Big Al

MODEL IM-1202 Digital Multimeter

Little mark

HEATHKIT®

ASSEMBLY MANUAL

HEATHKIT®

PRICE $2.00

I-595-1489

Refer to Pictorial 4-6 and prepare the meter test leads.

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

(✓) Install a test probe on one end of the large red wire as follows:

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

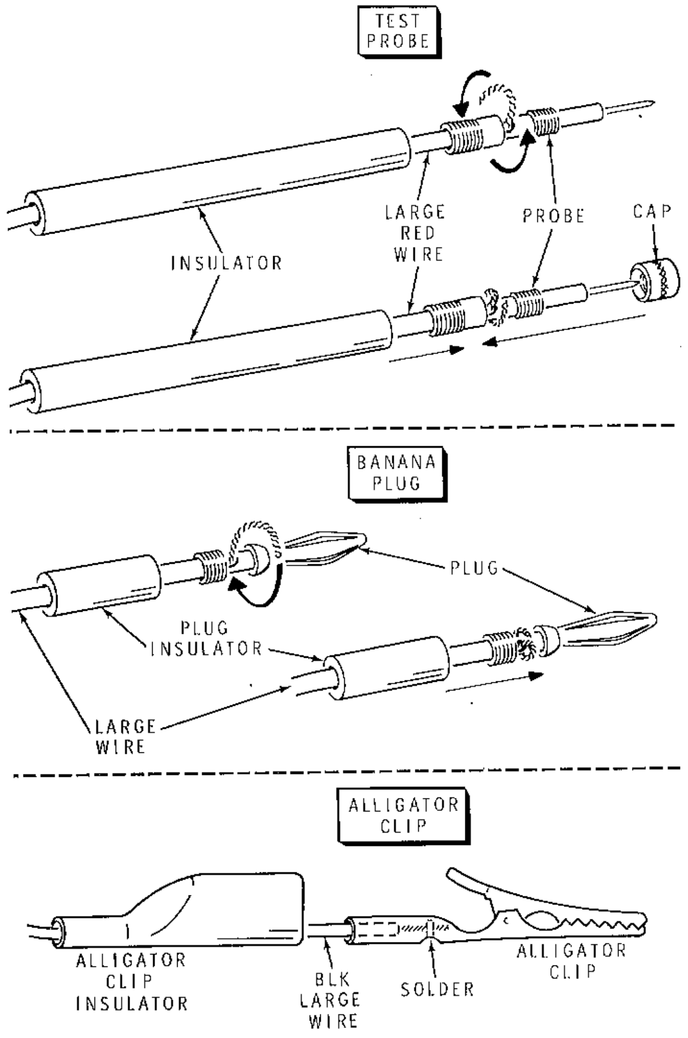
2. Twist the fine wires together and insert them through the hole in the probe. Then form the wires around the probe and screw the cap nut over them. Screw the insulator back on the probe.

(✓) Place the other end of the large red wire through the smaller hole of the red plug insulator.

(✓) Twist the fine wires together and insert the wires through a banana plug. Form the wires clockwise and screw the insulator on the banana plug as shown.

(✓) In a similar manner, install a banana plug and black insulator on the large black test wire.

(✓) Install the alligator clip on the free end of the large black wire. Insert the end of the black wire through the smaller end of the alligator clip insulator. Twist the fine wires together and insert them into the alligator clip (S-1). Slip the alligator clip insulator down over the alligator clip after the clip has cooled.

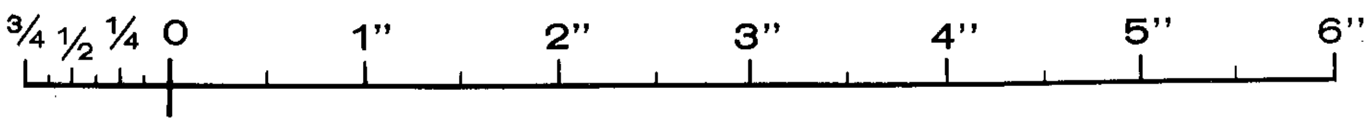


PICTORIAL 4-6

This completes the "Step-by-Step Assembly" section of the Manual. The cabinet will be installed later. Carefully inspect the Multimeter and all circuit boards for loose or unsoldered wires, and cold solder connections. Remove any wire clippings or solder splashes that may be lodged in the wiring.

Securely hold the Multimeter and shake it to be sure all clippings are removed. Then proceed with the "Tests and Calibration" section of the Manual.

NOTE: Save any parts remaining; they may be used later.



TESTS AND CALIBRATION

In this section of the Manual you will test and calibrate your IM-1202 Digital Multimeter. If at any time you do not obtain the results indicated, refer to the "In Case of Difficulty" section on Page 45. Locate and repair any problem before you continue with the calibration.

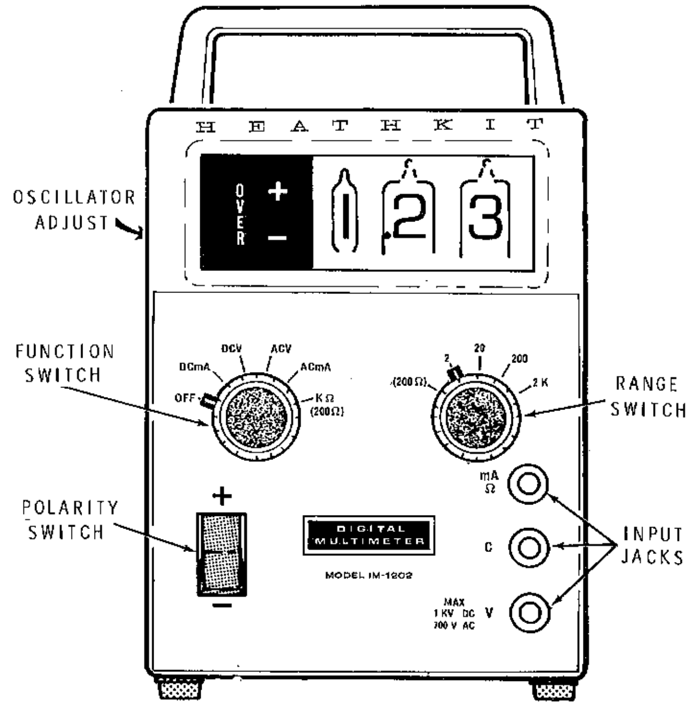


Figure 2

Figure 2 shows the front switches and input jacks of your Multimeter. Figure 3 (fold-out from Page 36) shows the remaining controls and test points. Carefully study Figures 2 and 3 and identify the function of each switch, control, and input.

( ) Refer to Figure 4 and insert all except approximately 3/8" of the alignment tool blade into the small end of the nut starter.

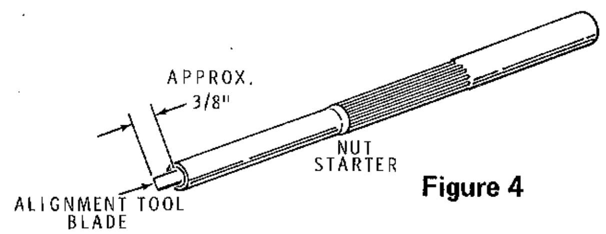


Figure 4

( ) Use this alignment tool to set all nine rear controls and the OSC ADJ control to their centers of rotation (slots vertical).

( ) Set the front panel switches to the following positions.

Function switch:	OFF.
Range switch:	2.
Polarity switch:	+.

WARNING: When the line cord is connected to an AC outlet, AC voltage will be present at several places. These areas are shown in boxed-in area in the "Circuit Board Voltage Charts" (on Page 61), and in Figure 3 (fold-out from Page 36).

( ) Plug the line cord into an AC outlet.

( ) Turn the Function switch to the DCV position and allow the unit to stabilize for at least 30 minutes. NOTE: The "+" polarity lamp, and the two right-hand digits (displaying any number) and the decimal point to the left of the left digit should all be lit. No other lamp should be lit.

( ) Use the alignment tool and turn the ZERO ADJ control until the readout is .01. Then slowly turn the control until the readout just changes to .00. Nothing should be plugged into the input jacks at this time. The threshold should rock between .01 and .00.

( ) Plug the red test lead into the red V input jack.

IMPORTANT: The value recorded on the calibration voltage envelope should be written on the margin of this page as it must be used for any future recalibration. If possible, you should also ink this information onto the foil side of the main circuit board and on the inside of the cabinet.

( ) Touch the red test lead probe tip to DC CAL TP and adjust the DC CAL control until the readout matches the value given on the calibration voltage envelope (#100-1612), whose contents were installed in Pictorial 2-5. NOTE: Observe that the number on the envelope has four digits, whereas the Multimeter can display only three digits. Convert the number to three digits by dropping the fourth digit if it is 4 or less, or by increasing the third digit by one if the fourth digit is 5 or more:

1.943 = 1.94
1.946 = 1.95

If the value on the envelope is 2 or higher, the Multimeter OVER lamp will be lit, but the 2 will not be displayed:

2.112 = OVER .11

( ) Disconnect the probe from the DC test point.

( ) Turn the Function switch to the kΩ position and adjust the Oscillator Adjust control for a readout of "OVER" .85, ±15 digits.

NOTE: If you are unable to obtain a reading of exactly "OVER .85," obtain the nearest possible reading with the Oscillator Adjust control. Then leave the control set at this point. This reading must fall within 15 digits (that is, no less than "OVER .70" or no more than "OVER 1.00"). If you are unable to calibrate within these limits, refer to the "In Case of Difficulty" section (Pages 45-49).

( ) Turn the Function switch to the DCV position and repeat the two previous steps until the correct readouts are obtained in both switch positions.

( ) Set the front panel switches in the following positions:

Function switch: DCV.
Polarity switch: +.
Range switch: 20.

( ) Touch the probe tip to AC CAL TP and adjust the AC CAL ADJ control (next to the AC TP) for a readout of 16.3.

NOTE: The readout may vary between 16.2, 16.3, and 16.4. A proper adjustment will readout 16.3 most of the time.

( ) Remove the probe from the AC CAL TP and turn the Function switch to the ACV position. Place the probe back on the AC CAL TP, allow the display to stabilize, and adjust the AC CAL control (at the top of the circuit board) for a meter reading of "OVER 0.0."

NOTE: The readout may vary between 19.9, "OVER" 0.0, and "OVER" 0.1. A proper adjustment will readout "OVER" 0.0 most of the time.

( ) Repeat the previous two steps until the correct readouts are obtained in both switch positions.

( ) Turn the Function switch to kΩ (200 Ω).

( ) Remove the red test lead from the V input jack and plug it into the white mA–Ω jack.

You will calibrate the five ohm ranges in the following steps. Touch the red test probe tip to the indicated OHMS CAL TP (test point) for each range and adjust the indicated control for an "OVER" 00 readout. The decimal point should be at the indicated position.

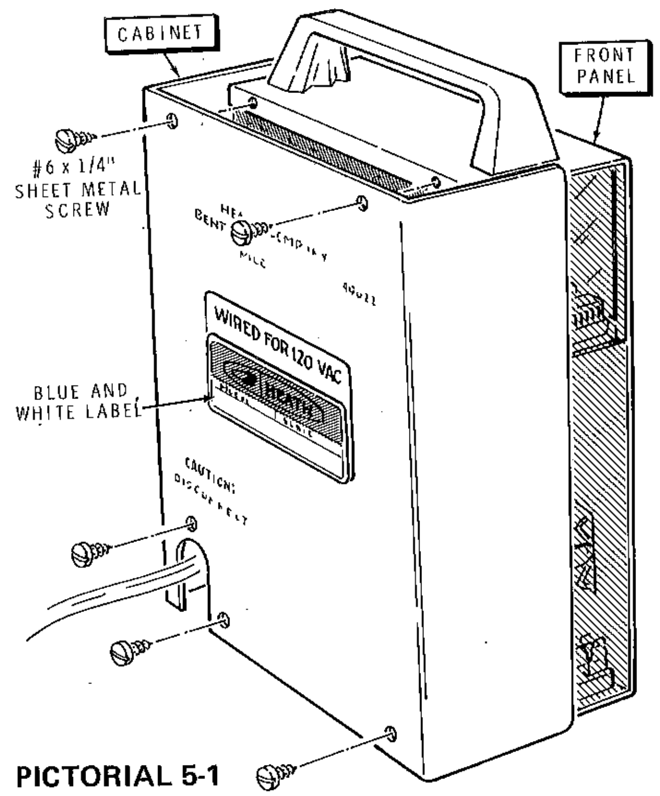
Range Switch	OHMS CAL TP (Test Point)	Control	Meter Reading
( ) (200 Ω)	200	200 ADJ	"OVER" 00
( ) 2	2 k	2 k ADJ	"OVER" .00
( ) 20	20 k	20 k ADJ	"OVER" 0.0
( ) 200	200 k	200 k ADJ	"OVER" 00
( ) 2 k	2 M	2 M ADJ	"OVER" .00

( ) Repeat the previous five steps as many times as necessary until you obtain a stable reading for each switch position.

