Errata

Title & Document Type: **735A DC Transfer Standard Operating and Service Manual**

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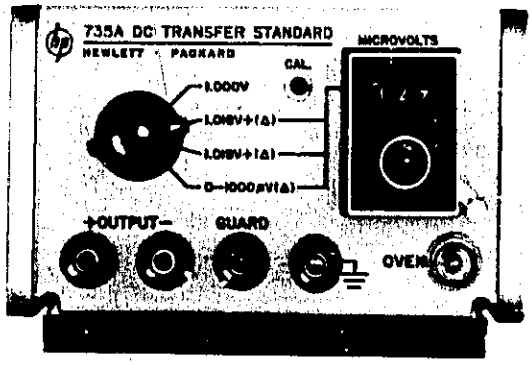
Agilent Technologies

OPERATING AND SERVICE MANUAL

HP 735A

DC TRANSFER STANDARD
735A



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HP 735A

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CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

OPERATING AND SERVICE MANUAL

(HP PART NO. 00735-90002)

MODEL 735A
DC TRANSFER STANDARD

SERIALS PREFIXED: 950-

Appendix C, Manual Backdating Changes, adapts manual to serials prefixed 504-, 547-, and 825-.

P.O. Box 301, Loveland, Colorado, 80537 U.S.A.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

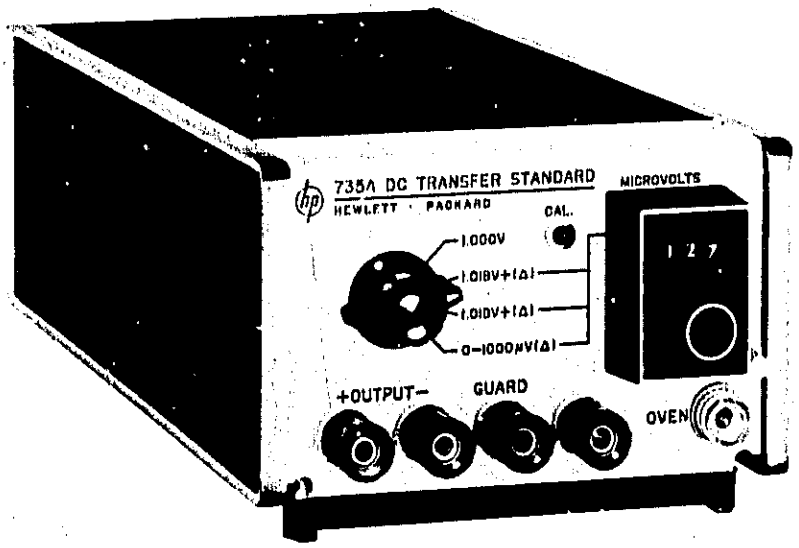


Figure 1-1. Model 735A DC Transfer Standard

Table 1-1. Specifications

Standard Outputs: 1.00000 v; 1.018 +Δ*; 1.019 +Δ*; 0 to 1000 μv Δ*.

Transfer Accuracy: (after 30 min. warmup) 2 ppm between saturated standard cells or unsaturated standard cells; 10 ppm standard cell to 1 volt; 10 ppm saturated standard cell to unsaturated standard cells. (Typically better than 5 ppm.)

Stability: (After 30 min. warmup) Better than 10 ppm/month.

Line Regulation: <1 μv for 10% line change.

Output Impedance: 1 K ohm, ±1%.

Short Circuit Current: <1.5 ma

Temperature Coefficient: <1 ppm/^{o}C, 0^{o} to +50^{o}C.

Variable Output:

RANGE: 0 to 1000 μv

ACCURACY: 0.1% ±1.5 μv

RESOLUTION: 1 μv

OUTPUT IMPEDANCE: 146 ohms ±1%

*A 3-digit direct-reading 0 to 1000 μv offset voltage.

Output Noise: DC to 1 cps: <1 μv p-p. 1 cps to 1 Mc: <100 μv rms.

Output: Floating and guarded.

Power: 115 or 230 volts ±10%, 50 to 1000 cps, approximately 12 watts.

Output Terminals: Four 5-way binding posts. Positive, negative, circuit guard shield, and chassis ground; positive and negative terminals are solid copper with gold flash. A maximum of 500 volts dc may be connected between chassis ground and guard or circuit ground.

Effective Guarded Capacity: <25 pf (capacity) between circuit and chassis ground with shield driven.

Dimensions: Standard 1/3 module, 3-14/32" high, 5-1/8" wide, 11" deep (87 x 130 x 279 mm).

Weight: Net: 5-1/2 lbs. (2.5 kg); shipping: 8 lbs. (3, 6 kg).

SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The -hp- Model 735A is a DC Transfer Standard (Figure 1-1) that may be used as a one volt dc standard, as a standard cell comparator, as a transfer standard for 1.000000 volt and voltages from 1.018000 volts to 1.020000 volts and as a dc supply for voltages from 0 to 1000 microvolts. For accuracy in these various functions, see Table 1-1, Specifications.

1-3. A function selector switch on the front panel selects output voltages of 1.000000 volts, 1.018000 volts +(Δ), 1.019000 volts +(Δ) and (Δ) 0-1000 microvolts. In the 1.019 +Δ position of the function switch, the output voltage may be varied from 1.019000 to 1.020000 with 1 microvolt resolution. The position of the 0-1000 microvolt control determines the last three digits. In the 1.018 +Δ position of the function switch, the output voltage may be varied from 1.018000 to 1.019000 with a 1 microvolt resolution. In the 1.000 volt position, the voltage can not be varied. The output is 1.000000 volts. The 0-1000 (Δ) microvolt position of the function switch has a resolution of 1 microvolt using the microvolt control only.

1-4. These voltages are obtained from the positive and negative OUTPUT terminals. An additional two terminals, connected to the guard (shield) and to chassis ground, are located on the front panel for versatile usage.

1-5. APPLICATION.

1-6. The stability and temperature coefficient of the 735A, as well as its small size and ruggedness, mak it adaptable for comparing field instruments against working standards. Although the standard laboratory environment is still the ideal condition for checking precision dc measurements, the stability and accuracy of the standard laboratory may be obtained in the field by using the Hewlett-Packard Model 735A and accurate dc differential or null voltmeters. See Application Note 70 for further methods of using the 735A.

1-7. When using the 735A as a voltage source, the stability is within specifications independent of the load. However, in the first three positions of the function switch, the load must be 100 megohms or more for the accuracy to be within specifications. See Figure 3-2 and the example in the note.

1-8. INSTRUMENT IDENTIFICATION.

1-9. Hewlett-Packard uses a two-section eight-digit serial number (000-00000). If the first three digits of the serial number on your instrument do not agree with those on the title page of this manual, change sheets supplied with the manual will define differences between your instrument and the Model 735A described in this manual.

1-10. If E or G prefixes the serial number, the instrument is manufactured in Europe. E denotes England, and G denotes Germany.

INSTALLATION

SECTION II
INSTALLATION

2-1. INSPECTION.

2-2. This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of mars or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage in transit. Also, test the electrical performance of the instrument using the procedure outlined in Paragraph 5-5. If there is damage in shipping, file a claim with your carrier and refer to the warranty on the inside front cover of this manual.

2-3. INSTALLATION.

2-4. The 735A is a one-third module unit and is designed as a bench-type instrument. If it is desired to rack mount this instrument with other submodule units, the 1051A and 1052A combining cases are designed for this purpose. Contact your local -hp- Sales and Service Office for additional information. (See list in Appendix B for location.) The installation instructions are included with the case.

2-5. The -hp- Model 735A is fully transistorized; therefore no special cooling is required. However, the instrument should not be operated where the ambient temperature exceeds 55°C (131°F).

2-6. THREE-CONDUCTOR POWER CABLE.

2-7. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. All Hewlett-Packard instruments are equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground wire.

2-8. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground (-hp- Part No. 1251-0048).

2-9. PRIMARY POWER REQUIREMENTS.

2-10. The Model 735A is operated from an ac source of either 115 or 230 volts, 50 to 1000 cycles. Before connecting the instrument to a power source, check to make sure that the slide switch, located on the rear panel, designates the voltage to be used.

2-11. REPACKAGING FOR SHIPMENT.

2-12. The following is a general rule for repackaging an instrument for shipment. If you have any questions, contact your local Sales and Service Office (see lists in Appendix for location).

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicating the service or repair to be accomplished; include the model number, and full serial number of the instrument. In any correspondence identify the instrument by model number and serial number prefix.

a. Place instrument in original container if available. If not available, one may be purchased from your nearest -hp- Sales and Service Office.

If original container is not used,

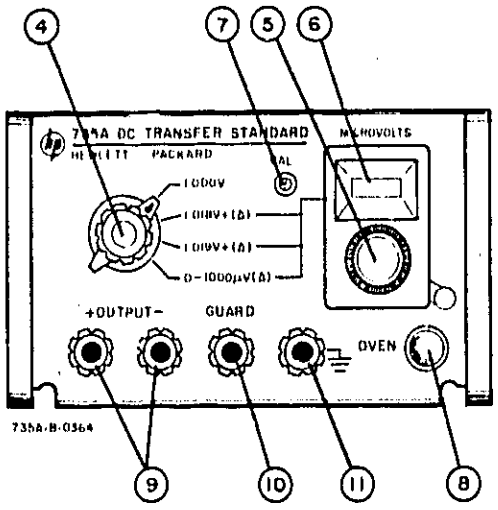
b. Wrap instrument in heavy paper or plastic before placing in inner container.

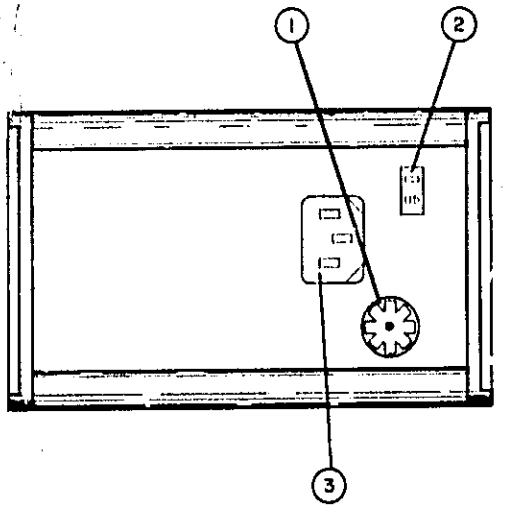
c. Use plenty of packing material around all sides of instrument and protect panel faces with cardboard strips.

d. Use a heavy carton or wooden box to house the instrument and inner container and use strong tape or metal bands to seal the shipping container.

e. Mark shipping container with "Delicate Instrument," "Fragile" etc.

