HEATHKIT® MANUAL

for the

TIME-VOLTAGE MODULE

Model IOA-4200

595-2985

HEATH COMPANY • BENTON HARBOR, MICHIGAN

HEATH COMPANY PHONE DIRECTORY

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

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

Technical Assistance Phone Numbers
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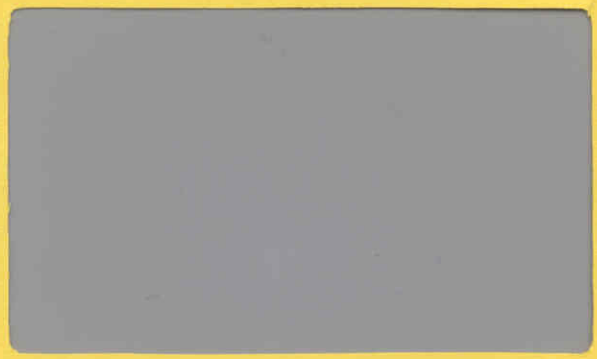

YOUR HEATHKIT 90-DAY LIMITED WARRANTY

Consumer Protection Plan for Heathkit Consumer Products

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

Heath's Responsibility

PARTS — Replacements for factory defective parts will be supplied free for 90 days from date of purchase. Replacement parts are warranted for the remaining portion of the original warranty period. You can obtain warranty parts direct from Heath Company by writing or telephoning us at (616) 982-3571. And we will pay shipping charges to get those parts to you . . . anywhere in the world.

SERVICE LABOR — For a period of 90 days from the date of purchase, any malfunction caused by defective parts or error in design will be corrected at no charge to you. You must deliver the unit at your expense to the Heath factory, any Heathkit Electronic Center (units of Veritechnology Electronics Corporation), or any of our authorized overseas distributors.

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

NOT COVERED — The correction of assembly errors, adjustments, calibration, and damage due to misuse, abuse, or negligence are not covered by the warranty. Use of corrosive solder and/or the unauthorized modification of the product or of any furnished componen, will void this warranty in its entirety. This warranty does not include reimbursement for inconvenience, loss of use, customer assembly, set-up time, or unauthorized service.

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

SUCH REPAIR AND REPLACEMENT SHALL BE THE SOLE REMEDY OF THE CUSTOMER AND THERE SHALL BE NO LIABILITY ON THE PART OF HEATH FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO ANY LOSS OF BUSINESS OR PROFITS, WHETHER OR NOT FORSEEABLE.

Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

Owner's Responsibility

EFFECTIVE WARRANTY DATE — Warranty begins on the date of first consumer purchase. You must supply a copy of your proof of purchase when you request warranty service or parts.

ASSEMBLY — Before seeking warranty service, you should complete the assembly by carefully following the manual instructions. Heathkit service agencies cannot complete assembly and adjustments that are customer's responsibility.

ACCESSORY EQUIPMENT — Performance malfunctions involving other non-Heath accessory equipment, (antennas, audio components, computer peripherals and software, etc.) are not covered by this warranty and are the owner's responsibility.

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

If you are not satisfied with our service (warranty or otherwise) or our products, write directly to our Director of Customer Service, Heath Company, Benton Harbor MI 49022. He will make certain your problems receive immediate, personal attention.

Heathkit® Manual

for the

TIME-VOLTAGE MODULE

Model IOA-4200

595-2985

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

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

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INTRODUCTION

The Heathkit Time-Voltage Module, Model IOA-4200 is a versatile accessory for any Heathkit Oscilloscope designed for its addition. It provides the following functions:

- It measures oscilloscope waveform time intervals from 1.0 seconds to less than 20 ns in 18 ranges with a typical accuracy of 2%.
- It measures oscilloscope waveform frequencies from 1 Hz to 19.99 MHz in 18 ranges with a typical accuracy of 3%.
- It measures DC voltages directly at the Y1 or Y2 BNC input from ±0.1 mV to ±199.9 V in three ranges with an accuracy of 0.75%*.
- It measures DC voltages using separate, isolated inputs from ±1 mV to ±1000 V in four ranges with an accuracy of 0.25%*.

For the Time (T) and Frequency (F) functions, you make measurements on the A Timebase range when you select the A-B (horizontal) sweep mode and position "cursors" on the waveform, using the Delay Time Position (DTP) control on the Oscilloscope and the Δ Delay control on the Module. Automatic placement of the decimal point and "s," "ms," or "μs" indicators (for T) or "Hz," "kHz," or "MHz" indicators (for F), provides a direct-reading display. For each range, the measurement circuitry auto-ranges by a factor of 10 to provide an additional lower (for T) or higher (for F) range.

The DTP control positions both the reference and measurement cursors in tandem; the Δ Delay control positions only the measurement cursor. If you press the side-accessed Tracking switch, the DTP and Δ Delay controls position the cursors separately.

*Laboratory Standards Calibration

On the VDC (internal) function, a ±1.999 V measurement range is provided on the 2 mV to 50 mV Volts/Div positions; a ±19.99 V measurement range is provided on the 100 mV to 500 mV Volts/Div positions; and a ±199.9 V measurement range is provided on the 1V to 10V Volts/Div positions for inputs at the BNC input of either channel. In addition, each of the ranges auto-range by a factor of 10 to provide a higher resolution range. When you use a X10 probe, each range is extended by a factor of 10 (to the probe voltage limit). The decimal is automatically positioned for each range and, when the X10 probe is used, the decimal is shifted according to the setting of the Probe switch. An indicator, X1 or X10, shows if the display is for direct reading or for a X10 probe input. You can display the Y1 and Y2 inputs separately by setting the Chan switch, and an indicator (Y1 or Y2) lights up to identify which input voltage is being displayed.

Using the EXT VDC function, the side-accessed banana jacks allow fully floating (from earth ground) DC voltage measurements with auto-ranging 2 V, 20 V, 200 V, or 2000 V (limited to 1000 V) ranges. Input resistance is 10 Megohms on all ranges, and each can withstand 1000 volts without damage.

Measurements are shown on a 3-1/2 digit, .43", high-brightness LED (light-emitting diode) display with an automatic "-" (and implied "+") polarity indication. You can turn off the entire display using the Module Off switch when you wish to use only the oscilloscope.

All of the dual-slope, analog-to-digital conversion circuitry, which provides extremely stable and accurate performance, is contained in one MOS/LSI* integrated circuit.

A precision time interval generator is required to calibrate the T and F functions. You can calibrate the VDC functions using Laboratory Standards or built-in references.

This compact and attractive instrument is housed in a low-profile cabinet to provide a minimum of added height to your oscilloscope. This Module is versatile, accurate, and easy to use, and is sure to be a very useful addition to your laboratory or shop oscilloscope.

IMPORTANT: After you assemble your Module, it will be necessary for you to make resistance checks and DC voltage measurements. For this, you must use an analog ohmmeter (VOM or VTVM), with a 1.5-volt test voltage and having a center-scale number greater than 5, but less than 50. The DC voltmeter you will need should also be an analog type. You may use a digital voltmeter, but the readings may be jittery for certain measurements. The voltmeter should have a 10-Megohm or higher input impedance and must have a floating (isolated from earth ground) measuring circuit. To properly calibrate your Module, you will need a calibrator capable of producing pulses having intervals of 1 ms, 100 μs, and 1 μs (repetition rates of 1000 Hz, 10 kHz, and 1 MHz) with an accuracy of ±0.1%.

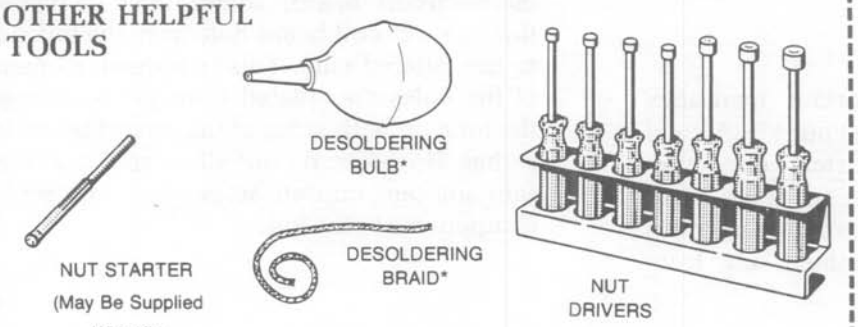
*Metal oxide semiconductor/large-scale integration.

ASSEMBLY NOTES

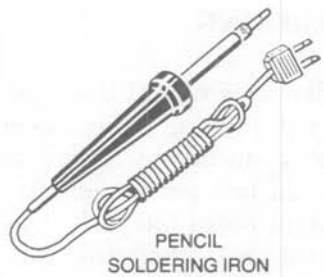
TOOLS

You will need these tools to assemble your kit.

OTHER HELPFUL TOOLS



*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 sections at the rear of the Manual.

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

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

SOLDERING

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

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

1. Use the right type of soldering iron. A 22 to 25-watt pencil soldering iron with a 1/8" or 3/16" chisel or pyramid tip works best.

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

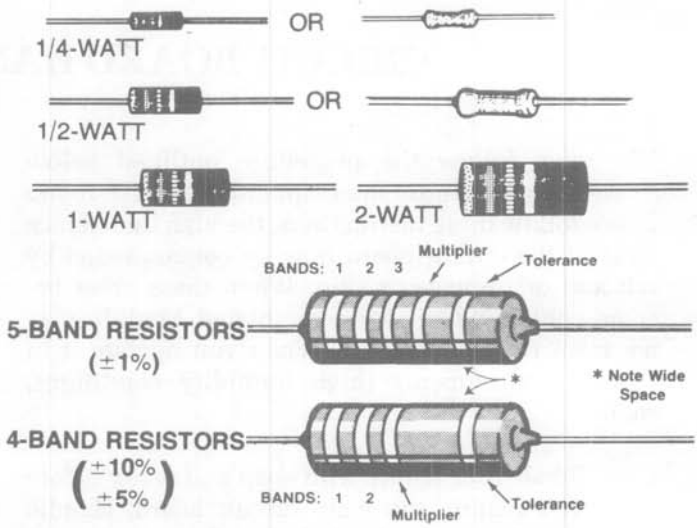
NOTE: Always use rosin core, radio-type solder (60:40 tin-lead content) for all of the soldering in this kit. This is the type we have supplied with the parts. The Warranty will be void and we will not service any kit in which acid core solder or paste has been used.

3. The main circuit board in this kit has foil on both sides. Note that the "component" (or lettered) side of the main circuit board has the outline of each component screened on it. All components will be mounted on this side of the circuit board and soldered to the other side. Do NOT solder on the component side of the circuit board unless you are instructed to do so.

4. Due to the nature of the foil pattern on the main circuit board, solder may be drawn through a circuit board hole from the foil side to the lettered side. This is normal, as many of the holes are "plated through" to connect the foils on both sides of the circuit board together. However, do not allow solder to flow into adjacent unused holes when you solder components to the foil.

PARTS

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



Band 1 1st Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

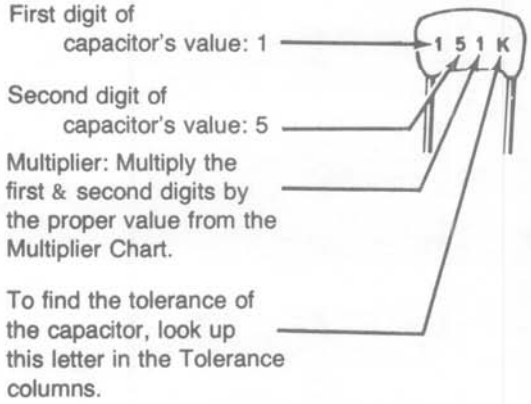
Band 2 2nd Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

Band 3 (if used) 3rd Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

Multiplier	
Color	Multiplier
Black	1
Brown	10
Red	100
Orange	1,000
Yellow	10,000
Green	100,000
Blue	1,000,000
Silver	0.01
Gold	0.1

Resistance Tolerance	
Color	Tolerance
Silver	± 10%
Gold	± 5%
Red	± 2%
Brown	± 1%
Green	± .5%
Blue	±.25%
Violet	± .1%
Gray	±.05%

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



EXAMPLES:

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

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

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

*DuPont Registered Trademark

CIRCUIT BOARD HANDLING PROCEDURE

You must follow the procedure outlined below whenever you handle the main circuit board. If you do not follow these instructions, the high impedance areas of the circuit board may be contaminated by salt and oil from your skin. When these areas become contaminated, your completed Module may not meet its specifications when you operate it in certain environments (high humidity conditions, etc.).

1. Wash your hands with soap and water before you handle the main circuit board. Handle this circuit board only by its edges.
2. Avoid any excessive accumulation of rosin build-up whenever you solder a connection on this board.

NOTE: The "In Case of Difficulty" section will allow you to determine if the main circuit board has become contaminated. If necessary, you will be instructed how to clean the board.

PARTS LIST

Unpack the kit and check each part against the following list. Any part that is packed in an individual envelope with the part number on it should be placed back in the envelope after you identify it until the part is called for in a step. Do not remove any component that is supplied on a tape until you are directed to use it in a step. Do not throw away any packing materials until you have accounted for all of the parts.

To order a replacement part: Always include the PART NUMBER. Use the Parts Order Form furnished with this kit. If one is not available, see "Replacement Parts" inside the rear cover of the Manual. Your Warranty is located inside the front cover. For prices, refer to the separate "Heath Parts Price List."

TAPED COMPONENTS

Refer directly to the enclosed "Taped Component Chart." Follow the instructions at the top of that chart to check the following components.

RESISTORS

NOTE: The following resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise stated. A 5% tolerance is indicated by a fourth color band of gold. 1% is indicated by a brown fifth color band. All 1% resistors are 100 PPM/°C.

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
6-220-12	2	22 Ω (red-red-blk)	R1009, R1018
6-1000-12	3	100 Ω, 1% (brn-blk-blk-blk)	R1072, R1101, R1122
6-271-12	5	270 Ω (red-viol-brn)	R1127, R1131, R1132, R1133, R1134
6-391-12	9	390 Ω (org-wht-brn)	R1001, R1002, R1003, R1008, R1042, R1043, R1135, R1136, R1157
6-7870-12	1	787 Ω, 1% (viol-gry-viol-blk)	R1124

Resistors (Cont'd)

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
6-102-12	6	1000 Ω (brn-blk-red)	R1004, R1005, R1006, R1007, R1103, R1158
6-1131-12	2	1130 Ω, 1% (brn-brn-org-brn)	R1061, R1118
6-1471-12	2	1470 Ω, 1% (brn-yel-viol-brn)	R1059, R1117
6-2051-12	1	2050 Ω, 1% (red-blk-grn-brn)	R1015
6-472-12	3	4700 Ω (yel-viol-red)	R1013, R1114, R1141
6-6191-12	1	6190 Ω, 1% (blu-brn-wht-brn)	R1024
6-6981-12	1	6980 Ω, 1% (blu-wht-gry-brn)	R1121
6-7871-12	1	7870 Ω, 1% (viol-gry-viol-brn)	R1065

Resistors (Cont'd)

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
6-1002-12	8	10 kΩ, 1% (brn-blk-blk-red)	R1011, R1019, R1021, R1026, R1027, R1031, R1032, R1036
6-123-12	4	12 kΩ (brn-red-org)	R1083, R1085, R1137, R1138
6-223-12	17	22 kΩ (red-red-org)	R1014, R1022, R1023, R1041, R1058, R1066, R1069, R1078, R1079, R1102, R1104, R1105, R1107, R1113, R1143, R1146, R1153
6-4992-12	1	49.9 kΩ, 1% (yel-wht-wht-red)	R1012
6-9002-12	2	90 kΩ, 1% (wht-blk-blk-red)	R1049, R1056
6-1133-12	1	113 kΩ, 1% (brn-brn-org-org)	R1111
6-224-12	3	220 kΩ (red-red-yel)	R1112, R1142, R1144
6-474-12	8	470 kΩ (yel-viol-yel)	R1045, R1052, R1106, R1108, R1126, R1149, R1151, R1152
6-225-12	2	2.2 MΩ (red-red-grn)	R1046, R1053

DIODES

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
56-56	9	1N4149	D1001, D1002, D1003, D1006, D1007, D1101, D1102, D1103, D1104
56-89	2	GD510	D1004, D1005
57-65	5	1N4002	D1105-D1109

NON-TAPED COMPONENTS

The following components are not taped on strips. The key numbers correspond to the numbers on the "Parts Pictorial" (Illustration Booklet, Page 1).

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
OTHER RESISTORS				
			NOTE: The following resistors are 1/2-watt precision resistors with a 0.1% tolerance, unless otherwise noted.	
A1	2-379	3	2500 Ω (2.5K or 2501B)	R1038, R1039, R1074
A1	2-380	1	5000 Ω (5K or 5001B)	R1037
A1	2-381	1	22.9 kΩ (2292B)	R1071
A2	6-104-12	26	100 kΩ ¼-watt, 5% (brn-blk-yel) (packaged separately)	R1016, R1017, R1033, R1034, R1044, R1051, R1057, R1067, R1068, R1075, R1076, R1077, R1081, R1082, R1084, R1086, R1087, R1125, R1128, R1139, R1145, R1147, R1148, R1154, R1155, R1156
A3	1-139	1	100 MΩ, 20% (brn-blk-viol)	R1025
Resistor Packs				
A4	9-140	3	390 Ω (391) resistor pack	RP1107, RP1108, RP1109
A4	9-141	3	1000 Ω (102) resistor pack	RP1004, RP1005, RP1006
A4	9-142	2	12 kΩ (123) resistor pack	RP1103, RP1104
A4	9-143	2	22 kΩ (223) resistor pack	RP1001, RP1003
A4	9-144	4	47 kΩ (473) resistor pack	RP1002, RP1102, RP1105, RP1106
A5	9-94	1	9 MΩ resistor pack	RP1101
CONTROLS				
A6	10-1138	9	10 kΩ	R1035, R1048, R1055, R1062, R1063, R1064, R1073, R1119, R1123
A7	10-1213	2	1 MΩ (1 MEG)	R1047, R1054
A8	10-1198	1	20 kΩ	R1028

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
CAPACITORS				
Mica				
B1	20-148	1	100 pF	C1103
B1	20-177	1	125 pF	C1004
Ceramic				
B2	21-75	3	100 pF (100K)	C1001, C1006, C1011
B3	21-761	42	.01 µF (103) glass (packaged separately)	C1002, C1003, C1007, C1015, C1017, C1029, C1032, C1034, C1036, C1038, C1039, C1043, C1045, C1046, C1049, C1051, C1052, C1053, C1056, C1057, C1058, C1059, C1061, C1062, C1063, C1064, C1108, C1112, C1129, C1131, C1132, C1133, C1134, C1135, C1136, C1137, C1138, C1139, C1141, C1142, C1143, C1144

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Electrolytic				
B4	25-925	20	4.7 µF	C1028, C1033, C1035, C1037, C1044, C1047, C1048, C1054, C1055, C1101, C1107, C1109, C1111, C1113, C1114, C1115, C1117, C1126, C1127, C1128
B4	25-915	5	47 µF	C1031, C1116, C1123, C1124, C1125
B5	25-875	2	1000 µF	C1121. C1122
Other Capacitors				
B6	27-192	4	.027 µF (273K) Mylar	C1018, C1019, C1022, C1023
B6	27-193	6	.047 µF (473K) Mylar	C1005, C1009, C1021, C1024, C1025, C1102
B6	27-211	4	.22 µF (224K) Mylar	C1008, C1014, C1016, C1106
B6	27-194	2	.47 µF (474K) Mylar	C1104, C1105
SWITCHES-RELAY				
C1	64-922	1	2-section pushbutton switch	SW1006, SW1007
C2	64-923	1	6-section pushbutton switch	SW1001 - SW1005, SW1101
C3	69-86	2	5-volt relay	RY1101, RY1102
INSULATORS-GASKET-TAPE				
D1	70-10	1	Black plug insulator	
D1	70-11	1	Red plug insulator	
D2	73-21	1	Alligator clip insulator	
D3	73-133	1	Nylon gasket	
	74-4	1	Plastic tape	
	75-179	1	5″ × 8″ paper insulator	
METAL PARTS				
E1	90-1288-1	1	Cabinet top	
E2	200-1427-1	1	Chassis	
E3	204-2633	2	Display bracket	
E4	204-2655	1	Right support bracket	
E5	204-2656	1	Left support bracket	
E6	204-2657-1	1	Connector bracket	
E7	204-2658-1	1	Spacer bracket	
E8	206-1465	2	Foil shield	

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
PLASTIC PARTS			
F1	210-134	1	Front panel
F2	446-737	1	Window
F3	462-1097	2	Rectangular knob
F4	462-1109	1	Round knob
HARDWARE			

NOTE: Hardware packets are marked to show the size of the hardware they contain (HDW #4, or, HDW #6 & #8, etc). You may have to open more than one packet — in this pack — to locate all the hardware of any one size (#6, for example).

#4 Hardware			
G1	250-1445	2	4-40 × 3/16″ screw
G2	250-1469	10	4-40 × 5/16″ screw
G3	250-1413	5	4-40 × 1/2″ screw
G4	252-15	3	4-40 nut
G5	252-731	7	4-40 brass insert
G6	254-9	15	#4 lockwasher
#6 Hardware			
H1	250-1282	1	6-32 × 1/8″ setscrew
H2	250-1325	13	6-32 × 1/4″ screw
H3	252-3	7	6-32 nut
H4	254-1	7	#6 lockwasher
Other Hardware			
J1	252-7	1	Control nut
J2	253-80	4	Flat washer
J3	254-4	1	Large control lockwasher
J4	254-15	2	Banana jack lockwasher
WIRE-CABLE-SLEEVING			
J5	134-1112	2	22 conductor interconnect assembly
	340-3	2″	Bare wire
	341-1	36″	Large black wire
	341-2	36″	Large red wire
	343-15	50″	Shielded cable
	346-21	3″	White sleeving
	346-60	1-1/2″	Clear tubing
	347-66	40″	25-conductor flat cable

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

LEDs-TRANSISTORS

K1	411-855	1	5-segment LED (light-emitting diode)	V1205
K2	411-853	4	7-segment LED	V1201, V1202, V1203, V1204
K3	412-654	10	Red LED	V1206-V1216

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

1. Part number.
2. Type number.
3. Part number and type number.
4. Part number with a type number other than the one listed.

K4	417-864	14	MPSA05	Q1001-Q1008, Q1108, Q1109, Q1113, Q1115, Q1116, Q1117
K4	417-865	10	MPSA55	Q1012, Q1013, Q1102, Q1103, Q1104, Q1105, Q1107, Q1111, Q1112, Q1114
K4	417-881	3	MPSA13	Q1011, Q1101, Q1106
K4	417-885	1	MPSA65	Q1009

INTEGRATED CIRCUITS

NOTES:

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

   A. Part number.
   B. Type number (For integrated circuits, this refers only to the numbers and letters shown in **bold** print in the Parts List. Disregard any other numbers or letters on the IC).
   C. Part number and type number.
   D. Part number with a type number other than the one shown.

2. Some ICs are packed in a special foam material to protect them from static electricity. Do not remove these ICs from their protective foam material until you are instructed to do so.

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

Integrated Circuits (Cont'd)

K4	442-665	1	**79L05**	U1126
K5	442-54	1	μA**7805**	U1125
K6	442-99	8	CD**4016**	U1006, U1007, U1014, U1016, U1017, U1102, U1105, U1122
K6	442-639	2	MLM**308A**	U1003, U1005,
K6	442-648	1	LM**310**	U1008
K6	442-679	2	TL**061** CP	U1011, U1012
K6	442-707	4	LF**353** (TL072)	U1004, U1009, U1015, U1101
K6	442-724	1	**7107**	U1103
K6	443-808	11	**4N26**	U1106, U1107, U1108, U1109, U1111, U1113-U1118
K6	443-829	1	**74LS76**	U1002
K6	443-887	3	**4023**	U1121, U1123, U1124
K6	444-194	1	Cap/Gain ROM	U1001
K6	444-195	1	Volts ROM	U1119
K6	444-196	1	T/F ROM	U1112
K7	442-680	1	ICL**8069**	U1013

PINS-SOCKETS-CONNECTORS

L1	432-120	3	Female terminal (1 extra)
L2	432-121	5	PCB pin (1 extra)
L3	432-134	15	Wire socket (1 extra)
L4	432-818	3	4-hole socket
L5	432-854	11	Male pin (1 extra)
L6	432-866	17	Small spring connector (2 extra)
L7	432-1283	3	6-hole socket

IC SOCKETS-JACKS-PLUGS

N1	434-230	9	8-pin IC socket
N1	434-253	1	40-pin IC socket
N1	434-298	16	14-pin IC socket
N1	434-299	3	16-pin IC socket
N1	434-311	1	20-pin IC socket
N1	434-371	11	6-pin IC socket
N2	436-11	1	Red banana jack
N2	436-22	1	Black banana jack
N3	438-47	2	Banana plug
N4	438-55	4	Polarizing plug (1 extra)

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

MISCELLANEOUS

IMPORTANT: Refer to the "Circuit Board Handling Procedure" on Page 8 before you handle the main circuit board.

	85-2760-1	1	Main circuit board	
	85-2761-1	1	Display circuit board	
P1	100-1807	1	DC calibration parts consisting of the following components. DO NOT remove them from the envelope until you are instructed to do so in a step.	
		1	*1960 Ω (brn-wht-blu-brn) resistor*	*R1116*
		1	*10.7 kΩ (brn-blk-viol-red) resistor*	*R1115*
		1	*1.2-volt IC*	*U1104*
P2	215-94	1	Heat sink	
P3	235-229	4	RF choke	L1001-L1004
P4	260-1	1	Alligator clip	
P5	439-7	1	Red probe	
P6	439-9	1	Probe collar	
			Solder	

KEY No.	HEATH Part No.	QTY.	DESCRIPTION

TOOLS

R1	490-5	1	Nut starter
R2	490-14	1	.062 allen wrench
R3	490-111	1	IC lifter
	490-185	1	Desoldering braid

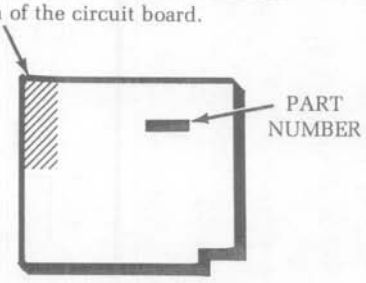
PRINTED MATERIALS

R4	390-1861	1	Calibration-warning label
R5	390-2434	1	Front panel label
R6		1	Blue and white label
	597-260	1	Parts Order Form
		1	Taped Component Chart
		1	Assembly Manual (See title page for part number.)