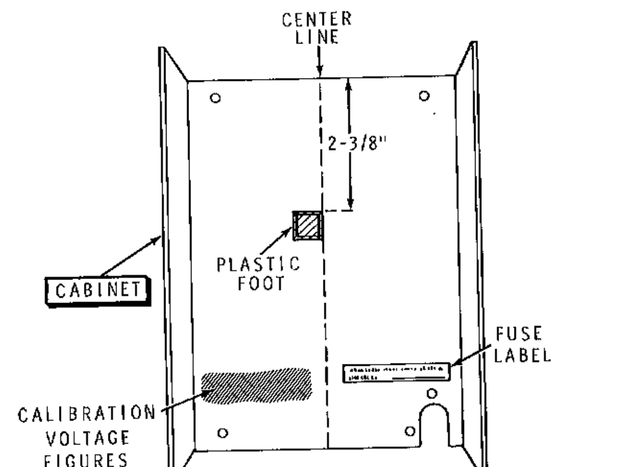
NOTE: If your Multimeter is operating from a 60 Hz power line during calibration, the infinity display will be "OVER" and approximately 85. In the unusual case when a 50 Hz AC power line is used during calibration and the Multimeter is then used on 60 Hz AC, the infinity reading will be "OVER" and approximately 35. This is due to the count period being approximately 2 ms shorter in the latter case.

This completes the "Initial Tests and Calibration" section of the Manual. Disconnect the AC line cord from the power source and proceed to the "Final Assembly" section.

FINAL ASSEMBLY



PICTORIAL 5-1



Detail 5-1A

Refer to Pictorial 5-1 for the following steps.

( ) Locate the cabinet and mark a vertical center line inside on the back surface. Then indicate a point 2-3/8" down from the top of the cabinet on the centerline. Remove the protective backing from a plastic foot and press it into place along the center line on the side opposite the cutout as shown.

( ) Write "1/4A, 3AG" in the blanks on the fuse label ("1/8A, 3AG" if your unit is wired for 240 VAC).

( ) Remove the backing from the fuse label, and mount it at the location shown in Detail 5-1A.

( ) Mount the cabinet to the front panel with five #6 x 1/4" screws. Position all wires inward so they are not pinched when the cabinet is installed.

NOTE: The blue and white label shows the model number and production series number of your kit. Refer to these numbers in any communications with Heath Company; this assures you that you will receive the most complete and up-to-date information in return.

( ) Carefully peel away the backing paper from the blue and white label. Then press the label onto the rear panel as shown. Be sure to position the label so the appropriate line voltage lettering is exposed.

Proceed to the "Operation" section.

OPERATION

DUTY CYCLE

The power consumption of the Digital Multimeter is very low, and there is no objection to leaving the instrument on continuously during the daily work period. Allow a 15 minute warmup period, from a cold start, to insure best accuracy.

SAFETY PRECAUTIONS

CAUTION: Always observe basic safety rules any time voltage measurements are made. Always handle the test leads by their insulated portions and do not touch the exposed tips.

When high voltage measurements are made, remove the power from the unit under test and then connect the test leads. If this is not possible, be careful to avoid accidental contact with nearby objects which could provide a ground return path. Keep one hand behind you to minimize accidental shock hazard and be sure to stand on a properly insulated floor or floor covering. Do not switch meter ranges when high voltages and high currents are at the Meter inputs; to do so will cause switch contact arcing.

MEASUREMENTS

Refer to Figure 5 (fold-out from Page 43) while you read the following information.

CONNECTING THE MULTIMETER

Place the Function switch in the OFF position.

Plug the line cord into an AC outlet.

Plug the black test lead into the C (black) jack and the red lead into the other appropriate jack.

Follow the instructions (current, voltage, resistance, etc.) according to the type of measurement to be made.

When the Multimeter is turned on, the display tubes should light. When the meter leads are connected together the tubes should display "00."

DC CURRENT MEASUREMENTS

CAUTION: 3 amperes is the maximum DC current allowable on the 2 k mA range.

1. Set the RANGE switch to 2 k or the desired lower range if known.

2. Set the FUNCTION switch to DCmA.

3. Plug the red test lead into the mA–Ω jack and observe the reading. If the OVER lamp comes on, switch to a higher range immediately as an overload condition exists. Otherwise, lower the setting of the RANGE switch until the proper range is reached. The following table indicates the readout limits for each range.

RANGE	DISPLAY RANGE	ALLOWABLE OVERRANGE
(200 Ω)	Does not function on DCmA	25% on all ranges.
2	.01 – 1.99	Over .50 (2.50)
20	0.1 – 19.9	Over 5.0 (25.0)
200	01 – 199	Over 50 (250)
2 k	.01 – 1.99	Over .50 (2.50)

DC VOLTAGE MEASUREMENTS

CAUTION: Do not connect the C input to a potential greater than 500 volts above power line ground; this can result in damage to the instrument.

1. Set the RANGE switch to 2 k or the desired lower range.
2. Set the FUNCTION switch to DCV.
3. Plug the red test lead into the V jack and observe the readings. If the OVER lamp comes on, switch to a higher range immediately as an overload condition exists. Otherwise, lower the setting of the RANGE switch until the proper range is reached. The following table indicates the readout limits for each range.

RANGE	DISPLAY RANGE	ALLOWABLE OVERRANGE
(200 Ω)	Does not function on DCV	25% on all ranges except the 2 k range.
2	.01 – 1.99	Over .50 (2.50)
20	0.1 – 19.9	Over 5.0 (25.0)
200	01 – 199	Over 50 (250)
2 k	.01 – 100 (1000)	None

AC VOLTAGE MEASUREMENTS

NOTE: When measuring AC voltage, any input other than a pure sine wave can cause an error because the AC converter is average-sensing and rms calibrated.

CAUTION: 700 volts rms is the maximum AC voltage allowable in the 2 k range; 140 volts rms on the 2 (volt) range.

1. Set the RANGE switch to 2 k or the desired lower range.
2. Set the FUNCTION switch to ACV.
3. Plug the red test lead into the V jack and observe the reading. If the OVER lamp comes on, switch to a higher range immediately as an overload condition exists. Otherwise, lower the setting of the RANGE switch until the proper range is reached. The following table indicates the readout limits for each range.

RANGE	DISPLAY RANGE	ALLOWABLE OVERRANGE
(200 Ω)	Does not function on ACV	25% on all ranges except the 2 k range.
2	.01 – 1.999	Over .50 (250)
20	0.1 – 19.99	Over 5.0 (25.0)
200	01 – 199.9	Over 50 (250)
2 k	.01 – 70 (700)*	None

*Approximate rms value of 1000V peak

AC CURRENT MEASUREMENTS

CAUTION: 3 amperes is the maximum AC current allowable on the 2 k range.

1. Set the RANGE switch to 2 k or the desired lower range if known.
2. Set the FUNCTION switch to ACmA.
3. Plug the red test lead into the mA–Ω jack and observe the reading. If the OVER lamp comes on switch to a higher range immediately as an overload condition exists. Otherwise, lower the setting of the RANGE switch until the proper range is reached. The following table indicates the readout limits for each range.

RANGE	DISPLAY RANGE	ALLOWABLE OVERRANGE
(200 Ω)	Does not function on ACmA.	25% on all ranges.
2	.01 – 1.99	Over .50 (2.50)
20	0.1 – 19.9	Over 5.0 (25.0)
200	01 – 199	Over 50 (250)
2 k	.01 – 1.99	Over .50 (2.50)

RESISTANCE MEASUREMENTS

CAUTION: The resistance circuits of the Multimeter are protected against the application of AC and DC voltages up to a level which would cause a current of 3 amperes.

1. Set the RANGE switch to the desired range.
2. Set the FUNCTION switch to kΩ (200 Ω).
3. Plug the red test lead into the mA–Ω jack.
4. Connect the load to the test leads and observe the reading. Raise or lower the setting of the RANGE switch until the proper range is reached. The following table indicates the readout limits for each range.

RANGE	DISPLAY RANGE	ALLOWABLE OVERRANGE
(200 Ω)		25% on all ranges.
	01 – 199	Over 50 (250)
2	.01 – 1.99	Over .50 (2.50)
20	0.1 – 19.9	Over 5.0 (25.0)
200	01 – 199	Over 59 (250)
2 k	.01 – 1.99	Over .50 (2.50)

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ALLOWABLE OVERRANGE
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Over 50 (250)
Over .50 (2.50)
Over 5.0 (25.0)
Over 59 (250)
Over .50 (2.50)

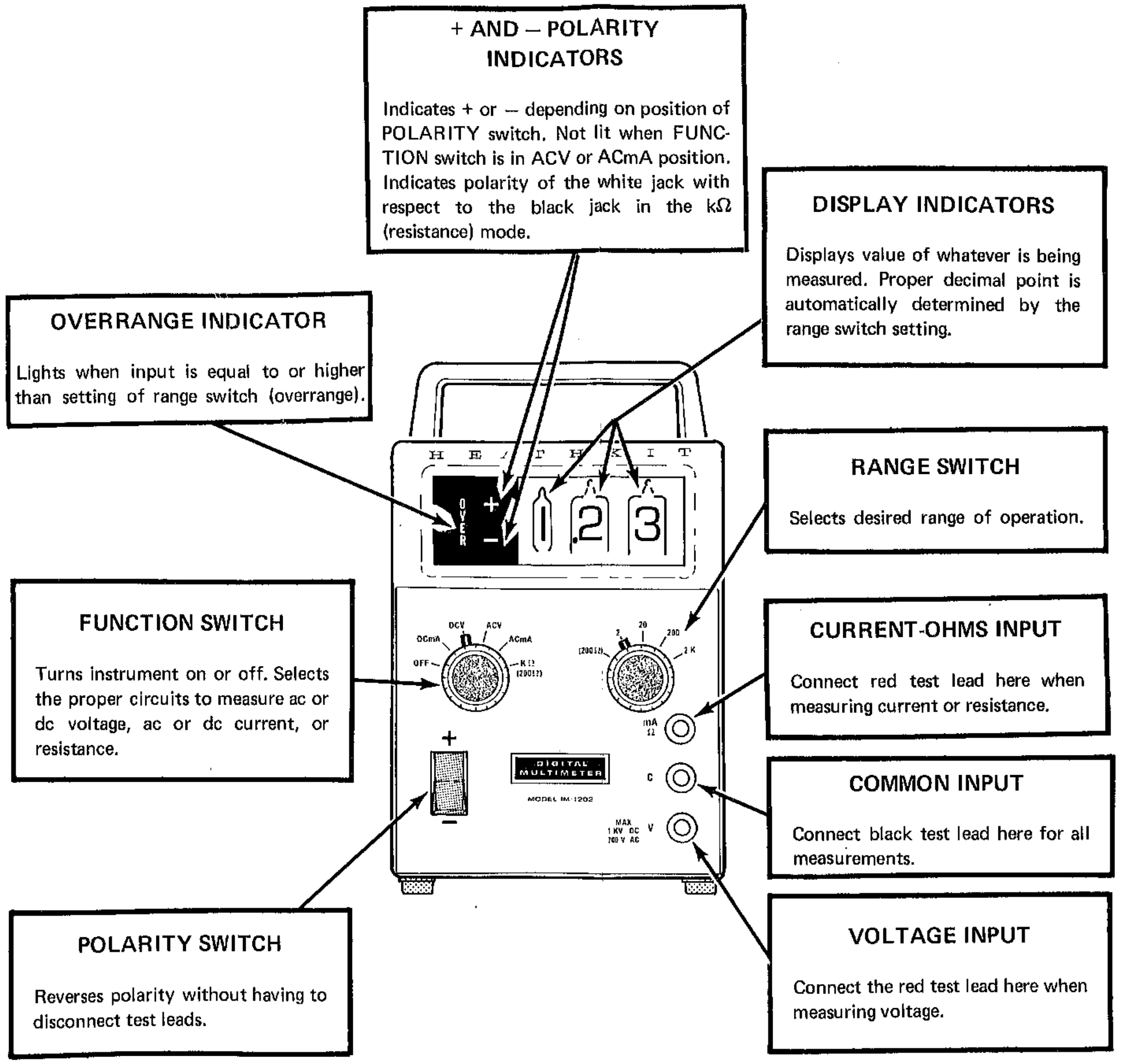

Figure 5

DC VOLT

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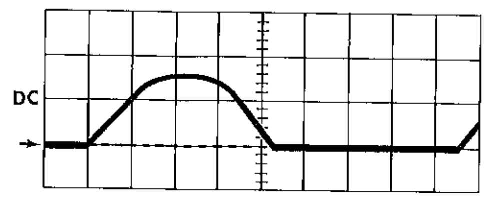
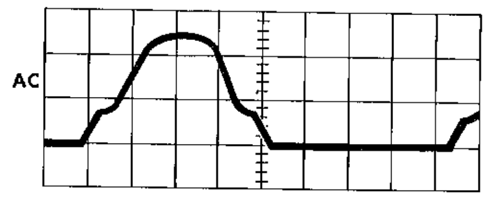
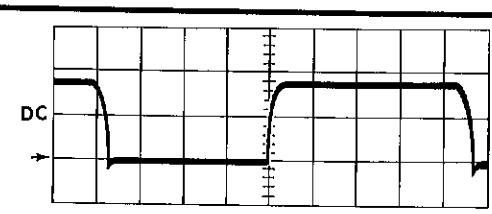
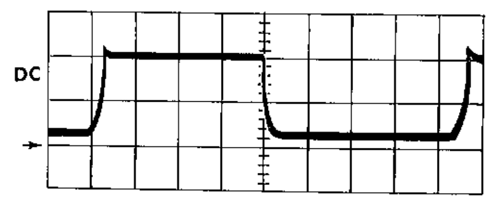
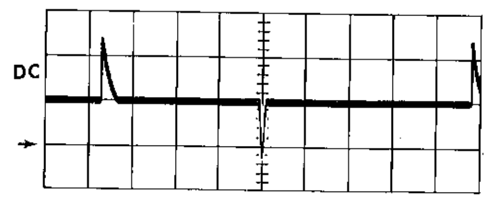
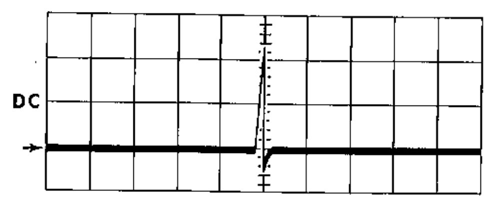
WAVEFORMS

Waveforms as displayed on Tektronix Model 547 with type 1A4 4-Channel Amplifier. Line sync.