OPERATION





(1) Fuseholder with 3/4 amp fuse.

(2) Slide switch: 115 V/230 V operation (displays source voltage to be used).

(3) Power input connector: connects to a detachable power cable.

(4) Function switch: selects one of four voltage outputs. Delta is from 0-1000 microvolts as selected by control (5) and readout (6). In the second and third position of the function switch, the value selected with (5) and read on (6) is added to the designated voltage at that position. Example: In the second position, (1.018 +Δ), for a voltage output of 1.018xxx volts, the delta control must be set for a readout of xxx; if 1.018 (150) is desired, the delta control must be set to read 150. In the volts position of the function switch, the output voltage will be delta only as adjusted by the control (0 to 1000 microvolts in 1 microvolt steps).

(5) MICROVOLT Control: adjusts the delta voltage in microvolts. Knob in depressed position locks the readout voltage. On later models a lever on the right of the dial assy is depressed to lock.

(6) MICROVOLT Readout: digital reading of delta voltage to three places. If 1000 microvolts is desired turn the control clockwise beyond 999 for a reading of 000. (The one does not show on the readout.) The top stop will read approximately 1002 microvolts.

(7) CAL: fine adjustment for 1.020000 volts or used for exact adjustment to a known voltage when the 735A is used as a transfer standard.

(8) OVEN Light glows brightly for approximately 15 minutes after connected to an external power source, then dims to glow proportionally to the power supplied to the oven heater. This indicates that the operating temperature of the oven has been reached.

(9) Floating OUTPUT Terminals: the output voltage is selected by the function switch and the MICROVOLT control.

(10) GUARD Terminal: connected to the internal chassis (shield).

(11) Chassis Ground (⏚) Terminal: connected to the frame of the instrument and to power line ground.

Figure 3-1. Front and Rear Panel Description

SECTION III
OPERATING INSTRUCTIONS

3-1. GENERAL.

3-2. The -hp- Model 735A DC Transfer Standard has a four position function switch to select the following output voltages: 1.000 volt, fixed; 1.018 volts, variable in microvolt increments to 1.019 volts; 1.019 volts, variable in microvolt increments to 1.020 volts; and 0 to 1000 microvolts with 1 microvolt resolution. These output voltages are applied to the OUTPUT terminals designated + and - according to the position of the selector switch. The output terminal engraved Guard is connected to the two shield boxes inside the instrument which encase a major portion of the components of this instrument. The output terminal marked ⏚ is connected to the outside case of the instrument and to power line ground.

CAUTION

DO NOT APPLY MORE THAN 500 VOLTS BETWEEN ANY TWO OF THESE THREE TERMINALS (-OUTPUT, GUARD, OR CHASSIS GROUND ⏚).

3-3. FRONT AND REAR PANEL DESCRIPTION.

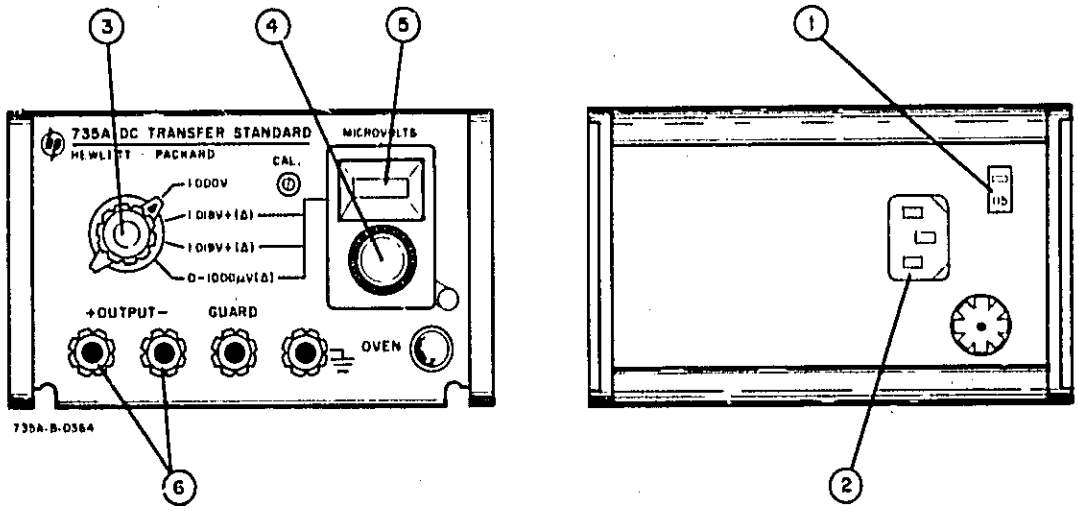
3-4. Figure 3-1 gives the keyed description of the front and rear panel components.

3-5. APPLICATION.

3-6. The stability and accuracy of this instrument, its rugged construction and its selective output voltages make it more advantageous, when used as a DC Standard, than a standard cell. The 735A may be used as a Transfer Standard between saturated or unsaturated standard cells and between a known voltage and an unknown voltage (a precision voltage divider may be used). 0 to 1000 microvolts may be used as a source voltage. See -hp- Application Note 70 for additional advantages and uses.

3-7. OPERATING PROCEDURE.

3-8. Operating instructions for the 735A when used as a DC Standard are given in Figure 3-2. Operating instructions for the 735A when used as a DC Transfer Standard are given in Figure 3-3.



(1) Slide switch: slide the switch to the position so that the source voltage to be used is displayed on the switch.

(2) Power input: connect the detachable power cord to the power input connector and to the power outlet. Before use, let instrument warm up for a minimum of 30 minutes in order to bring the oven to its operating temperature.

(3) Function switch: rotate function switch to the desired output voltage.

(4) MICROVOLT Control: rotate the MICROVOLT control to the desired readout. (If the function switch is in the second or third position, the MICROVOLT control must be rotated to the microvolt to be added to either 1.018000 volts or 1.019000 volts.)

(5) Readout for MICROVOLTS: the readout in microvolts will be the value for delta (Δ) and can be varied from 000 to 1000 (for 1000 microvolts the readout is 000 in a clockwise direction beyond 999).

(6) +OUTPUT-: connect the output terminals to the instrument desired. Use solid copper insulated wire inserted in the hole of the connector. Tighten securely.

NOTE

The 735A should be used as a DC Standard only for high impedance input voltmeters. >100 M Ω; for accuracy with lower impedance loads use the following formula:

$$E_{out} = \frac{RL}{RL + Rs} Eoc$$

where: Rs = source resistance of 735A

(1 K Ω in first positions)

RL = resistance of voltmeter as a load

Eoc = open circuit voltage

Eout = actual output voltage under voltmeter load

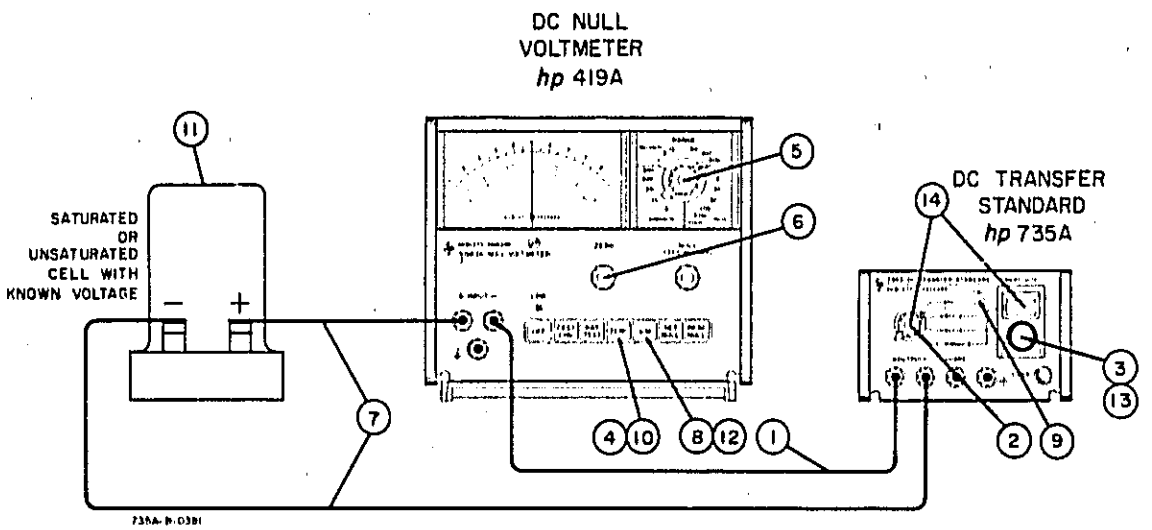
Example: For a load of 10 megohms 735A in the 1 volt position

$$Eout = \frac{10^7 \times 1.000}{10^7 + 1000} = .9999 \text{ volts}$$

Error 1.000 - .9999 = .000100 or 100 ppm

(This is in excess to the error specifications for the 735A.)

Figure 3-2. Operation as a DC Standard



The use of the 735A as a Standard Cell Comparator requires a 419A DC Null Voltmeter, a standard cell or known voltage and other standard cells. Allow the 735A to warm up for approximately 30 minutes. Allow the 419A to warm up 5 minutes.

(1) Connect +OUTPUT of the 735A to -INPUT of 419A with a solid copper insulated No. 16 wire (insert wire in hole of connector and tighten securely).

(2) Rotate the 735A selector switch to the 1.019 +Δ position for unsaturated cell of known voltage or to the 1.018 +Δ position for a saturated cell.

(3) Adjust the MICROVOLTS Control so that its readout added to 1.018 or 1.019 give the exact voltage on the cell certification. (Example: for a cell of 1.018250 set the selector switch to 1.018 +Δ position and the microvolt control to read 250.) Depress MICROVOLTS knob to lock position.

(4) Press ZERO button on the 419A Null DC Voltmeter.

(5) Rotate range switch on 419A to 3 μv position.

(6) Adjust 419A to read zero on the 3 μv range. Then turn range to 300 μv.

(7) Connect the -OUTPUT terminal of the 735A to the -terminal of the Standard Cell. Connect the +terminal of Standard Cell to the +INPUT terminal of the 419A. Use solid copper wire and tighten securely.

(8) Press VM button on the 419A.