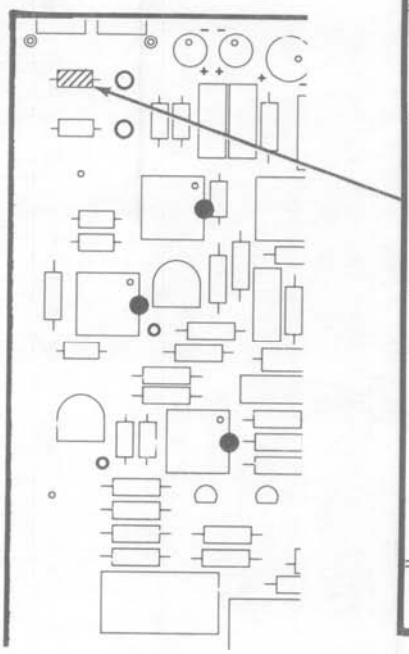
STEP-BY-STEP ASSEMBLY

MAIN CIRCUIT BOARD

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



IDENTIFICATION DRAWING



START

Make sure you have read the "Circuit Board Handling Procedure" on Page 8 before you start to assemble the main circuit board.

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

( ) Position the main circuit board as shown with the lettered side up. The identification drawing at the top of the page shows you the area of the circuit board you will be working in.

CONTINUE

( ) Hold a .01 µF (103) glass capacitor by the body and bend the leads straight down to fit the hole spacing on the circuit board.

NOTE: **Add 1000** to all component numbers screened on the circuit board.

( ) C1034: Push the capacitor leads through the holes at the indicated location on the circuit board. The capacitor may be positioned either way.

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

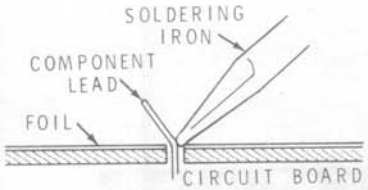
Proceed to the next page.

PICTORIAL 1-1

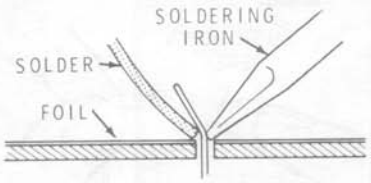
START

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

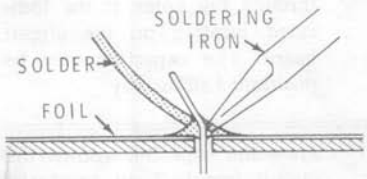
1. Push the soldering iron tip against both the lead and the circuit board foil. Heat both for two or three seconds.



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



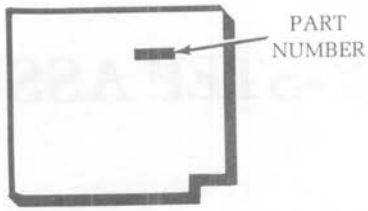
3. As the solder begins to melt, allow it to flow around the connection. Avoid excessive solder buildup on pads. Then remove the solder and the iron and let the connection cool.

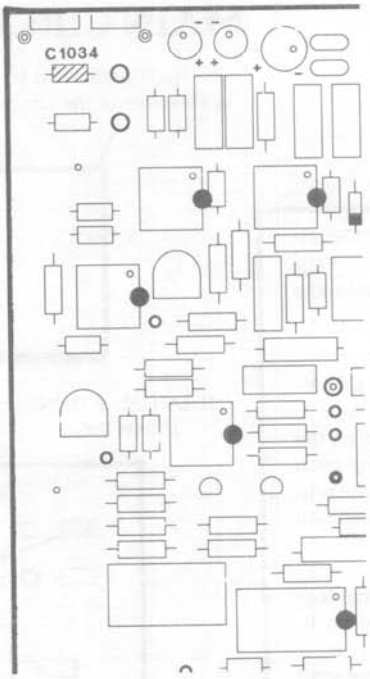


( ) Cut off the excess lead lengths close to the connection. WARNING: Clip the leads so the ends will not fly toward your eyes.

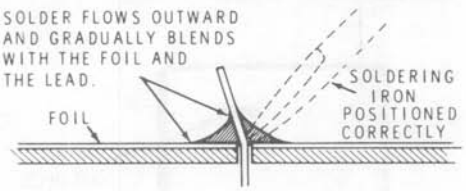
( ) Check the connection. Compare it to the illustration on Page 17. After you have checked the solder connections, proceed with the assembly on Page 18. Use the same soldering procedure for each connection.

IDENTIFICATION DRAWING



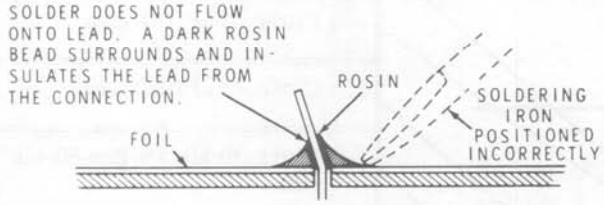


A GOOD SOLDER CONNECTION

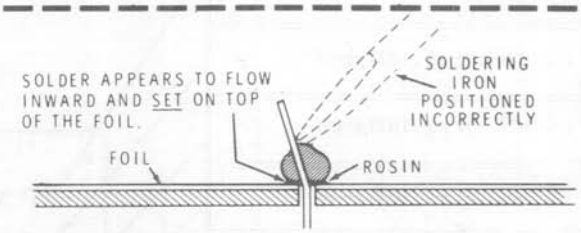


When you heat the lead and the circuit board foil at the same time, the solder will flow evenly onto the lead and the foil. The solder will make a good electrical connection between the lead and the foil.

POOR SOLDER CONNECTIONS



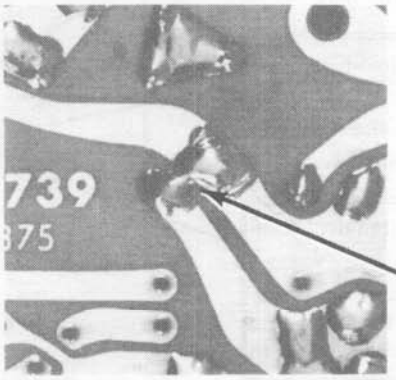
When the lead is not heated sufficiently, the solder will not flow onto the lead as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.



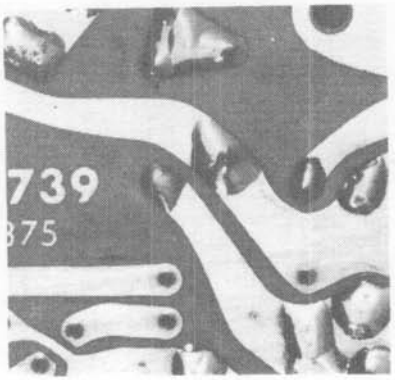
When the foil is not heated sufficiently the solder will blob on the circuit board as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.

SOLDER BRIDGES

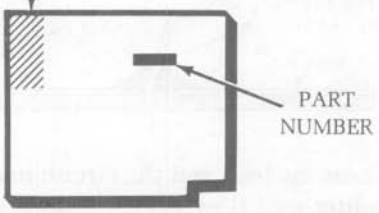
A solder bridge between two adjacent foils is shown in photograph **A**. Photograph **B** shows how the connection should appear. A solder bridge may occur if you accidentally touch an adjacent previously soldered connection, if you use too much solder, or if you "drag" the soldering iron across other 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.



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.



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



IDENTIFICATION DRAWING

START

( ) Make sure you installed capacitor C1034 in Pictorial 1-1 on Page 15.

( ) C1036: .01 µF (103) glass.

( ) C1058: .01 µF (103) glass.

( ) C1062: .01 µF (103) glass.

( ) R1021: 10 kΩ, 1% (brn-blk-blk-red).

( ) C1061: .01 µF (103) glass.

( ) C1051: .01 µF (103) glass.

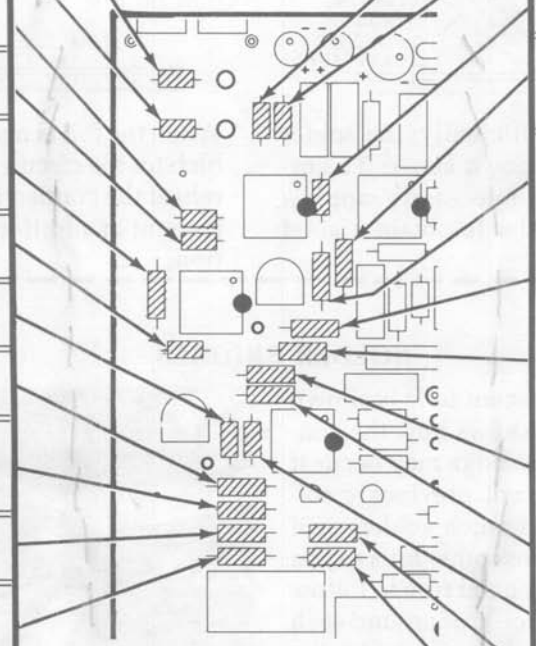
( ) R1013: 4700 Ω (yel-viol-red).

( ) R1015: 2050 Ω, 1% (red-blk-grn-brn).

( ) R1022: 22 kΩ (red-red-org).

( ) R1032: 10 kΩ, 1% (brn-blk-blk-red).

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



CONTINUE

( ) C1032: .01 µF (103) glass.

( ) C1059: .01 µF (103) glass.

( ) C1057: .01 µF (103) glass.

( ) R1011: 10 kΩ, 1% (brn-blk-blk-red).

( ) R1012: 49.9 kΩ, 1% (yel-wht-wht-red).

( ) R1049: 90 kΩ, 1% (wht-blk-blk-red).

( ) R1056: 90 kΩ, 1% (wht-blk-blk-red).

( ) R1019: 10 kΩ, 1% (brn-blk-blk-red).

( ) R1014: 22 kΩ (red-red-org).

( ) C1049: .01 µF (103) glass.

( ) R1023: 22 kΩ (red-red-org).

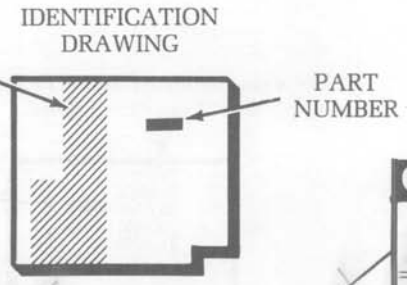
( ) R1031: 10 kΩ, 1% (brn-blk-blk-red).

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

PICTORIAL 1-2

Heathkit®

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



START

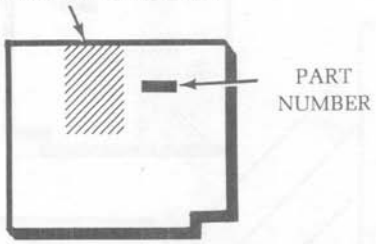
- ( ) R1046: 2.2 MΩ (red-red-grn).
- ( ) C1056: .01 µF (103) glass.
- ( ) R1053: 2.2 MΩ (red-red-grn).
- ( ) C1007: .01 µF (103) glass.
- ( ) R1017: 100 kΩ (brn-blk-yel).
- ( ) R1025: 100 MΩ, 1/2-watt (brn-blk-viol).
- ( ) R1027: 10 kΩ, 1% (brn-blk-blk-red).
- ( ) R1026: 10 kΩ, 1% (brn-blk-blk-red).
- ( ) R1024: 6190 Ω, 1% (blu-brn-wht-brn).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.
- ( ) R1058: 22 kΩ (red-red-org).
- ( ) C1029: .01 µF (103) glass.
- ( ) R1069: 22 kΩ (red-red-org).
- ( ) R1081: 100 kΩ (brn-blk-yel).
- ( ) C1046: .01 µF (103) glass.
- ( ) R1087: 100 kΩ (brn-blk-yel).
- ( ) R1086: 100 kΩ (brn-blk-yel).
- ( ) R1057: 100 kΩ (brn-blk-yel).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

CONTINUE

- ( ) R1045: 470 kΩ (yel-viol-yel).
- ( ) R1044: 100 kΩ (brn-blk-yel).
- ( ) R1051: 100 kΩ (brn-blk-yel).
- ( ) R1052: 470 kΩ (yel-viol-yel).
- ( ) R1018: 22 Ω (red-red-blk).
- ( ) R1033: 100 kΩ (brn-blk-yel).
- ( ) R1034: 100 kΩ (brn-blk-yel).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.
- ( ) C1052: .01 µF (103) glass.
- ( ) R1072: 100 Ω, 1% (brn-blk-blk-blk).
- ( ) R1078: 22 kΩ (red-red-org).
- ( ) R1079: 22 kΩ (red-red-org).
- ( ) R1077: 100 kΩ (brn-blk-yel).
- ( ) R1076: 100 kΩ (brn-blk-yel).
- ( ) R1075: 100 kΩ (brn-blk-yel).
- ( ) R1101: 100 Ω, 1% (brn-blk-blk-blk).
- ( ) C1133: .01 µF (103) glass.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 1-3

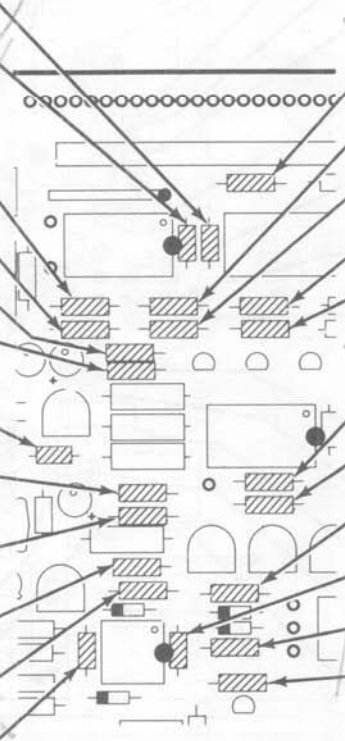
The steps performed in this Pictorial are in this area of the circuit board.



IDENTIFICATION DRAWING

START

- ( ) C1038: .01 µF (103) glass.
- ( ) C1039: .01 µF (103) glass. Be sure to use the correctly-spaced holes.
- ( ) R1082: 100 kΩ (brn-blk-yel).
- ( ) R1084: 100 kΩ (brn-blk-yel).
- ( ) R1016: 100 kΩ (brn-blk-yel).
- ( ) R1036: 10 kΩ, 1% (brn-blk-blk-red).
- ( ) C1053: .01 µF (103) glass.
- ( ) R1065: 7870 Ω, 1% (viol-gry-viol-brn).
- ( ) R1061: 1130 Ω, 1% (brn-brn-org-brn).
- ( ) R1059: 1470 Ω, 1% (brn-yel-viol-brn).
- ( ) R1068: 100 kΩ (brn-blk-yel).
- ( ) C1064: .01 µF (103) glass.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

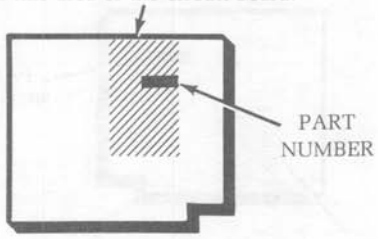


CONTINUE

- ( ) R1008: 390 Ω (org-wht-brn).
- ( ) R1083: 12 kΩ (brn-red-org).
- ( ) R1085: 12 kΩ (brn-red-org).
- ( ) R1005: 1000 Ω (brn-blk-red).
- ( ) R1004: 1000 Ω (brn-blk-red).
- ( ) R1042: 390 Ω (org-wht-brn).
- ( ) R1043: 390 Ω (org-wht-brn).
- ( ) R1067: 100 kΩ (brn-blk-yel).
- ( ) C1063: .01 µF (103) glass.
- ( ) R1003: 390 Ω (org-wht-brn).
- ( ) R1156: 100 kΩ (brn-blk-yel).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 1-4

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



START

IDENTIFICATION DRAWING

( ) R1009: 22 Ω (red-red-blk).

( ) R1002: 390 Ω (org-wht-brn).

( ) R1001: 390 Ω (org-wht-brn).

( ) R1007: 1000 Ω (brn-blk-red).

( ) C1003: .01 µF (103) glass.

( ) C1002: .01 µF (103) glass.

( ) C1017: .01 µF (103) glass.

( ) C1043: .01 µF (103) glass.

( ) R1041: 22 kΩ (red-red-org).

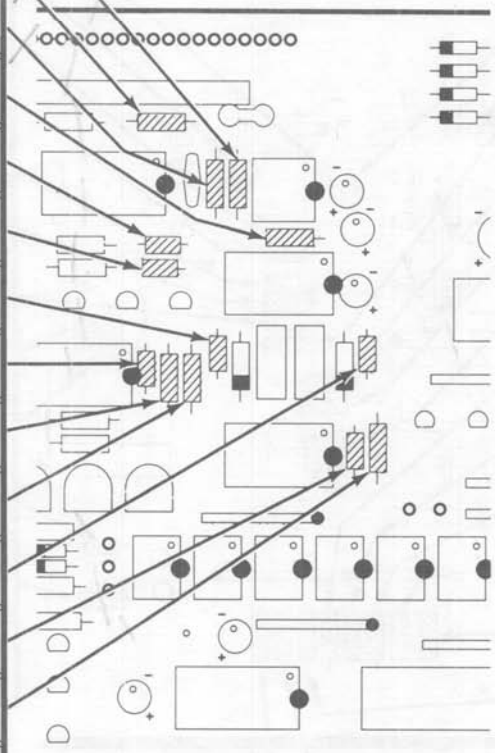
( ) R1006: 1000 Ω (brn-blk-red).

( ) C1015: .01 µF (103) glass.

( ) C1045: .01 µF (103) glass.

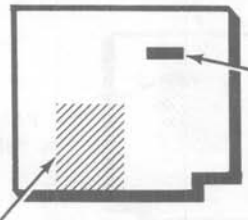
( ) R1066: 22 kΩ (red-red-org).

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



PICTORIAL 1-5

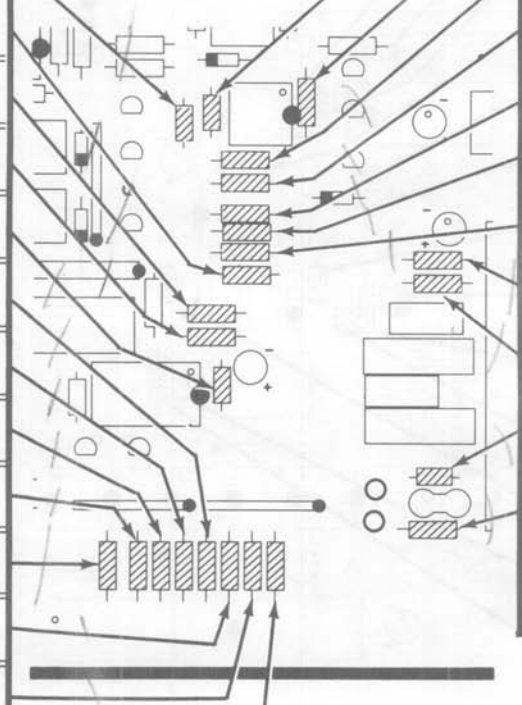
IDENTIFICATION DRAWING



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

START

- ( ) C1131: .01 µF (103) glass.
- ( ) R1106: 470 kΩ (yel-viol-yel).
- ( ) R1108: 470 kΩ (yel-viol-yel).
- ( ) R1126: 470 kΩ (yel-viol-yel).
- ( ) C1132: .01 µF (103) glass.
- ( ) R1131: 270 Ω (red-viol-brn).
- ( ) R1134: 270 Ω (red-viol-brn).
- ( ) R1133: 270 Ω (red-viol-brn).
- ( ) R1127: 270 Ω (red-viol-brn).
- ( ) R1128: 100 kΩ (brn-blk-yel).
- ( ) R1135: 390 Ω (org-wht-brn).
- ( ) R1136: 390 Ω (org-wht-brn).
- ( ) R1132: 270 Ω (red-viol-brn).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

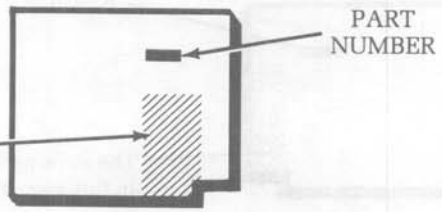


CONTINUE

- ( ) C1129: .01 µF (103) glass.
- ( ) R1155: 100 kΩ (brn-blk-yel).
- ( ) R1103: 1000 Ω (brn-blk-red).
- ( ) R1104: 22 kΩ (red-red-org).
- ( ) R1102: 22 kΩ (red-red-org).
- ( ) R1107: 22 kΩ (red-red-org).
- ( ) R1105: 22 kΩ (red-red-org).
- ( ) R1113: 22 kΩ (red-red-org).
- ( ) R1112: 220 kΩ (red-red-yel).
- ( ) C1108: .01 µF (103) glass.
- ( ) R1111: 113 kΩ, 1% (brn-brn-org-org).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

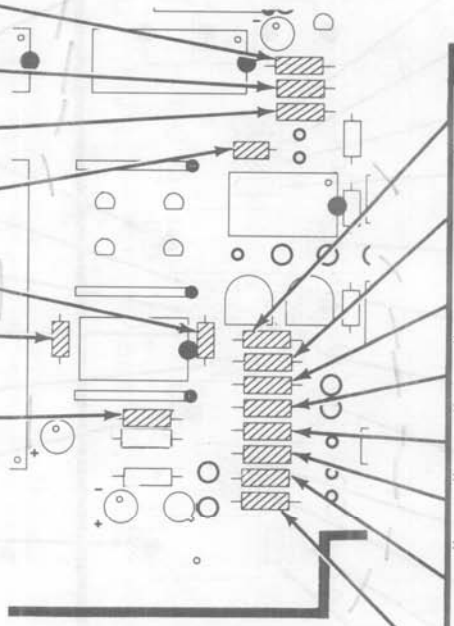
PICTORIAL 1-6

IDENTIFICATION DRAWING



START

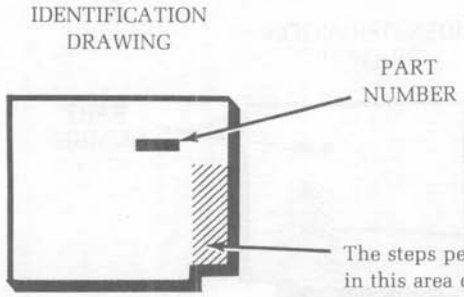
- ( ) R1139: 100 kΩ (brn-blk-yel).
- ( ) R1154: 100 kΩ (brn-blk-yel).
- ( ) R1151: 470 kΩ (yel-viol-yel).
- ( ) C1135: .01 µF (103) glass.
- ( ) C1136: .01 µF (103) glass.
- ( ) C1137: .01 µF (103) glass.
- ( ) R1124: 787 Ω, 1% (viol-gry-viol-blk).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE

- ( ) R1125: 100 kΩ (brn-blk-yel).
- ( ) R1121: 6980 Ω, 1% (blu-wht-gry-brn).
- ( ) R1118: 1130 Ω, 1% (brn-brn-org-brn).
- ( ) R1143: 22 kΩ (red-red-org).
- ( ) R1141: 4700 Ω (yel-viol-red).
- ( ) R1114: 4700 Ω (yel-viol-red).
- ( ) R1117: 1470 Ω, 1% (brn-yel-viol-brn).
- ( ) R1122: 100 Ω, 1% (brn-blk-blk-blk).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 1-7



( ) R1137: 12 kΩ (brn-red-org).

(√) R1138: 12 kΩ (brn-red-org).

(√) R1145: 100 kΩ (brn-blk-yel).

(√) R1147: 100 kΩ (brn-blk-yel).

(√) C1142: .01 µF (103) glass.

(√) C1134: .01 µF (103) glass.

(√) R1146: 22 kΩ (red-red-org).

(√) C1139: .01 µF (103) glass.

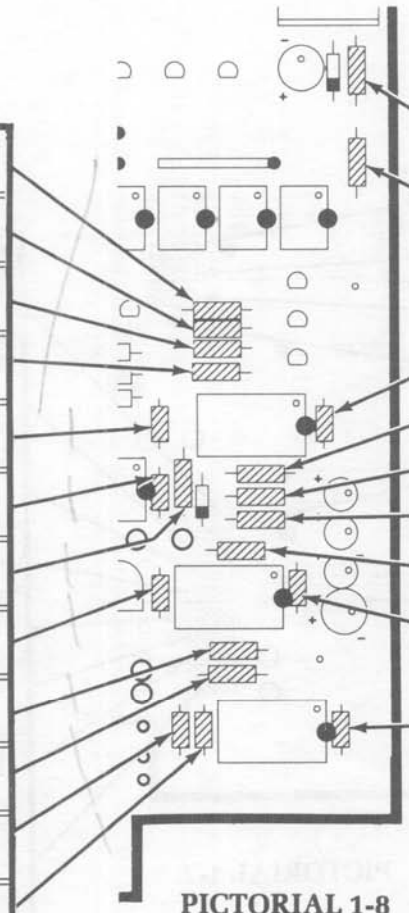
(√) R1142: 220 kΩ (red-red-yel).

(√) R1148: 100 kΩ (brn-blk-yel).

(√) C1144: .01 µF (103) glass.

(√) C1112: .01 µF (103) glass.

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



PICTORIAL 1-8

( ) R1158: 1000 Ω (brn-blk-red).

(√) R1157: 390 Ω (org-wht-brn).

(√) C1141: .01 µF (103) glass.

(√) R1152: 470 kΩ (yel-viol-yel).

(√) R1153: 22 kΩ (red-red-org).

(√) R1144: 220 kΩ (red-red-yel).