	TEST POINT	OSCILLOSCOPE Vertical: Volts/cm	OSCILLOSCOPE Horizontal: m sec	INPUT COUP-LING	Waveforms (DC zero-volt reference point indicated by arrowhead)	POSSIBLE CAUSE OF IMPROPER WAVEFORM
1	D16, Anode	200	2	DC		1. Diode D16. 2. No voltage from transformer.
2	IC8, pin 5 (2 VDC input)	1	2	AC		1. Resistor R219. 2. IC8. 3. Solder bridge.
3	IC8, pins 6 and 9	2	2	DC		1. Pin 4 not held high (+5 VDC). 2. IC8. 3. Solder bridge.
4	IC8, pin 8	2	2	DC		1. Pin 10 not held high (+5 VDC). 2. Pin 8 of IC2 grounded. 3. IC8. 4. Solder bridge.
5	IC8, pin 1	2	2	DC		1. Capacitor C205 or C206. 2. Resistor R217. 3. Solder bridge.
6	IC8, pins 3 and 12	2	2	DC		1. Pin 2 not held high (+5 VDC). 2. IC8.

DC VOLTAGE MEASUREMENTS

CAUTION: Do not connect the C input to a potential greater than 500 volts above power line ground; this can result in damage to the instrument.

1. Set the RANGE switch to 2 k or the desired lower range.

2. Set the FUNCTION switch to DCV.

3. Plug the red test lead into the V jack and observe the readings. If the OVER lamp comes on, switch to a higher range immediately as an overload condition exists. Otherwise, lower the setting of the RANGE switch until the proper range is reached. The following table indicates the readout limits for each range.

RANGE	DISPLAY RANGE	ALLOWABLE OVERRANGE
(200 Ω)	Does not function on DCV	25% on all ranges except the 2 k range.
2	.01 – 1.99	Over .50 (2.50)
20	0.1 – 19.9	Over 5.0 (25.0)
200	01 – 199	Over 50 (250)
2 k	.01 – 100 (1000)	None

AC VOLTAGE MEASUREMENTS

NOTE: When measuring AC voltage, any input other than a pure sine wave can cause an error because the AC converter is average-sensing and rms calibrated.

CAUTION: 700 volts rms is the maximum AC voltage allowable in the 2 k range; 140 volts rms on the 2 (volt) range.

1. Set the RANGE switch to 2 k or the desired lower range.

2. Set the FUNCTION switch to ACV.

3. Plug the red test lead into the V jack and observe the reading. If the OVER lamp comes on, switch to a higher range immediately as an overload condition exists. Otherwise, lower the setting of the RANGE switch until the proper range is reached. The following table indicates the readout limits for each range.

RANGE	DISPLAY RANGE	ALLOWABLE OVERRANGE
(200 Ω)	Does not function on ACV	25% on all ranges except the 2 k range.
2	.01 – 1.999	Over .50 (250)
20	0.1 – 19.99	Over 5.0 (25.0)
200	01 – 199.9	Over 50 (250)
2 k	.01 – 70 (700)*	None

*Approximate rms value of 1000V peak

AC CURRENT MEASUREMENTS

CAUTION: 3 amperes is the maximum AC current allowable on the 2 k range.

1. Set the RANGE switch to 2 k or the desired lower range if known.

2. Set the FUNCTION switch to ACmA.

3. Plug the red test lead into the mA–Ω jack and observe the reading. If the OVER lamp comes on switch to a higher range immediately as an overload condition exists. Otherwise, lower the setting of the RANGE switch until the proper range is reached. The following table indicates the readout limits for each range.

RANGE	DISPLAY RANGE	ALLOWABLE OVERRANGE
(200 Ω)	Does not function on ACmA.	25% on all ranges.
2	.01 – 1.99	Over .50 (2.50)
20	0.1 – 19.9	Over 5.0 (25.0)
200	01 – 199	Over 50 (250)
2 k	.01 – 1.99	Over .50 (2.50)

RESISTANCE MEASUREMENTS

CAUTION: The resistance circuits of the Multimeter are protected against the application of AC and DC voltages up to a level which would cause a current of 3 amperes.

1. Set the RANGE switch to the desired range.

2. Set the FUNCTION switch to kΩ (200 Ω).

3. Plug the red test lead into the mA–Ω jack.

4. Connect the load to the test leads and observe the reading. Raise or lower the setting of the RANGE switch until the proper range is reached. The following table indicates the readout limits for each range.

RANGE	DISPLAY RANGE	ALLOWABLE OVERRANGE
(200 Ω)		25% on all ranges.
	01 – 199	Over 50 (250)
2	.01 – 1.99	Over .50 (2.50)
20	0.1 – 19.9	Over 5.0 (25.0)
200	01 – 199	Over 59 (250)
2 k	.01 – 1.99	Over .50 (2.50)

WIRING HARNESS ASSEMBLY

If you decide to assemble the wiring harness for troubleshooting circuit boards as described on Page 46, remove the parts from the envelope marked 171-7325 and follow the instructions in Figure 6 below. If you do not use these parts, save them for possible future use.

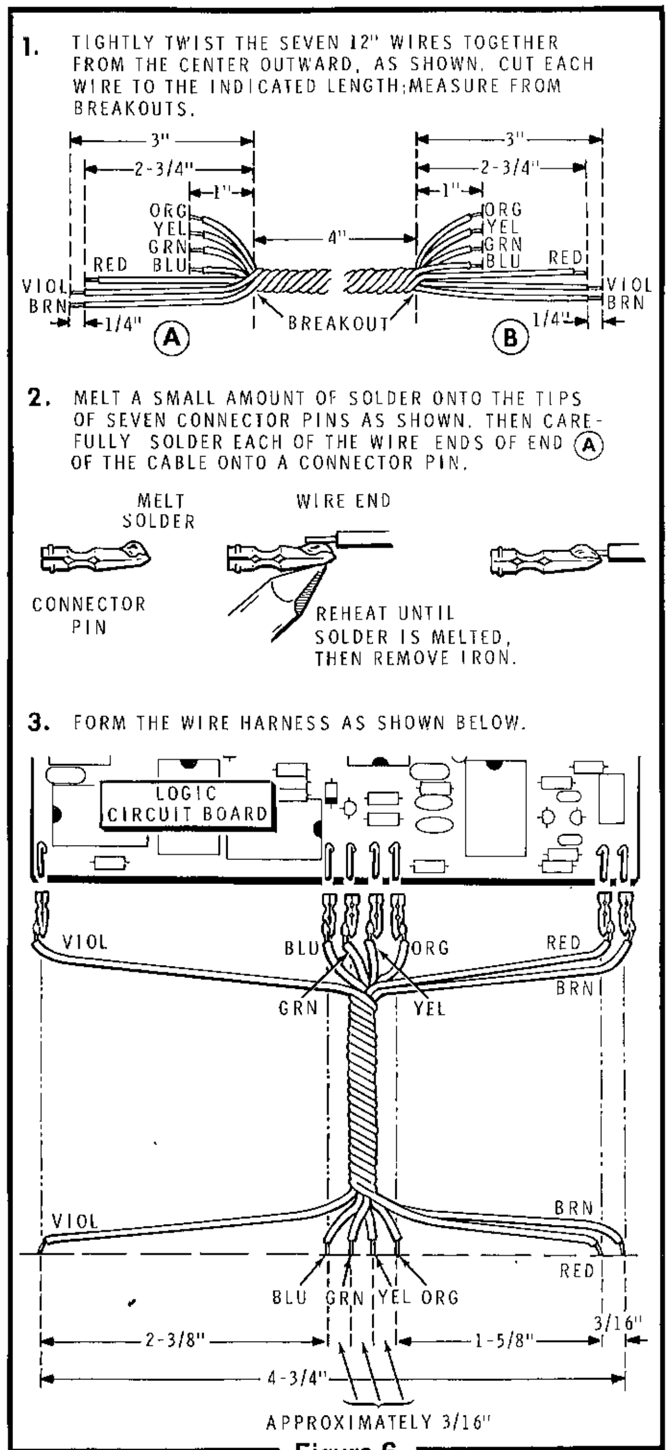
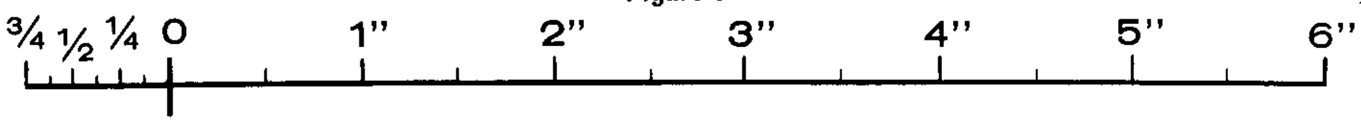


Figure 6



IN CASE OF DIFFICULTY

WARNING: When the line cord is connected to an AC outlet, AC voltage will be present at several places. These areas are shown in boxed-in area in the "Voltage Chart" (on Page 61).

Begin your search for any trouble that occurs after assembly by carefully following the steps listed in the "Visual Tests" secton. After visual tests are completed, refer to the "Troubleshooting Chart."

NOTE: Refer to the circuit board "X-Ray Views" on Pages 57, 58, and 59 for the phyical location of parts on the circuit boards.

VISUAL TEST

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the kit builder.

2. About 90% of the kits that are returned to the Heath Company for repair do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the "Soldering" section of the "Kit Builders Guide."

3. Check to be sure that all transistors are in their proper locations. Make sure each lead is connected to the proper point.

4. Check that each of the IC's are properly installed in their sockets, and that the pins are not bent out or under the IC. Also be sure the IC's are installed in their correct positions.

5. Check the values of the parts. Be sure in each step that the proper part has been wired into the circuit, as shown in the Pictorial diagrams. It would be easy, for example, to install a 680 Ω (blue-gray-brown) resistor where a 6800 Ω (blue-gray-red) resistor should have been installed.

6. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.

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

If the trouble is still not located after the visual tests are completed, and a voltmeter is available, check voltrages against those shown on the Voltage Chart on Page 61. Read the "Precautions for Troubleshooting" (Page 46) before making any measurements. NOTE: All voltage readings were taken with a high impedance voltmeter. Voltages may vary ±20%.

WAVEFORMS

As a service aid, fold-outs from Pages 44 and 49 are drawings of oscilloscope patterns to be expected at the designated points in the Multimeter circuit. A high impedance, low capacitance probe is required in addition to an oscilloscope which can be set up for the time and voltage requirements designated.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Service" section of the "Kit Builders Guide" and to the "Factory Repair Service" information on Page 49 of this Manual. Your Warranty is located inside the front cover of the Manual.

PRECAUTIONS FOR TROUBLESHOOTING

1. Be cautious when testing IC and transistor circuits. Although they have almost unlimited life when used properly, they are much more vulnerable to damage from excessive voltage or current than most other components.

2. Be sure you do not short any terminals to ground when making voltage measurements. If the probe should slip, for example, and short out a bias or supply point, it is very likely to cause damage to one or more IC's, transistors, or diodes.

TROUBLESHOOTING

Because the Digital Multimeter is fundamentally a DC voltmeter, the basic circuitry is used when the Function switch is in the DCV position, and conditioning circuits are added for other functions. Consequently, if a malfunction occurs, first check the circuitry used for the DC voltmeter function. If that is operating satisfactorily, then check the circuitry added for other functions.