(9) With a small screwdriver, adjust the CAL control on the 735A so that the 419A reads zero as the RANGE switch is decreased to the 3 μv range. Now the OUTPUT of the 735A is exactly equal to that of the standard cell.

(10) Depress the ZERO button on the 419A, return range to 300 μv and disconnect the standard cell.

(11) Connect a standard cell with unknown voltage in like manner.

(12) Depress VM button on the 419A.

(13) Adjust MICROVOLTS control on the 735A for a null on the 419A on the 3 μv range.

(14) Record the 735A switch position voltage + the microvolt readout. This is the exact voltage output of the second standard cell. (See specifications for accuracy.)

For additional applications for the 735A Transfer Standard, see Application Note 70.

Figure 3-3. Operation as a DC Transfer Standard

THEORY

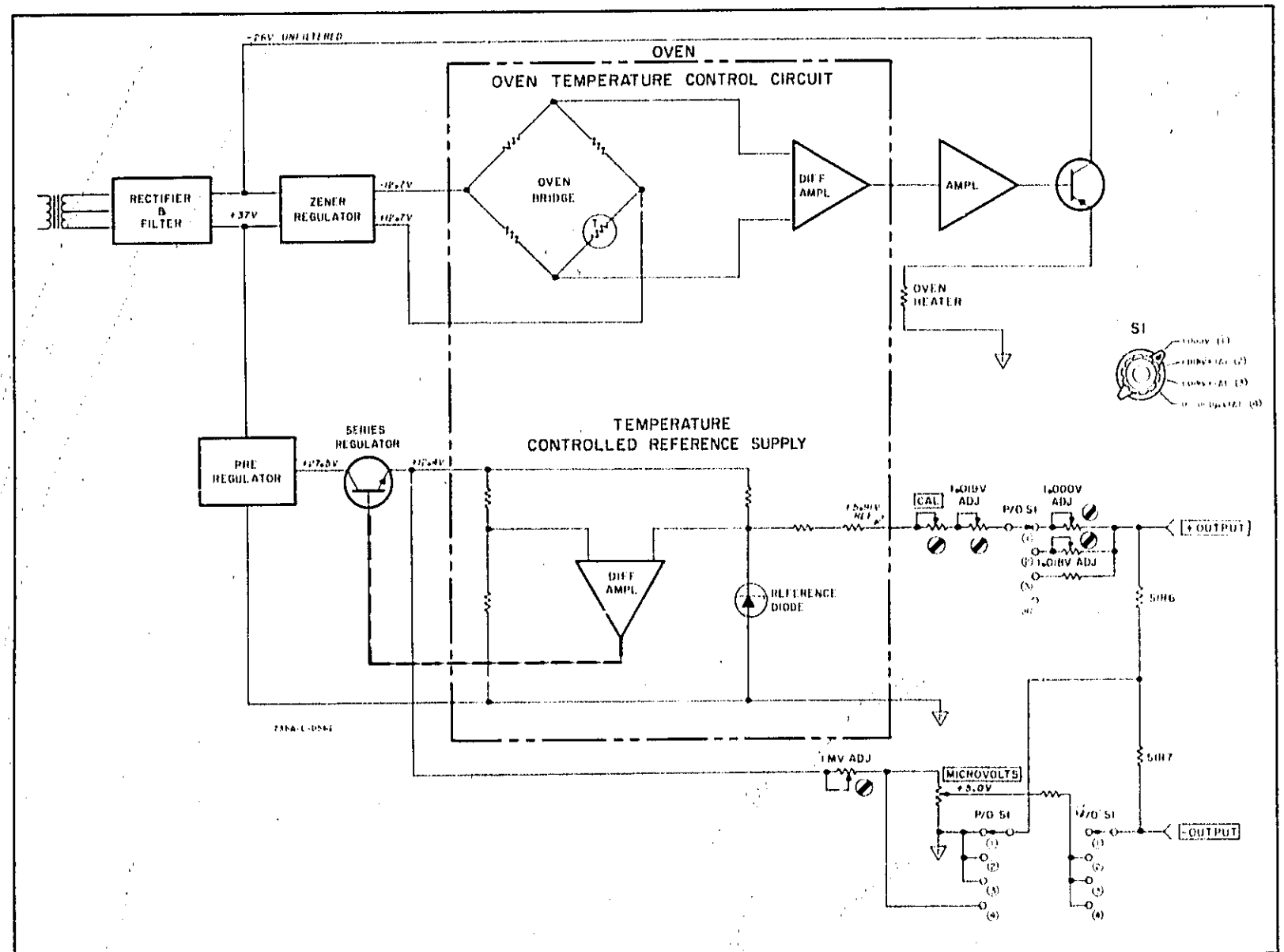


Figure 4-1. 735A Block Diagram

SECTION IV
THEORY OF OPERATION

4-1. GENERAL.

4-2. The -hp- Model 735A DC Transfer Standard is a multipurpose laboratory instrument that may be used as a 1 volt dc standard with standard cell accuracy, as a standard cell comparator, as a transfer standard for other voltages from 1.018 volts to 1.200 volts or as a 0 to 1000 microvolt source. (See Table 1-1 for specifications.)

4-3. This dc transfer standard has four voltage outputs obtained through a selector switch. The basic stability of the 735A is derived from a zener diode reference enclosed in a temperature controlled oven. The various voltage outputs are obtained from voltage divider networks comprised of ultra-stable resistors with matched temperature coefficients. The major portion of these circuits is enclosed within a shield (Guard). Output terminals on the front panel provide positive and negative floating output, shield output and chassis ground output.

CAUTION

THE SHIELD MAY BE DRIVEN BY AN EXTERNAL VOLTAGE NOT TO EXCEED 500 VOLTS DIFFERENCE BETWEEN ANY TWO OF THE BLACK CONNECTORS (-OUTPUT, GUARD AND (⏚) CHASSIS GROUND).

4-4. OVERALL DESCRIPTION.

4-5. Use the 735A Block Diagram, Figure 4-1, and Schematic, Figure 5-9, as referenced for this explanation in its entirety.

4-6. The output of the power transformer is rectified for an output of +37 volts dc and a -26 volts unfiltered using circuit common ⏚ as reference. These voltages are filtered and regulated by zener diodes for an output of approximately +12.7 volts and -12.7 volts. The -26 volts and ±12.7 volts are used for the oven heater circuit. The +37 volts is applied to a dual series voltage regulator circuit utilizing a differential amplifier. The regulated output +12.4 volts is used as a source for the differential amplifier and the zener diode. A selected zener diode is used as the reference for the differential amplifier and as the source for the +5.91 volt reference supply. This diode and the differential amplifier are encased in an oven kept at a constant temperature (+80°C). The 12.4 volts is also applied through an adjustable voltage divider network to the microvolt potentiometer. The high end of this potentiometer (+5 v) and the wiper arm are connected across S1R7 in the output circuit for the fourth (Δ) position of the function switch. S1R6 is shorted in this position to obtain low output impedance (this is not shown in the Block Diagram). In the 1.000 volt position of the function switch, this delta voltage is not used. In the second and third positions of the function switch, the negative reference ⏚ and the wiper arm are connected across S1R7 in such a manner that this voltage opposes the voltage across S1R6. The reference voltage, 5.91 volts, is applied to different voltage divider networks selected by the function switch. Each network includes S1R5 and 6. This provides the 1.000 volt, a 1.019 volts which is opposed by 1000 μv -Δ resulting in the 1.018 +(Δ) output, and a 1.020 volt which is opposed by 1000 μv -Δ, resulting in the 1.019 +(Δ) output.

4-7. BASIC CIRCUITS.

4-8. The -hp- Model 735A Transfer Standard can be divided into three major circuits: 1) the oven temperature control circuit, 2) the reference voltage circuit and 3) the precision voltage divider circuit. Use the 735A Schematic Diagram, Figure 5-9, for the explanation of these circuits.

4-9. OVEN TEMPERATURE CONTROL CIRCUIT.

4-10. The A3 Reference Supply Oven contains circuits that control a heating element HR1 to maintain a constant oven temperature of 80°C (176°F). Resistors A3R1, A3R4, and A3R5 are used with thermistor A3RT7 to form the legs of a bridge. A differential amplifier that consists of transistors A3Q1 and A3Q2 is used to sense the balance of the bridge. The legs of the bridge form voltage dividers from which the bases of A3Q1 and A3Q2 are biased. Q1 is an emitter follower that is used as a current amplifier to develop the power to drive the heater HR1 in the A3 Reference Supply Oven.

4-11. When the ambient temperature of the oven is less than 80°C (176°F), the internal resistance of the thermistor is greater than the rated resistance at 80°C (176°F) according to the negative temperature coefficient, and the bridge is out of balance. The increased resistance of the thermistor results in the bias at the base of A4Q2 being sufficiently positive to cause A3Q2 conduction to increase.

4-12. The differential amplifier output voltage is amplified by A1Q1 and A1Q2. The output voltage at the collector of A1Q2 is applied to the base of transistor Q1, mounted on the shield, increasing Q1's conduction causing increased dissipation in the heater winding HR1.

4-13. As the ambient temperature of the oven is raised by the heat dissipation of HR1, the resistance of RT7 decreases reducing the bias level at the base A3Q2. This reduces the conduction of the differential amplifier and consequently Q1's conduction decreases, reducing the heat dissipated by HR1. As the oven temperature is raised by the heater the amount of

heat dissipated by the heater becomes less and less. Thus the desired oven temperature is approached.

4-14. When the temperature of the oven reaches the desired level of 80°C (176°F) due to the heat dissipation of HR1, the resistance of A3RT7 reaches the amount necessary to balance the bridge. The heat dissipated by the heater is then just sufficient to overcome the losses through the oven case. This maintains the desired oven temperature.

4-15. REFERENCE VOLTAGE CIRCUIT.

4-16. The source for the reference voltage is a zener diode selected, aged and temperature compensated. A dual series regulator and a differential amplifier circuit maintain a constant current through this zener diode, A3CR1. The differential amplifier uses A3CR1 as a reference and feeds the difference voltage back to control the second series regulator. The differential amplifier, diode and associated resistors are located in the oven to eliminate temperature effects.

4-17. The absolute voltage of the reference diodes varies 10% from instrument to instrument; hence A3R13 and R14 are selected at the factory to give 5.91 volts ±.05% at the output of the oven.

4-18. PRECISION VOLTAGE DIVIDER OUTPUT CIRCUITS.