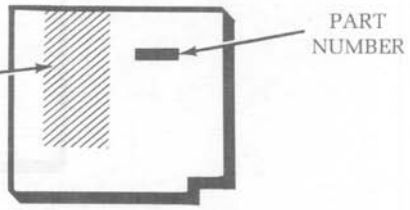
(√) R1149: 470 kΩ (yel-viol-yel).

( ) C1138: .01 µF (103) glass.

(√) C1143: .01 µF (103) glass.

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

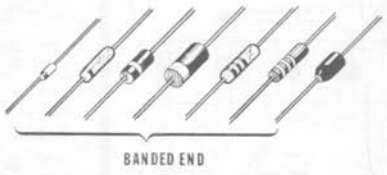
IDENTIFICATION DRAWING



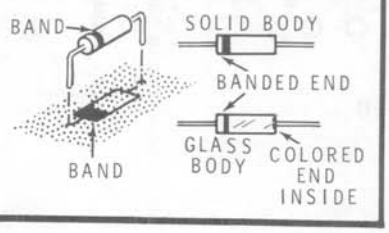
START

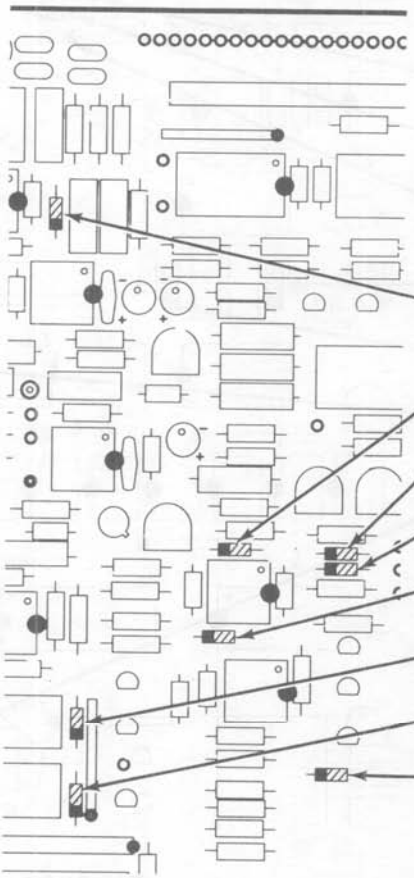
NOTE: When you install a diode, always match the band on the diode with the band mark on the circuit board. THE CIRCUIT WILL NOT WORK IF A DIODE IS INSTALLED BACKWARDS.

NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. ALWAYS POSITION THE BANDED END AS SHOWN ON THE CIRCUIT BOARD.



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.





PICTORIAL 1-9

CONTINUE

Install eight IN4149 diodes (#56-56) in the following steps.

( ) D1003.

( ) D1006.

( ) D1001.

( ) D1002.

( ) D1007.

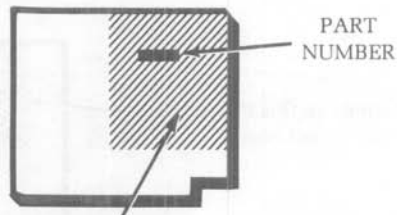
( ) D1102.

( ) D1101.

( ) D1104.

( ) 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.

START

( ) D1106: 1N4002 diode (#57-65).

( ) D1105: 1N4002 diode (#57-65).

( ) D1108: 1N4002 diode (#57-65).

( ) D1107: 1N4002 diode (#57-65).

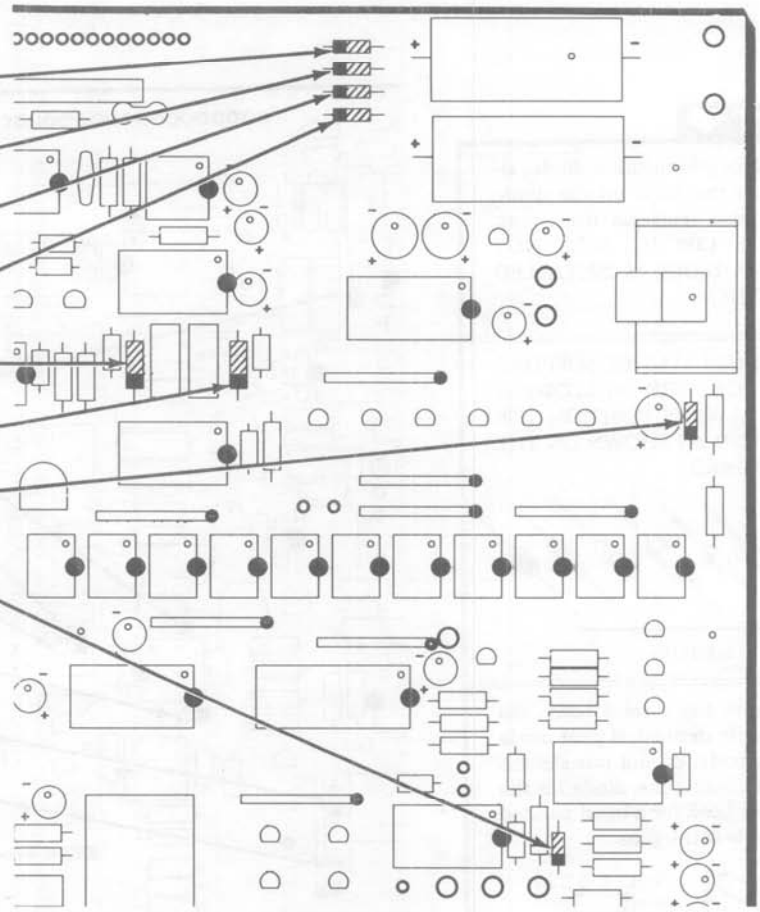
( ) D1005: GD510 diode (#56-89).

( ) D1004: GD510 diode (#56-89).

( ) D1109: 1N4002 diode (#57-65).

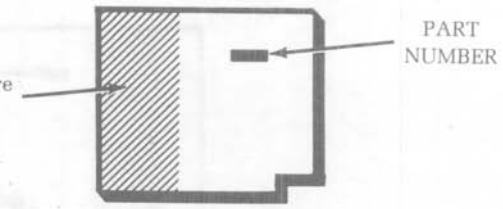
( ) D1103: 1N4149 diode (#56-56).

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



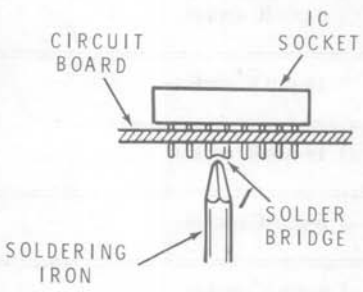
PICTORIAL 1-10

IDENTIFICATION DRAWING

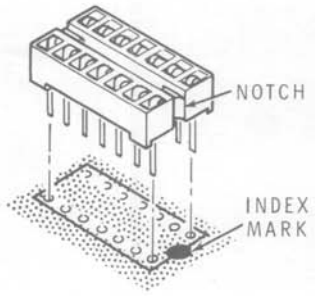


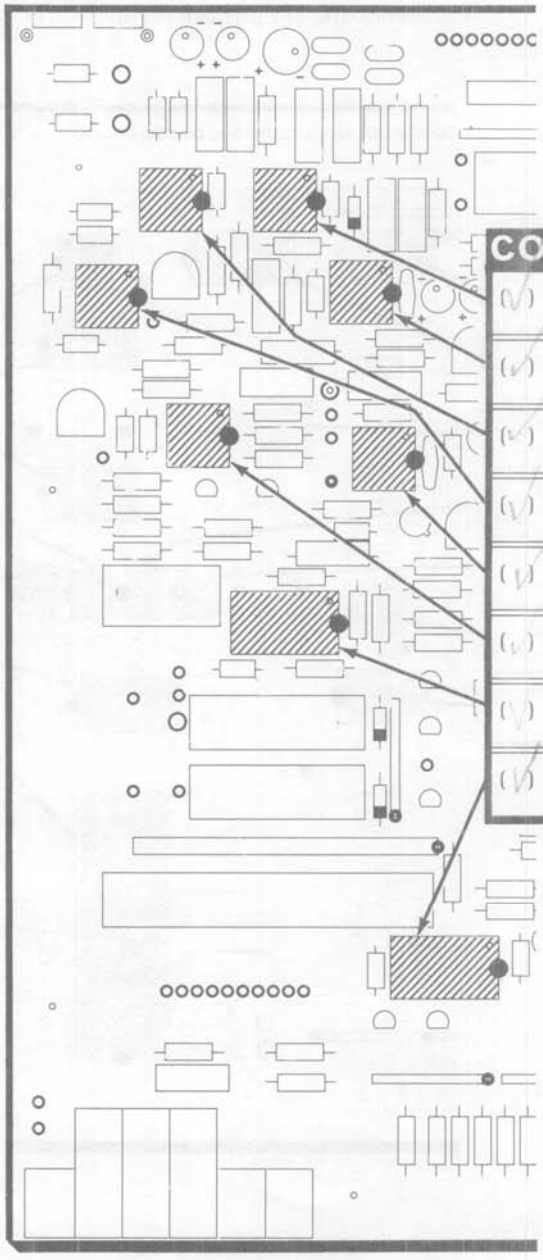
START

As you install IC sockets, be very careful that you do not bridge solder between socket pins. (Solder bridged between two pins that are on the same foil is alright.) If a solder bridge should occur, hold the circuit board foil-side down as shown. Then hold your soldering iron tip between the two points where solder is bridged. The solder will flow down the iron. Also, you can use desoldering braid.



To install IC sockets, be sure the socket pins are straight and insert the socket pins into the holes. The index mark on the circuit board must still be visible after it is installed. Solder the pins to the foil as you install each socket. Sockets may have fewer or a greater number of pins than shown here.



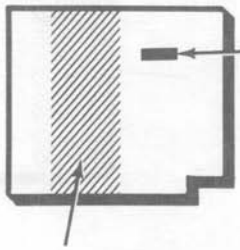


CONTINUE

- ( ) 8-pin IC socket.
- ( ) 8-pin IC socket.
- ( ) 8-pin IC socket.
- ( ) 8-pin IC socket.
- ( ) 8-pin IC socket.
- ( ) 8-pin IC socket.
- ( ) 14-pin IC socket.
- ( ) 14-pin IC socket.

PICTORIAL 1-11

IDENTIFICATION
DRAWING



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

START

( ) 14-pin IC socket.

( ) 16-pin IC socket.

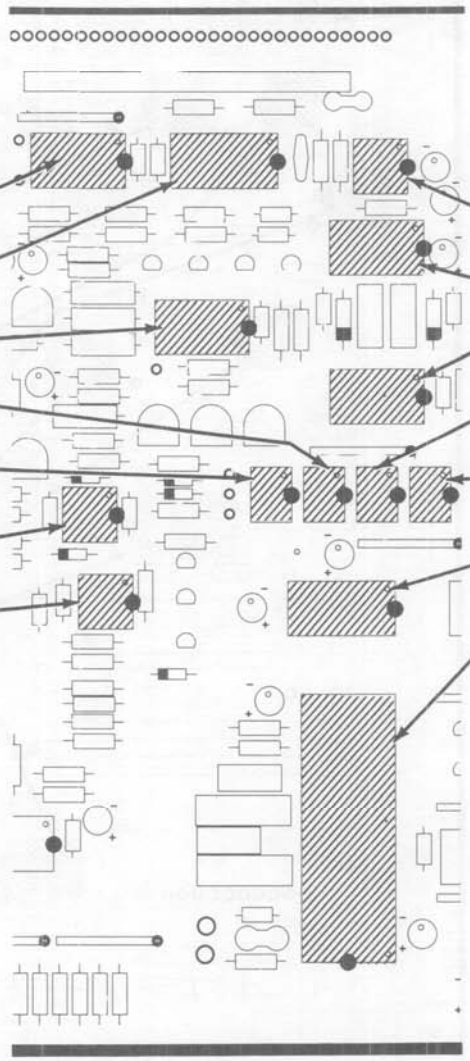
( ) 14-pin IC socket.

( ) 6-pin IC socket.

( ) 6-pin IC socket.

( ) 8-pin IC socket.

( ) 8-pin IC socket.



CONTINUE

( ) 8-pin IC socket.

( ) 14-pin IC socket.

( ) 14-pin IC socket.

( ) 6-pin IC socket.

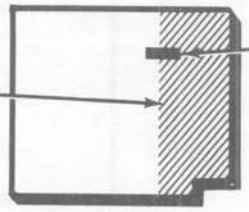
( ) 6-pin IC socket.

( ) 16-pin IC socket.

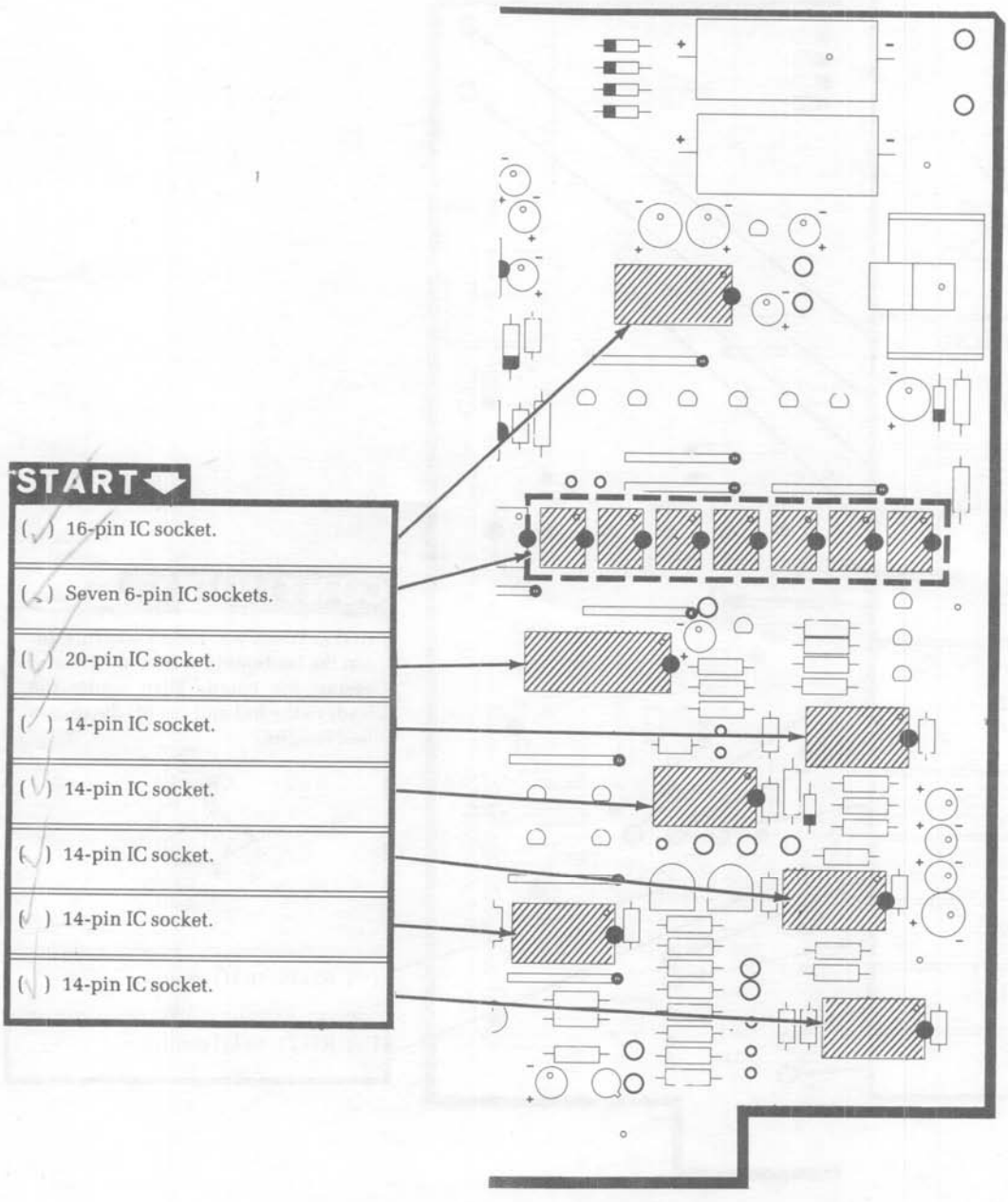
( ) 40-pin IC socket.

PICTORIAL 1-12

IDENTIFICATION DRAWING

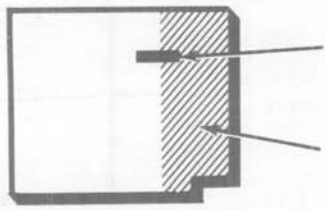


The steps performed in this Pictorial are in this area of the circuit board.



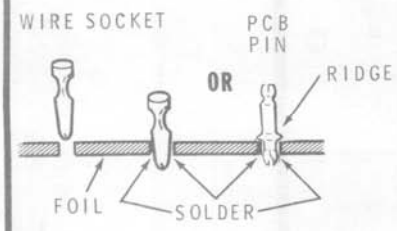
PICTORIAL 1-13

IDENTIFICATION DRAWING



START

NOTE: When you install wire sockets and PCB pins, push them as far as possible into the hole. Then solder them to the foil.



( ) Wire socket at CHASSIS GND.

( ) Wire socket at A/D GND.

( ) Wire socket at TPF.

( ) Wire socket at TPE.

( ) Wire socket at TPD.

( ) PCB pin at NORM.

( ) PCB pin at .2 V.

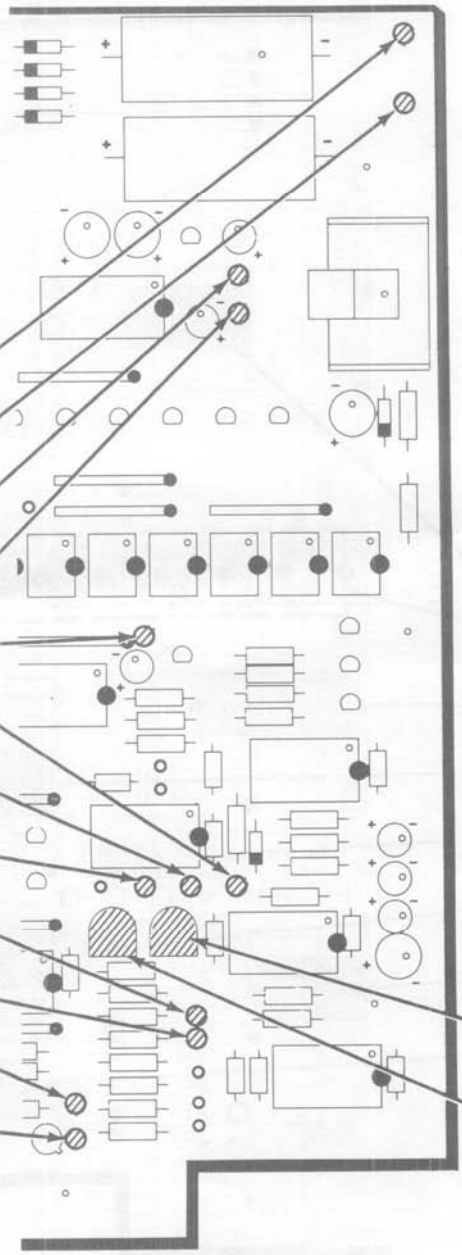
( ) PCB pin at 2 V.

( ) Wire socket at SET HV.

( ) Wire socket at SET HV.

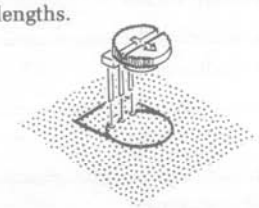
( ) Wire socket at LO CAL.

( ) Wire socket at HI CAL.



CONTINUE

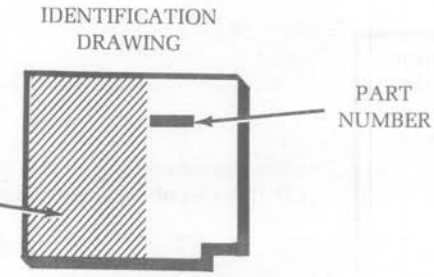
NOTE: When you install controls, insert the leads and position the control against the board. Then solder the leads to the foil and cut off the excess lead lengths.



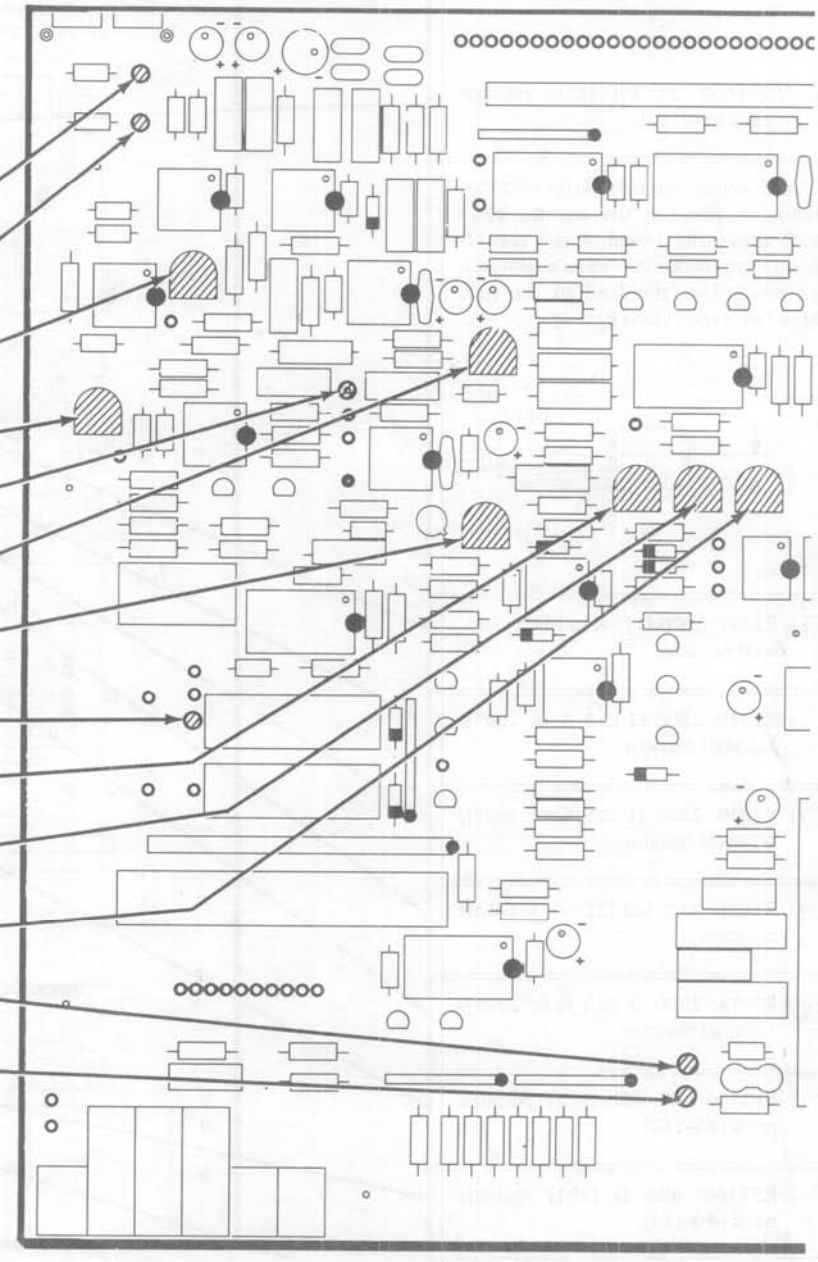
( ) R1119: 10 kΩ control.

( ) R1123: 10 kΩ control.

PICTORIAL 1-14



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



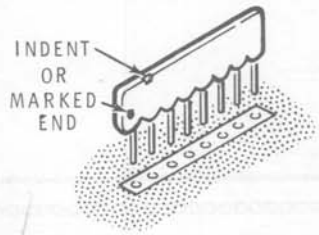
START

- ( ) Wire socket at TPB.
- ( ) Wire socket at TPC.
- ( ) R1048: 10 kΩ control.
- ( ) R1055: 10 kΩ control.
- ( ) Wire socket at TPA.
- ( ) R1035: 10 kΩ control.
- ( ) R1073: 10 kΩ control.
- ( ) PCB pin at NORM.
- ( ) R1062: 10 kΩ control.
- ( ) R1063: 10 kΩ control.
- ( ) R1064: 10 kΩ control.
- ( ) Wire socket at LAMP TEST.
- ( ) Wire socket at LAMP TEST.

PICTORIAL 1-15

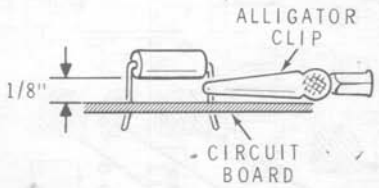
START

NOTE: When you install resistor packs, be sure to match the marked end with the number 1 location on the board. Solder the leads to the foil and cut off the excess lead lengths.



( ) RP1003: 22 kΩ (223) resistor pack (#9-143).

NOTE: When you install the next five resistors, position the resistor body 1/8" above the board. Place the alligator clip on each lead as a heatsink as you solder the lead to the foil. Make sure the values face up.



( ) R1037: 5000 Ω (5 K or 5001), 1/2-watt resistor.

( ) R1038: 2500 Ω (2.5 K or 2501), 1/2-watt resistor.

( ) R1039: 2500 Ω (2.5 K or 2501), 1/2-watt resistor.

( ) R1071: 22.9 kΩ (2292), 1/2-watt resistor.

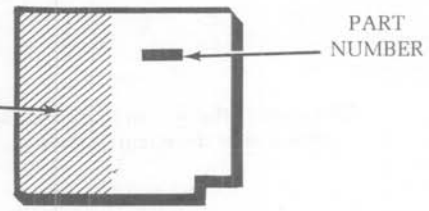
( ) R1074: 2500 Ω (2.5 K or 2501), 1/2-watt resistor.

( ) RP1104: 12 kΩ (123) resistor pack (#9-142).

