, Q3, Q4.<br>3. U1, U2, U3. |
| Counter has poor sensitivity (random count or no count) or does not operate at 225 MHz in the 50 MHz to 225 MHz frequency range. | 1. Q1, Q2, Q5.<br>2. U1, U2, U3, U4. |

# SPECIFICATIONS

| | |
|---|---|
| Display | 8-digit LED display. |
| Frequency Ranges | 10 Hz to 50 MHz.<br>20 MHz to 225 MHz. |
| Sensitivity | 10 Hz to 50 MHz range: 25 mV rms maximum, 10 mV typical from 10 Hz to 30 MHz. 50 mV rms maximum from 30 MHz to 50 MHz.<br><br>20 MHz to 225 MHz range:<br>25 mV rms maximum, 10 mV typical. |
| Input Impedance | 1 MΩ shunted by less than 24 pF. |
| Input Protection | 150 VAC up to 100 kHz, derating to 5 VAC from 160 MHz to 225 MHz. See the "Maximum Input Voltage Derating Curve," Page 41. |
| Internal Time Base Frequency | 3.58 MHz. |
| Setability | ±1 PPM. |
| Temperature Stability | ±10 PPM from 0° to 40°C. |
| Gate Time | 1 second or .1 second, switch selectable. |
| Power Requirements | 108 VAC to 132 VAC<br>or 216 VAC to 264 VAC,<br>50 to 60 Hz, 25 watts maximum. |
| Dimensions | 3-3/8"H × 7-1/4"W × 9-1/2"D<br>(8.57 × 18.42 × 24.13 cm). |
| Net Weight | 5 lbs.<br>(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.

# CIRCUIT DESCRIPTION

Refer to the Schematic Diagram as you read this description.

This Counter contains circuitry that operates on different voltages for logic "high" and "low" levels. Note that U1 and U2 are ECL (emitter coupled logic) devices. As such, they operate on logic highs of at least 4.25 volts (input and output) and logic lows of no more than 3.5 volts (input and output).

The TTL (transistor-transistor logic) used elsewhere in the Counter operates on logic highs of at least 2.0 volts (input) or 2.4 volts (output). TTL logic lows are less than 0.8 volts (input) and 0.4 volts (output).

"Time base" is the length of time (either 1 second or .1 second) that the input signal is allowed to reach the counters during one "count sequence." The "count sequence" is the procedure that the Digital Frequency Counter follows to count the input signal during one time base; the count sequency starts when the count begins and ends only after the time base ends, the count is displayed, and all circuitry is reset for the next count cycle.

Each section of this Circuit Description discusses a separate portion of the circuitry. It tells what that circuit part is, lists the inputs, tells what the circuit does (if necessary), and lists the outputs and where they go. If you are troubleshooting, and wish only to investigate one particular portion of the Counter's circuitry, you may read the description applying to that portion; but you may also need to read the descriptions for the other (input and output) circuits it refers you to.

## INPUT & BUFFER AMPLIFIER; J1, Q1, AND Q2

The input connector accepts the input signal of 10 Hz to 225 MHz and at least 70 mV peak-to-peak. FET Q1 provides a high input impedance while Q2 couples to the amplifier section of the front end.

## AMPLIFIER; U1A and U1B

These two sections of amplification receive the signal from Q2 and provide approximately 24 dB of gain. The output of U1B goes to both U1C and Q5.

NOTE: Frequencies of 10 Hz to 50 MHz will be referred to as low frequencies and will be handled by U1C, Q3, and Q4. Frequencies of 50 MHz to 225 MHz will be referred to as high frequencies and will be handled by Q5 and U2. The low frequency branch is discussed first, and then the high frequency branch.

## LOW FREQUENCY SCHMITT TRIGGER; U1C

U1C responds to the low frequency input signal, shaping it into pulses which are sent to the low frequency converter.