4-19. Two voltage sources are used for the OUTPUT in the four positions of the function switch. The 5.91 volts Reference is the primary source and the output of the dual series regulator 12.4 volts is the secondary source. Each circuit is independent of the other and an adjustment of one does not effect the other.

4-20. The total impedance of the precision voltage dividers, in all positions of the function switch, is adjusted so that one milliampere of current flows from the 5.91 volt reference supply. This in turn adjusts the OUTPUT voltage across the precision resistor S1R6. The CAL adjustment (coarse and fine) varies the current and hence the OUTPUT voltage in all functions except the 0-1000 microvolt position. There are individual internal adjustments for the 1.000000 volt and 1.018 +Δ volt positions.

4-21. The Δ voltage or 0-1000 μv has as its source the +12.4 regulated voltage from the dual series regulator. The precision voltage divider is adjusted until 5 volts is dropped across R1, the microvolt potentiometer. The wiper arm is applied through S1R8 to the -OUTPUT terminal. In the 0-1000 microvolt position of the function switch the +5 volt terminal of potentiometer is connected to the junction of S1R6 and S1R7. S1R6 is shorted. This puts a positive voltage 0-1000 microvolts on the +OUTPUT terminal. In the 1.018 +Δ and 1.019 +Δ positions, the other end of R1 (▽) is connected to the junction of S1R6 and S1R7. This opposing voltage (1000 μv - Δ) has a separate current path and is unaffected by changes in primary current path when the function switch is changed.

4-22. GUARDING.

4-23. The 735A is equipped with a guard shield which surrounds the primary of the power transformer and the floating circuitry of the instrument. This shield may be driven to prevent dc leakage to ground when the 735A is used in a floating configuration. It can also be useful in reducing common mode insertion into a circuit under test.

MAINTENANCE

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains information necessary for the proper maintenance of the -hp- Model 735A DC Transfer Standard. This section provides the necessary Performance Checks, Adjustment and Calibration Procedures and Troubleshooting Techniques required to accomplish the above objective.

5-3. TEST EQUIPMENT REQUIRED.

5-4. The test equipment required to perform the operations outlined in this section is listed in Table 5-1. This table contains the type of instrument required, critical specifications, type of operation to be conducted and recommended model. If the specific model recommended is not available, equipment which meets or exceeds the critical specifications listed may be substituted.

5-5. PERFORMANCE CHECKS.

5-6. The Performance Checks presented in this section are front panel procedures designed to compare the Model 735A with its published specifications. These operations may be incorporated in periodic maintenance, post-repair, or incoming quality control checks. These operations should be conducted before any attempt is made to adjust or calibrate the instrument.

Table 5-1. Test Equipment Required

Instrument	Critical Specifications	Use	Recommended Model
DC Milliammeter Clip-on Probe	Range: 1.5 ma	Performance Checks	-hp- Model 428B Clip-on DC Milliammeter
DC Null Voltmeter	Range: 3 μv to 400 v Accuracy: ±2%	Performance Checks Troubleshooting	-hp- Model 419A DC Null Voltmeter
Resistor	1 K ohm ±1%, 1/2 w	Performance Checks	-hp- Part No. 0757-0159
	146.2 ohm ±1/2%, 1/2 w	Performance Checks	-hp- Part No. 0727-0379
Saturated Standard Cell	Calibrated by National Bureau of Standards to 1 ppm	Performance Checks Calibration Procedure	
DC Differential Voltmeter	Range: 0-1 vdc Accuracy: ±0.01% Resolution: ±0.0002% of full scale	Performance Checks Calibration Procedure	-hp- Model 740B DC Standard/Differential Voltmeter
Ohmmeter	Range: 10 M maximum	Troubleshooting	-hp- Model 412A Vacuum Tube Voltmeter
Unsaturated Standard Cell	Known Accuracy	Performance Checks	
AC Voltmeter	Range: 0.001 volt Frequency: 1 cps to 1 Mc	Performance Checks	-hp- Model 403A Transistorized AC Voltmeter
Variable Transformer	Output Voltage: 0-256 vac	Performance Checks	Superior Electric Model V216T

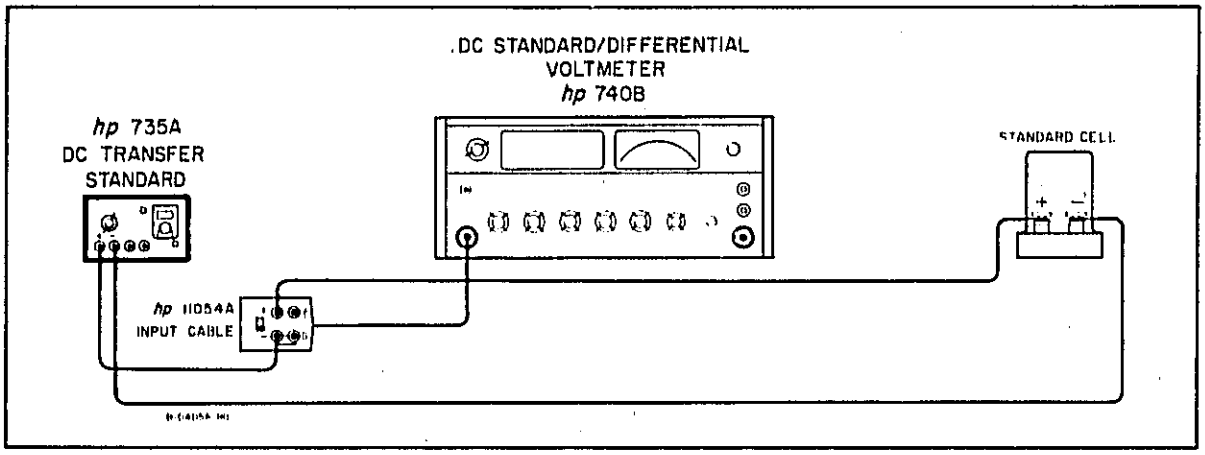


Figure 5-1. Standard Output Accuracy Check

5-7. TRANSFER STANDARD OUTPUT ACCURACY.

a. Connect the OUTPUT of the 735A to the input of the 740B Differential Voltmeter (observe polarity).

b. Set 735A function switch to 0-1000 μv (Δ) position and the dial to 1000 μ volts.

c. Set 740B Range to 10 millivolts. The reading should be 1 millivolt ±2.5 microvolts.

d. Connect the 735A as shown in Figure 5-1. (Use solid copper wire tightened securely for all operations of the 735A.) Use an unsaturated standard cell and connect the positive terminal of the standard cell to the positive terminal of the 740B.

e. Set the 735A to 1.019 +Δ position.

f. Set the 740B to differential voltmeter mode and 100 millivolt range for this procedure.

g. Adjust the 0-1000 μ volts on the 735A for a null on the 740B Differential Voltmeter. Push control knob into lock.

h. Vary the line voltage of the 735A from 103 volts ac the 127 vac (207 to 253 for 230 vac line). The output should change less than 1 μ volt. Return to 115 ac volt line.

j. Set 735A to 1.018 +Δ position (do not change delta control). Read the difference with the 740B. The 740B should read 1 millivolt ±10 microvolts.

k. Set the 735A to the 1.000000 volt position. Read the difference with the 740B. The 740B should read 19 millivolts +Δ ±10 microvolts where Δ (delta) is the reading on the dial of the 735A obtained in step g.

m. Absolute reference may be checked by connecting the 735A as in Figure 5-1 or Figure 5-2 using the saturated standard cell (1 ppm) and the 1.018 +Δ position of the 735A. Adjust the 0-1000 microvolt control for the exact reading on the standard cell. Adjust CAL on the 735A for a null on the 740B Differential Voltmeter or 419A Null Voltmeter using the most sensitive range.

n. If the 735A does not meet the criteria specified in the preceding checks, refer to Paragraph 5-14 for complete calibration procedure.

5-8. OUTPUT IMPEDANCE CHECK.

a. Set Model 735A output to 1.000 V.

b. Connect the Model 735A OUTPUT to DC Null Voltmeter (-hp- Model 419A) INPUT; observe polarity. Set null voltmeter RANGE to 1 V.

c. Null voltmeter should indicate full scale deflection (1 V).

d. Place 1 K ohm ±1%, 1/2 w resistor (-hp- Part No. 0757-0159) across Model 735A OUTPUT.

e. Null voltmeter indication should decrease to 0.5 volts ±0.03 volts. This verifies a Model 735A output impedance of 1 K ohm ±1%. (The output impedance equals the external load resistor.)

5-9. OUTPUT NOISE CHECK.

a. Connect the Model 735A as shown in Figure 5-2.

b. Set Model 735A output to 1.018 V +(Δ) for saturated cell, 1.019 V +(Δ) for unsaturated cell.

c. Adjust Model 735A MICROVOLTS control until the DC Null Voltmeter (-hp- Model 419A) indicates a null on the 3 μv RANGE.

d. Observe null meter pointer. Maximum deflection

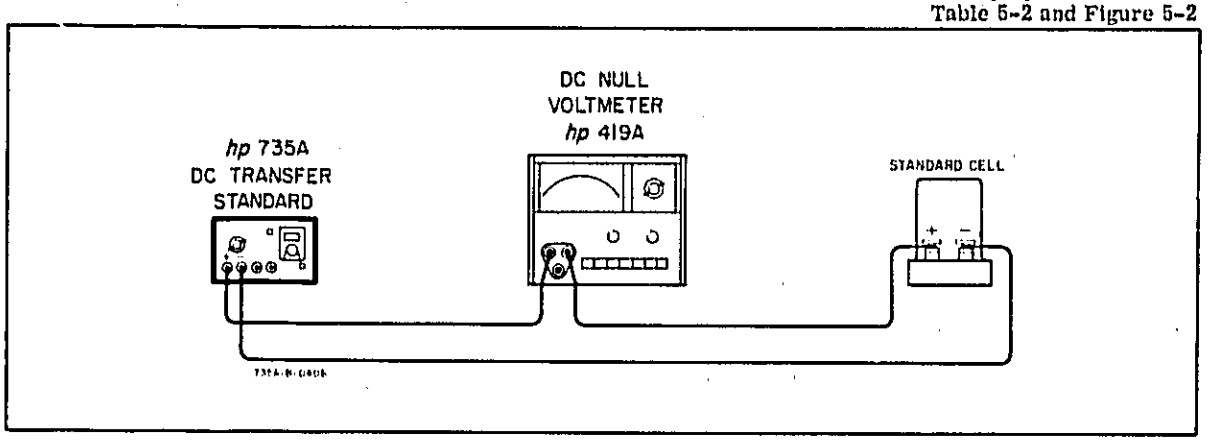


Figure 5-2. Output Noise Test Setup

from null should never exceed ±0.5 μv. This will verify output noise of less than 1 μv peak-to-peak. (This is in addition to any noise from the test setup.)

e. Connect the AC Voltmeter (-hp- Model 403A) to the OUTPUT of the 735A. Set 403A RANGE to 0.001 V and FUNCTION to 1 cps - 1 Mc. The ac voltmeter should read less than 100 μv.