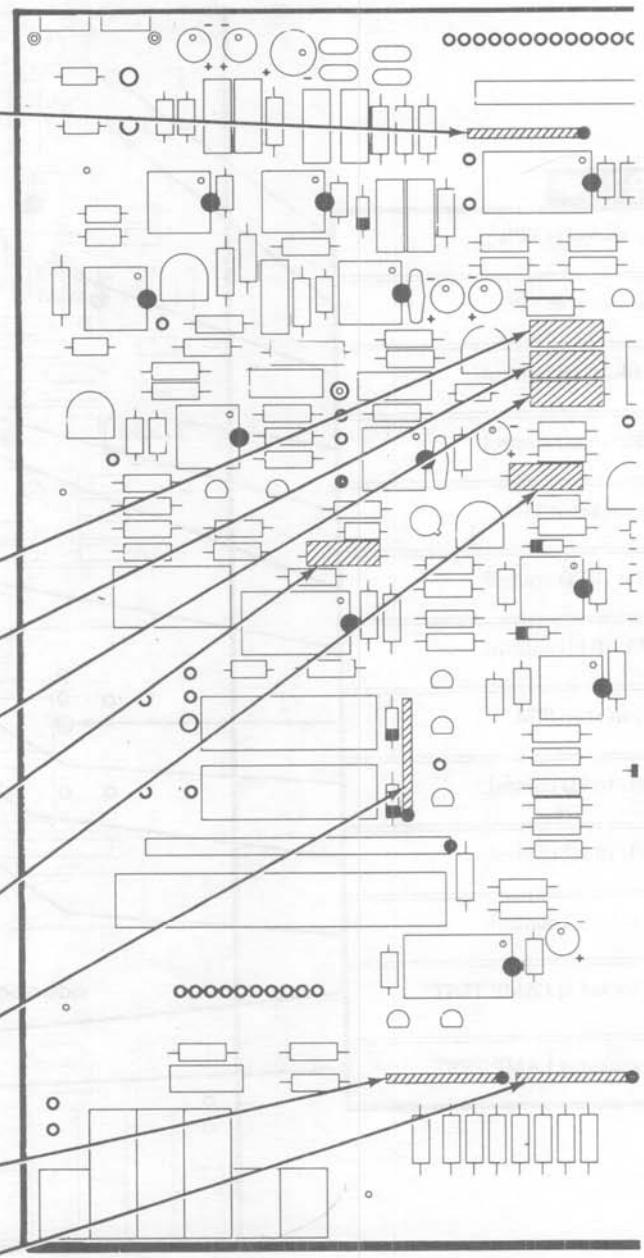
( ) RP1109: 390 Ω (391) resistor pack (#9-140).

( ) RP1107: 390 Ω (391) resistor pack (#9-140).

IDENTIFICATION DRAWING

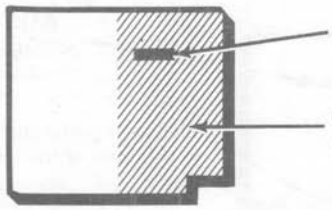


The steps performed in this Pictorial are in this area of the circuit board.



PICTORIAL 1-16

IDENTIFICATION DRAWING



START

( ) RP1001: 22 kΩ (223) resistor pack (#9-143).

( ) RP1004: 1000 Ω (102) resistor pack (#9-141).

( ) RP1002: 47 kΩ (473) resistor pack (#9-144).

( ) RP1005: 1000 Ω (102) resistor pack (#9-141).

( ) **RP1006**: 1000 Ω (102) resistor pack (#9-141).

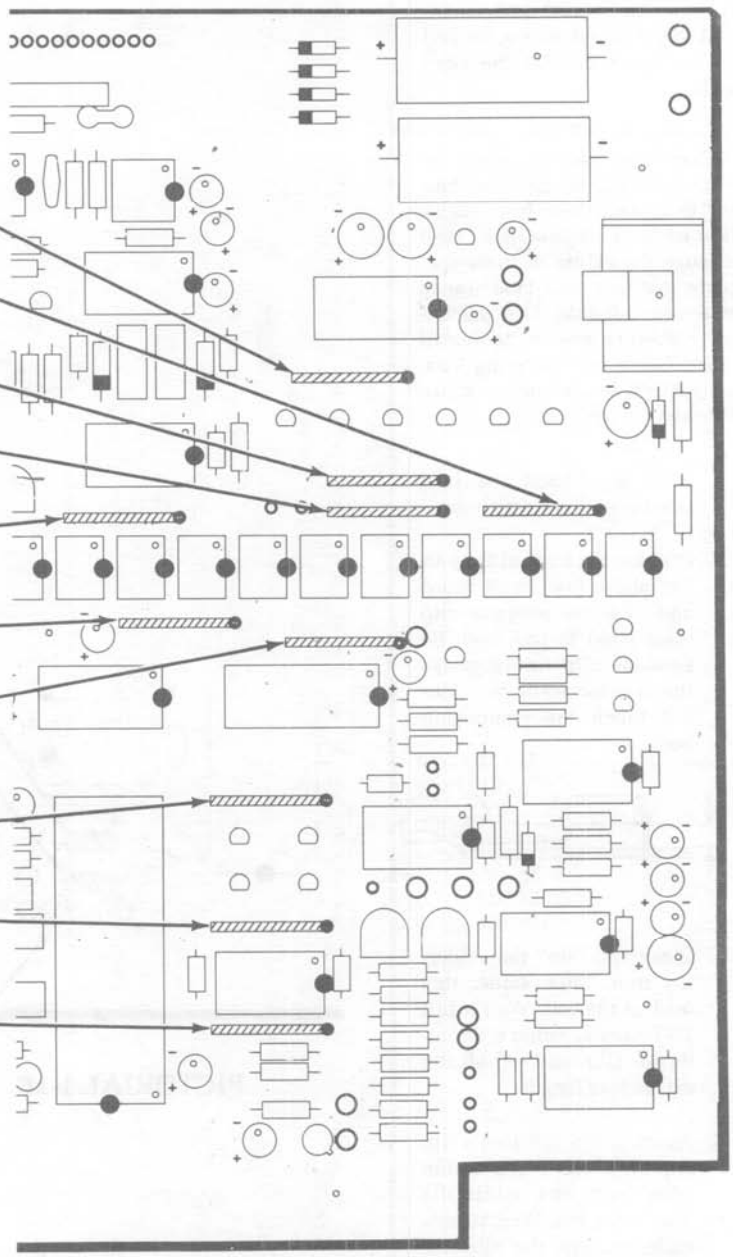
( ) **RP1106**: 47 kΩ (473) resistor pack (#9-144).

( ) RP1105: 47 kΩ (473) resistor pack (#9-144).

( ) RP1103: 12 kΩ (123) resistor pack (#9-142).

( ) RP1102: 47 kΩ (473) resistor pack (#9-144).

( ) RP1108: 390 Ω (391) resistor pack (#9-140).



PICTORIAL 1-17

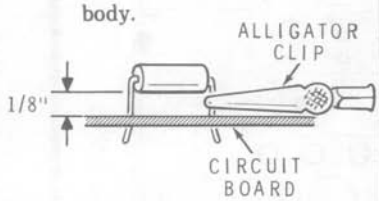
START

( ) Locate the calibration-warning label and the envelope containing the calibration parts (#100-1807). Write the numbers (**only**) from the "Calibration Values" found on the envelope in the appropriate place on the calibration label, adding decimal points as shown in Detail 1-18A. Disregard any decimal points printed on the envelope. Set the label aside.

CAUTION: The special parts installed in this Pictorial must be "heat sinked" to protect them from excessive heat when you solder them. Heat may change the values of these special parts that you will later use to calibrate your Module. Use the following procedure exactly to install each part. Use a hot soldering iron, but apply it only long enough to make a good solder connection.

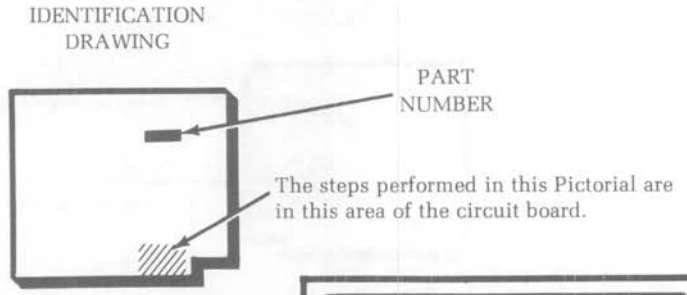
1. Bend and insert the lead into the circuit board holes.

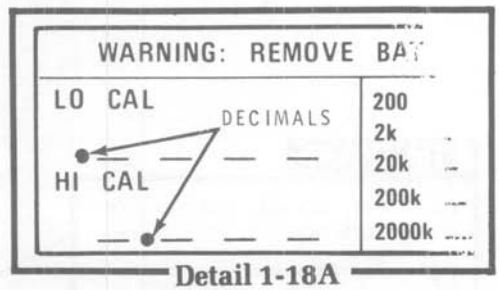
2. Position the body of the part 1/8" above the circuit board and clip the alligator clip (heat sink) to one lead. Be sure the clip firmly grasps the resistor lead, but does not touch the component body.



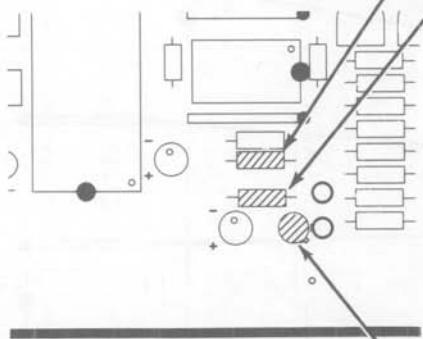
3. Clean and "tin" the soldering iron. Then solder this lead to the foil. Wait a full 10 seconds, remove the alligator clip, and cut off the excess lead length.

4. Again, clean the iron's tip, clip the alligator clip on the other lead, and solder the lead to the foil. Wait 10 seconds, remove the alligator clip, and then cut off the excess lead lengths.





Detail 1-18A



PICTORIAL 1-18

CONTINUE

( ) Open the envelope of calibration parts. These parts will be installed in the following steps. Solder each part, as you were directed in the left column. Then cut off the excess lead lengths.

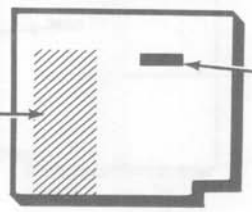
( ) R1116: 1960 Ω (brn-wht-blu-brn).

( ) R1115: 10.7 kΩ (brn-blk-viol-red).

NOTE: When you install the IC, line up the tab on the IC with the outline of the tab on the circuit board. Then insert the leads into the correct holes. Space the IC approximately 1/8" from the circuit board, as shown. Solder the leads to the foil and cut off the excess lead lengths.

( ) U1104: 1.2 V.

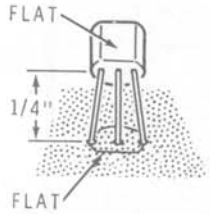
IDENTIFICATION DRAWING



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

START

NOTE: When you install each of the following transistors, position the flat on the transistor over the outline of the flat on the circuit board. Then insert the leads into the circuit board holes and solder them to the foil. Cut off any excess lead lengths.



( ) Q1009: MPSA65 (#417-885).

( ) Q1011: MPSA13 (#417-881).

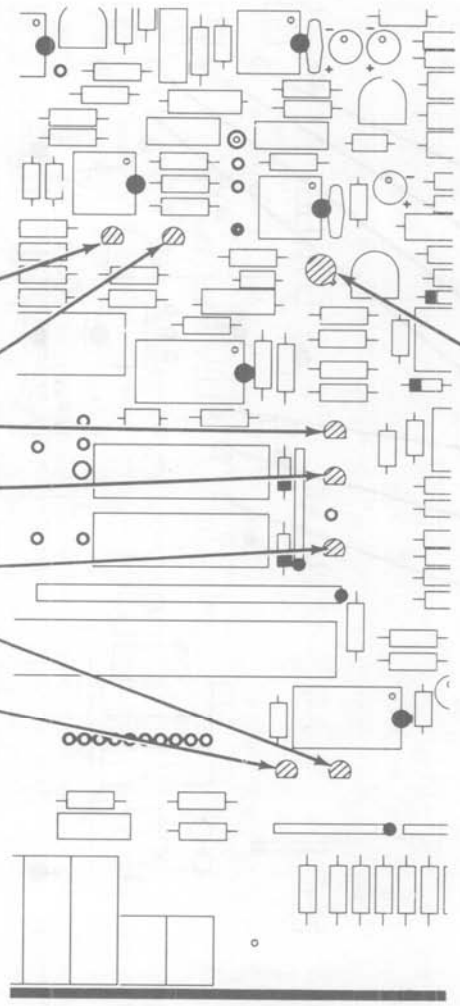
( ) Q1109: MPSA05 (#417-864).

( ) Q1108: MPSA05 (#417-864).

( ) Q1107: MPSA55 (#417-865).

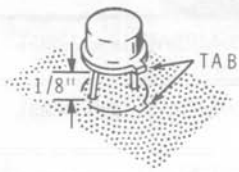
( ) Q1106: MPSA13 (#417-881).

( ) Q1101: MPSA13 (#417-881).



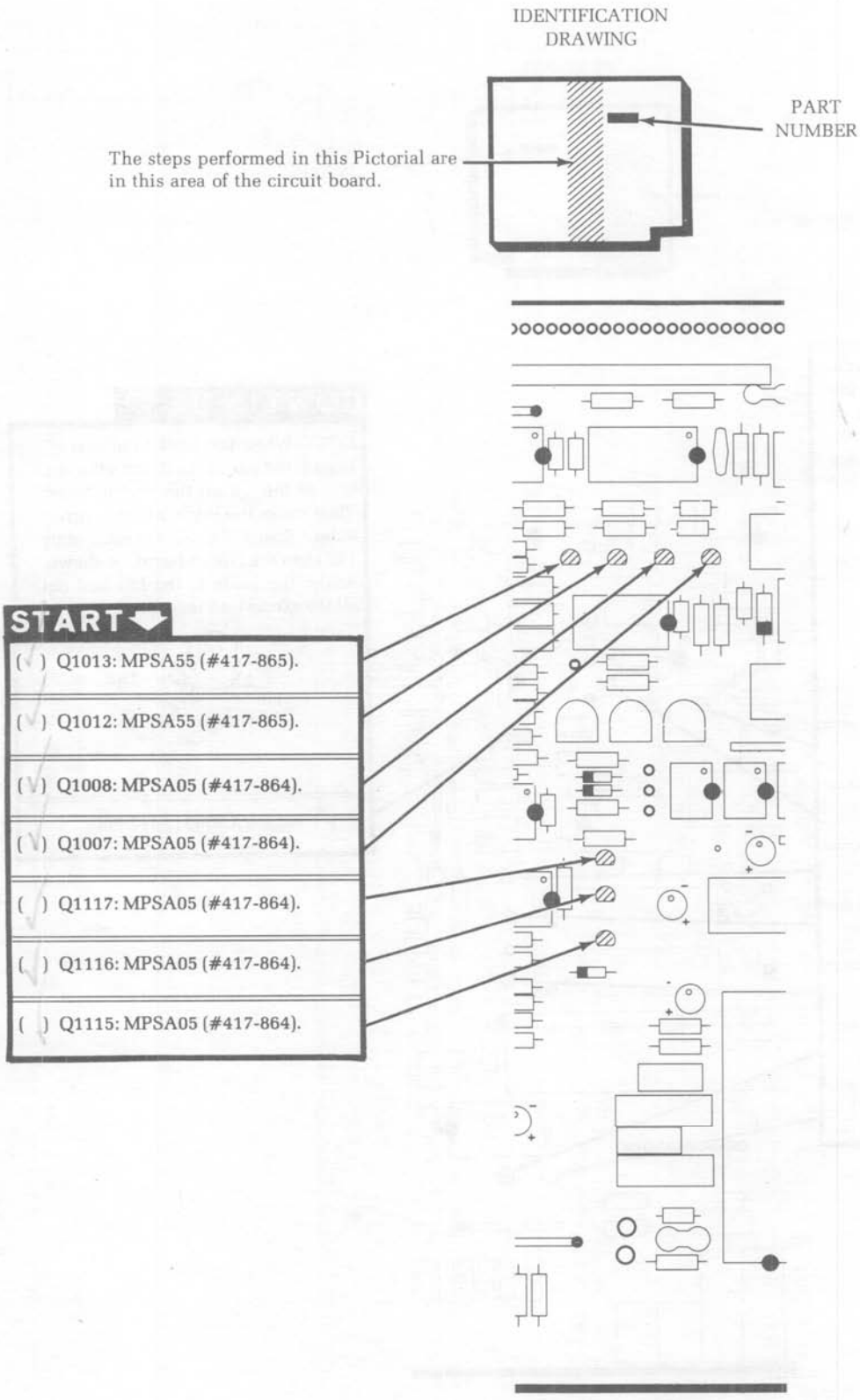
CONTINUE

NOTE: When you install the next IC, line up the tab on the IC with the outline of the tab on the circuit board. Then insert the leads into the correct holes. Space the IC approximately 1/8" from the circuit board, as shown. Solder the leads to the foil and cut off the excess lead lengths.



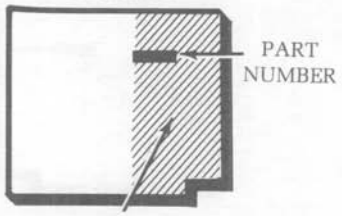
( ) U1013: ICL8069 (#442-680).

PICTORIAL 1-19



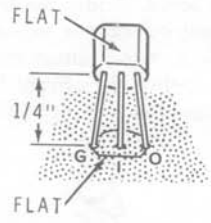
PICTORIAL 1-20

IDENTIFICATION DRAWING



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

NOTE: Identify the G, I and O leads and install the following IC as shown. Solder the leads to the foil and cut off the excess lead lengths.

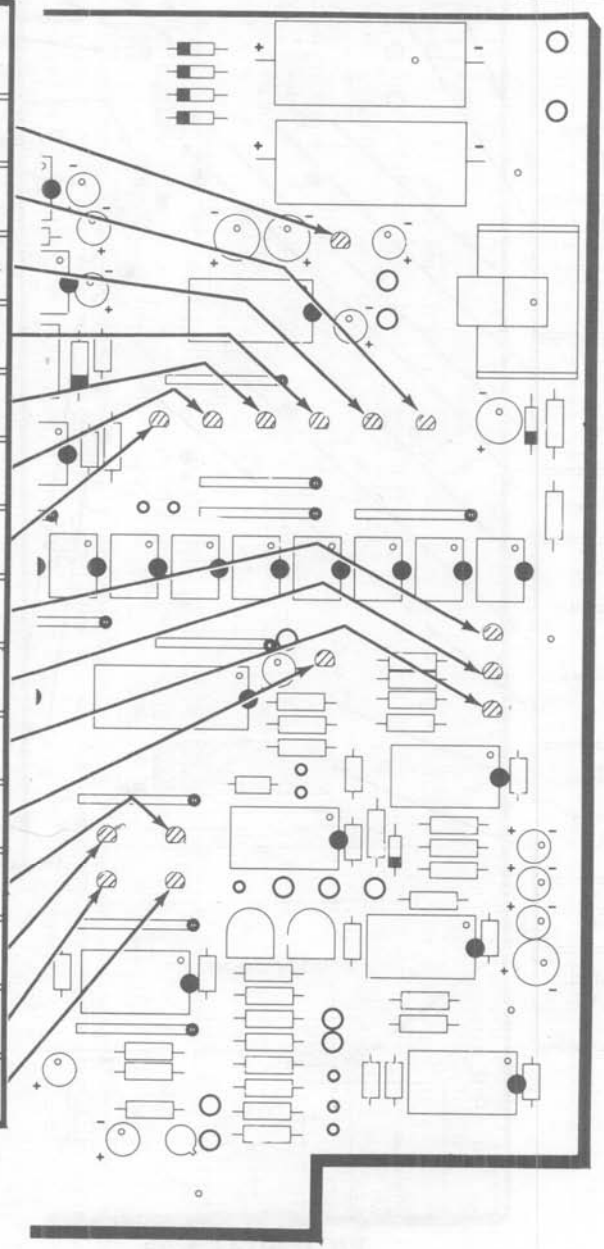


Detail 1-21A

START

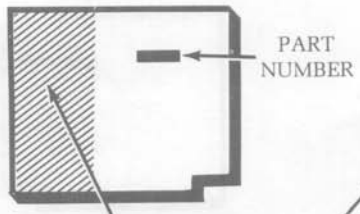
Refer to Detail 1-22A when you install the following IC.

- ( ) U1126: 79L05 (#442-665).
- ( ) Q1001: MPSA05 (#417-864).
- ( ) Q1002: MPSA05 (#417-864).
- ( ) Q1003: MPSA05 (#417-864).
- ( ) Q1004: MPSA05 (#417-864).
- ( ) Q1005: MPSA05 (#417-864).
- ( ) Q1006: MPSA05 (#417-864).
- ( ) Q1111: MPSA55 (#417-865).
- ( ) Q1112: MPSA55 (#417-865).
- ( ) Q1114: MPSA55 (#417-865).
- ( ) Q1113: MPSA05 (#417-864).
- ( ) Q1104: MPSA55 (#417-865).
- ( ) Q1103: MPSA55 (#417-865).
- ( ) Q1102: MPSA55 (#417-865).
- ( ) Q1105: MPSA55 (#417-865).



PICTORIAL 1-21

IDENTIFICATION DRAWING



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

START

NOTE: As you install the following controls, be sure they are perpendicular to the board. Solder the leads to the foil and cut off the excess lead lengths. Be sure to position the knob (rotating side) of the control toward the rear edge of the circuit board.

( ) R1054: 1 MΩ (1 MEG) control.

( ) R1047: 1 MΩ (1 MEG) control.

( ) C1019: .027 µF (273 K) Mylar.

( ) C1018: .027 µF (273 K) Mylar.

( ) C1022: .027 µF (273 K) Mylar.

( ) C1021: .047 µF (473 K) Mylar.

( ) C1023: .027 µF (273 K) Mylar.

( ) C1008: .22 µF (224 K) Mylar.

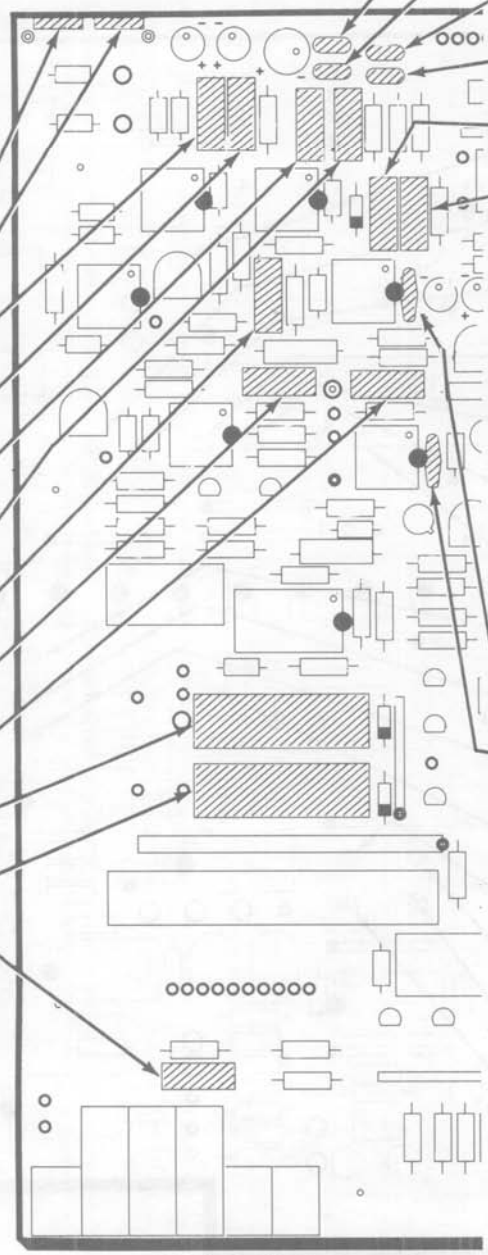
( ) C1009: .047 µF (473 K) Mylar.

( ) RY1102: 5-volt relay (#69-86).

( ) RY1101: 5-volt relay (#69-86).

( ) C1025: .047 µF (473 K) Mylar.

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



CONTINUE

( ) L1001: RF choke.

( ) L1002: RF choke.

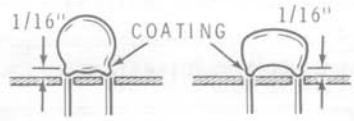
( ) L1003: RF choke.

( ) L1004: RF choke.

( ) C1005: .047 µF (473 K) Mylar.

( ) C1024: .047 µF (473 K) Mylar.

NOTE: A coating on disc and mica capacitor leads next to the capacitor body will sometimes make soldering difficult. When you install one of these capacitors, position it 1/16" off the circuit board. This will prevent the coating from protruding through the circuit board.



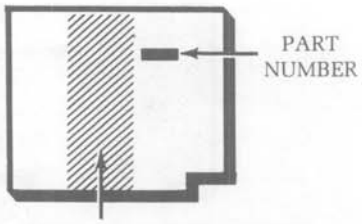
( ) C1006: 100 pF (100 K) ceramic.

( ) C1011: 100 pF (100 K) ceramic.

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

PICTORIAL 1-22

IDENTIFICATION DRAWING



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

START

(✓) C1004: 125 pF mica.

(✓) C1001: 100 pF (100 K) ceramic.

(✓) C1016: .22 µF (224 K) Mylar.

(✓) C1014: .22 µF (224 K) Mylar.

( ) C1106: .22 µF (224 K) Mylar.