## LOW FREQUENCY CONVERTER; Q3 AND Q4

These two transistors amplify the pulses from the Schmitt trigger and provide the necessary drive for the range selection circuitry.

NOTE: With frequency range switch SW3 in the 20 MHz to 225 MHz position, the following circuitry provides the input that is used by the count stage of the Counter.

## HIGH FREQUENCY AMPLIFIER; Q5

The high frequency amplifier input comes from U1B pin 7. Transistor Q5 provides about 20 dB of amplification. The output goes past diodes D5 and D6, which protect U2 from too large a signal. The output then goes to the high frequency divider.

## HIGH FREQUENCY DIVIDER; U2

U2 receives the amplified input signal from Q5 and produces an output that has a frequency that is one-tenth of the input signal. The output goes to the range selection circuitry, as does the output of the low frequency converter.

## RANGE SELECTION CIRCUIT; SW3, U3A, U3B, and U3C

There are two inputs to the selection circuit: the low frequency input from Q4 to U3A pin 1, and the high frequency input from U2 to U3C pin 5. Frequency Range switch SW3, which is connected to both U3A and U3C, allows the input from one of the two sources to pass while stopping the other input at the NAND gate. SW3 also provides high or low logic levels to the decimal placement logic.

U3B responds to either the high or low frequency NAND gate, and its output goes to the pulse shaper.

## PULSE SHAPER; U4

The input to the pulse shaper is the string of fairly wide pulses from the range selection circuit. The configuration of U4's NOR gates provides a very short (200 nsec) delay and inversion of the pulse to U4D pin 9, so that the output is a 200 $\mu$sec pulse occuring on the negative-going side of the input signal.

## COUNTER GATE; U3D

U3D is a two-input NAND gate. One input is the string of narrow pulses from the pulse shaper. The second input is the time base input from time base gate U5. As long as the time base input is high (either 1 second or .1 second), the output of U3D is a string of negative pulses (from the pulse shaper). This output goes to U13 (the least significant digit) of the counters. When the time base input to U3D is low, there is no output.

## COUNTERS; U13 through U17

The string of pulses from counter gate U3D is applied to the input to the counters. This input is applied to U13 pin 8, which counts for the least significant digit of the display. The counter for the next digit is then driven from the output of U13 (pin 12). Each "tens" overflow from one digit counter is used to drive the next digit counter.

The reset to zero pulse from reset monostable U6B is coupled to the counters as a second input. This pulse occurs at the end of a count sequence, and clears the counters for the next count to begin.

The output of the counters is a binary representation of each decimal digit, provided to latch/drivers U18 through U25. The current count is available at any time, but is only accepted by the latch counters at the end of a count sequence, just before the reset occurs.

## LATCH/DRIVERS; U18 THROUGH U25

Each latch/driver receives its primary input (one decimal digit, coded in binary) on the four input pins, 1, 2, 6, and 7, from the counter section. A secondary input is the store pulse from store monostable U6A.

When the store pulse is received, each latch/driver accepts the count that is currently on its corresponding counter. It translates the binary and produces the output voltage from the driver to light the sections of the display necessary to show the decimal number. Each display is held until the next store pulse causes a new number to be accepted by the latch/driver.

## LED DISPLAY

Each LED display digit has seven sections, which can be lit by the display/driver to show any decimal number (zero through nine). The seven lines from the driver to each digit are connected to the seven segments of the display. Three of the digits also have a decimal point and the input necessary to drive it.

NOTE: The following four sections deal with the time base control circuitry. This circuitry controls the length of time that the input signal is allowed to reach the counters (either 1 second or .1 second).

## OSCILLATOR/DIVIDER; U10

The oscillator produces a 3.58 MHz crystal-controlled signal which is used as the clock for the time base. The divider then divides down this signal to produce a 60 Hz output. The output goes to driver transistor Q6.