The following charts list the malfunctions that might arise and the same possible causes. Look at the problem column and try to locate your difficulty. Then try to correct the difficulty by checking the possible cause column.

Use charts #1 or #2 if any malfunction should arise in the DCV position. Use chart #3 if any malfunction should arise in any of the remaining positions. If a particular part or parts are mentioned (transistor Q2 for example, or resistor R6) as a possible cause, check these parts to see if they are incorrectly installed or wired. Check to see if an improper part was installed at that location. It is also possible for a part to be faulty, although this is rare.

The logic circuit board has foil patterns on both sides. Several "plated-through" holes carry the circuit from one side of the board to the other. When troubleshooting, be sure to check circuit continuity through the holes.

If it becomes necessary to troubleshoot your Multimeter, the task will be made easier if you assemble a wiring harness (as described on Page 44) so that the two circuit boards may be separated to provide better access to each. To use the wiring harness, proceed as follows:

1. Disconnect the logic circuit board from the main circuit board pins.

2. Push the bare wire ends into the main circuit board connector pins: brown to A, red to B, orange to C, yellow to D, green to E, blue to F, and violet to G.

3. Push the connectors on the wire ends onto the logic circuit board, in exactly the same order as noted in Step #2: brown wire connector to A, red wire connector to B, orange wire connector to C, yellow wire connector to D, green wire connector to E, blue wire connector to F, and violet to G.

4. For convenience during troubleshooting, you may temporarily install the knobs on their shafts; then rest the foil side of the logic board on these knobs.

Refer to the pages associated with the Schematic Diagram for IC basing diagrams and a cross reference table of Heath and manufacturers' numbers.

NOTE: Some of the circuits use IC's of the same type. An IC thought to be faulty can often be interchanged with one known to be good.

Troubleshooting Charts

The following two charts are for the DCV position. Chart #1 deals with the possibility of a malfunction that prevents the neon lamps or readout tubes from lighting or stabilizing. In chart #2, you will make measurements to check out the DCV position of the Function switch.

CHART #1

PROBLEM	POSSIBLE CAUSE
Neon lamps and readout tubes do not light.	1. Power line fuse blown. 2. Diode D16. 3. Function switch in OFF position. 4. Function switch miswired.
"1" or "OVER" lamp and readout tubes do not light.	1. Connector wire G on logic circuit board not making good contact with connector pin G on main circuit board.
Readout tubes light but are dim and all ten digits come on.	1. Connector wire A on logic circuit board not making good contact with connector pin A on main circuit board. 2. Connector wire B on logic circuit board not making good contact with connector pin B on main circuit board. 3. Transistor Q11 and its associated resistors, capacitors, and diodes.
A particular digit lights. However, all numerals appear dimly lit. (For example, a "3" condition always faintly lights 0 through 9.)	1. Open tube socket pin. 2. Open decoder driver pin(s).
Readout does not read 00 with inputs shorted.	1. ZERO ADJUST control not set properly. 2. Integrated circuit IC8 not producing reset pulse.
Readout counts up continuously.	1. Transistor Q12. 2. Integrated circuit IC8 not producing reset pulse.
Readout does not stabilize after warmup time.	1. Diode D17; transistors Q12, Q15, Q16; or an associated resistor or capacitor.
"1" or "OVER" lamps come on when inputs are shorted.	1. Transistor Q13 or Q14. 2. Integrated circuit IC5.
Two or more digits in a readout tube on at the same time.	1. Solder bridge at readout tube socket. 2. Solder bridge at IC3 or IC4 sockets. 3. Interchange readout tubes. 4. Interchange IC3 or IC4.
Oscillator does not adjust to "OVER .85," ±15 digits.	1. Resistors R206 and R208. 2. Control R207. 3. Capacitors C201 and C203.

CHART #2

RED LEAD (V INPUT) TO:	FUNCTION SWITCH	RANGE SWITCH	"+", "–" SWITCH	PROBLEM	POSSIBLE CAUSE
Black lead (C input)	DCV position	2 position	"+" position	Readout does not read +.00.	1. Integrated circuit IC8 not producing reset pulse. 2. Transistor Q11 and its associated resistors, capacitors, and diodes. 3. Diode D16. 4. Integrated circuit IC6 or IC7. 5. Integrated circuit IC3 or IC4.
DC CAL TP	DCV position	2 position	"+" position	Readout does not read the value stamped on the voltage reference source package.	1. Transistors Q1 through Q7. 2. Integrated circuit IC2. 3. Transistor Q12, Q15, or Q16. 4. Transistor Q11 and its associated resistors, capacitors, and diodes. 5. Diode D16. 6. Integrated circuit IC6 or IC7. 7. Integrated circuit IC3 or IC4. 8. Instrument not calibrated.

CHART #3

FUNCTION SWITCH POSITION	PROBLEM	POSSIBLE CAUSE
DC mA	Readout does not seem to read correctly.	1. Resistors R101 through R109.
ACV		1. Transistor Q8 or integrated circuit IC1.
AC mA		1. Resistors R101 through R109. 2. Transistor Q8 or integrated circuit IC1.
KΩ (200 Ω)		1. Controls R111, R113, R115, R117, or R119 not adjusted properly. 2. Resistors R111 through R119, or R121 wrong value. 3. Transistor Q9 or Q10, or diode D1, D2, or D3.

OSCILLOSCOPE WAVEFORM PATTERNS

To check for the presence of waveforms shown in the charts (fold-out from this page and from Page 44), use an oscilloscope capable of the settings given. Set up the oscilloscope for line triggered sync and use a high impedance, low capacitance probe.

1. Set the Multimeter as follows:

   A. Set the POLARITY switch at +.

   B. Set the FUNCTION switch at DCV.

   C. Set the RANGE switch at 2.

2. Connect the common lead of the oscilloscope to the C input jack on the Multimeter.

3. Adjust the oscilloscope for the designated vertical and horizontal settings for the waveform to be observed.

4. Connect or touch the oscilloscope probe tip to the test point and compare the pattern to the one in the chart. If you do not obtain the proper waveform, look at the "Possible Cause of Improper Waveform" column to determine the problem.

5. If you do not see the proper waveform display at the first test point tried, check lower numbered steps until you do observe the desired display. The difficulty will then be covered by the following step.

FACTORY REPAIR SERVICE

You can return your completed kit to the Heath Company Service Department to have it repaired for a minimum service fee. (Kits that have been modified will not be accepted for repair.) Or, if you wish, you can deliver your kit to a nearby Heathkit Electronic Center. These centers are listed in your Heathkit catalog.

To be eligible for replacement parts under the terms of the warranty, equipment returned for factory repair service, or delivered to a Heathkit Electronic Center, must be accompanied by the invoice or the sales slip, or a copy of either. If you send the original invoice or sales slip, it will be returned to you.

If it is not convenient to deliver your kit to a Heathkit Electronic Center, please ship it to the factory at Benton Harbor, Michigan and observe the following shipping instructions:

Prepare a letter in duplicate, containing the following information:

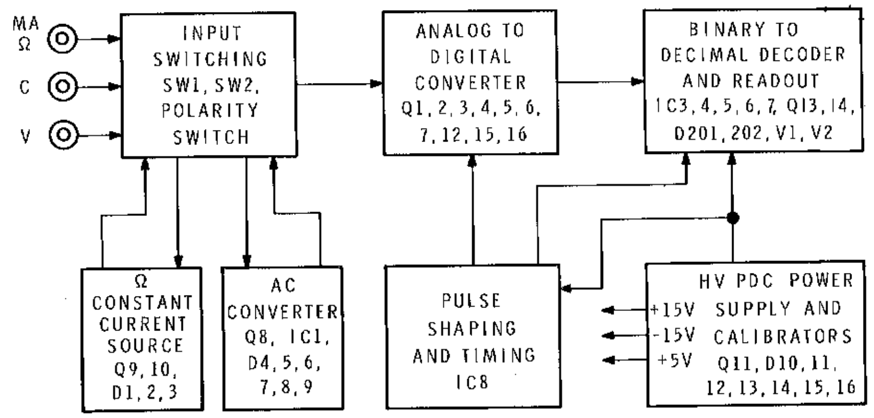
- Your name and return address.
- Date of purchase.
- A brief description of the difficulty.
- The invoice or sales slip, or a copy of either.
- Your authorization to ship the repaired unit back to you C.O.D. for the service and shipping charges, plus the cost of parts not covered by the warranty.

Attach the envelope containing one copy of this letter directly to the unit before packaging, so that we do not overlook this important information. Send the second copy of the letter by separate mail to Heath Company, Attention: Service Department, Benton Harbor, Michigan 49022.

Check the equipment to see that all parts and screws are in place. Then, wrap the equipment in heavy paper. Place the equipment in a strong carton, and put at least THREE INCHES of resilient packing material (shredded paper, excelsior, etc.) on all sides, between the equipment and the carton. Seal the carton with gummed paper tape, and tie it with a strong cord. Ship it by prepaid express, United Parcel Service, or insured parcel post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