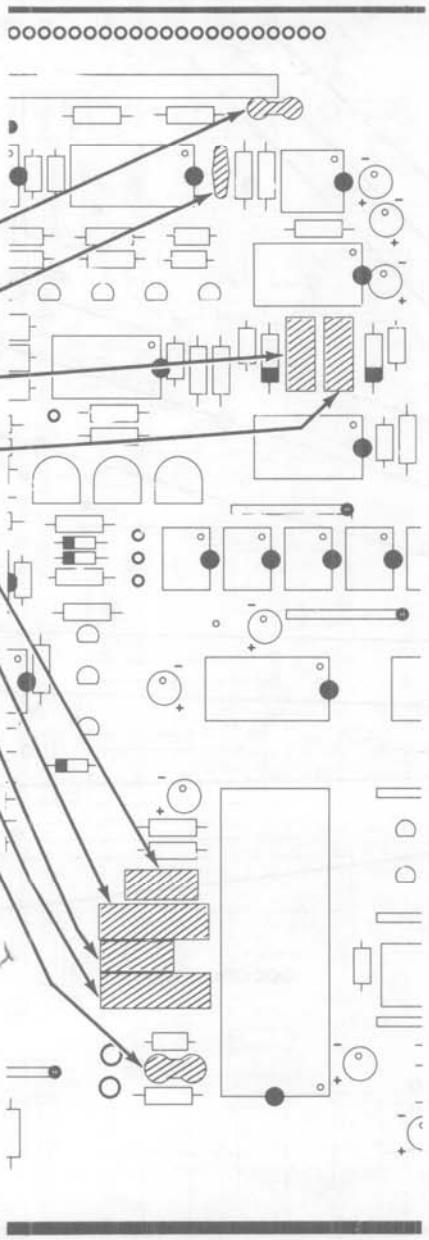
( ) C1105: .47 µF (474 K) Mylar.

( ) C1102: .047 µF (473 K) Mylar.

( ) C1104: .47 µF (474 K) Mylar.

( ) C1103: 100 pF mica.

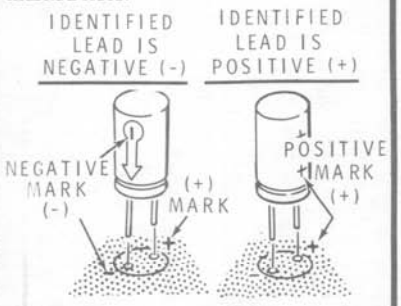
( ) Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 1-23

START

NOTE: Before you install an electrolytic capacitor, look at it and identify the leads. One lead will have a positive (+) mark or a negative (−) mark near it. Be sure to install the positive lead in the positive-marked hole, or the negative lead in the negative-marked hole.



( ) C1033: 4.7 µF.

( ) C1035: 4.7 µF.

( ) C1031: 47 µF.

( ) C1048: 4.7 µF.

( ) C1047: 4.7 µF.

( ) C1028: 4.7 µF.

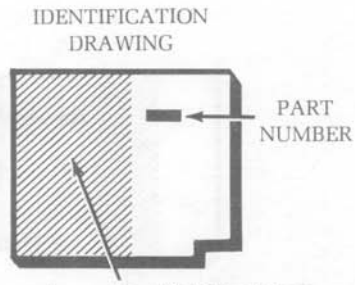
( ) C1117: 4.7 µF.

( ) C1128: 4.7 µF.

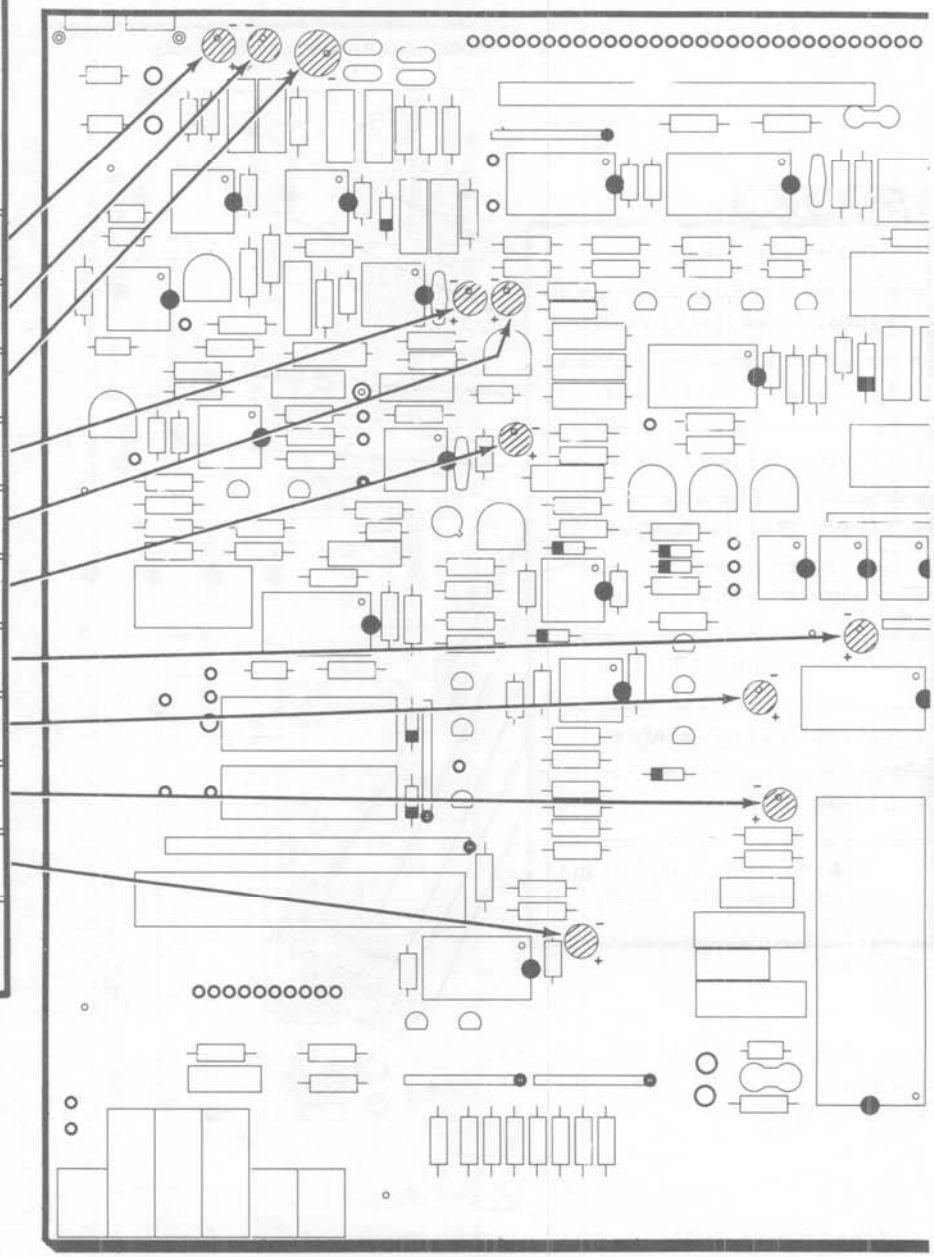
( ) C1107: 4.7 µF.

( ) C1101: 4.7 µF.

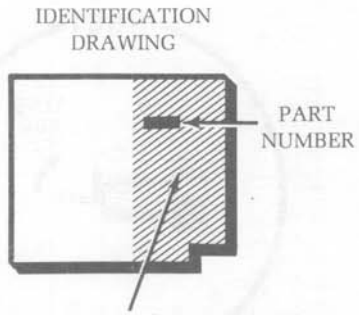
( ) Solder the leads to the foil and cut off the excess lead lengths.



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



PICTORIAL 1-24



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

START

( ) C1055: 4.7 µF.

( ) C1054: 4.7 µF.

( ) C1044: 4.7 µF.

( ) C1124: 47 µF.

( ) C1125: 47 µF.

( ) C1126: 4.7 µF.

( ) C1037: 4.7 µF.

( ) C1123: 47 µF.

( ) C1127: 4.7 µF.

( ) C1114: 4.7 µF.

( ) C1115: 4.7 µF.

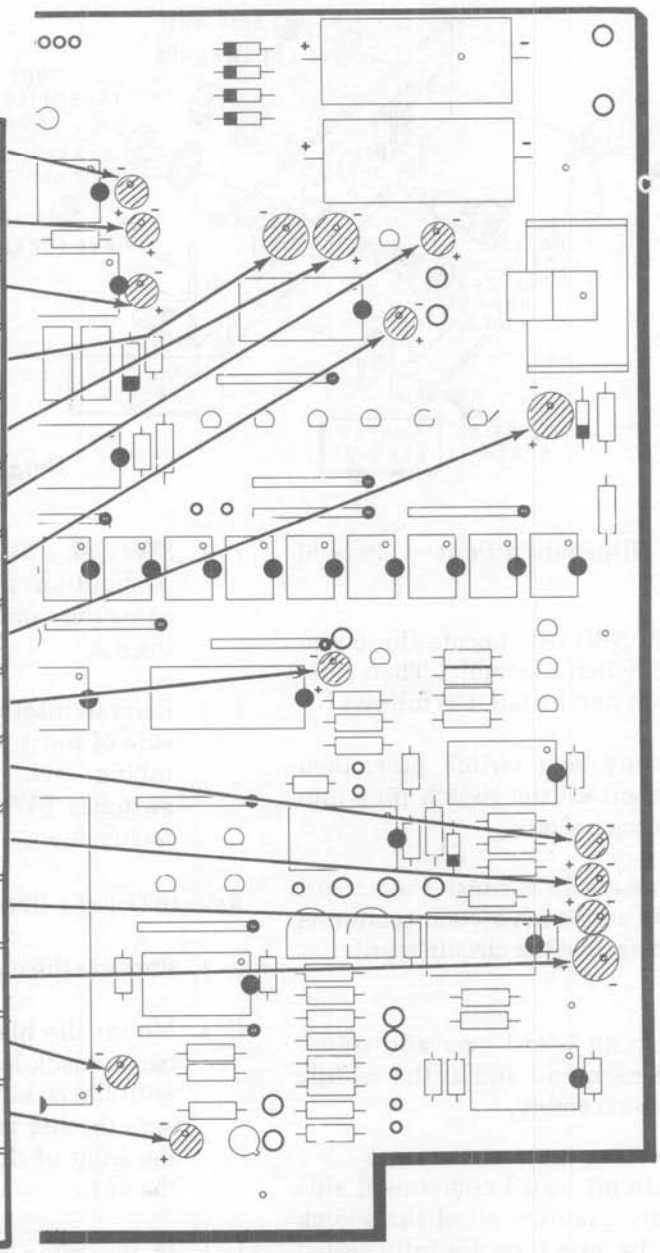
( ) C1113: 4.7 µF.

( ) C1116: 47 µF.

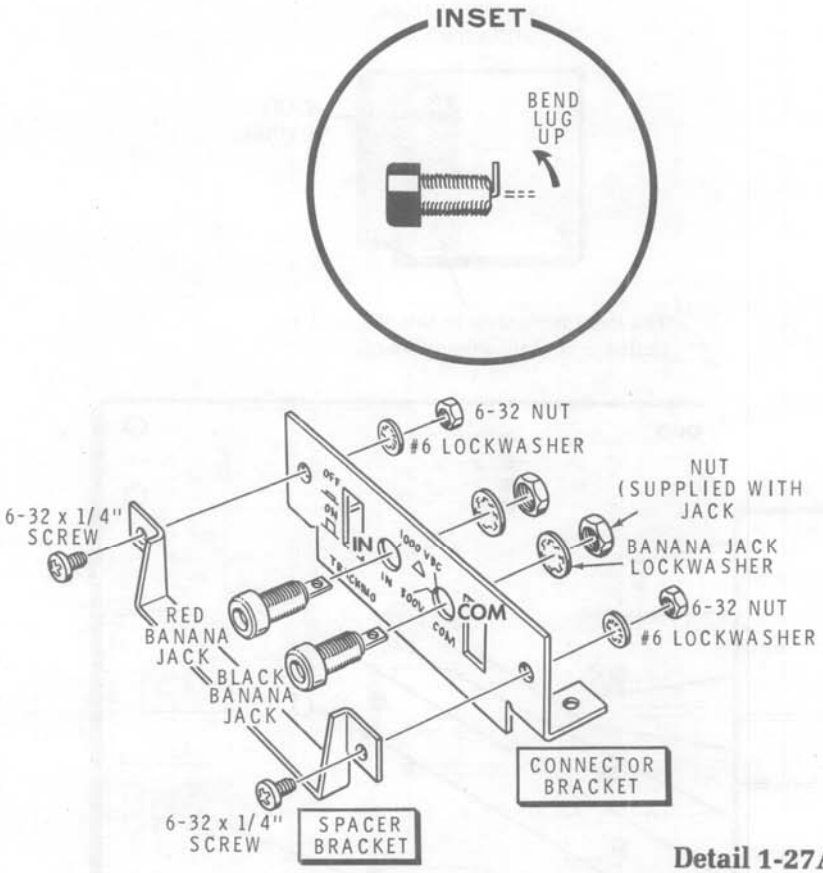
( ) C1109: 4.7 µF.

( ) C1111: 4.7 µF.

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



PICTORIAL 1-25



Detail 1-27A

Refer to Pictorial 1-27 (Illustration Booklet, Page 5) for the following steps.

( ) SW1001-SW1005, SW1101: Locate the 6-section pushbutton switch assembly. Then refer to inset drawing #1 and install it as follows.

1. Straighten any bent switch pins; then carefully insert all the switch pins into their mounting holes.

2. Push the assembly against the circuit board. Make sure each switch section is fully seated against the circuit board.

3. Turn the circuit board over and solder one pin on each end and at the middle of the switch assembly.

4. Turn the circuit board component side up. Carefully examine all of the switch sections to be sure they are fully seated down onto the surface of the board. Reheat the previously soldered pins as necessary. Then solder all the remaining pins to the foil.

( ) SW1006, SW1007: Locate the 2-section pushbutton switch assembly and install it using the same procedure. Refer to inset drawing #2.

( ) Refer to inset drawing #3 and cut through one side of the 1-1/2″ clear tubing. Then place the tubing over the entire bracket between switches SW1006 and SW1007 with the cut facing down.

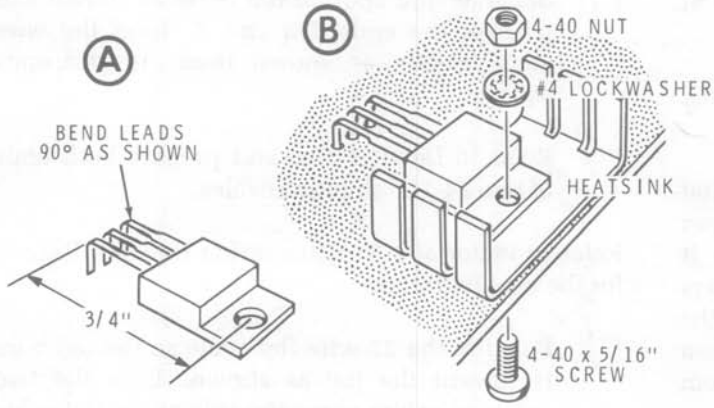
Refer to Detail 1-27A for the next five steps.

( ) Position the connector bracket as shown.

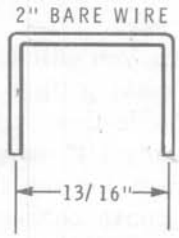
( ) Mount the black banana jack at COM with a banana jack lockwasher and the nut supplied with the jack. When you tighten the nut, make sure the lug is positioned as shown. Press on the front of the jack to hold it as you tighten the nut.

( ) In the same manner, mount the red banana jack at IN.

( ) Refer to the inset drawing and bend the banana jack lugs up 90° against the rear of the jack.



Detail 1-27B



Detail 1-27C

NOTE: Use the plastic nut starter to hold and start 6-32 and 4-40 nuts on screws.

( ) Position the spacer bracket as shown and mount it to the front of the connector bracket with two 6-32 × 1/4" screws, #6 lockwashers, and 6-32 nuts. Center the spacer bracket on the connector bracket and tighten the hardware.

( ) Refer to Pictorial 1-27 and mount the connector bracket on the component side of the circuit board with one 6-32 × 1/4" screw, #6 lockwasher, and a 6-32 nut at location A. Do not tighten the hardware at this time.

( ) Install a rectangular knob on each switch by pushing it firmly onto the shaft. If necessary, move the connector bracket slightly so the knobs are centered in the holes, and tighten the bracket mounting screw.

Refer to Detail 1-27B for the following steps.

( ) U1125: Position a **7805** IC (#442-54) as shown in Part A and bend the leads 90° 3/4" from the mounting hole.

( ) Refer to Part B of the Detail and insert the leads into holes I, G, and O. While holding the IC in place, slide the heat sink under the IC and line up the hole in the heat sink with the hole in the board. Secure the IC with a 4-40 × 5/16" screw, #4 lockwasher, and 4-40 nut. Center the heat sink in the outline on the board and tighten the hardware.

( ) Solder the three IC leads to the foil.

( ) Cut a 2" bare wire.

( ) Refer to Detail 1-27C and form the wire as shown. Use the Detail as a template.

( ) Cut two 1/4" pieces of white sleeving. Place a 1/4" piece of sleeving on each leg of the prepared wire.

( ) Install the bare wire (and sleeving) onto the circuit board directly behind and against vertically-mounted control R1054 and R1047.

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

When you install the next two electrolytic capacitors, be sure to insert the positive (+) marked lead in the positive (+) marked hole, or the negative (−) marked lead in the negative (−) marked hole. Then solder the leads to the foil and cut off the excess lead lengths.

( ) C1121: 1000 µF electrolytic.

( ) C1122: 1000 µF electrolytic.

( ) RP1101: Match leads of the 9 MΩ resistor pack (#9-94) with the holes in the board and install the pack at RP1101. Solder the leads to the foil and cut off the excess lead lengths.

Set the circuit board aside temporarily.

Refer to Pictorial 1-28 (Illustration Booklet, Page 6) for the following steps.

( ) Cut a 12″ length from the 25-wire flat cable. Set the longer length aside temporarily.

In the following step, you will separate the 12″ flat cable into groups, making three cables and seven individual wires. To do this, separate the wires at one end approximately 1/4″ using a pair of cutters as shown in the inset. Let the sharp edges of the cutter seat in the groove between the wires, then cut them apart. Then pull the group of wires from the cable.

( ) Position the flat cable so the outer black wire is toward the top as shown. Then pull the following groups from the cable and cut them to the dimensions given.

One 10-wire cable, cut to 9-1/2″.
One 6-wire cable, uncut.
One 2-wire cable, cut to 8-1/2″.
Seven individual wires, each cut to 1-3/4″.

NOTE: To prepare wires, as in the following steps, cut the wires to the lengths indicated and remove 1/4″ of insulation from each wire end. Tightly twist each bare wire end and add a small amount of solder to hold the fine strands together.

( ) Refer to Pictorial 1-29 (Illustration Booklet, Page 6) and prepare the 10-wire, 6-wire, and 2-wire cables. Separate and shorten the wires as shown.

( ) Prepare the ends of the black, red, yellow and gray wires. NOTE: The remaining three wires will be prepared later.

Set the cables and wires aside until they are called for later.

Refer to Pictorial 1-30 (Illustration Booklet, Page 7) for the next two steps.

( ) Locate the remaining length of 25-wire flat cable and cut it to 28″. Remove the orange and yellow wires from one side and the black wire from the other side. You may discard these wires.

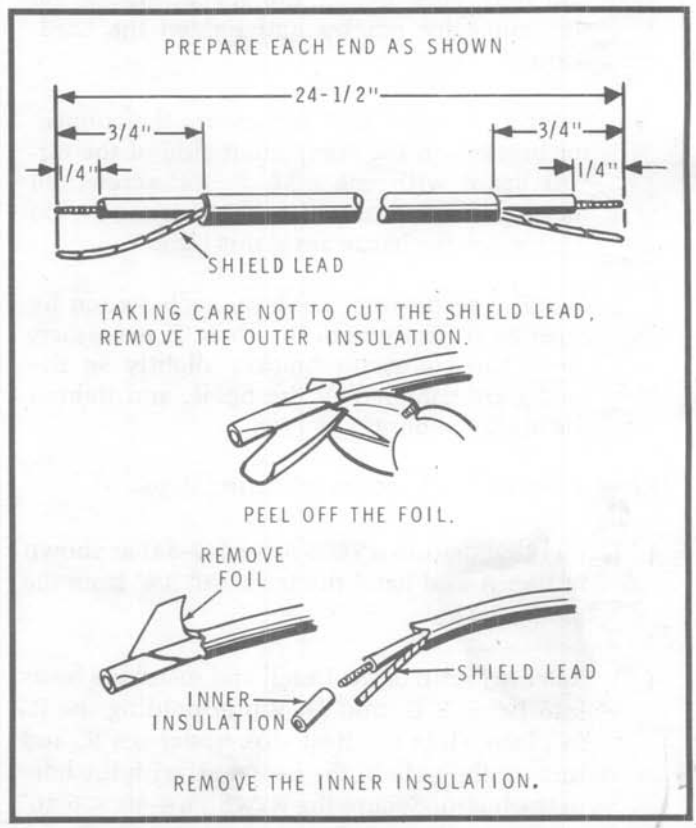
( ) Separate and shorten the wires as shown and prepare the ends. On end A, form the wire ends exactly as shown **then** cut the ends squarely.

( ) Refer to Detail 1-30A and prepare both ends of two 24-1/2″ shielded cables.

Refer to Pictorial 1-31 (Illustration Booklet, Page 8) for the next two steps.

( ) Position the 22-wire flat cable so the red wire is toward the top as shown. Tape the two shielded cables along the side of the flat cable at six locations. Lay the cables side by side so the ends are even with the ends of the flat cable.

( ) To identify one of the shielded cables later, install a piece of tape on each end of the cable (approximately 1″ from the end) that is nearest the red wire of the flat cable.



Detail 1-30A

Refer to Pictorial 1-32 (Illustration Booklet, Page 9) for the following steps.

( ) Position the cable assembly with the indicated end as shown and the outside brown wire toward the top.

In the following steps, you will install male pins and small spring connectors on this end of the flat cable and the shielded cables starting with the outside brown wire. Before you install them, cut the end of each wire to 1/8".

( ) Refer to inset drawing #1 and install male pins on the first seven wires (brown through violet).

( ) Refer to inset drawing #2 and install small spring connectors on the next five wires (gray through red).

( ) Install male pins on the next four wires (orange through blue). NOTE: Install the yellow and green wires in one pin.

( ) Install small spring connectors on the ends of the remaining wires and shielded cables.

( ) Locate the three 4-hole sockets and cut off both tabs on each one.

In the following steps, you will insert the male pins into three 4-hole sockets, starting with the outside brown wire. Be sure to position the sockets with the beveled side up as shown when you insert the pins.

SOCKET S401

( ) Brown wire in hole 1.

( ) Red wire in hole 2.

( ) Orange wire in hole 3.

( ) Yellow wire in hole 4.

SOCKET S501

( ) Green wire in hole 1.

( ) Blue wire in hole 2.

( ) Violet wire in hole 3.

( ) Hole 4 is unused.

SOCKET S1101

( ) Orange wire in hole 1.

( ) Yellow and green wire in hole 2.

( ) Blue wire in hole 3.

( ) Hole 4 is unused.

In the following steps, you will insert the spring connectors into the 6-hole sockets. Be sure to position the sockets with the slotted side up and the connectors with the small tab up when you insert them.

SOCKET S111

( ) Gray wire in hole 1.

( ) White wire in hole 2.

( ) Black wire in hole 3.

( ) Brown wire in hole 4.

( ) Position a polarizing plug with the small tab up and insert it into hole 5.

( ) Red wire in hole 6.

SOCKET S704

( ) Violet wire in hole 1.

( ) Inner lead of the marked cable in hole 2. Shield lead in hole 5.

( ) Inner lead of the unmarked cable in hole 3. Shield lead in hole 4.

( ) Push a polarizing plug into hole 6.

( ) Tape together the shielded cables and the violet wire as shown.

SOCKET S703

( ) Gray wire in hole 1.

( ) White wire in hole 2.

( ) Black wire in hole 3.

( ) Brown wire in hole 4.

( ) Red wire in hole 5.

( ) Push a polarizing plug into hole 6.

Set this cable assembly aside temporarily.

Refer to Pictorial 1-33 for the following steps.

Connect the previously prepared 2-wire, 6-wire, and 10-wire cables and the hookup wires to the circuit board in the following steps. Solder them to the foil side and cut off the excess wires lengths.

6-WIRE CABLE

( ) Lay the cable on the circuit board with ends A and B as shown.

End B

( ) Green wire to hole CB.

( ) Yellow wire to hole BZ.

( ) Orange wire to hole BY.

( ) Red wire to hole BP.

( ) Brown wire to hole BN.

( ) Black wire to hole BM.

End A

( ) Green wire to hole CT.

( ) Yellow wire to hole CD.

( ) Orange wire to hole CC.

The black, brown, and red wires will be connected later.

2-WIRE CABLE

End A

( ) Blue wire to hole CR.

( ) Violet wire to hole CS.

End B

( ) Blue wire to hole CU

( ) Violet wire to hole CV.

( ) Pretrim one end of the 1-3/4" yellow and gray wires to 1/8". Refer to inset drawing #1 and install female terminals on the shortened end of the yellow and gray wires.

Connect the free end of these wires to the circuit board in the following steps.

( ) Yellow wire to hole A/D. Push the terminal onto PCB pin NORM.

( ) Gray wire to hole CAL. Push the terminal onto PCB pin NORM.

NOTE: When you solder these wires to the banana jacks in the following steps, move the end of the bracket, that they are mounted to, away from the circuit board slightly so you will not burn the clear sleeving on the switch assembly. Install the wires **straight up** from the banana jack lugs.

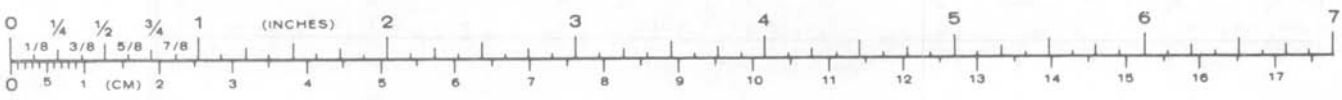
( ) Red wire to the red banana jack.