## DRIVER TRANSISTOR; Q6

Q6 receives the signal from the oscillator/divider and amplifies it to drive the divide-by-six that follows it.

### DIVIDE-BY-SIX; U8

The primary input to U8 is the 60 Hz signal generated by U10. A secondary input is the reset signal from reset monostable U6B.

The primary input is reduced from 60 Hz to 10 Hz to provide the time base for the .1 second count sequence. The other input, the reset signal, comes at the end of a count sequence, and resets the divider to "5" so the next count sequence will begin with the next cycle from U10.

### DIVIDE BY TEN; U9

The primary input to U9 is the 10 Hz signal from U8. A secondary input is the reset signal from reset monostable U6B.

The primary input is reduced from 10 Hz to 1 Hz to provide the time base for the 1 second count sequence. The reset signal comes at the end of a count sequence, and resets the divider to "9" so that the next count sequence will begin with the next cycle of the input signal.

### TIME BASE SELECTION; SW2, U7A, U7B, AND U7C

The time base selection circuitry has two inputs. The 10 Hz input signal from U8 goes to U7A pin 1, and the 1 Hz input signal from U9 goes to U7B pin 5.

Gate switch SW2 grounds an input of either NAND gate (U7A or U7B) to "inhibit" the time base signal from passing. Meanwhile, the switch allows the input of the other NAND gate to be high ("enable" ), so that the time base signal to the "enabled" NAND gate can pass through to the time base gate. NAND gate U7C receives the signal from the enabled gate and inverts if again before sending it on to the time base gate.

A secondary output from the time base selection circuitry comes from gate switch SW2. The same high or low voltage that is used to inhibit or enable U7A and U7B is also the output to the decimal placement logic. This voltage allows the decimal point to be positioned correctly for either the 1 second or .1 second time base.

### TIME BASE GATE; U5

The primary input to U5 is the time base signal from the time base selection circuitry; this input goes to the clock input. The J and K inputs and the preset input are all tied high so U5 will change state whenever a pulse is received at the clock.

Because of this configuration, the first pulse at U5's clock input will send the output (pin 15) high, and the second pulse to the clock input (either 1 second or .1 second later) will send the output low. This produces the time base for a single count sequence. The U5 output goes to counter gate U3D and to store monostable U6A.

A reset pulse from reset monostable U6B is also applied to the input of U5. This pulse resets U5 after each count sequence so that is is ready to begin the next count sequence.

### STORE MONOSTABLE U6A AND DRIVER U12A

The input to U6A is the time base pulse from time base gate U5. The store monostable responds only to the trailing (negative going) edge of this input. When the U5 output goes low at the end of a count sequence and stops the counters from receiving any more input signal to be counted, U6A generates a narrow pulse (about 5 $\mu$s, determined by the R34, C21 time constant) that is coupled to the pin 3 inputs of the latch/drivers (U18 through U25). U12A is used to reinforce part of the signal from U6A.

U6A also has a second output, the inverted pulse (from pin 6) to reset monostable U6B.

### RESET MONOSTABLE; U6B

The input to U6B is the inverted store pulse from store monostable U6A. The reset monostable responds to the trailing (positive-going) edge of this pulse to produce a reset pulse right after the store pulse. The pulse width of about 5 $\mu$s is determined by the R35-C22 time constant. This output pulse goes to the counters and to the divide-by-six and divide-by-ten (U8 and U9). A second output from U6B connects the inverted pulse at pin 9 to the reset input of time base gate U5.

## DECIMAL PLACEMENT LOGIC; U11 AND Q7

The inputs to the four NOR gates of U11 are high or low voltages from Frequency Range switch SW3 and Gate switch SW2. Any combination of switch positions produces at least one high input to three of the four gates. The output of the fourth gate goes high and drives the correct decimal display. Transistor Q7 acts as an OR gate to allow U11B or U11C to drive a single decimal point. The outputs go to input pin 9 of display segments V2, V3, and V4.