RED LEAD INPUT) TO
Black lead (C input)
DC CAL TP



BLOCK DIAGRAM

IV. DC AT A to D CONVERTER (EMITTER OF Q1)

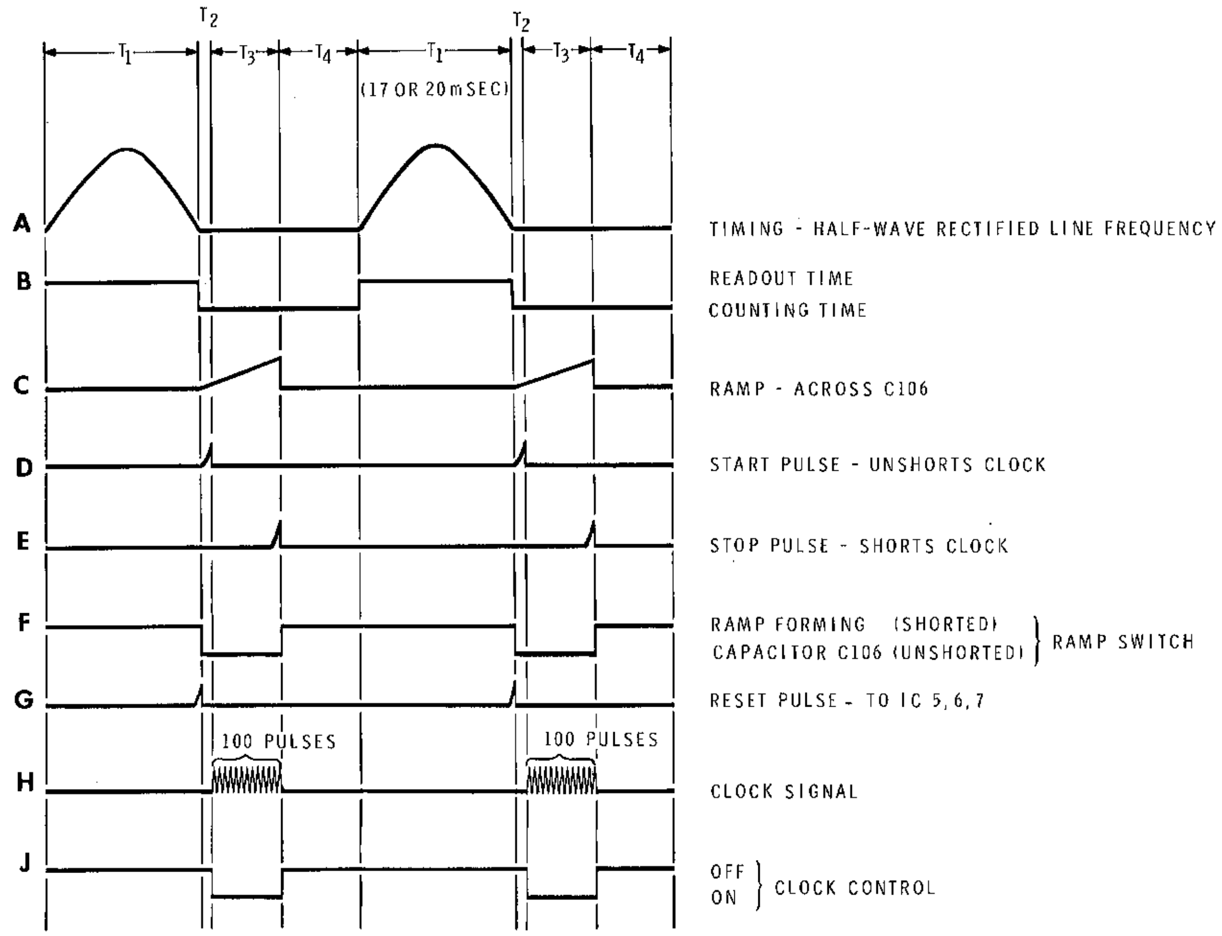


Figure 7

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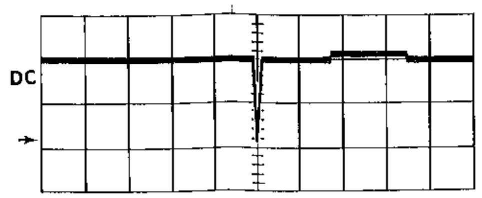
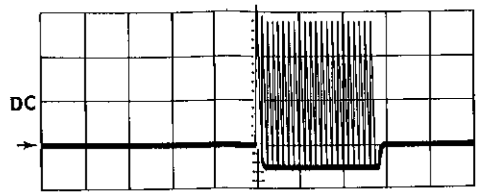
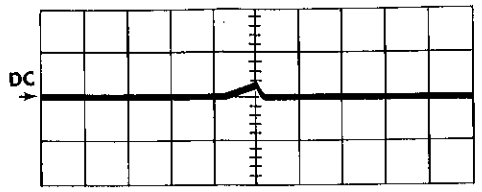
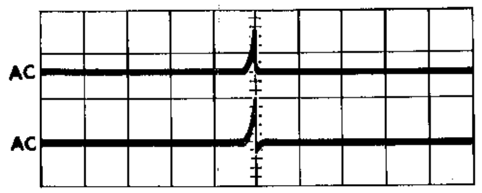
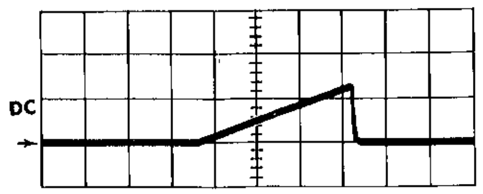
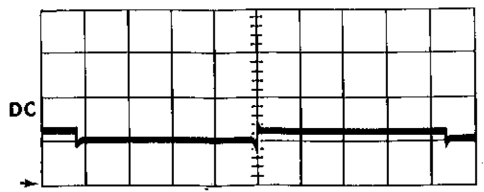
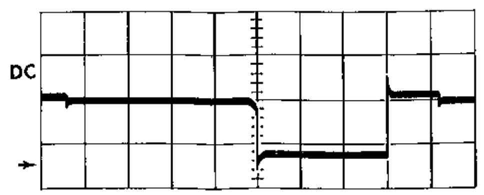
WAVEFORMS (Continued)

	TEST POINT	OSCILLOSCOPE Vertical: Volts/cm	OSCILLOSCOPE Horizontal: m sec	INPUT COUP-LING	Waveforms (DC zero-volt reference point indicated by arrowhead)	POSSIBLE CAUSE OF IMPROPER WAVEFORM
7	IC8, pin 11	2	2	DC		1. Pin 13 not held high (+5 VDC). 2. IC8. 3. Solder bridge.
8	IC7, pin 14 (2 VDC input)	2	2	DC		1. No signal from transistor Q15. 2. Solder bridge.
9	Q1, base (input shorted)	2	2	DC		1. Capacitor C106. 2. Transistor Q5 "on" (emitter negative to base and collector). 3. Transistor Q7.
10	IC2: (input shorted) Pin 6 Pin 12	 .5 .5	 1 1	 AC AC		1. Pin 6: A. Transistor Q1 or Q4 (check voltages). B. Control R152 misadjusted. Pin 12: A. Transistor Q2, Q3, or Q6 (check voltages). B. Control R152 misadjusted.
11	Q1 base (2 VDC input)	2	2	DC		1. Transistor Q1. 2. Check for input to Q1 base. 3. Check meter switch positions. 4. Should be 1 MΩ from V panel jack to Q1 emitter.
12	D17 anode (input shorted)	1	2	DC		1. Diode D17. 2. Control R204 or R210. 3. IC2.
13	D17 anode (2 VDC input)	1	2	DC		1. Refer to step 12.

REPLACEMENT PARTS AND PRICE INFORMATION

To order Replacement Parts: Use the Parts Order Form furnished with this kit. If one is not available, see "Replacement Parts" in the "Kit Builders Guide."

The prices in the Parts Lists apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering from a Heathkit Electronic Center to cover local sales tax, postage, and handling. Outside the U.S.A., parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties, and rates of exchange.

SPECIFICATIONS

Functions	DC volts, DC current, AC volts, AC current, ohms.
Ranges (Full Scale)	DC volts: 0-2, 20, 200, 1,000 V. DC current: 0-2, 20, 200, 2,000 mA. AC volts: 0-2, 20, 200, 700 V rms (25 Hz to 10 kHz). AC current: 0-2, 20, 200, 2,000 mA rms (25 Hz to 10 kHz). Ohms: 0-200, 2K, 20K, 200K, 2,000K ohms.
Overrange	25% on all functions, within maximum input limits.
Maximum Input Without Damage	3 amperes into AC or DC mA, and Ohms (fuse protected). 700 VAC rms into Volts (except 2 V range: 140 VAC rms). 1000 VDC into Volts (except 2 V range: 200 VDC).
Resolution (low range)	Volts: 10 mV. Current: 10 μA. Ohms: 1 ohm.
Display	2-1/2 digit numeric.
Accuracy (Full Scale ±1 digit)	DC volts ±1%. DC current ±1.5%. AC volts ±1.5%. AC current ±1.5%. Ohms ±2%.
Input Impedance	1 megohm on all voltage ranges. 2 V drop maximum on current ranges.
Sample Rate	Line frequency.
Power Requirements	110-130 VAC/220-260 VAC, 50/60 Hz, 8 watts.
Dimensions (overall)	7-3/4" high, 5-3/16" wide, 3-1/8" deep.
Weight	2-1/2 pounds (1.2 kg).

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

CIRCUIT DESCRIPTION

Refer to the Schematic Diagram (fold-out from Page 63) and the Block Diagram (fold-out from Page 50) while you read the following description.

To help you locate parts in the Meter or on the Schematic, the resistors, capacitors, and other components are numbered in the following groups. NOTE: Transistors, diodes, integrated circuits, and tubes are numbered without regard to specific grouping.

0-99	Chassis mounted parts.
100-199	Parts mounted on the main circuit board.
200-299	Parts mounted on the logic circuit board.

Selected inputs of resistance, current, or voltage to be measured are directed through the contacts of the Polarity switch, the Function switch, and through the scaling networks of the Range switch to the input of the A to D (analog-to-digital) converter. Inputs other than DC volts are directed through conversion circuits. The result of switching, scaling, and conversion is that all inputs are converted to a proportional DC voltage level acceptable by the A to D converter.

The analog-to-digital converter converts the input DC voltage to a pulse count during a time period. This time period allows a clock oscillator to generate a number of pulses which are directly proportional to the DC input level. After passing through the decade divider and the decoder driver circuits, the number of gated pulses from the clock oscillator are displayed by the digital readout tubes.

BASIC MEASURING CIRCUIT

The basic measuring circuit is a monopolar analog-to-digital converter using a single ramp technique along with a stable oscillator for long-term accuracy. All inputs are converted to +DC volts before being applied to the A to D converter. Negative DC voltage or current is first inverted by the Polarity switch. Full scale input voltage to the A to D converter is +2 volts DC, regardless of the selected function or range.

If the input exceeds 2 volts DC, it is scaled down to 2 volts or less by the range switch before it enters the converter. AC voltages are converted to +DC by an average-sensing, rms calibrated operational rectifier circuit. When DC current is measured, a precision resistor is placed in shunt with the input to the A to D converter. For AC current, the shunt resistor is placed across the input to the AC converter. The voltage developed across the shunt resistor is thus measured, rectified if AC, and applied to the input of the A to D converter.

Resistance is measured by routing a calibrated constant current through the unknown resistance. The voltage drop developed across the unknown resistance is applied to the input to the A to D converter.

Timing for the conversion and readout circuits is controlled by the cyclic rate of the AC line frequency. The display tubes are illuminated only during the positive portions of the half-wave rectified high voltage pulses, and the A to D converter is cut off and no oscillator pulses are generated during this time. During the zero-level portion of the rectified high-voltage pulses, the readout is extinguished and a pulse is generated to reset the decade dividers to zero. Then the clock oscillator output is counted. The pulses are routed to the decoder network and applied to the readout tubes before the next half-wave voltage disables the oscillator and turns on the display tubes. The counting and readout time is equally divided, and both occur in slightly less than 17 milliseconds for the 60 Hz line frequency, and in 20 milliseconds for a 50 Hz line frequency. Normal persistence of vision does not permit the eye to detect the on-off operation of the readout tubes. Thus the display appears to be constant to the observer and provides a pseudo type of memory for the count.

INPUT SWITCHING

DC Current

DC Current is applied to the meter through the mA-Ω jack and the C jack on the front of the Meter. After passing through contacts on wafer 1 of the Function switch (FS1) and contacts of the Polarity switch, the current is routed to lugs 2 and 7 of FS4. As the current passes through lug 7 of FS4, and through a shunt resistor (R106 through R109 selected by range switch wafer RS2R), a voltage is developed across this shunt. This DC voltage is then applied to lug 2 of FS4 and through lug 1 of FS4 to the input of the A to D converter (the emitter of transistor Q1).

DC Voltage

When a DC voltage is being measured it is routed through the V input jack to lug 10 on FS1, through the switch contacts to lug 9 of FS1, and then to the Polarity switch. Voltage from the Polarity switch is routed through lugs 4 and 3 of FS1. The voltage is then applied to a voltage divider network on the range switch (RS2) consisting of precision resistors R101 through R104. A DC voltage developed across this divider, proportional to the input voltage, is routed through FS4 contacts and to the A to D converter input circuit.

AC Voltage

AC voltage is routed in the same manner as DC voltage through the input switching, until it passes through the voltage divider network, R101 through R104, on the Range switch where a proportionate voltage is developed. This scaled AC voltage is then applied to the AC converter through FS2, lugs 10 and 7. The DC output of the AC converter is routed through lugs 4 and 5 of FS4, to lug 1 of FS4, and then to the input of the A to D converter.

AC Current

AC current is directed through Function switch contact and into the shunt resistors of the Range switch, where a proportional voltage is developed, as in the case of the DC current. This AC voltage developed across a shunt resistor is applied through the AC converter, in the same manner as the AC voltage previously described. The resultant DC voltage is routed to the Function switch wafer 4 contacts, and then to the input of the A to D converter.

Resistance

When a resistance is being measured, the mA–Ω input lead is connected through lugs 7 and 8 of FS1, through contacts 7 and 11 of the Polarity switch (in the + position), and through lugs 1 and 2 of FS1 to lugs 7 and 12 of FS4. From this point, the unknown resistance is connected to the collector of constant current source transistor Q10, through diode D2 and resistor R132. Depending on the ohms range selected by the Range switch, a selected, calibrated resistance is placed in the emitter circuit of transistor Q10 and controls the level of the constant current through the circuit. Calibration resistances are composed of resistors R111 and R112 in the 2M circuit, R113 and R114 in the 200K circuit, R115 and R116 in the 20K circuit, R117 and R118 in the 2K circuit, and R119 and R121 in the 200 Ω circuit. A constant current passed through the unknown resistance will develop a voltage that is proportional to the value of that resistance. This voltage is then applied through lugs 6 and 1 of FS4 to the input of the A to D converter.

Ohms Constant Current Source

Transistors Q9 and Q10; diode D3; and resistors R111 through R119, R121, and R137 are the main components

for the OHMS constant current source. Diodes D1 and D2 are protection devices to prevent destruction of this circuit if the input leads are inadvertently connected across a voltage source. Transistor Q9 is connected as a zener diode. Transistor Q9, diode D3, and resistor R137 will maintain a constant bias for Q10, which is determined by the current through the Q10 emitter resistors (R111 through R119 and R121). The variable resistors are adjusted to allow the correct amount of current to flow through Q10 and each of the standard calibration resistors to provide a +2-volt DC level to be applied to the A to D converter for each range selected.

A 200 ohm resistor will require 10 milliamperes of current to develop a 2-volt drop across it. Therefore, resistor R119 is adjusted for a constant current of 10 mA when the Function switch is in the kΩ position, the Range switch is in the 200 Ω position, and a 200 Ω resistor is across the Ω and C input jacks of the Multimeter. Each of the remaining ohm ranges will divide the amount of constant current by ten so that as the range is decaded up, the current is decaded down to maintain a 2-volt DC level for full-scale readings on all five ranges.