5-10. SHORT CIRCUIT CURRENT.

a. Set Model 735A output to 1.000 V.

b. Short Model 735A output with small wire.

c. Set milliammeter RANGE to 3 ma. Place DC Milliammeter (-hp- Model 428B) clip-on probe around shorting conductor.

d. DC milliammeter should read less than 1.5 ma.

5-11. VARIABLE OUTPUT ACCURACY, IMPEDANCE AND NOISE CHECK.

a. Connect the Model 735A OUTPUT to DC Differential Voltmeter (-hp- Model 740A); observe polarity. Leave function switch set to 0-1000 μv (Δ) position and place the dc differential voltmeter on the 10 millivolt range.

b. Set Model 735A MICROVOLTS control fully counterclockwise. Front panel should indicate 000 μv.

c. Measure Model 735A output with dc differential voltmeter.

d. Differential voltmeter should indicate between +1.5 and -1.5 μv.

e. Continue to test Model 735A variable output accuracy using the data contained in Table 5-2. Once null is obtained, differential voltmeter should indicate voltage level within limits specified.

Table 5-2. Accuracy Check

Model 735A Microvolts Setting	Model 740B Final Indication
200 μv	198.3 to 201.7 μv
400 μv	398.1 to 401.9 μv
600 μv	597.9 to 602.1 μv
800 μv	797.7 to 802.3 μv
1000 μv	997.5 to 1002.5 μv

f. While the Model 735A is in the 0-1000 μv (Δ) position and the MICROVOLT control is at 1000 μ volts, place a 146 ohm ±1/2%, 1/2 w resistor (-hp- Part No. 0727-0379) across the Model 735A OUTPUT.

g. The differential voltmeter should indicate 0.495 to 0.505 millivolts ± 1/2 the variation from 1 millivolt before the resistor was added. This verifies the Model 735A variable output impedance to be 146 ohms ±1%.

5-12. ADJUSTMENT AND CALIBRATION PROCEDURE.

5-13. The following is a complete Adjustment and Calibration Procedure for the Model 735A DC Transfer Standard. These operations should be conducted only after it has previously been established by the Performance Checks, Paragraph 5-5, that the Model 735A is in need of adjustment. Indescriminate adjustment of the internal controls simply to "refine" settings, may actually cause more difficulty. If the procedures outlined below do not rectify any discrepancy which may exist, and all connections and settings have been rechecked, refer to Paragraph 5-15, Trouble-shooting Techniques, for possible cause and recommended corrective action.

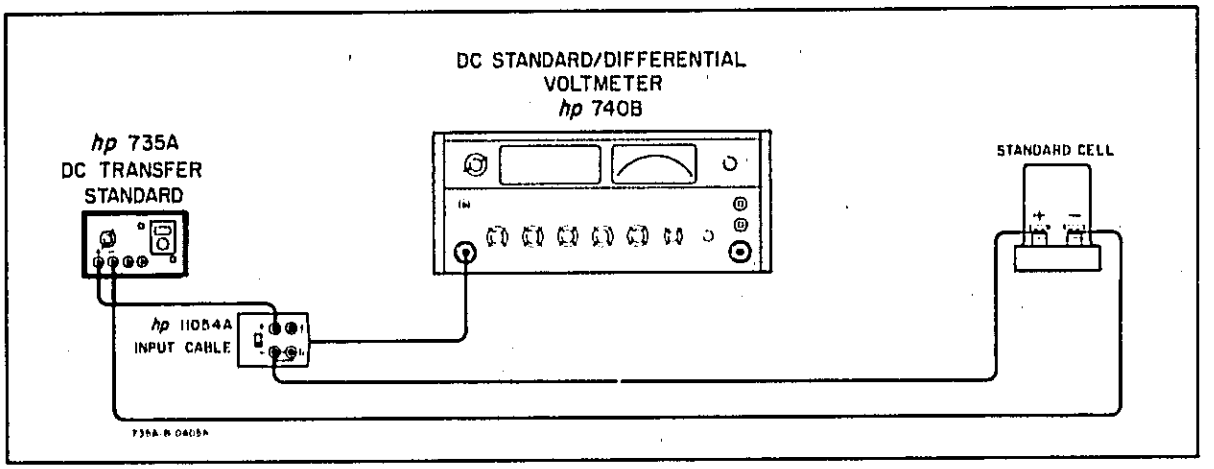
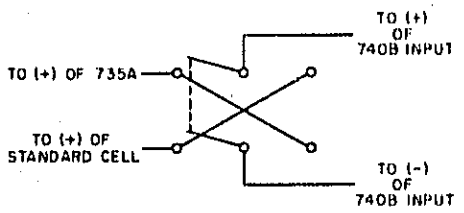


Figure 5-3. Adjustment and Calibration Test Setup

5-14. CALIBRATION PROCEDURE.

NOTE

The -hp- Model 740B Differential Voltmeter must read in a positive direction. Connect the positive terminal of the higher voltage output (either the Standard Cell or the Model 735A) to the positive input terminal of the 740B. A copper knife blade Type Switch, Leeds and Northrup No. 3294, may be used for quick disconnect and polarity reversal. (Connect as shown below.)



a. Set the selector switch and microvolt control of the Model 735A to 1.019 v + 1000 μv.

b. Connect the 735A as shown in Figure 5-3 using a saturated standard cell and a Differential Voltmeter (-hp- Model 740B). The positive OUTPUT terminal of the 735A must be connected to the positive terminal of the 740B.

c. Set the differential voltmeter on the 100 mv range.

d. Bring A2R5 (front panel CAL adjust) to the center of its range. Adjust A2R2, designated coarse cal on the top cover of the front shield, for a differential voltmeter reading of 1.020 - Standard Cell voltage. (Fine adjustment may be accomplished with A2R5 front panel CAL adjust.)

e. Set Model 735A to 1.018 v + 1000 μv Δ.

f. Set the 740B Differential Voltmeter to the 100 mv range.

g. Adjust A2R9 (designated 1.018 v on the bottom cover of front shield) for a reading of 1.019 v - Standard Cell voltage.

h. Set 735A to 1.019 + 000 μv.

j. Adjust 1 mv (A2R6) to obtain same reading on Δvm as in (g).

k. Set the 740B Differential Voltmeter to the 100 mv range and reverse polarity of input leads.

m. Set 735A to 1.000 v.

n. Adjust A2R8 for a reading on the 740B of Standard Cell - 1.000 v.

p. Final adjustment: connect the 735A as in Figure 5-1 or Figure 5-2 using a calibrated saturated Standard Cell and a 419A Null Voltmeter or 740B Differential Voltmeter.

q. Set the Model 735A to the exact voltage of the Saturated Standard Cell as certified by the National Bureau of Standards (1 ppm).

r. Adjust the CAL potentiometer on the front panel of the 735A for a null on the 3 microvolt range of the 419A or the 740B on the 1 mv ranging using all sensitivity controls. (This tends to correct the possible error of the 740B and affects the first three positions of the 735A Function switch.)

s. Check the 0 - 1000 microvolt position of the function switch as described in Paragraph 5-11 steps a through e. If voltages are within limits do not readjust A2R6 (1 mv).

5-15. TROUBLESHOOTING TECHNIQUES.

5-16. This section contains procedures designed to assist in the isolation of malfunctions. These pro-

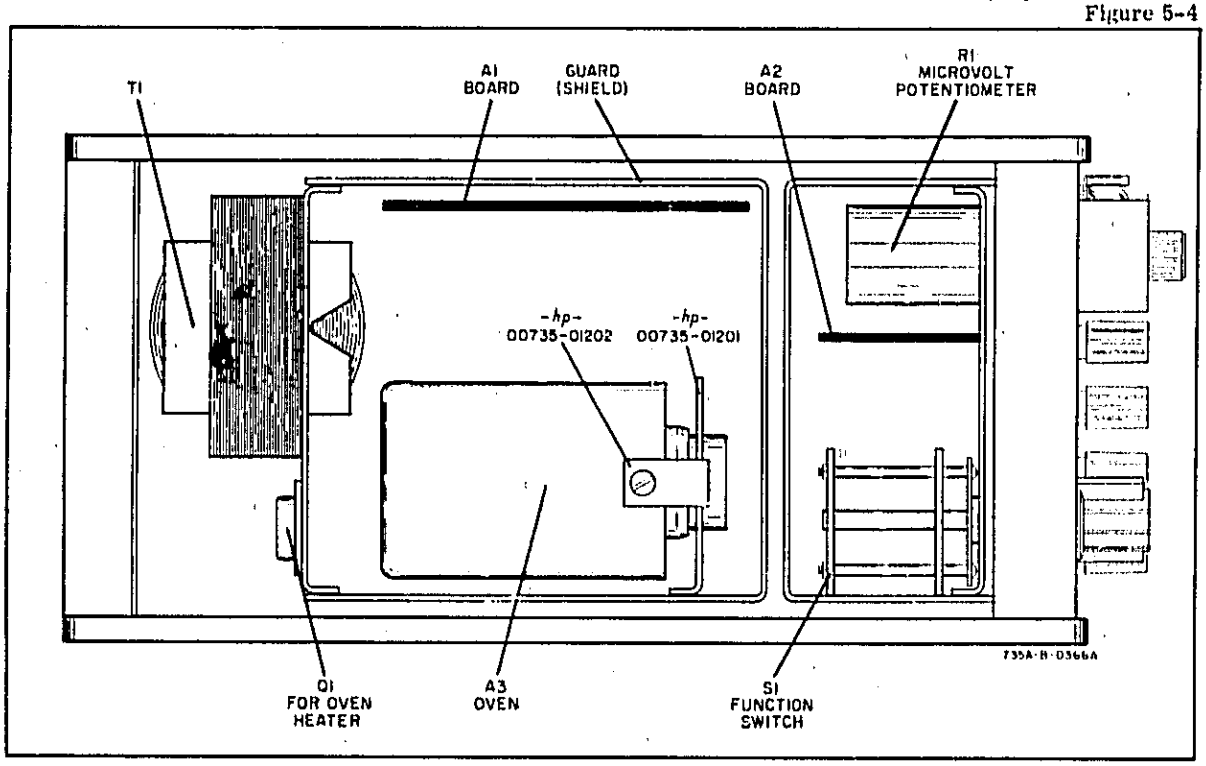


Figure 5-4. Top View

cedures are based on an analysis of the instrument circuit. These operations should be undertaken only after it has been established that the difficulty cannot be eliminated by the Adjustment and Calibration Procedure, Paragraph 5-12. An investigation should also be conducted to insure that the trouble is not a result of conditions external to the Model 735A.