## ZERO BLANKING; U12B AND U12C

The display digits are easier to read if unnecessary **zeros** on the left of the decimal point are blanked out (for example, 1.0500 MHz is easier to read than 0001.0500 MHz). Zeros for any display digit may be blanked if pin 5 of that display's latch/driver is grounded or kept at a low voltage. If the pin 5 is unconnected or kept at a high voltage, the zero will not be blanked.

Display V1 may always have its zeros blanked. Pin 5 of U18 is grounded to accomplish this.

Display V2 should have its zero blanked **if** V1 is blank. Pin 4 of U18 indicates when V1 is blank, and so is connected to pin 5 of U19.

Display V3 should have its zero blanked if there is no decimal point at V2, and V2 is blanked. OR gate U12B senses a high at pin 13 (decimal present) or a high at pin 12 (digit not blanked on V2) and outputs a high to U20 (to avoid blanking). If both inputs to U12B are low, its output is low and V3 will have its zeros blanked.

Display V4 and U12C operates exactly the same way as V3 and U12B. Displays V5 through V8 are all to the right of the decimal point. As such, they should never have their zeros blanked. Pin 5 for their latch/drivers (U22 through U25) are not connected; so zero blanking does not occur.

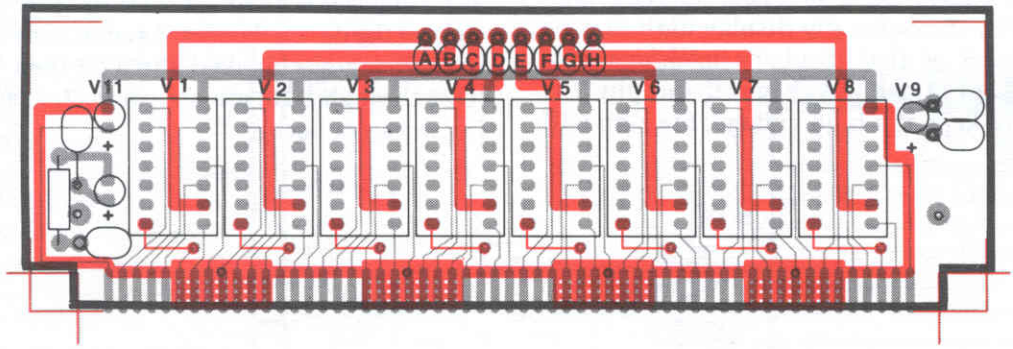
# CIRCUIT BOARD X-RAY VIEWS

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

A. Find the circuit component number (R5, C3, etc.) on the X-Ray View.

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 must be supplied when you order a replacement part.