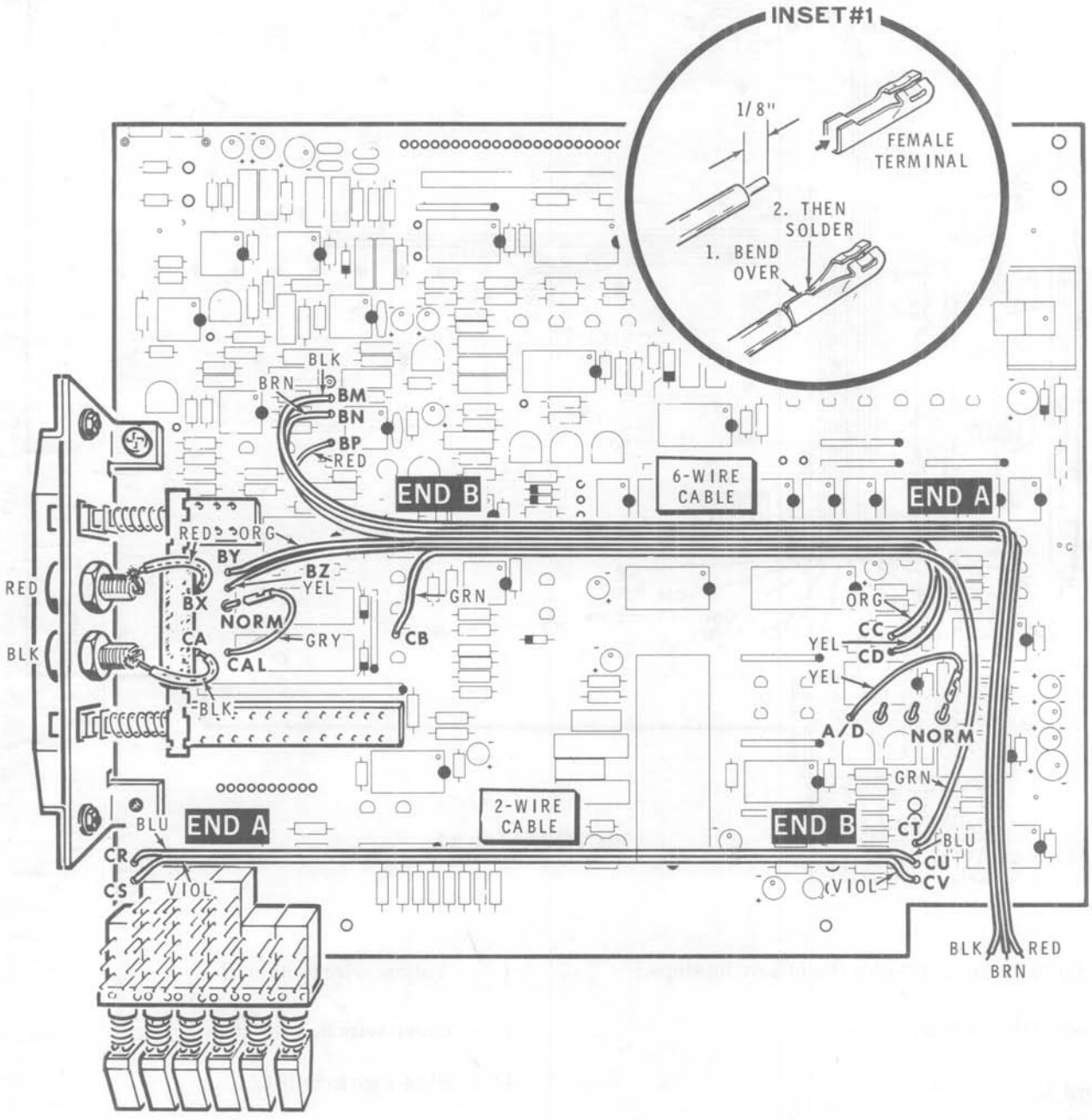
( ) Black wire to the black banana jack.

( ) Cut two 1-1/4" lengths of white sleeving and slide them over the black and red hookup wires.

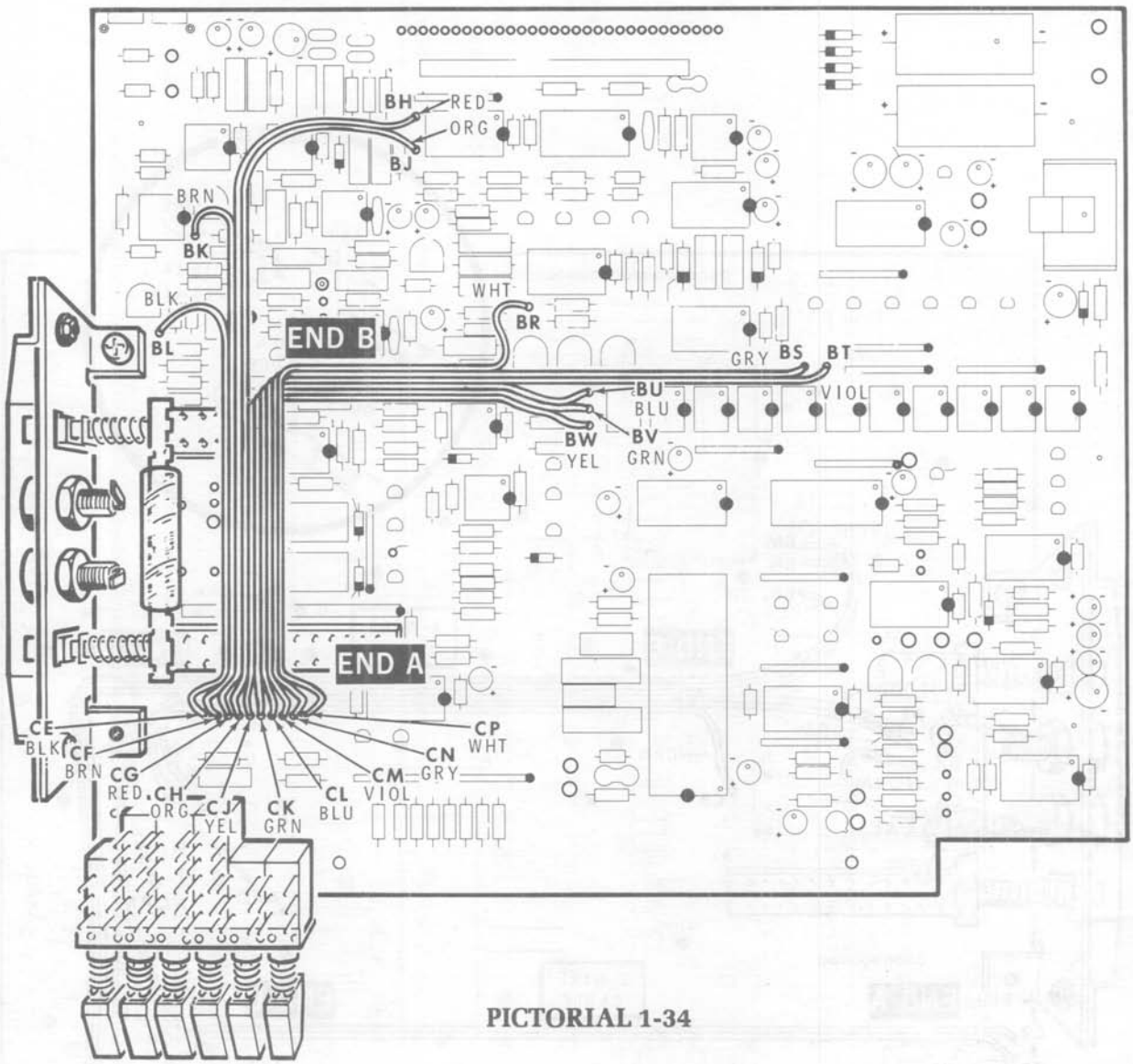
( ) Move the bracket back onto the circuit board and connect the other end of the black wire to hole CA.

( ) Connect the red wire to hole BX.





PICTORIAL 1-33



PICTORIAL 1-34

Refer to Pictorial 1-34 for the following steps.

10-WIRE CABLE

End A

( ) Black wire to hole CE.

( ) Brown wire to hole CF.

( ) Red wire to hole CG.

( ) Orange wire to hole CH.

( ) Yellow wire to hole CJ.

( ) Green wire to hole CK.

( ) Blue wire to hole CL.

( ) Violet wire to hole CM.

( ) Gray wire to hole CN.

( ) White wire to hole CP.

End B

( ) Form the cable as shown at end B by folding the group of five wires under where they split at the orange wire.

( ) Black wire to hole BL.

( ) Brown wire to hole BK.

( ) Red wire to hole BH.

( ) Orange wire to hole BJ.

( ) Yellow wire to hole BW.

( ) Green wire to hole BV.

( ) Blue wire to hole BU.

( ) Violet wire to hole BT.

( ) Gray wire to hole BS.

( ) White wire to hole BR.

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions:

( ) Unsoldered connections, except for the "+" and "−" solder pads which will remain unsoldered temporarily, and the rows of holes at the front and rear.

( ) Poor solder connections.

( ) Solder bridges between foil patterns.

( ) Protruding leads that could touch together.

( ) Transistors for the proper type and installation. Note that the flat of all transistors and U1126 are positioned in the same direction.

( ) Electrolytic capacitors for the correct position of the positive (+) and negative (−) leads.

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

Set the circuit board aside and proceed to "Display Circuit Board."

DISPLAY CIRCUIT BOARD

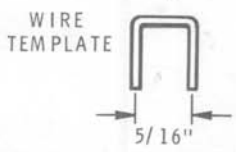
START

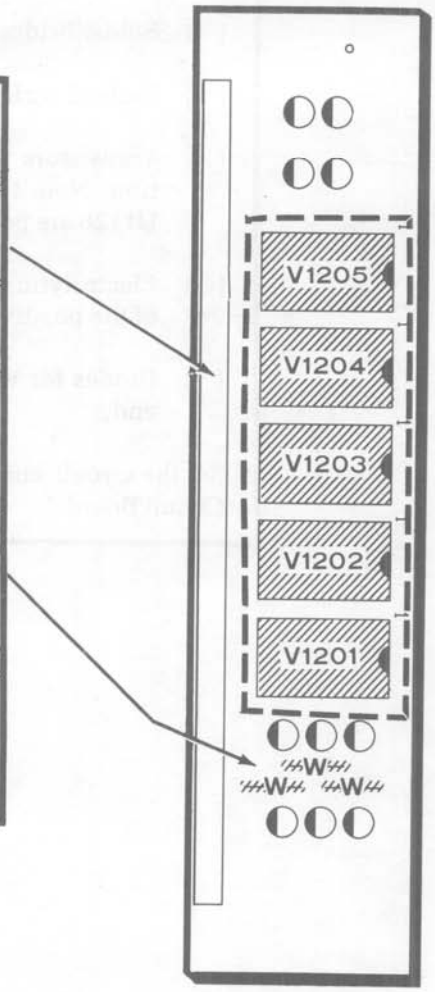
( ) Position the display circuit board as shown.

( ) Install five 14-pin IC sockets at locations V1201 through V1205.

( ) Locate the three remaining 1-3/4" wires that you set aside earlier. Remove 1" of insulation and apply a small amount of solder over the entire length of each wire end. Then cut off the 1" bare wires.

( ) Form each 1" wire into a 5/16" U shape as shown. Install the wires at locations W. Solder the wires to the foil and cut off the excess wire lengths.





PICTORIAL 2-1

START

To install a display LED, position it so the two dots on one side are toward the left, as shown. Make sure the pins are straight. Then match up the pins with the holes in the socket and install the LED. Be careful that none of the pins bend as you insert them.

( ) V1205: 5-segment LED (light-emitting diode).

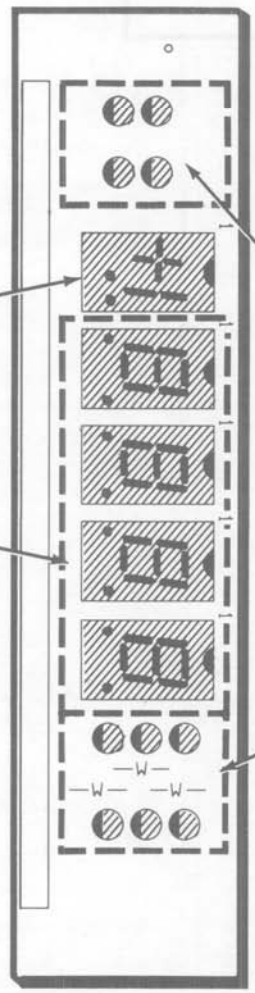
Install four 7-segment LEDs at the following locations:

( ) V1204 .....

( ) V1203 .....

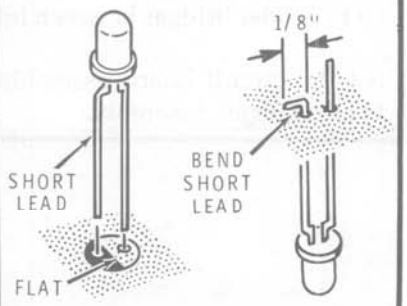
( ) V1202 .....

( ) V1201 .....



CONTINUE

When you install the red LEDs, insert the leads into the holes with the short lead near the outline of the flat on the board. The short lead must be next to the flat or the device will not work. Then turn the board over and bend the SHORTER lead 1/8" from the end so the LED will not fall out. **Do not solder the leads at this time.**



Install four red LEDs at the following locations:

( ) V1206.

( ) V1207.

( ) V1208.

( ) V1209.

Install six red LEDs at the following locations:

( ) V1211.

( ) V1212.

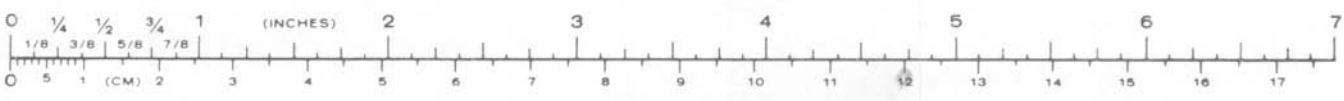
( ) V1213.

( ) V1214.

( ) V1215.

( ) V1216.

PICTORIAL 2-2



CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions:

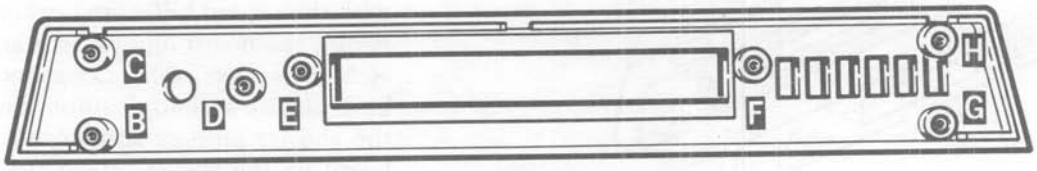
( ) Unsoldered connections (except for the red LEDs, and the row of holes at the edge).

( ) Poor solder connections.

( ) Solder bridges between foil patterns.

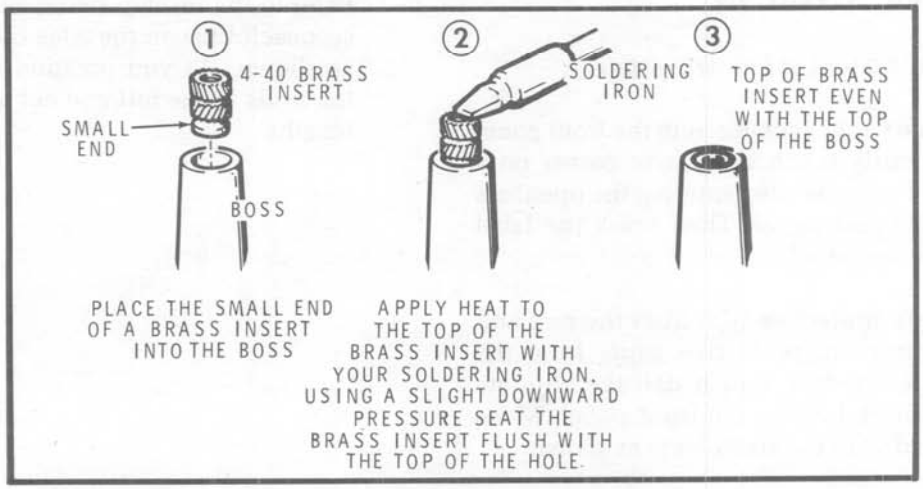
Set the circuit board assembly aside and proceed to Front Panel Assembly.

FRONT PANEL ASSEMBLY



FRONT PANEL

Ⓐ



Ⓑ

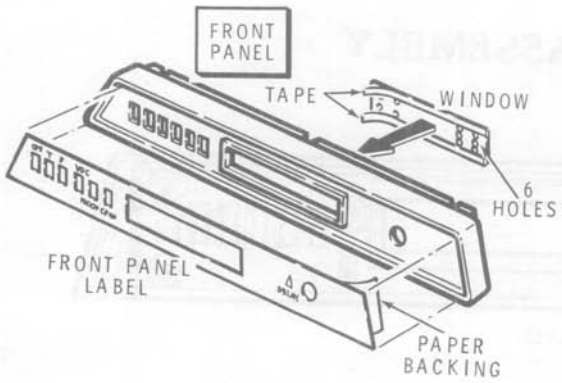
PICTORIAL 3-1

Refer to Pictorial 3-1 for the following steps.

( ) Refer to Part A of the Pictorial and position the front panel as shown.

NOTE: Before you install brass inserts make sure your soldering iron is clear of solder or it may flow down into the insert. Refer to steps 1, 2, and 3 in Part B of the Pictorial to install the inserts.

( ) Install seven 4-40 brass inserts into bosses B, C, D, E, F, G, and H.



PICTORIAL 3-2

Refer to Pictorial 3-2 for the following steps.

( ) Remove the paper backing from the front panel label. Carefully touch one lower corner only to the front panel while centering the openings in the label and panel. Then press the label in place on the panel.

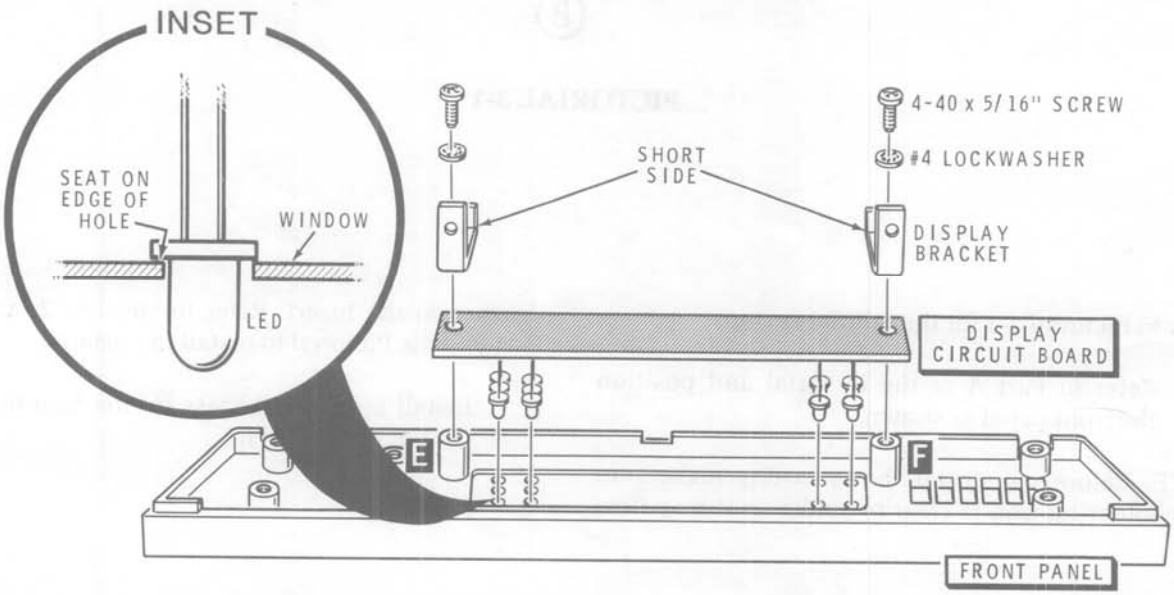
( ) Remove any protective film from the rear and the two pieces of protective paper from the front of the window, and install the window in the opening behind the front panel. Make sure the end with the six holes is as shown.

Refer to Pictorial 3-3 for the following steps.

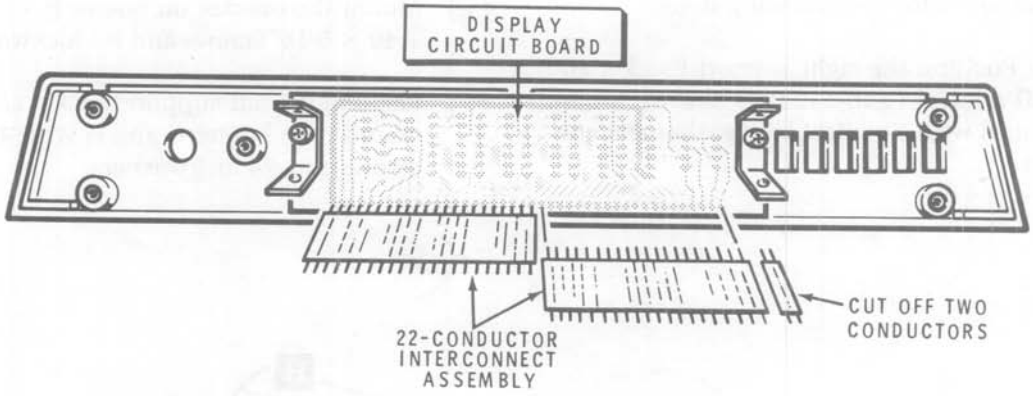
( ) Position the front panel as shown.

( ) Position the display circuit board so the side with the six red LEDs are toward the left. Then mount the board on bosses E and F with 4-40 × 5/16" screws, #4 lockwashers, and display brackets. Be sure to position the brackets with the shorter side as shown. As you place the board on the bosses, insert the ten LEDs into their respective holes in the front panel. Do not be concerned if the LEDs fall through the holes at this time.

( ) Refer to the inset drawing on Pictorial 3-3 and seat each LED on the edge of the window hole as shown. As you position each LED, solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 3-3



PICTORIAL 3-4

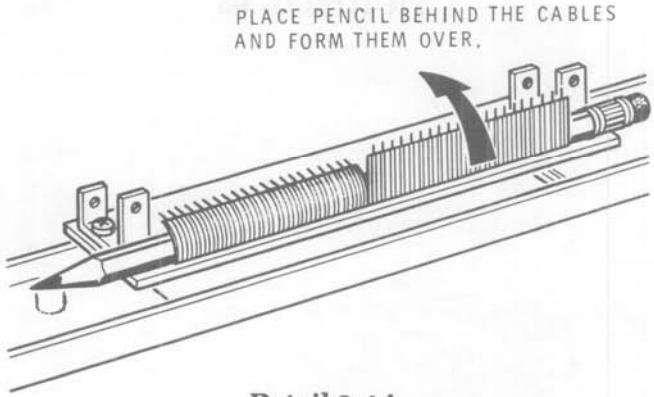
Refer to Pictorial 3-4 for the following steps.

( ) Insert the leads of a 22-conductor interconnect assembly into the circuit board holes starting from the left side. Positon the assembly so the insulation is 1/16" away from the board and solder the leads to the foil.

( ) Cut two conductors from the remaining assembly and install the assembly in the same manner.

( ) Carefully inspect both assemblies for solder bridges between foil patterns. NOTE: It may be helpful to use a magnifying glass.

( ) Refer to Detail 3-4A and place a regular size pencil on the circuit board between the cables and brackets. Then form the cables approximately 90° over the pencil. Make sure the ends of the cables are straight; then remove the pencil.



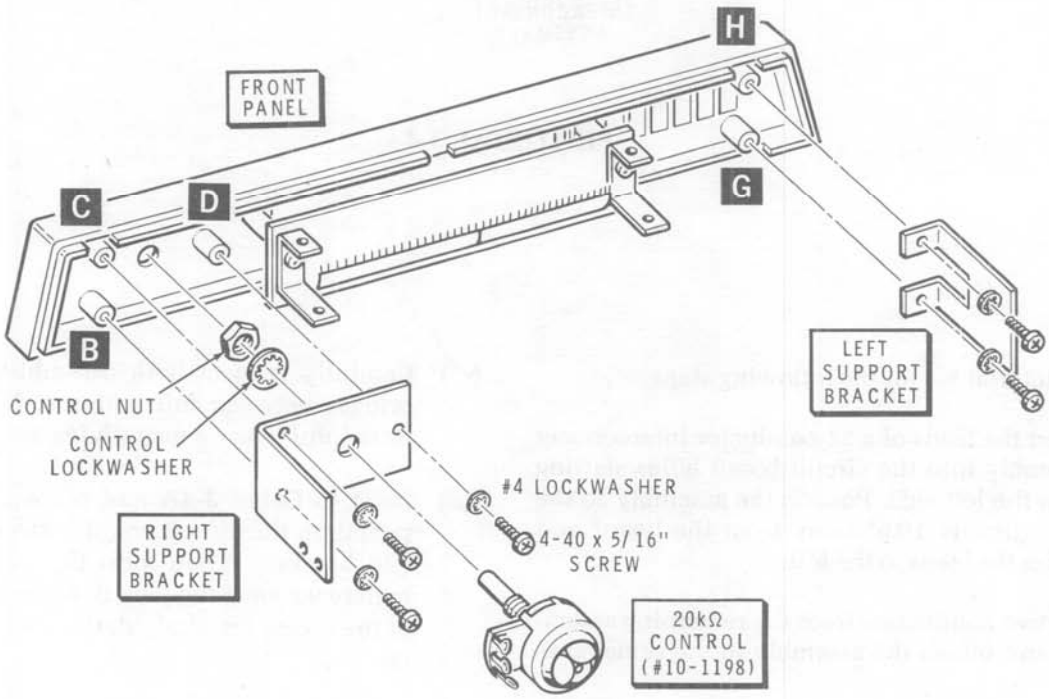
Detail 3-4A

Refer to Pictorial 3-5 for the following steps.

( ) R1028: Position the right support bracket and a 20 kΩ control (#10-1198) as shown. Mount the control with a control lockwasher and control nut.