AC Converter

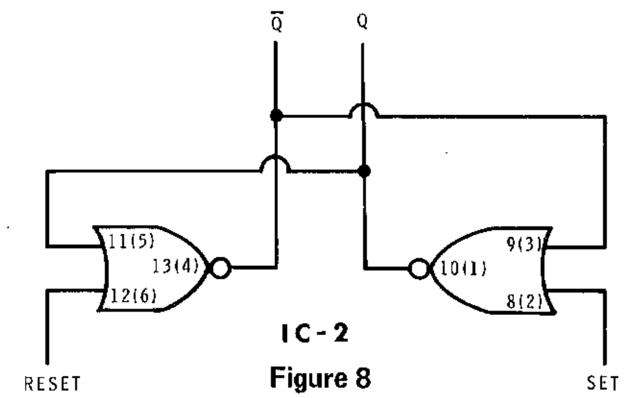
The AC converter consists of transistor Q8, IC1, and the associated components to function as an operational rectifier having a gain such that the average rectified voltage of a sine wave will produce a DC voltage equal to the rms value of the applied input AC voltage. Capacitor C103 will prevent DC from entering the converter and diodes D4 and D5 are protection diodes to limit the input voltage for safe operation of Q8. Q8 is a source follower (a buffer stage) that provides a high input impedance at its input and a low output impedance to the operational amplifier, IC1. R153 is for DC stability, D8 and R154 provide negative feedback during negative inputs, and D9 and R155 provide negative feedback during positive inputs. R156 and R167 adjust the gain of IC1 to provide a DC voltage to the input of the A to D converter which is equal to the rms value of the AC voltage input to Q8. R129, R128, and C104 filter the half-wave voltage before it is applied to the A to D converter. C101, R133, and C105 give additional filtering for all inputs regardless of the function.

ANALOG-TO-DIGITAL CONVERTER

Refer to the waveshapes in Figure 7 (fold-out from Page 50) while you read the following information.

When a DC voltage is applied to the emitter of transistor Q1, the A to D converter will function as follows:

During time T1 (waveform A), the display is illuminated and the A to D converter is disabled. At the start of T2, the display is extinguished and the base of transistor Q5 goes low (waveform F). This removes the short across capacitor C106 and allows C106 to take on a charge by the current from transistor Q7, a constant current source. This charge is in the form of a ramp (waveform C). The termination of time T1 also produces a reset pulse (waveform G) to clear the counting circuit (IC's 5, 6, and 7) to zero for the start of another count. At the end of time T2, the voltage across capacitor C106 is at a level that permits transistor Q2 to conduct, lowering the voltage at its collector. This lower voltage at Q2's collector is inverted and amplified by transistor Q6 and applied at the input to IC2, which is wired as an R-S (Set-Reset) flip-flop (see Figure 8). The "high" at the reset input, pin 12, produces a "low" at the $\overline{Q}$ output, pin 13; this in turn turns off transistor Q3 and then transistor Q2. This forms a short start pulse (waveform D) and produces a "low" at the base of transistor Q12 (waveform J) which removes the short from clock oscillator transistors Q16 and Q15 and allows the oscillator to produce a series of pulses until a stop pulse is generated to disable the oscillator.



IC-2

Figure 8

As an example, assume a 1-VDC input to the emitter of transistor Q1. This will cause a display of 100 on the readout tubes. When the ramp amplitude reaches the Q1 emitter voltage, plus the .6 to .8 volt forward base-to-emitter drop, Q1 will conduct and quickly lower the Q1 collector voltage. This negative going pulse is inverted by transistor Q4 which places a "high" on the input to the Stop R-S flip-flop, pins 1 through 6 (see Figure 8). The output (pin 1 of IC1) of the Stop R-S flip-flop will go high and allow transistor Q5 to conduct and discharge capacitor C106. This cuts off transistor Q1 to form the stop pulse (waveform E). The start and stop R-S flip-flops form a latching circuit to control the switching operation of transistor Q12 (waveform J), which controls the on/off period of the clock oscillator (waveform H). The clock frequency is adjusted with R207 so that one volt of DC applied to the emitter of Q1 will produce 100 pulses at the input to the counter circuits.

BINARY TO DECIMAL READOUT

The output string of clock oscillator pulses from the collector of oscillator transistor Q15 is applied to pin 14 of decade counter IC7. In IC7 the pulses are counted, and every tenth pulse (carry pulse) is connected from output pin 11 to input pin 14 of IC6. Once again, each tenth pulse is applied from output pin 11 of IC6 to input pin 1 of IC5. IC5 is a dual J-K flip-flop, each of which divides its input by two. This first carry pulse from pin 11 of IC6 will produce a "high" at pin 12, the Q output of FF1, and allows Q14 to conduct and illuminate DS202, the "ONE" lamp. The second pulse from IC6 will produce a low at FF1's Q output and extinguish the "ONE" lamp. The Q output of FF1 is connected to the CP input of FF2. The second pulse from the Q output of IC6 will produce a "high" at the base of transistor Q13 and complete the circuit for DS201 and illuminate the "OVER" lamp. The reset pulse to clear IC5 requires a pulse opposite that of the two decade counters, IC6 and IC7. Therefore the IC6 and IC7 reset pulse is inverted by IC8B before it is applied to IC5. In this manner, pulses are counted in units, tens, and hundreds in the decade counter IC's. Decoder drivers, IC3 and IC4, convert the binary count to decimal and drive the corresponding numerals in the readout tubes.

During the period in which the pulses are being coupled into the counter circuits, readout illumination is disabled by the absence of line frequency rectified pulses. When the binary information has been stored in the decoder drivers and the oscillator input is complete, the anode voltage to the readout tubes is raised to a high level and the appropriate numerals are illuminated. The repetition rate is such that the output display appears to be continuous to the observer.

POWER SUPPLY

The blue-leads winding of the power transformer, diodes D11 and D12, capacitor C114, zener diode D10, and transistor Q11 make up the regulated +5-volt DC power supply. The black lead of the transformer is the center tap for this full-wave winding and is connected to the Multimeter circuit ground. Transistor Q11 is a zener-controlled, Darlington, pass transistor stage. The output voltage at the emitter of Q11 remains constant over a wide range of input voltage and output load and current. Diode D10 and resistors R148 and R149 are factory selected components which provide an accurate, near full-scale voltage reference for DC calibration.

The yellow-leads winding of the power transformer; diode D13; capacitors C117, C115, and C116; resistor R158; and zener diodes D14 and D15 are the components of the +15-volt and −15-volt regulated supply. Because of the uniformity of the the current demand, a pass transistor is unnecessary. Resistor R151 limits the current to zener diode D10. The junction between zener diodes D14 and D15 center taps the supply voltage, and references both the positive and negative voltages to ground.

The red power transformer winding creates a secondary step-up voltage. This voltage is the supply that enables the readout tubes to be fired at the proper time, and also supplies the power for the four neon lamps used to illuminate the "+", "−", "1", and "OVER" symbols. The rectified AC pulses that control the oscillator and readout timing are derived from this circuit. The black transformer lead also connects this transformer circuit to the circuit and chassis grounds.

Resistors R161 and R163, plus AC TP ADJ control R162, provide the Meter with a transfer method for the calibration of the AC converter.

Resistors R218 and R219 in the pulse shaping network of IC8 form a voltage divider to attenuate the half-wave voltage to a level suitable to drive IC8.

The primary winding of power transformer T1 may be wired for a source voltage of either 120-volts or 240-volts AC, 50 to 60 Hz. Capacitor C118 connects the power line ground to circuit ground to eliminate shock hazard and to minimize A to D converter "hunt" while measuring any power line voltage or current.

Separate resistor standards on the main circuit board; R123, R124, R125, R126, and R127, permit full-scale calibration of the Meter ohms ranges.

CIRCUIT BOARD X-RAY VIEWS

NOTE: To identify a part shown in one of these Views, so you can order a replacement, proceed in either of the following ways:

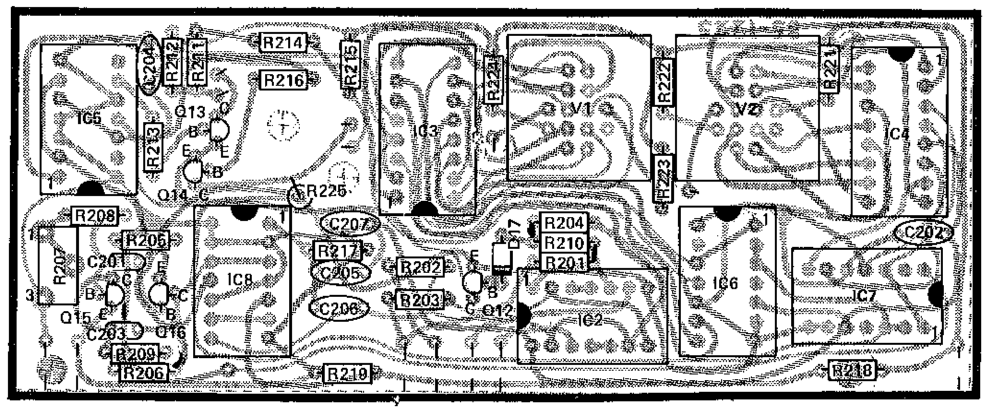
1. A. Refer to the place where the part is installed in the Step-by-Step instructions and note the "Description" of the part (for example: 22 kΩ, .05 μF, or 2N3638A).

   B. Look up this Description in the "Parts List."

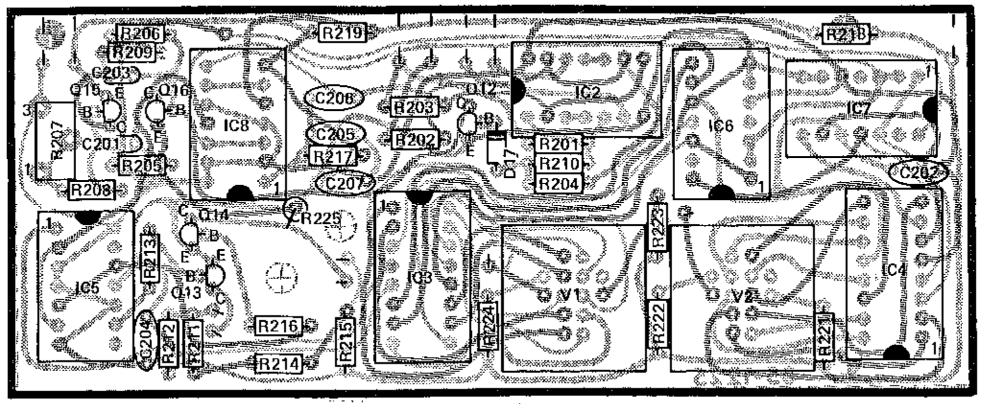
2. A. Note the identification number of the part (R-number, C-number, etc.).

   B. Locate the same identification number (next to the part) on the Schematic. The "Description" of the part will also appear near the part.

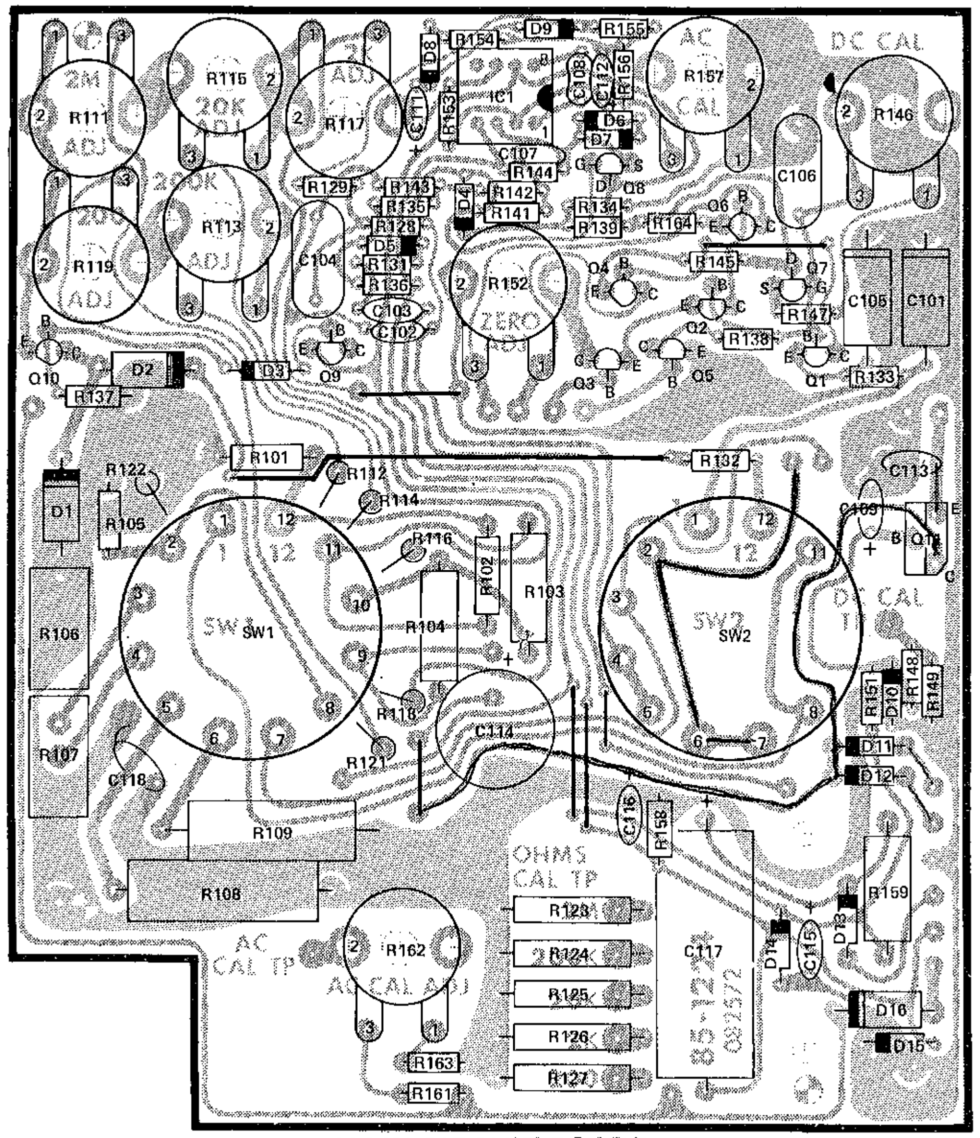
   C. Look up this Description in the "Parts List."