5-17. Conduct a visual check of the Model 735A for possible burned or loose components, loose connections, or any other obvious conditions which might suggest a source of trouble. (Component location is shown in Figure 5-4. Top View.)

5-18. Table 5-3 contains a summary of the front panel symptoms which may be encountered. It should be used in initial efforts to select a starting point for troubleshooting operations.

5-19. Table 5-4 contains procedures which may be used as a guide in isolating malfunctions. These steps describe the normal conditions which should be encountered during the checks outlined.

5-20. The tests outlined in Table 5-4 are not designed to check all circuit parameters, rather, only to localize the malfunction. Therefore, it is quite possible that additional measurements will be required to completely isolate the problem. The voltage values described in Table 5-4 and Figure 5-9 are based on the Model 735A output set to 1.019 V + (Δ), and MICROVOLTS set to 500 μv.

5-21. SERVICING THE ETCHED CIRCUIT BOARDS.

5-22. The -hp- Model 735A has two etched circuit boards. Figures 5-6 and 5-7 show these boards and their components. Use caution when removing them to avoid damaging mounted components. The -hp- part number of the assembly is etched on the exterior of the circuit board to identify it. Refer to Section VI for -hp- part number information.

5-23. The etched circuit boards are a plated-through type. The electrical connection between sides of the boards is made by a layer of metal plated through the component holes. When working on these boards, observe the following general rules.

a. Use a low-heat (25 to 50 watts) small-tip soldering iron, and a small diameter rosin core solder.

b. Circuit components can be removed by placing the soldering iron on the component lead on either side of the board, and pulling up on lead. If a component is obviously damaged, clip leads as close to component as possible and then remove. Excess heat can cause the circuit and board to separate, or cause damage to the component.

c. Component lead hole should be cleaned with a toothpick or other such device before inserting new lead.

d. To replace components, shape new leads and insert them in holes. Reheat with iron and add solder as required to insure a good electrical connection.

e. Clean excess flux from the connection and adjoining area.

f. To avoid surface contamination of the printed circuit, clean with weak solution of warm water and mild detergent after repair. Rinse thoroughly with clean water. When completely dry, spray lightly with Krylon (#1302 or equivalent).

5-24. REMOVAL OF OVEN.

5-25. The components inside the oven are not separately replaceable. If the oven circuitry is not operating properly, the entire oven must be replaced. Use the following procedure for removal and replacement of the oven.

a. Remove top cover of the instrument by removing one Phillips-head screw at the rear of the top cover; slide the top cover toward the rear and lift.

b. Remove left (facing the front of the instrument) side cover by removing four Phillips-head screws.

c. Remove top cover of rear shield by removing two screws.

d. Remove the bottom screw, holding the oven bracket, located on the left side of the rear shield. Loosen the top screw slightly and turn the oven in a vertical position using the oven bracket as a swivel.

e. Secure the oven mount by tightening the top screw.

f. While holding the end of the bracket, gently pull oven from socket without disturbing the wire connected to the socket.

g. For replacement of the oven, use the reverse order of this procedure.

5-26. REMOVAL OF Q1 (HEATER TRANSISTOR).

a. Follow the procedure contained in Paragraph 5-25, steps a through e.

b. Remove the transistor socket from the transistor taking care not to damage the wire connections.

c. With an offset screwdriver (90°), remove the two screw-headed bolts retaining the transistor. (Observe the position of insulator and lock washers so that they may be replaced in the reverse order of disassembly.)

CAUTION

BEFORE REPLACEMENT OF THE TRANSISTOR, CHECK THE CONDITION OF THE LARGE INSULATOR BETWEEN THE TRANSISTOR AND THE SIDE OF THE SHIELD. IF NOT IN GOOD CONDITION, REPLACE. COVER BOTH SIDES OF INSULATOR WITH SILICON GREASE (DOW CORNING 5 COMPOUND) BEFORE REPLACING IN THE INSTRUMENT.

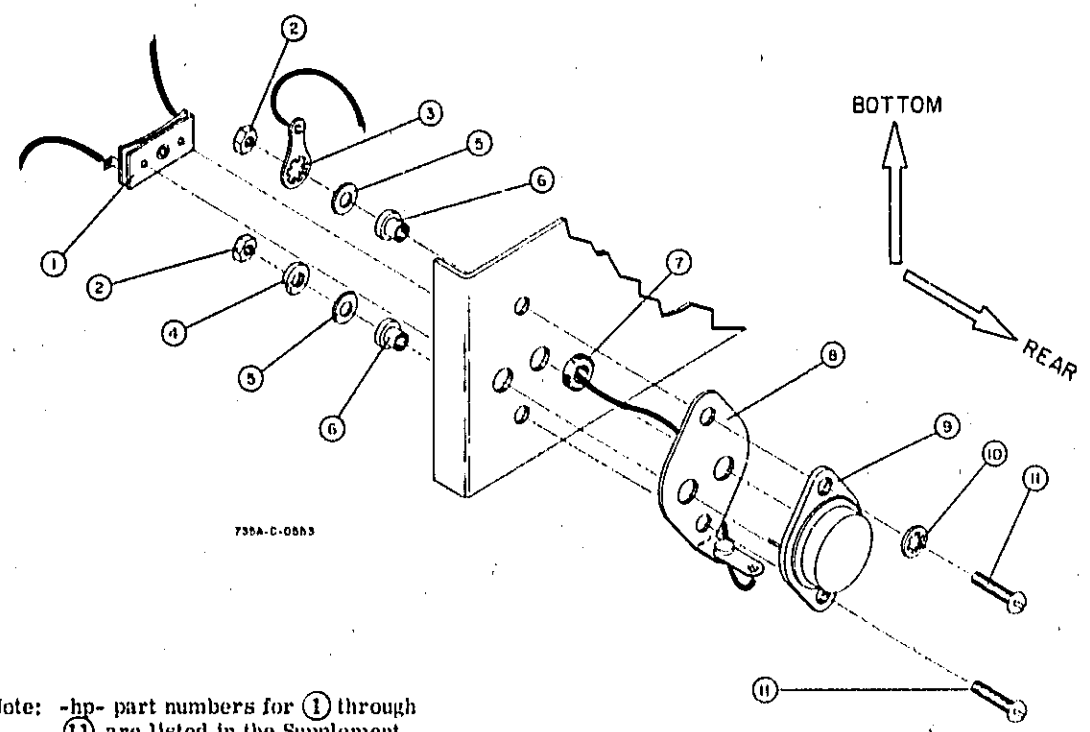
d. Use the reverse order of this procedure for replacement of transistor. (See Figure 5-5 for order of assembly.)

CAUTION

WHEN TIGHTENING THE NUT WHERE THE BLUE WIRE IS ATTACHED, BE SURE THAT THE SOLDER LUG DOES NOT TOUCH THE CHASSIS OR ANOTHER LUG.

Table 5-3. Troubleshooting Summary

Trouble	Possible Cause
Front panel oven light off.	Check power cord, fuse, DS1, Q1 (mounted on inner chassis).
Front panel oven light does not dim.	Check oven voltage pins 1, 2, 3, 4, and 9. If OK, check A1Q1, A1Q2, Q1 and oven heater pins 11 and 12. (If oven is defective, replace entire oven.)
All outputs unstable over period of time.	Check oven heater circuit and voltage regulator circuits. If circuits outside the oven are OK, then replace oven.
One function output fails, all others are correct.	Check portion of output voltage divider used only in this function. (See Figure 5-8 for location of components on the switch.)
All functions fail to operate properly.	Refer to Table 5-4.



Note: -hp- part numbers for (1) through (11) are listed in the Supplement for Table 6-2.

Figure 5-5. Transistor Mounting

Table 5-4. Troubleshooting Procedures

Use negative output terminal as common for all voltage measurements except in step (3). In step (3) use the junction as common and negative output as high or reverse polarity of the instrument.

1 Measure the dc voltage levels at the pins indicated below. DC voltage levels should be as specified:

A Pin 6, A3: +12.4 v

B Pin 7, A3: 5.91 v

If voltage levels are correct, proceed to (2). If not, go directly to (4).

2 Measure the dc voltage at the junction of R5 and R6 on the function switch. DC level should be 1.019 v. If correct, proceed to (3). If not, check A2R1 - A2R5, and R5 on function switch.

3 Measure the dc voltage at the junction of R6 and R7 on the function switch. DC level should be 0.5 mv. If not, check A2R6 and R7; MICROVOLTS control adjustment and R7 and R8 on the function switch.

4 Measure the dc voltage levels at the points indicated below. DC levels should be as specified. If not, check the parameters listed.

Location	DC Level	Possible Malfunction
A Jct of A1CR4 and A1C1	+36 v	A1CR3, A1CR4, A1R1 and T1
B Jct of A1R2 and A1CR5	+12.7 v	A1C1, A1R2 and A1CR5
C Jct of A1CR2 and A1R3	-25 v	A1CR5, A1CR2, A1R1 and T1
D Jct of A1R4 and A1CR6	-12.7 v	A1R3, A1R4, A1C2 and A1CR6

If all of the above are correct, proceed to 5 .

5 Measure the dc voltage level at pin 4, A3 (base of A1Q1). DC level should be + 1 v. If correct, proceed to (7). If incorrect, go directly to (8).

Table 5-4. Troubleshooting Procedures (Cont'd)

6 Check the transistor bias levels for A1Q1 - A1Q4 as provided in Figure 5-5. If correct, proceed to (7). In correct, replace faulty component.	
7 Measure the dc voltages at the points indicated below. DC levels should be as prescribed. If not, check the components listed.	