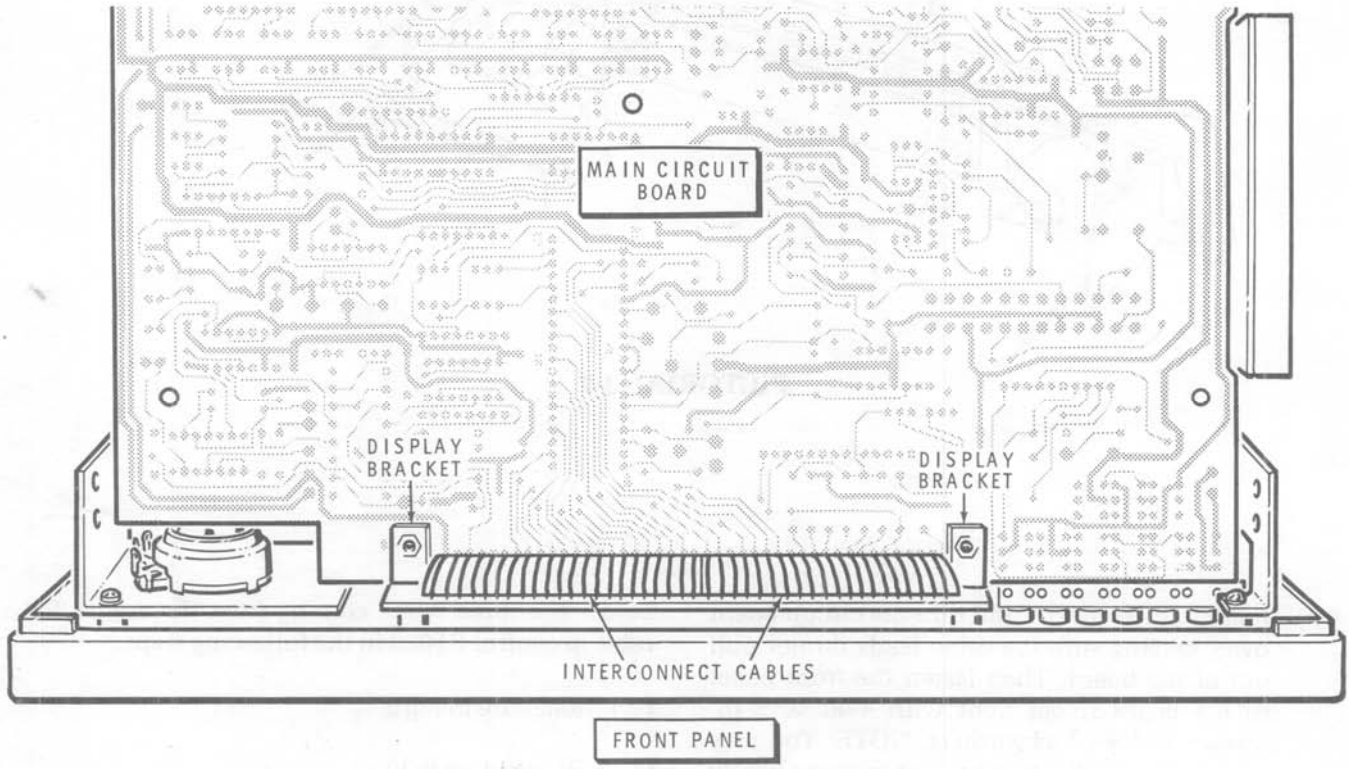
( ) Mount the bracket on bosses B, C, and D with 4-40 × 5/16" screws and #4 lockwashers.

( ) Position the left support bracket as shown and mount it on bosses G and H with 4-40 × 5/16" screws and #4 lockwashers.



PICTORIAL 3-5

WIRING

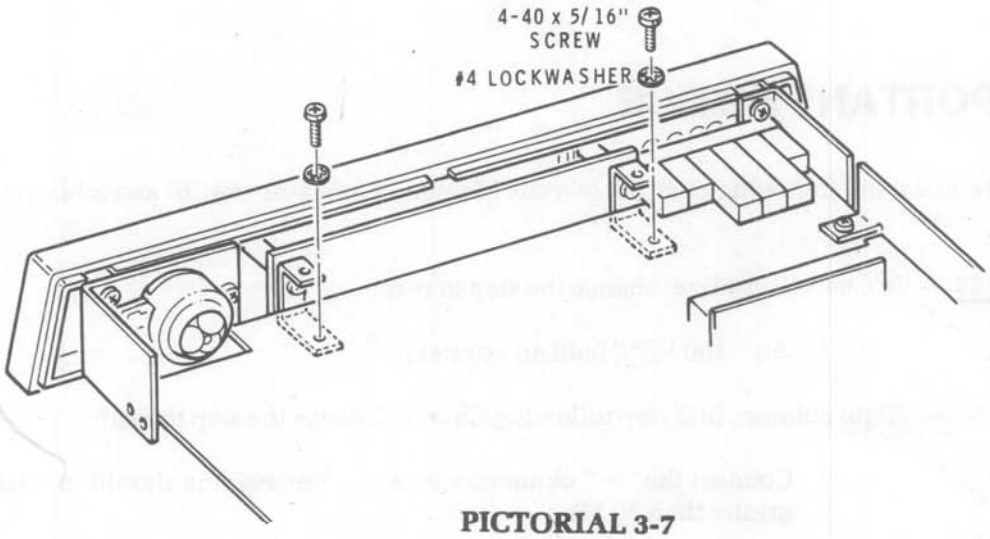


PICTORIAL 3-6

Refer to Pictorial 3-6 for the following steps.

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

( ) Position the front panel as shown, in front of the circuit board with the display brackets on the foil side. Then insert each lead of the interconnect cables into the circuit board holes. Do **not** solder the leads at this time.



PICTORIAL 3-7

( ) Refer to Pictorial 3-7 and turn the circuit board over, making sure the cable leads do not pull out of the board. Then fasten the front panel to the board finger tight with 4-40 × 5/16" screws and #4 lockwashers. NOTE: You may have to loosen the two bracket screws slightly to center the holes.

( ) Solder the interconnect cable assemblies to the foil on the **component** side of the board.

( ) On the front panel, test the action of the four leftmost switches (OFF, T, F, VDC). Each should latch to the "in" position, while unlatching any of the other three to the "out" position. Test the action of the two rightmost switches (PROBE, CHAN). Each should independently alternate between the "in" and "out" positions. If any of these switches does not operate as required, loosen the four display board mounting screws and adjust the display board away from the right side of the switch mechanism.

Refer to Pictorial 3-8 (Illustration Booklet, Page 10) for the following steps.

( ) Start a 6-32 × 1/8" setscrew in the knob. Then install the knob on control R1028. Keep the control approximately 1/16" away from the front panel. Disregard the pointer setting of the knob.

Solder the three wires coming from the 6-wire flat cable to control R1028 in the following steps.

( ) Red wire to lug 3.

( ) Brown wire to lug 2.

( ) Black wire to lug 1.

Position the 22-wire flat cable with the outside brown wire to your right. Connect the wires to the circuit board in the following steps. Then solder the wires to the foil and cut off the excess lengths.

NOTE: Hole AA is not used.

( ) Brown wire to hole AB.

( ) Red wire to hole AC.

( ) Orange wire to hole AD.

( ) Yellow wire to hole AE.

( ) Green wire to hole AF.

( ) Blue wire to hole AG.

( ) Violet wire to hole AH.

( ) Gray wire to hole AJ.

( ) White wire to hole AK.

( ) Black wire to hole AL.

( ) Brown wire to hole AM.

( ) Red wire to hole AN.

NOTE: Holes AP and AR are not used.

( ) Orange wire to hole AS.

( ) Yellow wire to hole AT.

( ) Green wire to hole AU.

( ) Blue wire to hole AV.

NOTE: Holes AW and AX are not used.

( ) Violet wire to hole AY.

( ) Inner lead of the marked shielded cable to hole AZ, shield lead to hole BA. Do not solder the shield lead at this time.

( ) Inner lead of the unmarked shielded cable to hole BB, shield lead to hole BA. Solder both shield leads.

( ) Gray wire to hole BC.

( ) White wire to hole BD.

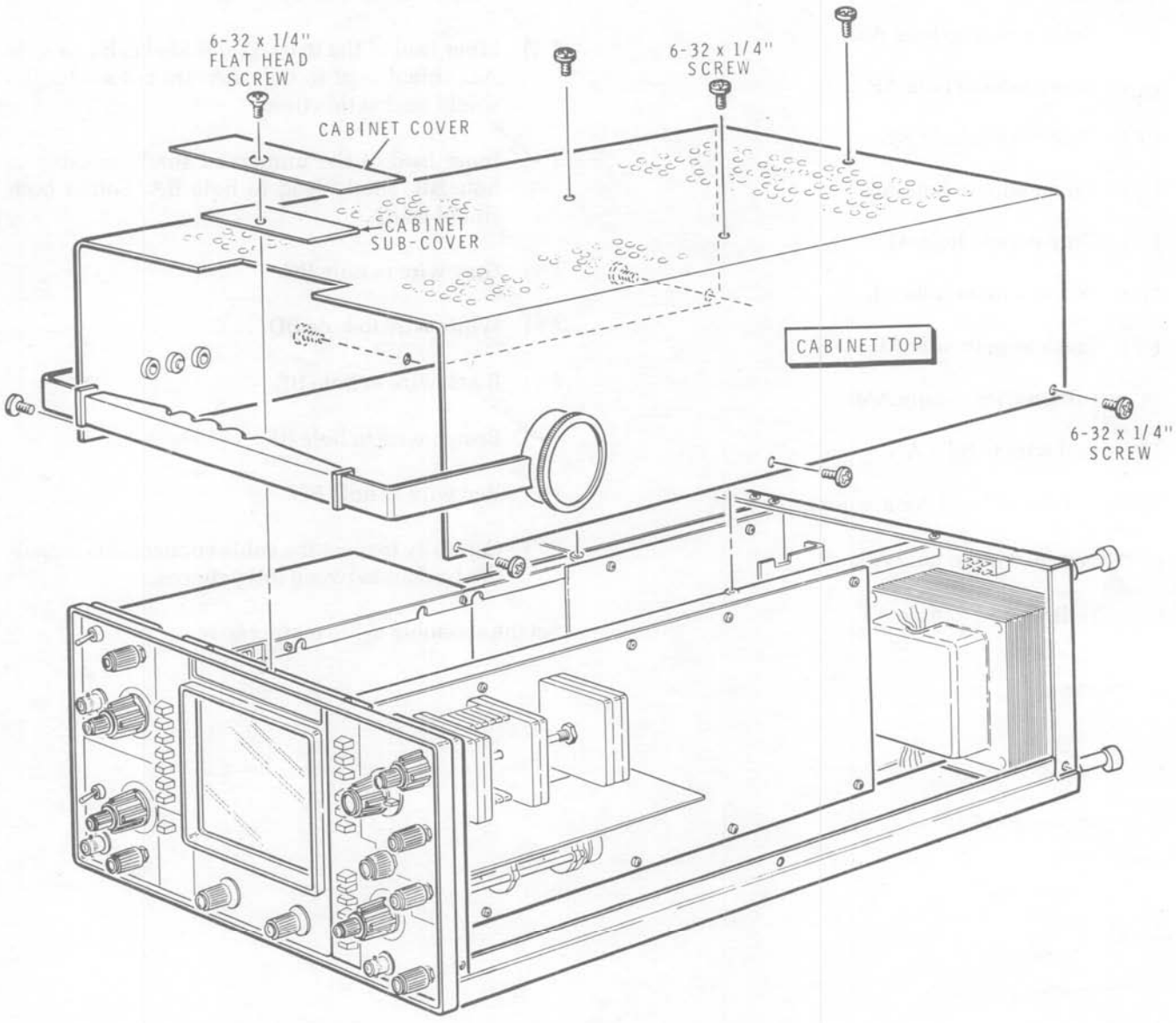
( ) Black wire to hole BE.

( ) Brown wire to hole BF.

( ) Red wire to hole BG.

( ) Carefully inspect the cable connections for solder bridges between foil patterns.

Set the assembly aside temporarily.



PICTORIAL 4-1

CHASSIS

Refer to Pictorial 4-1 for the following steps.

In the following steps, you will remove the cabinet top from your IO-4360 Oscilloscope and mount the chassis and circuit board assembly on it. NOTE: If your Heathkit Oscilloscope is a different model, consult that specific manual for related assembly information.

( ) Remove the cabinet cover and cabinet subcover. These parts will not be used again.

( ) Remove the nine 6-32 × 1/4″ cabinet mounting screws and remove the cabinet top. Save these screws.

Refer to Pictorial 4-2 (Illustration Booklet, Page 10) for the following steps.

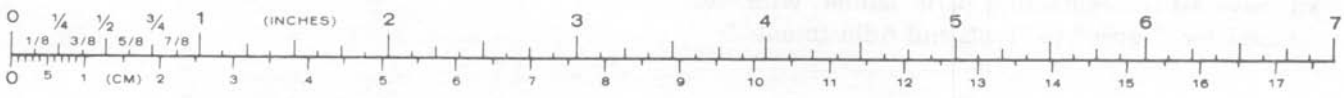
( ) Position the chassis as shown and mount it on the cabinet top with 6-32 × 1/4″ screws, #6 lockwashers, and 6-32 nuts at locations J, K, L, and N. Be sure the Oscilloscope and Module notches are aligned.

( ) Cut a 2-7/8″ length of nylon gasket and slide it over the edge of the cutout in the chassis and cabinet top.

( ) Cut off the LO CAL and HI CAL portion from the calibration-warning label. Peel the backing from the label and install the label on the Module chassis at the location shown.

( ) Peel the backing from the blue and white label and install the label on the back of the Module chassis. Align the label at the bottom edge of the chassis; do not cover any holes. NOTE: Be sure to refer to the numbers on this label in any communications with the Heath Company about this kit.

( ) Route the large flat cable, coming from the main circuit board, under the board and to the front. Temporarily mount the Module assembly on spacers P and R with 4-40 × 1/2″ screws. Make sure the cable is routed to either side of the center spacer on the chassis. NOTE: The remaining screws will be installed later.



TEST LEAD ASSEMBLY

Refer to Pictorial 4-3 for the following steps.

( ) Remove 1/2" of insulation from one end of the large red wire.

( ) Install a test probe on this end of the red wire as follows:

1. Unscrew the insulator from the probe tip and insert the wire through the smaller hole in the insulator.

2. Twist the fine wires together and insert them through the hole in the probe. Then form the wires around the probe and screw the probe collar (recessed side first) over them. Screw the insulator back on the probe.

( ) Remove 3/4" of insulation from the free end of the large red wire.

( ) Insert this end of the red wire into a banana plug as shown. Then bend the wire flat against the plug body.

( ) Place the banana plug on a small phillips screwdriver (or similar tool) and push a red plug insulator onto the plug and wire until the plug is fully seated.

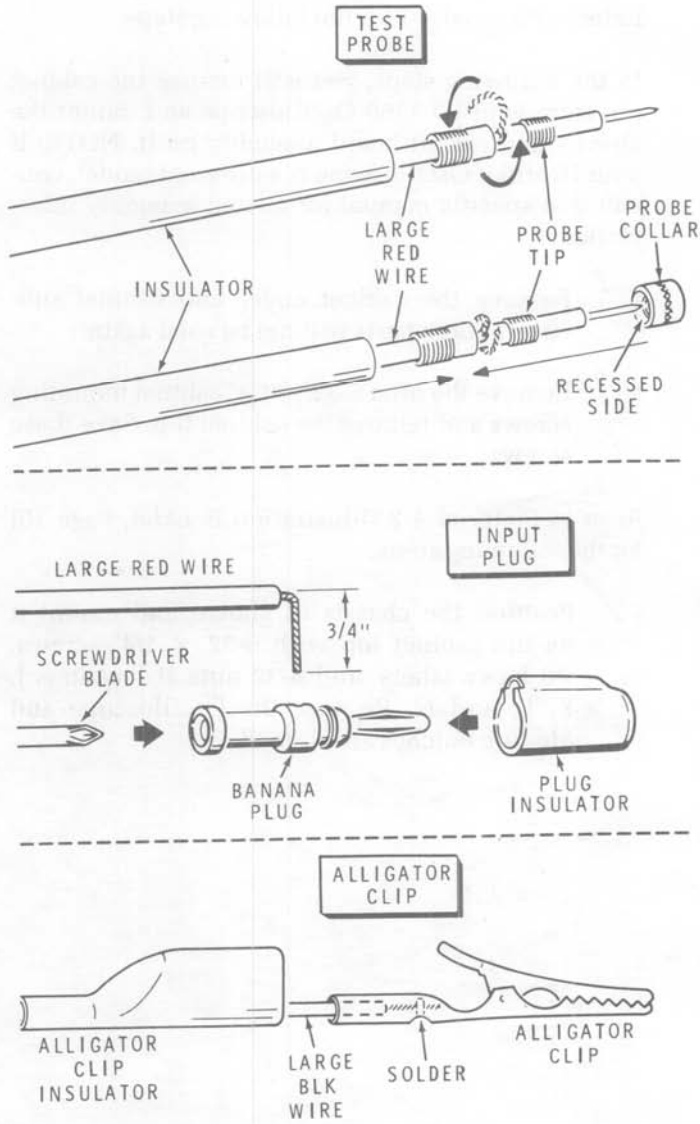
( ) Remove 3/4" insulation from one end of the large black wire.

( ) In the same manner, install a banana plug and black plug insulator on this end of the black wire.

( ) Remove 1/4" insulation from the free end of the large black wire.

( ) Insert this end of the black wire through the smaller end of the alligator clip insulator. Twist the fine wires together insert them into the alligator clip, and solder them. Slip the alligator clip insulator down over the alligator clip after the clip has cooled.

This completes the Step-By-Step Assembly of your kit. Save **all** the remaining parts, solder, wire, etc, for use later. Proceed to "Tests and Adjustments."



PICTORIAL 4-3

TESTS AND ADJUSTMENTS

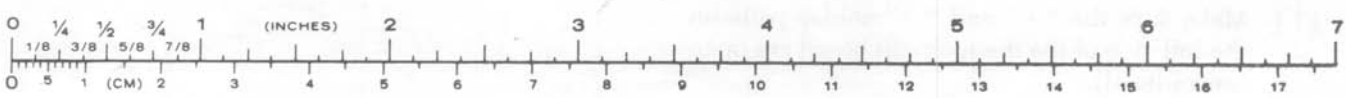
As previously noted, this Manual deals with the application, testing, calibration, etc., of your Module for use with the Heathkit Triple Trace Oscilloscope, Model IO-4360. The application of this Module to other Heathkit Oscilloscopes will be dealt with in the Manuals written for those other products. Be sure to refer directly to those Oscilloscope Manuals for the installation, testing, and operation of this Module with other than the IO-4360 Oscilloscope.

This section of the Manual is divided into two parts, "Resistance Checks" and "Operational Tests." In the first part, "Resistance Checks," you will use an ohmmeter to verify wiring and component installation, and in "Operational Tests," you will use a DC voltmeter to make certain voltage measurements, as well as other tests, as you install designated integrated circuits.

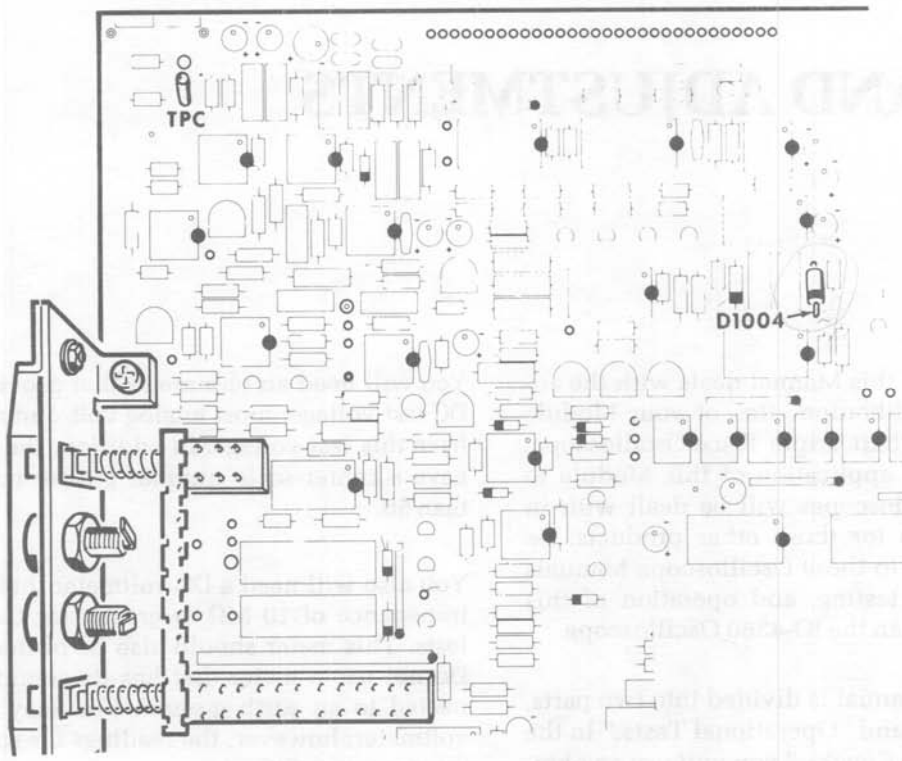
You will need an ohmmeter that provides a 1.5-volt DC test voltage; most analog volt-ohmmeters (VOM) have this test voltage. In addition, the meter should have a center-scale number greater than 5 but less than 50.

You also will need a DC voltmeter that has an input impedance of 10 MΩ or greater for the operational tests. This meter should also be of the analog type. Do **not** use a meter that has its common lead connected to an earth ground. You may use a digital voltmeter; however, the readings for some measurements may be jittery.

IMPORTANT: Do not proceed with the following tests unless you have these recommended test instruments.



RESISTANCE CHECKS



PICTORIAL 5-1

CAUTION: Do not install any of the connectors from the Module to the Oscilloscope connectors until you are directed to do so in a step.

NOTE: In the following tests, if you do not obtain the proper readings, do not proceed further until you have found and corrected the problem. Refer to the "Resistance Checks Problem Charts" on Page 69.

On the Module, set the switches as follows:

( ) Push the OFF switch to the "in" position, making sure the T, F, and VDC switches are in their "out" positions.

( ) Release the PROBE and CHAN switches to their "out" positions.

( ) Release the EXT VDC and TRACKING switches to their "out" positions.

( ) Make sure the "+" and "−" solder pads on the foil side of the main circuit board are open (unsoldered).

Refer to Pictorial 5-1 for the following steps.

NOTE: Most ohmmeters have a positive test voltage polarity (+ input test lead), while some others have a negative test voltage polarity. You will determine the polarity of your ohmmeter test voltage in the following steps.

( ) Connect the ohmmeter "common" test lead to the circuit board TPC (test point "C") connector.

( ) Set the ohmmeter range to X10 or X100.

( ) Touch the ohmmeter input probe to the banded-end lead of diode D1004 and note the resistance reading.

( ) Reverse the ohmmeter leads and again note the resistance reading.

NOTE: If the resistance reading was higher during the first test, your meter has a positive polarity, and identifies the ohmmeter input lead as the "+" lead. If the first reading was the lower of the two, your meter has a negative polarity, and the common lead is the "+" lead. Be sure to keep this in mind as you perform the following tests.

CAUTION: In the following steps, use only the X10 or the X100 ranges. Other meter ranges could cause excessive currents or may produce erroneously low readings.

Allow time for circuit capacitors to become fully charged before you take a final reading.

Refer to Pictorial 5-2 (Illustration Booklet, Page 11) and to Chart A for the following steps.

( ) Connect the ohmmeter "–" lead to the TPC connector.

( ) Refer to the Pictorial and, in turn, check each of the test points on socket S111 and the chassis ground connector referred to in Chart A for the readings indicated.

NOTE: In the following charts > means greater than; ≈ means approximately.

Chart A

TEST POINT	READING
S111 Pins:	
( ) 1	>4000 Ω
( ) 2	>100 kΩ
( ) 3	>100 kΩ
( ) 4,6	≈0 Ω
( ) CHASSIS GND	>100 kΩ

( ) Reverse the ohmmeter test leads and touch the "–" lead to the same test points, and observe the readings as indicated in Chart B.

Chart B

TEST POINT	READING
( ) 1	>100 kΩ
( ) 2	>100 kΩ
( ) 3	>6000 Ω
( ) 4,6	≈0 Ω
( ) CHASSIS GND	>6000 Ω

( ) Refer to Pictorial 5-3 (Illustration Booklet, Page 12) and, on your Oscilloscope, remove the 2-pin shorting plug from horizontal circuit board P704 as shown in the inset drawing. Save this shorting plug for possible future use.

( ) Connect Module plug S401 to Oscilloscope socket S401.

( ) Connect Module plug S501 to Oscilloscope socket S501.

( ) Connect Module socket S111 to Oscilloscope plug P111.