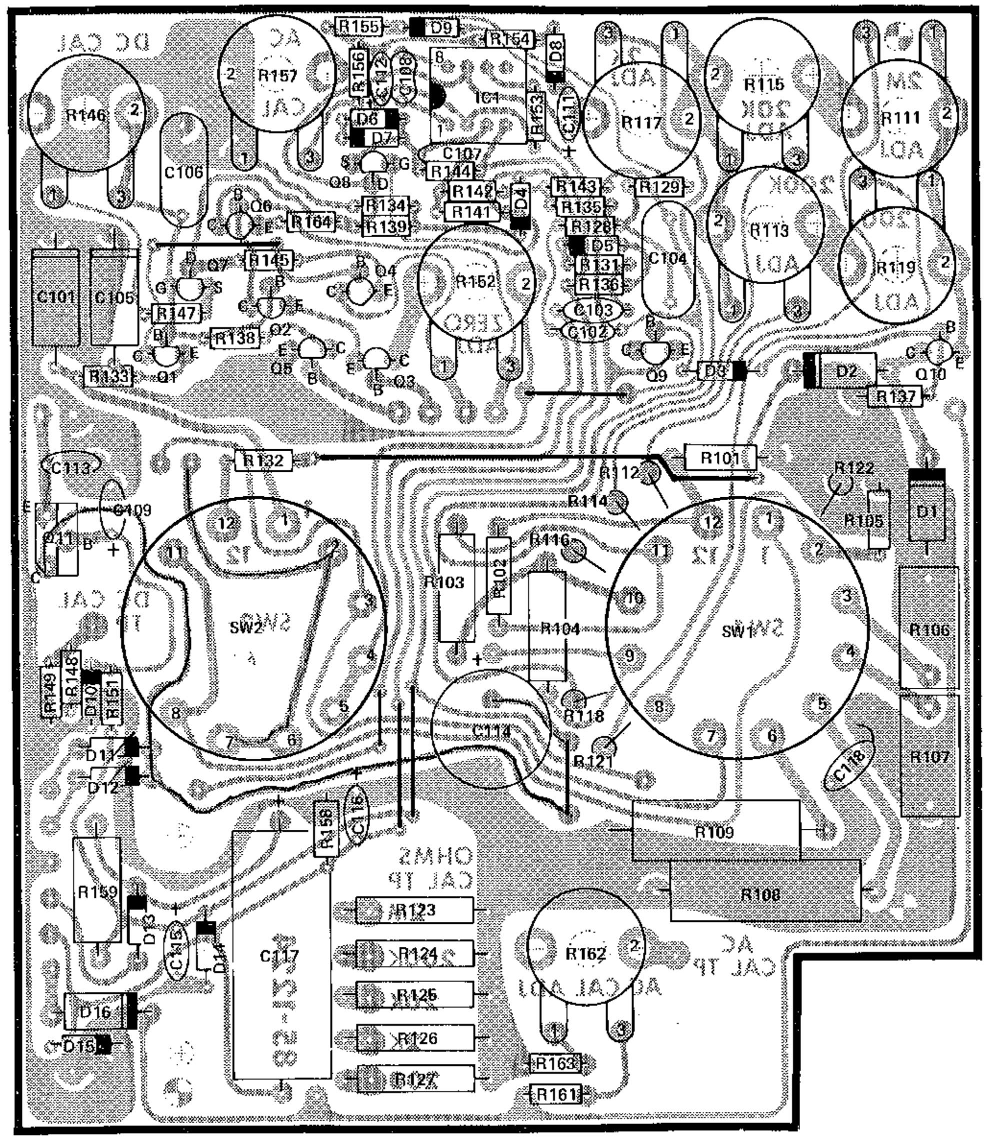
LOGIC CIRCUIT BOARD
(Viewed from foil side)



LOGIC CIRCUIT BOARD
(Viewed from component side)

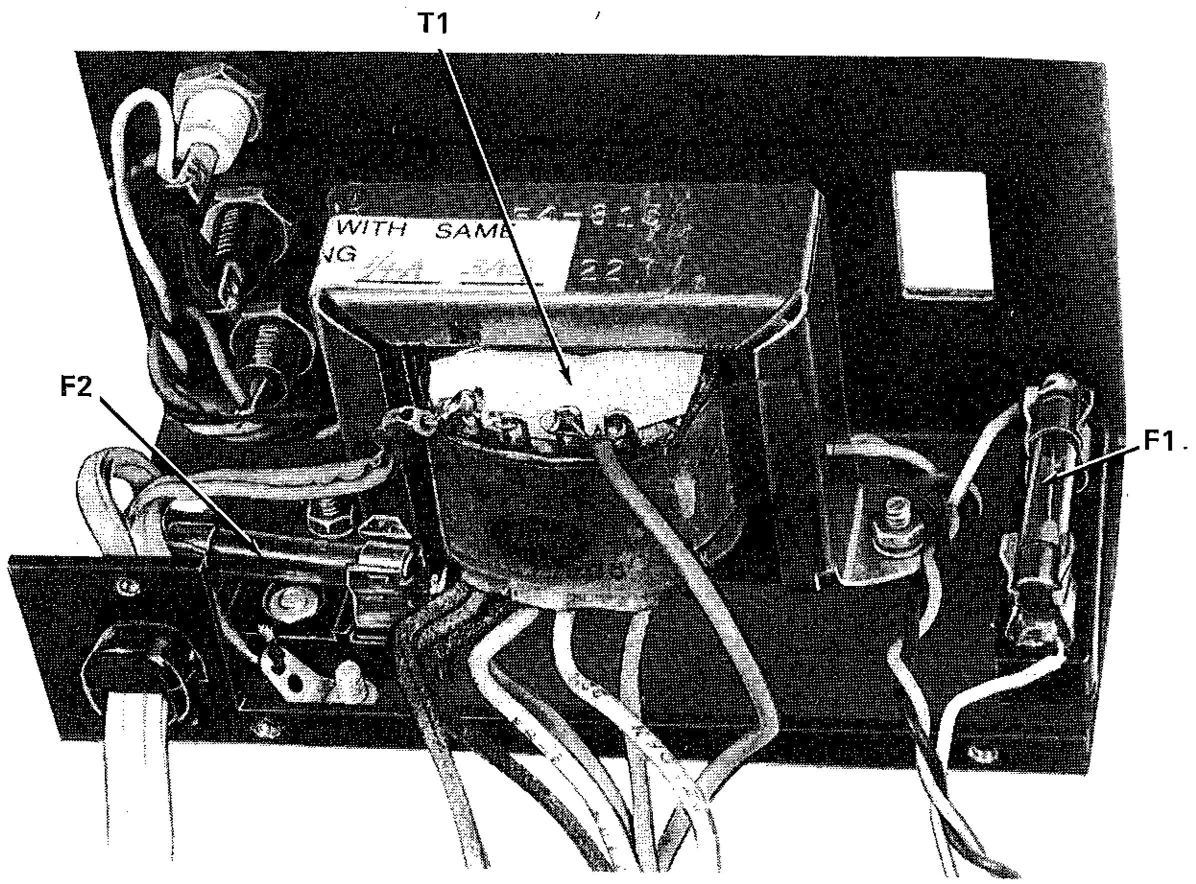


MAIN CIRCUIT BOARD
(Viewed from foil side)

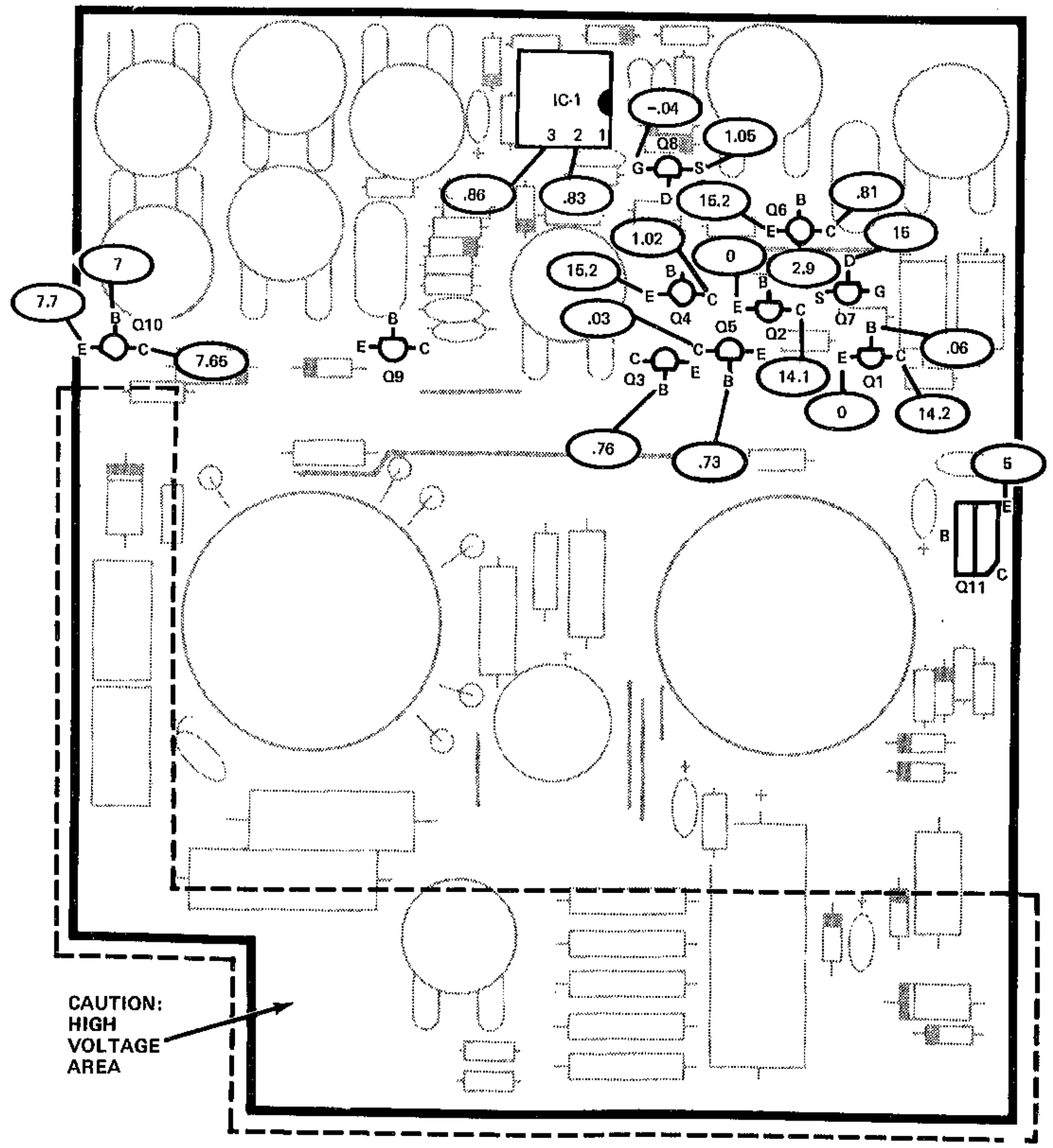


MAIN CIRCUIT BOARD
(Viewed from component side)

CHASSIS PHOTOGRAPH



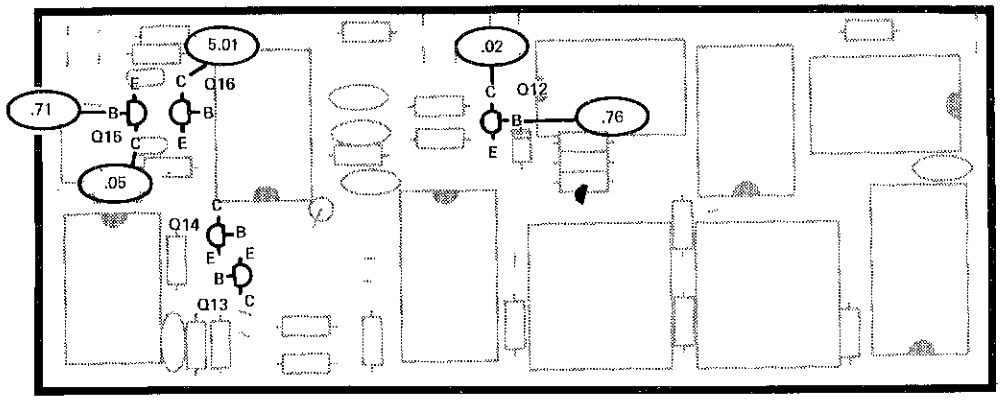
CIRCUIT BOARD VOLTAGE CHARTS



NOTE: VOLTAGES SHOWN ARE TAKEN UNDER THE FOLLOWING CONDITIONS:

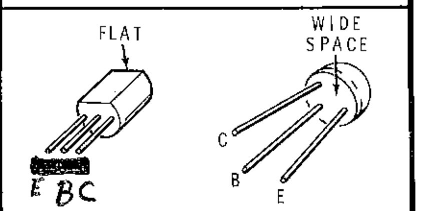
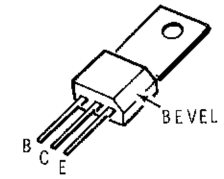
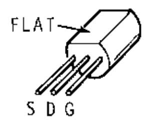
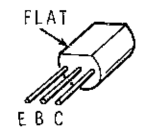
FUNCTION SWITCH: DC.
RANGE SWITCH: 2 VOLTS.
INPUT: V LEAD SHORTED TO C LEAD.