Location	DC Level	Possible Malfunction
Pin 6, A3	12.4 v	A3Q4 and A3CR1
Pin 5, A3	13.5 v	A3Q3

8 To check oven control operation, proceed as follows. Disconnect instrument power cord for approximately 30 seconds; then reapply line power. Oven lamp (front panel) should come on brightly for approximately 15 seconds; then momentarily extinguish, and re-illuminates to a lesser brilliance. This indication verifies proper oven control.

A1
ASSEMBLY
(00735-66501)

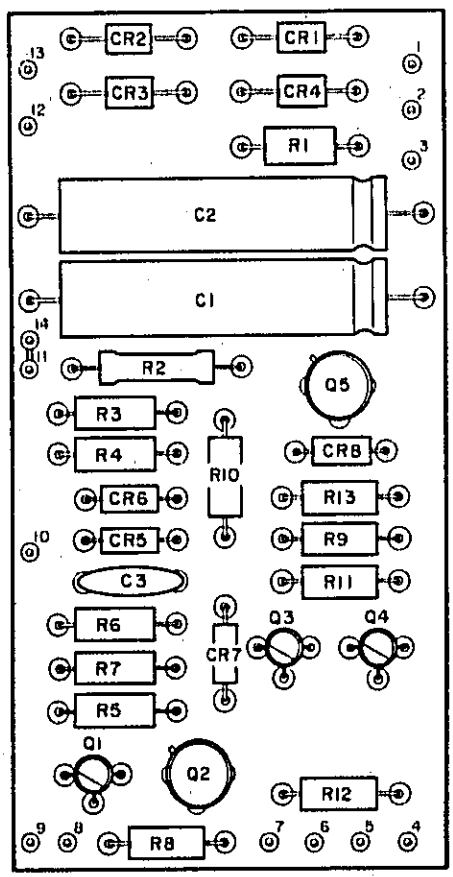


Figure 5-6. A1 Component Location

A2
ASSEMBLY
(00735-66502)

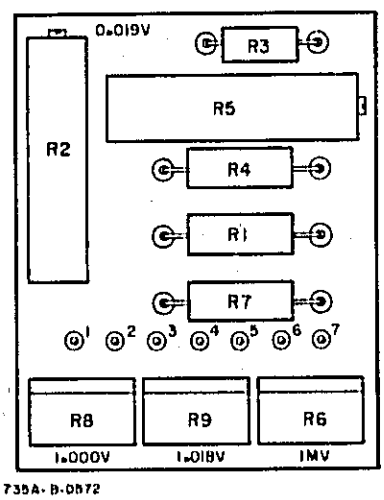
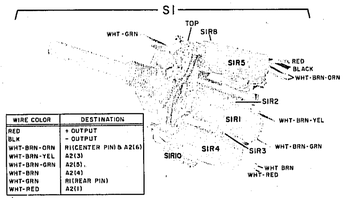


Figure 5-7. A2 Component Location



WIRE COLOR	DESTINATION
RED	+ OUTPUT
BLK	- OUTPUT
WHT-BRN-ORN	RICCENTER PIN) & A2(6)
WHT-BRN-YEL	A2(3)
WHT-BRN-GRN	A2(5)
WHT-BRN	A2(4)
WHT-GRN	R(NEAR PIN)
WHT-RED	A2(1)

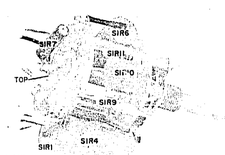
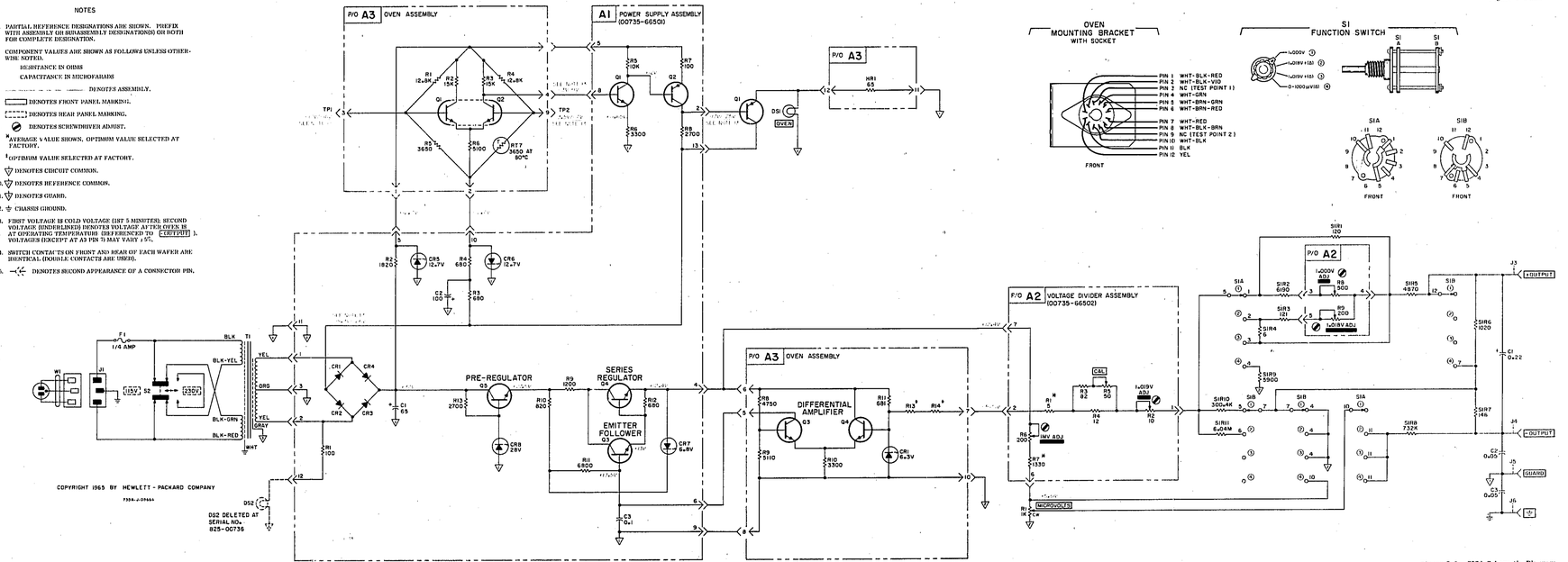


Figure 5-8. S1 Component Location

NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATIONS OR BOTH FOR COMPLETE DESIGNATION.
2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED.
   RESISTANCE IN OHMS
   CAPACITANCE IN MICROFARADS
3. ---------- DENOTES ASSEMBLY.
4. ▭ DENOTES FRONT PANEL MARKING.
5. ▭ DENOTES REAR PANEL MARKING.
6. ⊘ DENOTES SCREWDRIVER ADJUST.
7. ④ AVERAGE VALUE SHOWN. OPTIMUM VALUE SELECTED AT FACTORY.
8. ⑤ OPTIMUM VALUE SELECTED AT FACTORY.
9. ▽ DENOTES CIRCUIT COMMON.
10. ▽ DENOTES REFERENCE COMMON.
11. ▽ DENOTES GUARD.
12. ⏚ CHASSIS GROUND.
13. FIRST VOLTAGE IS COLD VOLTAGE (1ST 5 MINUTES); SECOND VOLTAGE (UNDERLINED) DENOTES VOLTAGE AFTER OVEN IS AT OPERATING TEMPERATURE (REFERENCED TO CHASSIS). VOLTAGES EXCEPT AT A3 PIN 7) MAY VARY ±5%.
14. SWITCH CONTACTS ON FRONT AND REAR OF EACH WAFER ARE IDENTICAL (DOUBLE CONTACTS ARE USED).
15. —⟨ DENOTES SECOND APPEARANCE OF A CONNECTOR PIN.



735A-J-07444

01782-1

Figure 5-9. 735A Schematic Diagram

PARTS LIST

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alphameric order of their reference designators and indicates the description and -hp- part number of each part, together with any applicable notes. Table 6-2 lists parts in alphameric order of their -hp- part number and provides the following information on each part:

a. Description of the part. (See list of abbreviations below.)

b. Typical manufacturer of the part in a five-digit code. (See Appendix A for list of Manufacturers.)

c. Manufacturer's part number.

d. Total quantity used in the instrument (TQ column).

6-3. Miscellaneous parts are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (See Appendix B for list of office locations.) Identify parts by their Hewlett-Packard part numbers.

6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

DESIGNATORS

A	= assembly	F	= fuse	P	= plug	V	= vacuum tube, neon bulb, photocell etc.
B	= motor	FL	= filter	Q	= transistor	W	= cable
BT	= battery	HR	= heater	QCR	= transistor-diode	X	= socket
C	= capacitor	J	= jack	R	= resistor	XDS	= lampholder
CR	= diode	K	= relay	RT	= thermistor	XF	= fuseholder
DL	= delay line	L	= inductor	S	= switch	Z	= network
DS	= lamp	M	= meter	T	= transformer		
E	= misc electronic part	MP	= mechanical part	TC	= thermocouple		

ABBREVIATIONS

Ag	= silver	ID	= inside diameter	ns	= nanosecond (s) = 10^{-9}	SPDT	= single-pole double-throw
Al	= aluminum	impg	= impregnated	nsr	= not separately replaceable	SPST	= single-pole single-throw
amp	= ampere (s)	incd	= incandescent				
Au	= gold	ins	= insulation (ed)				
				obd	= order by description	Ta	= tantalum
C	= capacitor	K	= kilohm (s) = 10^{+3}	OD	= outside diameter	TiO_2	= titanium dioxide
cer	= ceramic	Kc	= kilocycle (s) = 10^{+3}			tog	= toggle
coef	= coefficient			p	= peak	tol	= tolerance
com	= common			pc	= printed circuit	trim	= trimmer
comp	= composition	L	= inductor	pf	= picofarad (s) = 10^{-12}	TSTR	= transistor
conn	= connection	lin	= linear taper	piv	= peak inverse voltage		
cps	= cycles per second	log	= logarithmic taper	p/o	= part of	v	= volt (s)
dep	= deposited	m	= milli = 10^{-3}	pos	= position (s)	vacw	= alternating current working volt (s)
DPDT	= double-pole double-throw	ma	= milliampere (s) = 10^{-3}	poly	= polystyrene		
DPST	= double-pole single-throw	Mc	= megacycle (s) = 10^{+6}	pot	= potentiometer	var	= variable
		meg	= megohm (s) = 10^{+6}	p-p	= peak-to-peak	vdcw	= direct current working volt (s)
elect	= electrolytic	met flm	= metal film	prec	= precision (temperature coefficient, long term stability, and/or tolerance)		
encap	= encapsulated	mfr	= manufacturer			w	= watt (s)
f	= farad (s)	mtg	= mounting			w/	= with
FET	= field effect transistor	μ	= micro = 10^{-6}	R	= resistor	wiv	= reverse working voltage
fxd	= fixed	my	= Mylar ®	Rh	= rhodium	w/o	= without
				rms	= root-mean-square	ww	= wirewound
GaAs	= gallium arsenide	na	= nanoampere (s) = 10^{-9}	rot	= rotary	*	= optimum value selected at factory, average value shown (part may be omitted)
Ge	= gigacycle (s) = 10^{+9}	NC	= normally closed				
gd	= guard (ed)	Ne	= neon				
Ge	= germanium	NO	= normally open	Se	= selenium	**	= no standard type number assigned (selected or special type)
grd	= ground (ed)	NPO	= negative positive zero (zero temperature coefficient)	sect	= section (s)		
				Si	= silicon		
h	= henry (ies)			sl	= slide		
Hg	= mercury						