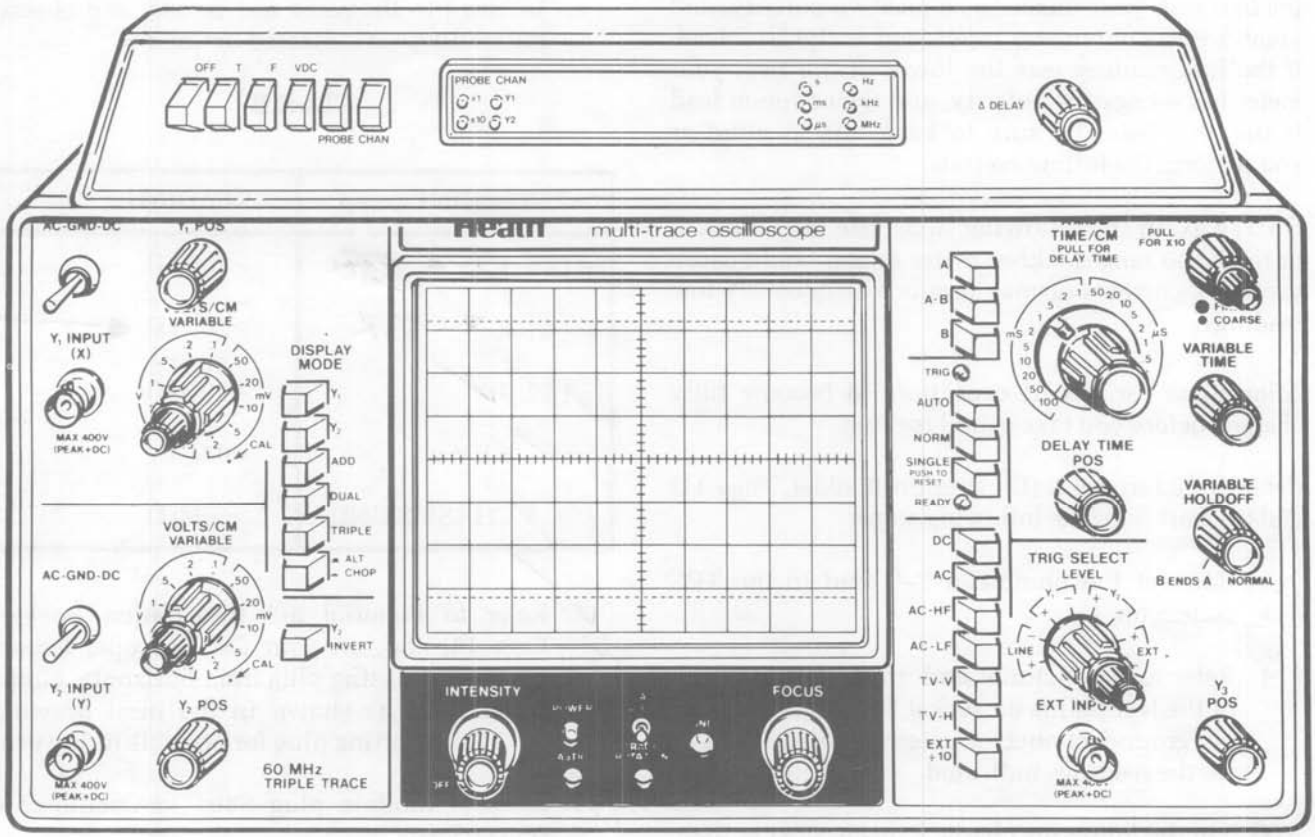
( ) Connect Module plug S1101 to Oscilloscope socket S1101.

( ) Push Module socket S704 onto Oscilloscope plug P704.

( ) Push Module socket S703 onto Oscilloscope plug P703.

( ) Set (do not secure) the Oscilloscope cabinet top onto the Oscilloscope chassis. NOTE: Be sure not to pinch any wires or cables between the two assemblies.

WARNING: Do not connect the Oscilloscope line cord to an AC outlet until you are specifically instructed to do so in a step.



PICTORIAL 5-4

Refer to Pictorial 5-4 for the following steps.

( ) On the Oscilloscope, set the front panel controls and switches as follows.

Vertical Preamp (both channels)

✓ INPUT: No probe connected.

✓ COUPLING (AC-GND-DC): Switch at GND.

✓ VOLTS/DIV: 50 mV, VARIABLE at CAL.

✓ POSITION (POS): Center of rotation.

Horizontal

✓ MODE: A (in).

✓ A TIME/DIV: 1 ms/DIV.

✓ B TIME/DIV: Pull out and set to 50 μs/DIV.

✓ HORIZ POS: COARSE and FINE at centers of rotation.

✓ PULL FOR X10: Pushed in.

✓ DELAY TIME POS: Fully counterclockwise (may be several turns until some resistance is encountered).

✓ VARIABLE TIME: CAL.

Triggering

✓ MODE: AUTO (in).

✓ COUPLING: DC (in).

✓ TRIG SELECT: Y1+ with LEVEL at center of rotation.

✓ VARIABLE HOLDOFF: NORMAL.

Display Mode

Y1: In.

ALT/CHOP: Out.

Y2 INVERT: Out.

INTENSITY: Fully CCW to OFF.

FOCUS: Center of rotation.

Y3 INPUT: No input.

Y3 POSITION: Center of rotation.

Refer to Pictorial 5-5 (Illustration Booklet, Page 13) for the following steps.

( ) Connect the ohmmeter "–" test lead to the Module TPC connector.

( ) As in a previous step, check each of the following Module test points for the indicated reading as shown in Chart C.

Chart C

TEST POINT	READING
( ) A	≈0 Ω
( ) B	>100 kΩ
( ) C	>50 kΩ
( ) D	>5000 Ω
( ) E	>6000 Ω
( ) F	>400 Ω
( ) G	>400 Ω
( ) H	>5000 Ω
( ) J	>5000 Ω
( ) K	>50 Ω
( ) L	>50 kΩ
( ) M	>100 kΩ

( ) Reverse the ohmmeter leads. Then refer to Chart D below and, using the "–" meter lead, check the listed points for the indicated readings.

Chart D

TEST POINT	READING
( ) A	≈0 Ω
( ) B	>100 Ω
( ) C	>5000 Ω
( ) D	>200 Ω
( ) E	>200 Ω
( ) F	>100 kΩ
( ) G	>100 kΩ
( ) H	>100 kΩ
( ) J	>100 kΩ
( ) K	>30 Ω
( ) L	>100 kΩ
( ) M	>100 kΩ

Refer to Pictorial 5-6 (Illustration Booklet, Page 13) for the following steps.

( ) Connect your ohmmeter "–" lead to the A/D GND connector.

( ) Touch the "+" meter probe to the points designated in Chart E to check for the indicated resistances.

Chart E

TEST	POINT READING
( ) AA	>5000 Ω
( ) AB	>2000 Ω
( ) AC	>30 Ω
( ) AD	>50 Ω
( ) AE	>100 Ω
( ) AF	>5000 Ω
( ) AG	>5000 Ω
( ) AH	>5000 Ω
( ) AJ	>5000 Ω
( ) AK	>100 Ω
( ) AL	>10 kΩ*

*Except >300 Ω at 4B and 4C.

( ) Reverse the ohmmeter leads. Then refer to Chart F for the indicated resistances, using the "–" ohmmeter lead.

Chart F

TEST POINT	READING
( ) AA	>30 Ω
( ) AB	>100 Ω
( ) AC	>5000 Ω
( ) AD	>2000 Ω
( ) AE	>4000 Ω
( ) AF	>100 kΩ
( ) AG	>100 kΩ
( ) AH	>100 kΩ
( ) AJ	>100 kΩ
( ) AK	>100 kΩ
( ) AL	>100 kΩ

* Except >300 Ω at 4B and 4C.

( ) Connect either ohmmeter lead to the A/D GND connector. Touch the other lead to the CHASSIS GND connector. The reading should indicate greater than 100 kΩ. 20 kΩ

( ) On the Module front panel, push the VDC switch to its **in** position. You should measure approximately 0Ω at the CHASSIS GND connector and an open circuit (infinity) at the COM banana jack.

( ) On the Module side panel, push the EXT VDC switch in. You should measure an open circuit at the CHASSIS GND connector and approximately 0Ω at the COM banana jack.

( ) Disconnect the ohmmeter leads from the Module.

Proceed to Page 71.

RESISTANCE CHECKS PROBLEM CHARTS

NOTE: When you check for the cause of improper readings during your resistance checks using the following chart, be sure to carefully check all foil areas adjacent or connected to the listed component(s) for solder bridges between adjacent foils. The most common faults in circuit board difficulties are poor solder connections and bridged adjacent foils. As you check the foils on the board, it may be helpful if you refer to the "Circuit Board X-Ray Views," (Illustration Booklet, Page 25).

If you still are unable to find the cause of a problem, refer to the "In Case of Difficulty" section of this Manual.

PROBLEM	POSSIBLE CAUSE OF LOW READING
Improper reading at S111, pin 1.	1. Wiring at socket S111. 2. +5-volt circuits.
Improper reading at S111, pin 2.	1. Wiring at socket S111. 2. −15-volt circuits.
Improper reading at S111, pin 3.	1. Wiring at socket S111. 2. +15-volt circuits.
Improper reading at S111, pins 4 and 6.	1. Wiring at socket S111.
Improper reading at Test Point A. (CHASSIS GND connector).	1. Wiring at plug P401. 2. Shorted connections at U1011, U1012, or SW1003 circuits.
Improper reading at Test Point B.	1. Wiring at socket S704. 2. Check U1002 circuits.
Improper reading at Test Point C.	1. Wiring at socket S704. 2. Check U1008 circuits.
Improper reading at Test Point D.	1. Wiring at R1028. 2. Check for shorts in the circuits of U1003, SW1001, or SW1002.
Improper reading at Test Point E.	1. Check for shorts in the circuits of U1005, U1006, SW1001, or SW1002.
Improper reading at Test Point F.	1. Check for shorts in the circuits of SW1001, U1113, or "T."
Improper reading at Test Point G.	1. Check for shorts in the circuits of SW1002, U1114, or "F."
Improper reading at Test Point H.	1. Check for shorts in the circuits of Q1012/U1115.

Improper reading at Test Point J.	1. Check for shorts in the circuits of Q1013/U1116.
Improper reading at Test Point K.	1. Check for shorts in the circuits of U1017, U1117, SW1005.
Improper reading at Test Point L.	1. Check for shorts in the circuits of U1017, SW1005.
Improper reading at Test Point M.	1. Check for shorts in the circuits of U1118, SW1004.
Improper reading at Test Points AA or AB.	1. Check for short in circuitry at U1125.
Improper reading at Test Points AC or AD.	1. Check for short in circuitry at U1126.
Improper reading at Test Point AE.	1. Check for short in + 5-volt or SW1101 circuits.
Improper reading at Test Point AF.	1. Check for shorts in − 5-volt circuits.
Improper reading at Test Point AG.	1. Check for shorts in + 4-volt circuits.
Improper reading at Test Point AH.	1. Check for short in circuits of Q1111.
Improper reading at Test Point AJ.	1. Check for short in circuits of Q1112.
Improper reading at Test Point AK.	1. Check for shorts in circuits of Q1107, Q1108, and Q1109.
Improper reading at Test Point AL.	1. Check for shorts in U1103, V1201-V1205 circuits, or at one or more of the display interconnections.

This completes the "Resistance Checks" on your Module. Proceed to "Operational Tests."

OPERATIONAL TESTS

The charts in this part of the "Tests and Adjustments" provide a series of instructions and tests which verify the basic operation of all of the Module circuits. Make sure you obtain the correct test results in each step before you proceed. If you fail to obtain the correct results, an "Area of Possible Problem" column identifies the most likely area that would cause an incorrect indication. The problems you are most apt to encounter are shorted circuits due to solder bridges, open circuits, incorrectly installed components and, in rare instances, a defective part.

CAUTION: When you make voltage measurements, be sure to touch your probe only to the indicated test point. Should your probe slip and short to an adjacent wire, lead, or connection, severe damage to the Module circuits might result.

Most of the integrated circuits used in this Module are CMOS (complementary metal oxide semiconductor) devices. They are rugged and reliable parts once they are installed, but they may be damaged by static electricity as you install them. The remaining ICs are not subject to the same kind of damage. However, you should treat all ICs as though they were of the CMOS type to avoid any confusion between them, thereby providing the proper protection in every instance. Use the following procedure, without interruption, to install an IC. Refer to Figure 1 (Illustration Booklet, Page 4).

1. Hold the protective foam pad for any IC so packaged, and remove the IC with the other hand.

2. While holding the IC, straighten any bent IC pins.

3. With your free hand, touch any foil area near the location where this IC is to be installed; then install the IC. Once you have installed the IC, it is then protected.

If you do not obtain the correct results in the following steps, turn off the Oscilloscope power (turn the Intensity knob to the OFF position). Carefully recheck to make sure you performed the test exactly as directed. Then proceed as follows:

- Be sure the IC is correctly positioned. Refer to Figure 1 and check to make sure its pin 1 is in the correct position in the socket.
- If you still do not obtain the correct results, refer to the "Area of Possible Problem" column and check the circuits listed for the proper installation of associated parts, such as diodes for the correct position of the banded ends, or capacitors for the correct position of either the "+" or "-" marked leads. Refer to the "Circuit Board X-Ray Views" or to the schematic to help to locate these other components.
- Carefully check the ICs and make sure none of the IC pins have become accidentally bent under. Make sure all pins are in their socket holes.
- Carefully inspect the foils near the circuit areas listed in the charts for solder bridges. Compare the foil areas with the "Circuit Board X-Ray Views."
- If you are still unable to locate the problem, refer to the "In Case of Difficulty" section of the Manual for further assistance.

Use the following sequence for each test in the Charts.

1. Carefully and completely read the "Instruction or Test" information in each step to be sure you are familiar with the procedure and what the result will be.

2. Before you follow any instruction where an IC is to be installed or a solder connection is to be made, **turn off the Oscilloscope power.** Then, after you have performed the operation, turn the Oscilloscope power back on again.

( ) At the Oscilloscope power transformer, disconnect plug and socket P1101/S1101 (see Pictorial 5-3, Illustration Booklet, Page 12).

( ) On the Module, push the OFF switch to its **in** position, making sure the other seven switches are in their **out** positions.

( ) Connect the common (−) DC voltmeter lead to the CHASSIS GND connector.

NOTE: All voltage readings are ±10% unless otherwise stated.

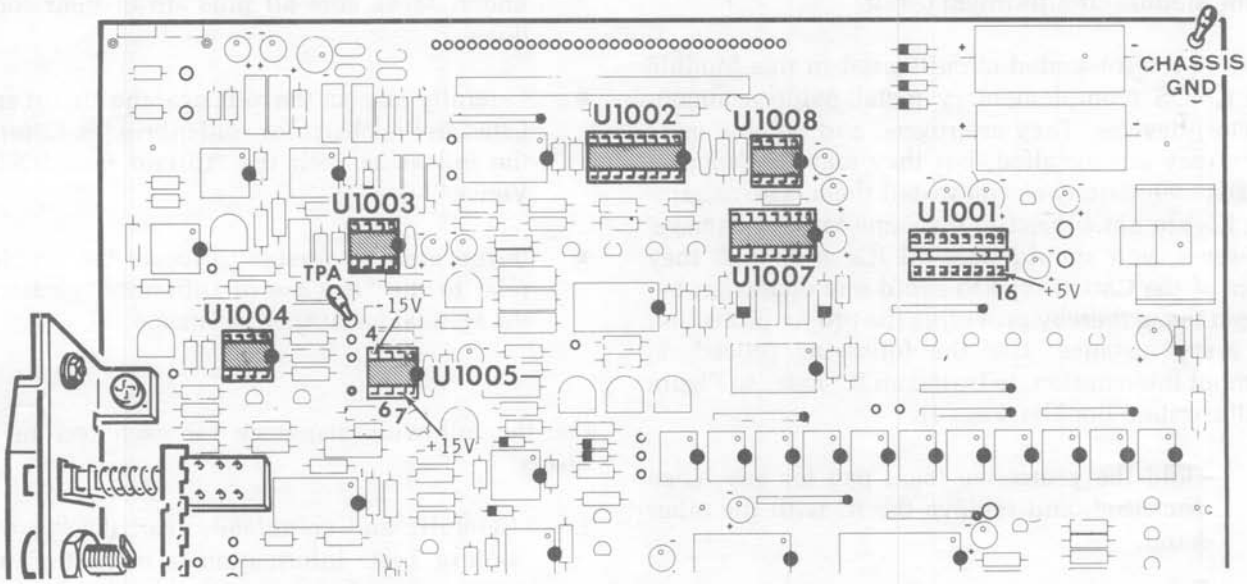
WARNING: Be especially careful to avoid the "High Voltage Areas" in the Oscilloscope at any time the Oscilloscope line cord is plugged in. THE VOLTAGES IN THESE AREAS ARE POTENTIALLY LETHAL. See Pictorial 5-7 (Illustration Booklet, Page 14). Do not remove the Oscilloscope cover while its line cord is plugged into an AC outlet.

( ) Connect the Oscilloscope line cord to an AC outlet.

Refer to Pictorial 5-8 for the following steps.

( ) Turn the Oscilloscope power (Intensity control) on.

NOTE: In the following steps, you will alternately check for indicated DC voltages, adjust certain controls, and install IC's. Perform each step carefully and make sure you install each IC as directed in the step and on Figure 1 (Illustration Booklet, Page 4).



PICTORIAL 5-8

INSTRUCTION OR TEST	AREA OF POSSIBLE PROBLEM
1. Measure where indicated for the following voltages. ( ) U1001 pin 16: +5V. ( ) U1005 pin 7: +15V. ( ) U1005 pin 4: −15V.	1. S111 improperly installed. 2. Open or short in +5, +15, or −15-volt supply circuitry.
2. NOTE: Be sure to turn off the Oscilloscope power when you install ICs in any of the following steps. Turn on the power following IC installation. Install the following ICs. ( ) U1003: LM**308**A IC (#442-639). ( ) U1004: LF**353** IC (TL072)(#442-707). ( ) U1005: LM**308**A IC (#442-639).	
3. ( ) Touch the voltmeter probe to the Module TPA connector and, as you rotate the Oscilloscope DTP (**D**elay **T**ime **P**osition) control from fully CCW to fully CW, check for +0.3 to +5.3V. Set the control for a reading of +1.0 volt.	1. S704 improperly installed. 2. U1003 circuitry.
4. ( ) Touch the voltmeter probe to U1005 pin 6. As you rotate the Δ Delay control, check for −0.5 to +7.0 V (fully CCW to fully CW). Set the control for a reading of +4.0 volts. Turn off the Scope power.	1. U1004A/Q1009 circuitry. 2. U1004B/Q1011 circuitry. 3. U1005 circuitry.
5. Install the following ICs: ( ) U1002: **74LS76** (#443-829). ( ) U1007: **4016** (#442-99). ( ) U1008: LM**310** (#442-648).	

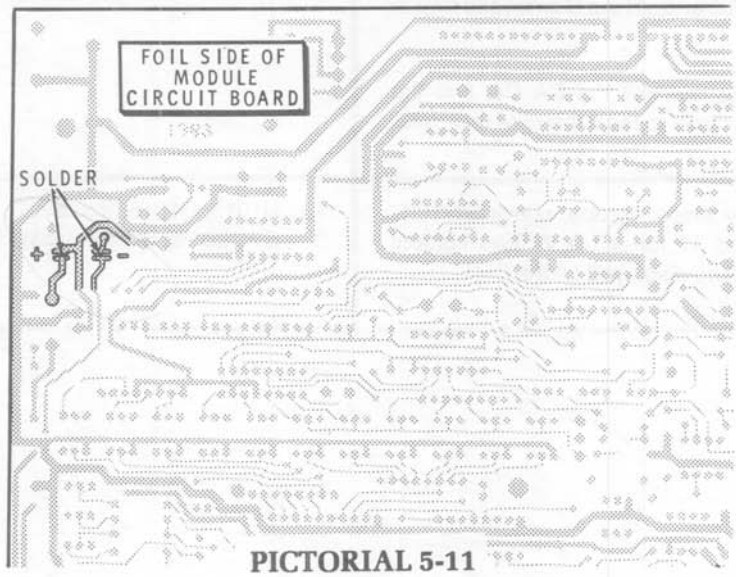
INSTRUCTION OR TEST	AREA OF POSSIBLE PROBLEM
6. ( ) On the Module, push the T switch. On the Scope, push the A-B switch, set the A Timebase switch to 1 ms, and pull and set the B Timebase switch to 50 μs.	
NOTE: Place the **leading** (left) **edge** of the left cursor at the indicated position when you are directed to position the cursor in the following step. 7. ( ) Adjust the Intensity control as required for a somewhat dim trace on the CRT. You should see a "cursor" or intensified area at each side of the trace. As you rotate the DTP control, both of these cursors should move. Set the DTP control fully CCW. Using the Horiz Pos control, set the left cursor at the left CRT vertical graticule line.	1. U1002 circuitry (see Waveforms I, II, and III). 2. U1007 or U1008 circuitry (see Waveform IV). 3. SW1001 circuitry.
8. ( ) On the Module, rotate the Δ Delay control to position the right cursor, first at the left CRT graticule, and then at the right vertical graticule line. The left cursor should not move. Turn off the Scope power.	cursor does not move

Refer to Pictorial 5-9 (Illustration Booklet, Page 15) for the following steps.

9. Install the following ICs. ( ) U1001: Cap/Gain ROM (#444-194). ( ) U1006: **4016** IC (#442-99). ( ) U1014: **4016** IC (#442-99). 10. ( ) On the Module, set the CA Cal control fully CCW, the CB Cal control to the center of its rotation, and the CC Cal control fully CW. Connect the voltmeter common lead to the A/D GND connector.	

INSTRUCTION OR TEST	AREA OF POSSIBLE PROBLEM
11. NOTE: In the following steps, the voltmeter reading may "flicker" as you rotate the Scope controls. ( ) Touch the voltmeter probe to U1006 pin 4. Adjust the T Cal control for a reading of +2.0 volts. ( ) Touch the voltmeter probe to U1006 pin 3. As you rotate the Scope A timebase switch from fully CCW to fully CW, observe the voltmeter readings as follows: a. +2.0 V in all "2" positions. b. +1.0 V in all "1" positions (and x-y). c. +0.5 V in all "5" positions.	1. S703 improperly installed. 2. U1001, Q1001 to Q1006 circuitry (see Logic Charts I, II). 3. U1006 Circuitry for problem at pin 3. 4. U1014 circuitry for problem at pin 9. 5. SW701, SW1001 circuitry.
12. ( ) Turn the A Timebase switch fully CCW. Place the voltmeter probe on U1014 pin 9 and check for the following readings as you rotate the switch to fully CW. a. +1.05 V from 100 ms to 2 ms. b. +1.00 V from 1 ms to 20 µs. c. +0.95 V from 10 µs to X-Y. Turn off the Scope power.	
13. Install the following ICs: ( ) U1015: LF**353** (TL072)(#442-707). ( ) U1016: **4016** (#442-99).	
14. ( ) On the Scope, set the A timebase switch to 1 ms. Pull and set the B timebase switch to 50 µs. ( ) On the Module, set the CA Cal and the CC Cal controls to the centers of their rotation.	
15. ( ) With the voltmeter probe, check SW1007 pins 8 and 17 for +1.0 V. Two cursors should still be displayed on the CRT.	1. U1015, U1016 circuitry. 2. SW1001 to SW1003, SW1007.

INSTRUCTION OR TEST	AREA OF POSSIBLE PROBLEM
16. ( ) Turn off the Oscilloscope power and remove the line cord from the AC socket. Refer to Pictorial 5-10 (Illustration Booklet, Page 15) and temporarily slide the Scope top rearward. Plug P1101 into power transformer socket S1011 and return the top to its former position. Reconnect the line cord. Do **not** turn on the Ocilloscope power.	
17. CAUTION: In the next step, if you do not **immediately** measure the required voltages, turn off the Oscilloscope power and locate the problem before you proceed. Refer to Pictorial 5-9 (Illustration Booklet, Page 15). Turn on the Oscilloscope power and check for the indicated voltages on the Module main circuit board. ( ) Measure at TPE for +5.0V. ( ) Measure at TPF for −5.0V.	1. P1101 incorrectly installed. 2. U1125 or U1126 circuitry. 3. Power transformer T1.
18. ( ) Turn off the Oscilloscope power. ( ) Dismount the Module assembly. ( ) Refer to Pictorial 5-11 below and, on the underside of the main circuit board, solder the "+" and "−" foil pads. ( ) Remount the Module assembly. Do **not** turn on the Oscilloscope power.	



PICTORIAL 5-11

INSTRUCTION OR TEST	AREA OF POSSIBLE PROBLEM
19. CAUTION: In this step, if you do not **immediately** measure the correct voltages, turn off the Oscilloscope power and correct the problem before you proceed. Turn on the Oscilloscope power and, on the A/D jumper pins, check for the following voltages: ( ) +5.0 V on the .2 V pin. ( ) −5.0 V on the 2 V pin. ( ) +4.3 V at the cathode (banded) end of diode D1109. A display "1" should be lit. Turn off the Scope power.	1. Open or short in the +5, +4, or −5 V circuitry. 2. "+" or "−" foil pads not soldered. 3. Short at one or more of the display connections.
20. Refer to Pictorial 5-12 (Illustration Booklet, Page 16) for the following steps. Install the following ICs: ( ) U1101: LF**353** (TL072) IC (#442-707). ( ) U1102: **4016** IC (#442-99). ( ) U1103: **7107** IC (#442-724).	
21. NOTE: In the following steps, ignore any display lighting. Using the voltmeter probe, check the pins of IC U1103 for the indicated voltages: ( ) +5.0V at pin 1. ( ) −5.0V at pin 26. ( ) Zero volts at pin 35. ( ) Approximately +1.0V at pin 36. ( ) Approximately +2.8V at pin 38.	1. U1101, U1102 circuitry. 2. U1103 (see Waveform V). 3. V1201-V1205 circuitry.
22. ( ) Using a screwdriver blade, short the Lamp Test pins together. The display should indicate "−1888".	

INSTRUCTION OR TEST	AREA OF POSSIBLE PROBLEM
23. ( ) On the Module, turn the Δ Delay control CCW. You should be able to uniformly set the display from approximately "1000" to "–0100". Set the display to read "0000". ( ) On the Scope, turn the DTP control to position the cursors at the center graticule line. ( ) On the Module, turn the Δ Delay control to display "0505". Push the F switch; the display should read approximately "1980".	1. U1101, U1102 circuitry. 2. U1103 (see Waveforms VI to IX).
24. ( ) Turn the Δ Delay control CCW; the display should quickly indicate "1 " (overrange). When the cursors are superimposed, the display should change to "–1 ". Turn the control CCW until the display comes out of overrange. Set the display for a reading of "–1980". ( ) On the Module, push the T switch. The display should indicate approximately "–0505". ( ) On the Scope, turn the DTP control to set the center cursor at the left vertical graticule line. ( ) On the Module, turn the Δ Delay control for a display reading of "0950". Turn off the Scope power.	
25. Install the following ICs: ( ) Seven **4N26** ICs (443-808) at U1106 through U1109, U1111, U1113, and U1114. ( ) U1112: T/F ROM (#444-196).	
26. Plug the black test lead into the Oscilloscope GND jack.	