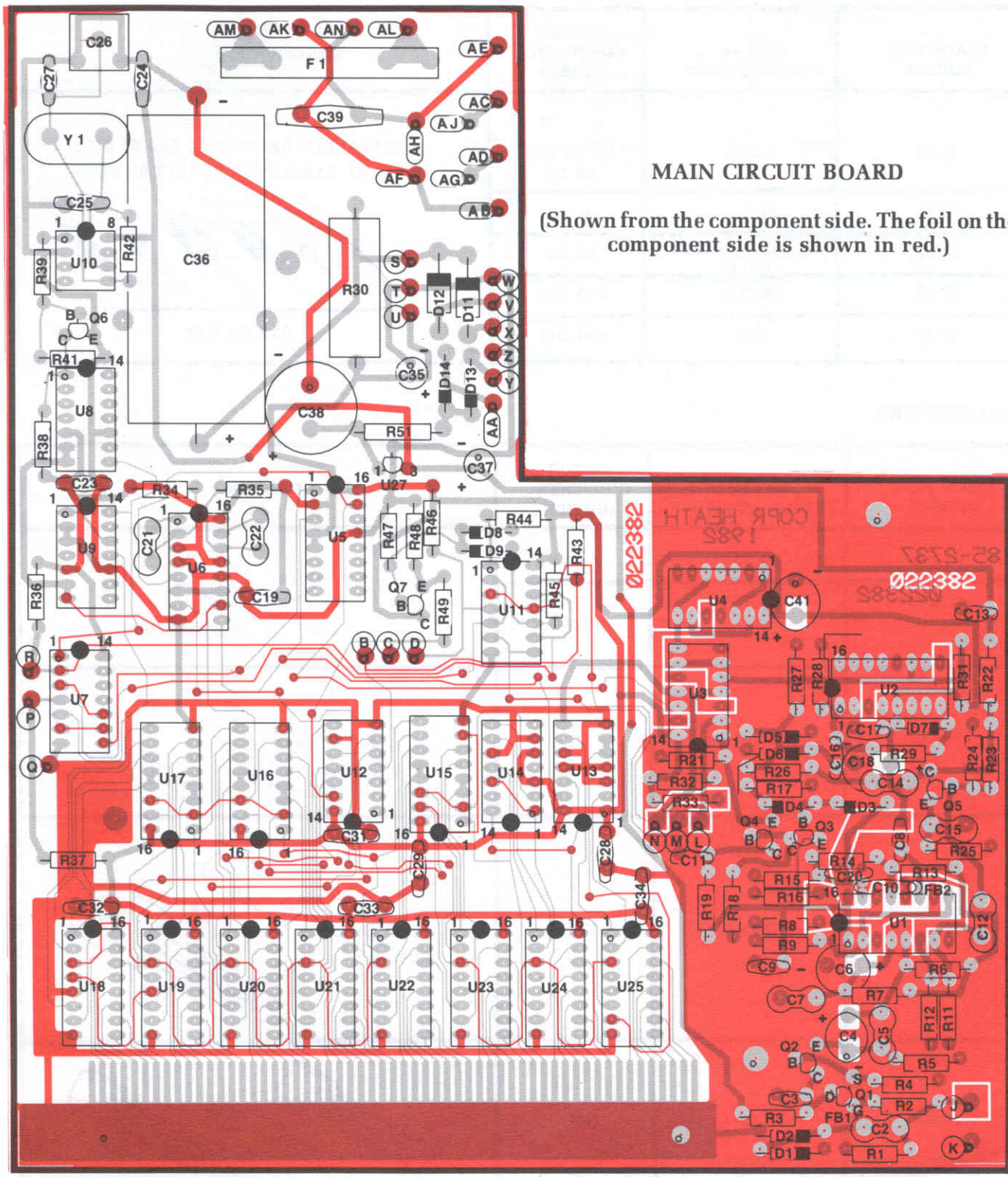



**DISPLAY CIRCUIT BOARD**

**Shown from the component side. The foil on the component side is shown in red).**

## MAIN CIRCUIT BOARD

**(Shown from the component side. The foil on the component side is shown in red.)**

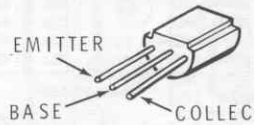
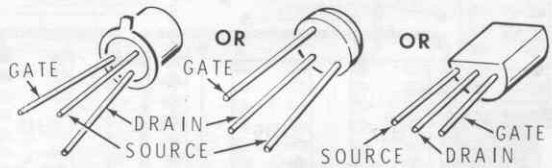
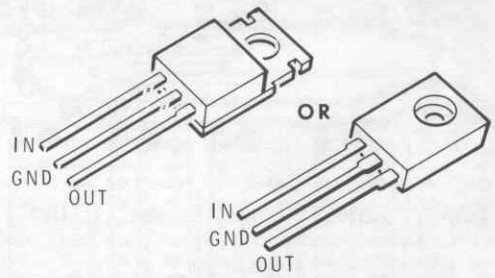
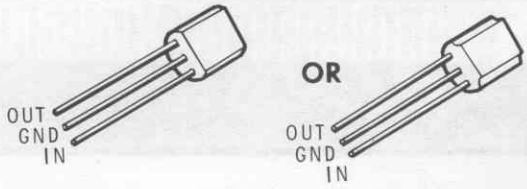