MAIN CIRCUIT BOARD
(Viewed from foil side)



LOGIC CIRCUIT BOARD
(Viewed from component side)

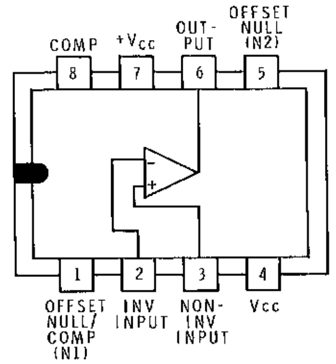
TRANSISTOR BASING DIAGRAMS

COMPONENT	HEATH PART NUMBER	TYPE	CASE DIAGRAM
Q4, Q6, Q10	417-234	2N3638A	
Q11	417-272	D40C1	
Q7, Q8	417-291	2N5458	
Q1, Q2, Q3, Q5, Q9, Q12, Q15, Q16	417-801	MPSA20	
Q13, Q14	417-294	MPSA42	

INTEGRATED CIRCUIT PIN-OUT DIAGRAMS

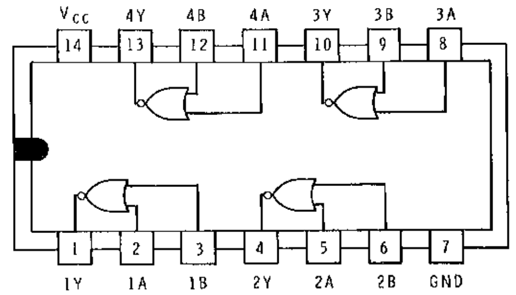
(ALL DIAGRAMS SHOWN FROM TOP)

IC1



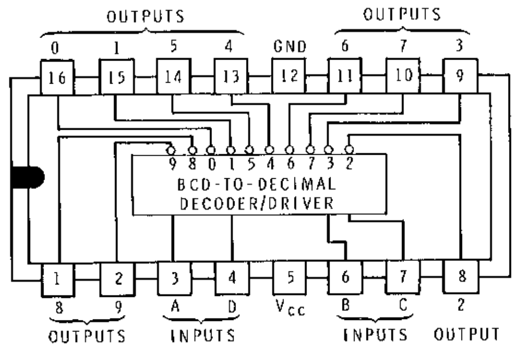
301A LINEAR
OPERATIONAL AMPLIFIER
#442–39

IC2



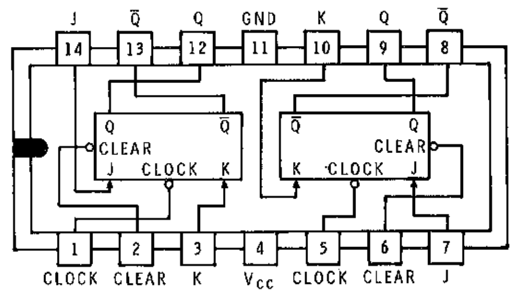
7402 QUADRUPLE–2 INPUT
POSITIVE NOR GATE
#443–46

IC3
IC4



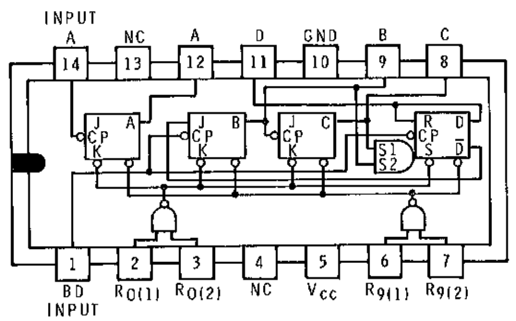
7441 BCD–TO–DECIMAL
DECODER/DRIVER
#443–35

IC5



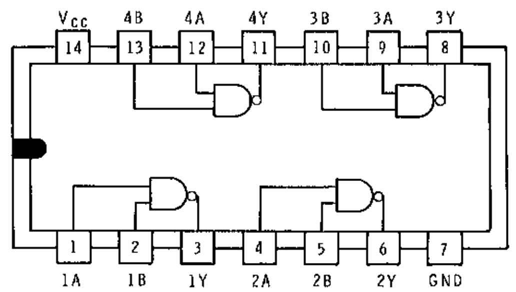
7473 DUAL J–K MASTER
SLAVE FLIP–FLOP
#443–5

IC6
IC7



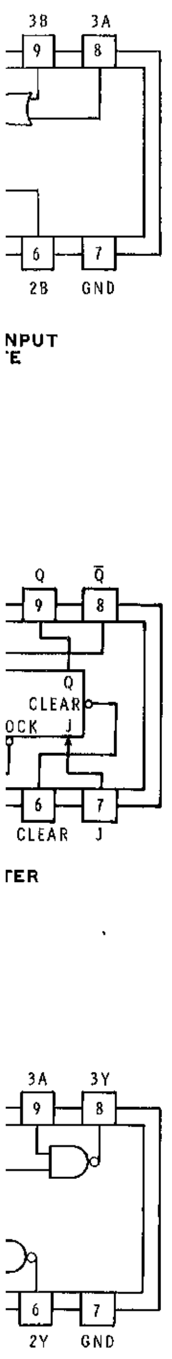
7490 DECADE COUNTER
#443–7

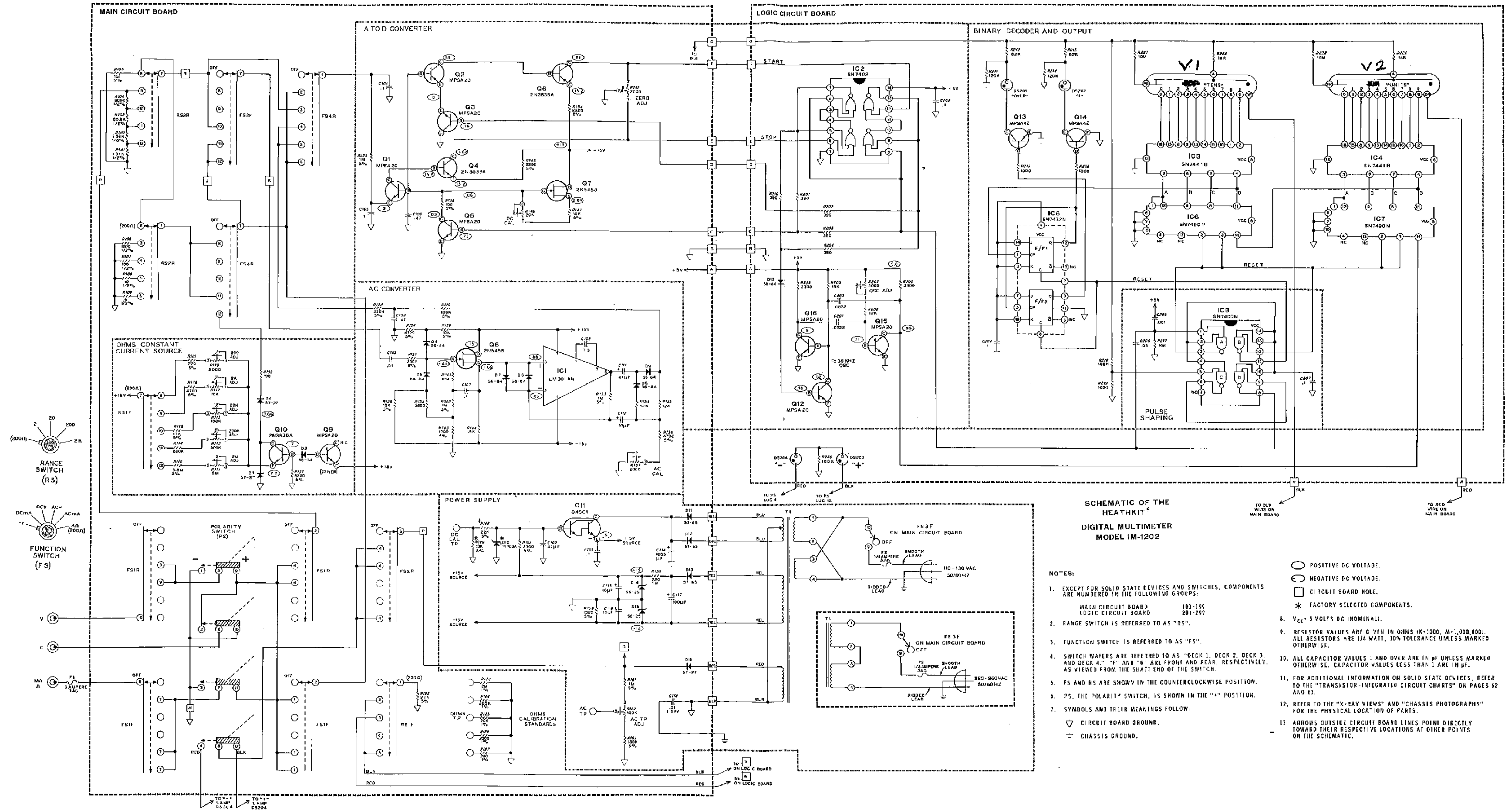
IC8



7400 QUADRUPLE 2–INPUT
POSITIVE NAND GATE
#443–1

IS





SCHEMATIC OF THE HEATHKIT®

DIGITAL MULTIMETER

MODEL IM-1202

NOTES:

1. EXCEPT FOR SOLID STATE DEVICES AND SWITCHES, COMPONENTS ARE NUMBERED IN THE FOLLOWING GROUPS:

MAIN CIRCUIT BOARD	101-199
LOGIC CIRCUIT BOARD	201-299

2. RANGE SWITCH IS REFERRED TO AS "RS".
3. FUNCTION SWITCH IS REFERRED TO AS "FS".
4. SWITCH WAFERS ARE REFERRED TO AS "DECK 1, DECK 2, DECK 3, AND DECK 4." "F" AND "R" ARE FRONT AND REAR, RESPECTIVELY, AS VIEWED FROM THE SHAFT END OF THE SWITCH.
5. FS AND RS ARE SHOWN IN THE COUNTERCLOCKWISE POSITION.
6. PS, THE POLARITY SWITCH, IS SHOWN IN THE "+" POSITION.
7. SYMBOLS AND THEIR MEANINGS FOLLOW:
   - ▽ CIRCUIT BOARD GROUND.
   - ⏚ CHASSIS GROUND.
   - ⬭ POSITIVE DC VOLTAGE.
   - ⊖ NEGATIVE DC VOLTAGE.
   - □ CIRCUIT BOARD HOLE.
   - * FACTORY SELECTED COMPONENTS.
8. V_{cc} = 5 VOLTS DC (NOMINAL).
9. RESISTOR VALUES ARE GIVEN IN OHMS (K=1000, M=1,000,000). ALL RESISTORS ARE 1/4 WATT, 10% TOLERANCE UNLESS MARKED OTHERWISE.
10. ALL CAPACITOR VALUES 1 AND OVER ARE IN pF UNLESS MARKED OTHERWISE. CAPACITOR VALUES LESS THAN 1 ARE IN µF.
11. FOR ADDITIONAL INFORMATION ON SOLID STATE DEVICES, REFER TO THE "TRANSISTOR-INTEGRATED CIRCUIT CHARTS" ON PAGES 62 AND 63.
12. REFER TO THE "X-RAY VIEWS" AND "CHASSIS PHOTOGRAPHS" FOR THE PHYSICAL LOCATION OF PARTS.
13. ARROWS OUTSIDE CIRCUIT BOARD LINES POINT DIRECTLY TOWARD THEIR RESPECTIVE LOCATIONS AT OTHER POINTS ON THE SCHEMATIC.

HEATH
Schlumberger

HEATH COMPANY • BENTON HARBOR, MICHIGAN

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