# SEMICONDUCTOR IDENTIFICATION CHART

## DIODES

| HEATH PART NUMBER | MAY BE REPLACED WITH | CIRCUIT COMPONENT NUMBER | IDENTIFICATION |
|---|---|---|---|
| 56-56 | 1N4149 | D3, D4, D7, D8, D9 | IMPORTANT: THE BANDED END OF DIODES CAN BE MARKED IN A NUMBER OF WAYS.  BANDED END |
| 56-86 | FD777 | D1, D2 | |
| 56-87 | FH1100 HP2835 BAT 29 | D5, D6 | |
| 57-65 | 1N4002 | D13, D14 | |
| 57-42 | 3A1 | D11, D12 | |

## TRANSISTORS

| HEATH PART NUMBER | MAY BE REPLACED WITH | CIRCUIT COMPONENT NUMBER | IDENTIFICATION |
|---|---|---|---|
| 417-292 | 2N5771 | Q3 |   |
| 417-293 | 2N5770 | Q2, Q4, Q5, Q6, Q7 | |
| 417-828 | E304 (Selected) | Q1 |   |
| 442-54 | 7805 | U26 |   |
| 442-644 | 78L12 | U27 |   |

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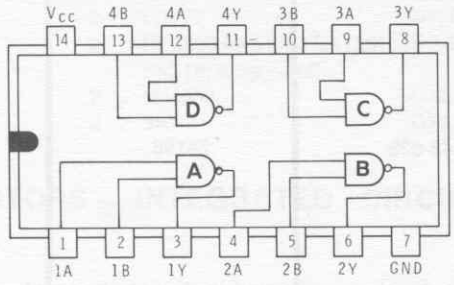
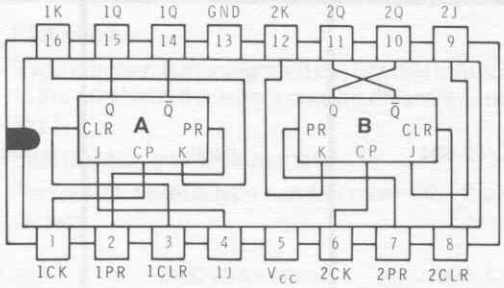
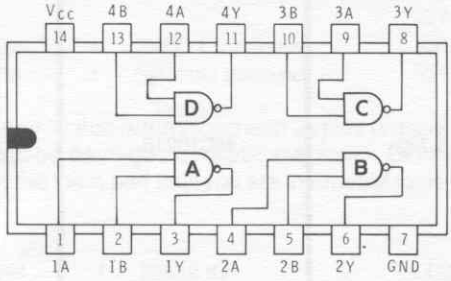
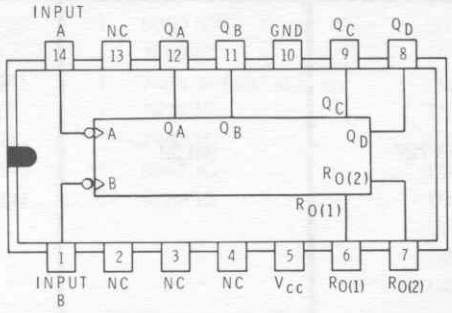
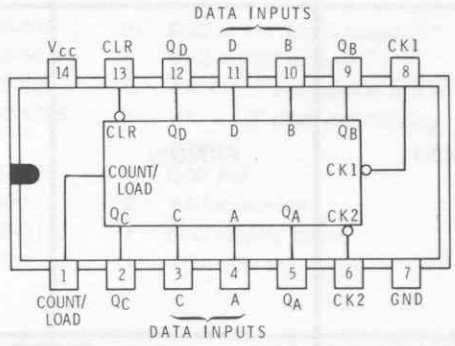
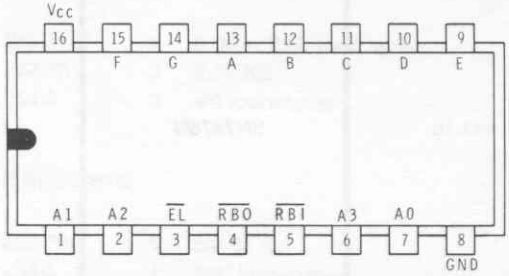
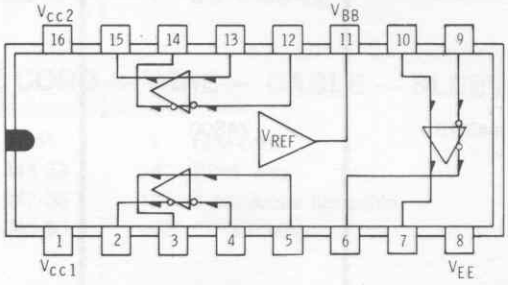
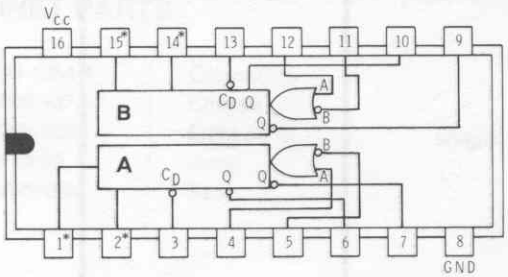
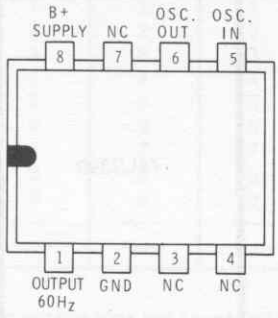
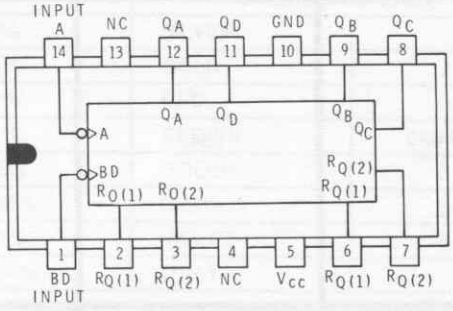
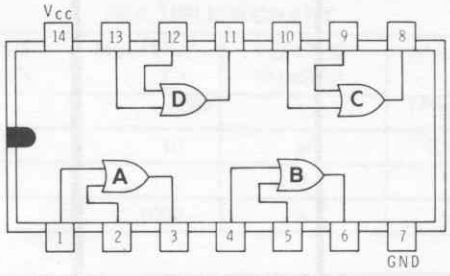
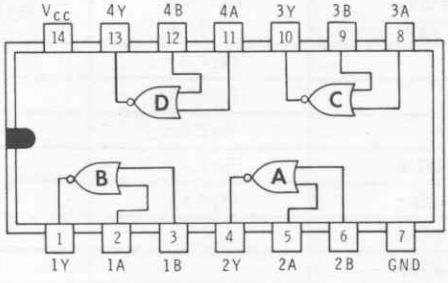
## INTEGRATED CIRCUITS

| HEATH PART NUMBER | MAY BE REPLACED WITH | CIRCUIT COMPONENT NUMBER | IDENTIFICATION |
|---|---|---|---|
| 443-1 | SN7400N | U7 |   |
| 443-16 | SN7476N | U5 |   |
| 443-26 | 74S00 | U3 |   |
| 443-34 | 7492N | U8 |   |

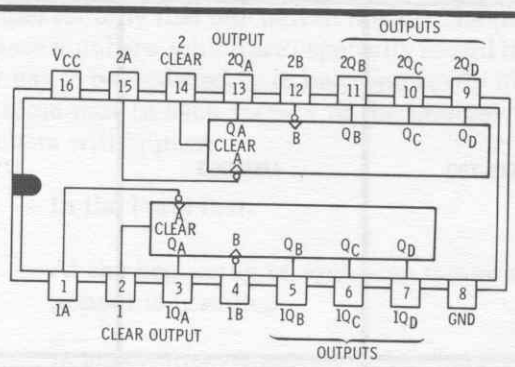
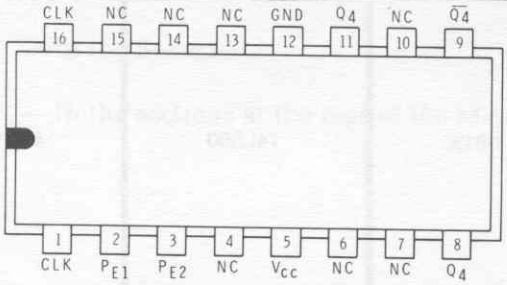
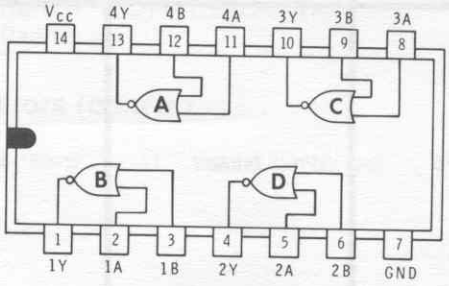
## Integrated Circuits (Cont'd.)

| HEATH PART NUMBER | MAY BE REPLACED WITH | CIRCUIT COMPONENT NUMBER | |
|---|---|---|---|
| 443-628 | 74196 | U13 |   |
| 443-694 | 9368 | U18 through U25 |   |
| 443-723 | MC10216 | U1 |   |
| 443-727 | 96L02 | U6 |   |

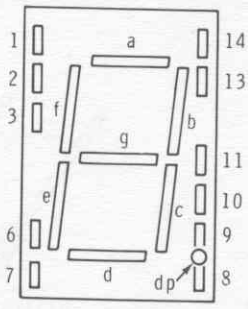
## Integrated Circuits (Cont'd.)

| HEATH PART NUMBER | MAY BE REPLACED WITH | CIRCUIT COMPONENT NUMBER | IDENTIFICATION |
|---|---|---|---|
| 443-750 | MM5369 | U10 |   |
| 443-813 | 74LS90 | U9, U14 |   |
| 443-875 | 74LS32 | U12 |   |
| 443-896 | 74S02 | U4 |   |

## Integrated Circuits (Cont'd.)

| HEATH PART NUMBER | MAY BE REPLACED WITH | CIRCUIT COMPONENT NUMBER | IDENTIFICATION |
|---|---|---|---|
| 443-921 | 74LS390 | U15, U16, U17 |  |
| 443-940 | 8647 | U2 |  |
| 443-941 | 7433 | U11 |  |

## LED DISPLAY

| HEATH PART NUMBER | MAY BE REPLACED WITH | CIRCUIT COMPONENT NUMBER | IDENTIFICATION |
|---|---|---|---|
| 411-860* | 5082-7760 | V1 through V8 |   PIN CONNECTION<br>1. ANODE a<br>2. ANODE f<br>3. COMMON CATHODE<br>4. NO PIN<br>5. NO PIN<br>6. NC<br>7. ANODE e<br>8. ANODE d<br>9. ANODE dp<br>10. ANODE c<br>11. ANODE g<br>12. NO PIN<br>13. ANODE b<br>14. COMMON CATHODE |

*A brightness code letter (A, B, C, or D) is stamped on the side of each LED. This code letter should be identical for all of the LED displays. Include this code letter if you should have to order replacement LED's.

# 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