® Dupont de Nemours

Table 6-1. Reference Designation Index

REFERENCE DESIGNATION	-hp- PART NO.	DESCRIPTION	NOTE
A1	00735-66501 (Rev. B)	Assembly: pc board includes C1 thru C3, Q1 thru Q5, CR1 thru CR8, R1 thru R13	
A1C1	0180-0149	C: fxd Al elect 65 μf +100% -10% 60 vdcw	
A1C2	0180-0094	C: fxd Al elect 100 μf +100% -10% 25 vdcw	
A1C3	0150-0084	C: fxd cer 0.1 μf +80% -20% 50 vdcw	
A1CR1-A1CR4	1901-0045	Diode: Si 100 piv	
A1CR5, A1CR6	1902-0031	Diode: breakdown 12.7 v ±5% 400 mw	
A1CR7	1902-0048	Diode: breakdown 6.81 v ±5% 400 mw	
A1CR8	1902-3277	Diode: breakdown 28 v	
A1Q1	1854-0033	TSTR: Si NPN 2N3391	
A1Q2	1853-0001	TSTR: Si PNP **	
A1Q3, A1Q4	1854-0033	TSTR: Si NPN 2N3391	
A1Q5	1854-0039	TSTR: Si NPN 2N3053	
A1R1	0687-1011	R: fxd comp 100 ohms ±10% 1/2 w	
A1R2	0757-0823	R: fxd prec met flm 1820 ohms ±1% 1/2 w	
A1R3, A1R4	0687-6811	R: fxd comp 680 ohms ±10% 1/2 w	
A1R5	0687-1031	R: fxd comp 10 K ±10% 1/2 w	
A1R6	0687-3321	R: fxd comp 3300 ohms ±10% 1/2 w	
A1R7	0687-1011	R: fxd comp 100 ohms ±10% 1/2 w	
A1R8	0687-2721	R: fxd comp 2700 ohms ±10% 1/2 w	
A1R9	0687-1221	R: fxd comp 1200 ohms ±10% 1/2 w	
A1R10	0687-8211	R: fxd comp 820 ohms ±10% 1/2 w	
A1R11	0687-6821	R: fxd comp 6800 ohms ±10% 1/2 w	
A1R12	0687-6811	R: fxd comp 680 ohms ±10% 1/2 w	
A1R13	0687-2721	R: fxd comp 2.7 K ±10% 1/2 w	
A2	00735-66502	Assembly: pc board includes , R1 thru R9	
A2R1*	0811-1539	R: fxd prec ww 5 ohms ±1% 1/2 w	
A2R2	2100-1751	R: var ww 10 ohms ±10% 1 w	
A2R3	0687-8201	R: fxd comp 82 ohms ±10% 1/2 w	
A2R4	0811-1541	R: fxd prec ww 12 ohms ±1% 1/4 w	
A2R5	2100-1481	R: var 50 ohms +20% -10% 1 w	
A2R6	2100-0783	R: var ww 200 ohms ±5%	
A2R7*	0698-3406	R: fxd prec met flm 1330 ohms ±1% 1/2 w	
A2R8	2100-0740	R: var ww 500 ohms ±5%	
A2R9	2100-0783	R: var ww 200 ohms ±5%	
A3	00735-66901	Oven (parts not separately replaceable)	
	00735-01201	Bracket: oven mtg	
	00735-01202	Bracket: oven mtg	
	1200-0038	Socket: 12 pin oven	
C1	0170-0038	C: fxd my 0.22 μf ±10% 200 vdcw	
C2, C3	0150-0052	C: fxd cer 0.05 μf ±20% 400 vdcw	
DS1	2140-0025	Lamp: incd 28 v 0.04 amp clear bulb	
	1450-0032	Holder: lamp front mtg 2 terminals	
	1450-0033	Lamp: pilot jewel 17/32 inch long	
F1	2110-0201	Fuse: 0.25 Amp S.B.	
J1	1251-2357	Connector: ac power cord receptacle	
J2		Not Assigned	
J3	1510-0026	Assembly: binding post red (+ OUTPUT)	
J4	1510-0027	Assembly: binding post black (- OUTPUT)	
J5, J6	1510-0009	Binding post: black (GUARD and ⏚)	

Table 6-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	-hp- PART NO.	DESCRIPTION	NOTE
Q1	1850-0098	TSTR: Ge PNP **	
	1200-0044	Socket: TSTR	
	00735-64101	Insulator: anodized alum	
R1	2100-1580	R: var ww 1 K ±5% 1-1/2 w	
S1	00735-61901	Assembly: switch function includes R1 thru R11	
	3100-1715	Switch: ort w/o components	
S1R1	0811-1534	R: fxd prec ww 120 ohms ±0.02% 1/4 w	
S1R2	0757-0196	R: fxd prec met flm 6.19 K ±1% 1/2 w	
S1R3	0757-0790	R: fxd prec met flm 121 ohms ±1% 1/2 w	
S1R4	0811-1545	R: fxd prec ww 6.0 ohms ±0.5% 1/8 w	
S1R5, S1R6	0811-1106	R: set matched prec ww (R5 4.870 K ±0.01%) (R6 1.020 K ±0.01%)	
S1R7	0811-1576	R: fxd prec 146 ohms ±1% 1/4 w	
S1R8	0698-3574	R: fxd prec met flm 732 K ±1% 1/2 w	
S1R9	0698-3536	R: fxd prec met flm 5900 ohms ±1% 1/2 w	
S1R10	0811-1535	R: fxd prec ww 300.4 K ±0.2% 1/4 w	
S1R11	0698-3539	R: fxd prec met flm 6.04 meg ±1% 1/4 w	
S2	3101-0033	Switch: sl DPDT non-shorting 0.5 amp 125 vdc 3 amp 125 vac	
T1	9100-1325	Transformer: power 50 to 1000 cycles	
W1	8120-1348	Assembly: cable power 7.5 feet long	
		MISCELLANEOUS	
	5060-0727	Assembly: foot third module	
	1410-0069	Bushing: pot (CAL.)	
	1410-0289	Bushing: range switch nylon	
	5000-0711	Cover: bottom 5 x 11	
	5000-0700	Cover: side 3 x 11	
	5060-0709	Cover: top 5 x 11	
	1140-0047	Dial: Ten Turn for R1	
	5040-0700	Hinge: foot assembly	
	1400-0084	Holder: fuse extractor post type	
	0340-0099	Insulator: binding post front single	
	0340-0100	Insulator: binding post rear single	
	0370-0104	Knob: skirted bar 5/8 inch diam black (Function)	
	00735-90002	Manual: operating and service	
	00735-00205	Panel: front	
	00735-00207	Panel: rear	
	00735-00602	Shield: bottom cover 2.125 inches x 4.215 inches	
	00735-00601	Shield: top cover 2.125 inches x 4.215 inches	
	00735-00603	Shield: top cover 4.875 inches x 4.215 inches	

Table 6-2. Replaceable Parts

-hp- PART NO.	DESCRIPTION	MFR	MFR PART NO.	TQ
0150-0052	C: fxd cer 0.05 μf ±20% 400 vdcw	56289	33C17A	2
0150-0084	C: fxd cer 0.1 μf +80% -20% 50 vdcw	56289	33C41 obd	1
0170-0036	C: fxd my 0.22 μf ±10% 200 vdcw	56289	148P22492	1
0180-0094	C: fxd Al elect 100 μf +100% -10% 25 vdcw	56289	30D107G025 DH4	1
0180-0149	C: fxd Al elect 65 μf +100% -10% 60 vdcw	56289	Type 30D# obd	1
0340-0099	Insulator: binding post front single	28480	0340-0099	4
0340-0100	Insulator: binding post rear single	28480	0340-0100	3
0370-0104	Knob: skirted bar 5/8 inch diam black (Function)	28480	0370-0104	1
0687-1011	R: fxd comp 100 ohms ±10% 1/2 w	01121	EB1011	2
0687-1031	R: fxd comp 10 K ±10% 1/2 w	01121	EB1031	1
0687-1221	R: fxd comp 1.2 K ±10% 1/2 w	01121	EB1221	1
0687-2721	R: fxd comp 2700 ohms ±10% 1/2 w	01121	EB2721	1
0687-3321	R: fxd comp 3300 ohms ±10% 1/2 w	01121	EB3321	1
0687-5601	R: fxd comp 56 ohms ±10% 1/2 w	01121	EB5601	1
0687-6811	R: fxd comp 680 ohms ±10% 1/2 w	01121	EB6811	1
0687-6821	R: fxd comp 6800 ohms ±10% 1/2 w	01121	EB6821	1
0687-8201	R: fxd comp 82 ohms ±10% 1/2 w	01121	EB8201	1
0687-8211	R: fxd comp 820 ohms ±10% 1/2 w	01121	EB8211	1
0698-3406	R: fxd prec met flm 1330 ohms ±1% 1/2 w	75042	CEC T-O obd	1
0698-3536	R: fxd prec met flm 5900 ohms ±1% 1/2 w	75042	CEC T-O obd	1
0698-3539	R: fxd prec met flm 6.04 meg ±1% 1/4 w	03888	PME 65 obd	1
0698-3574	R: fxd prec met flm 732 K ±1% 1/2 w	75042	CEC T-O obd	1
0757-0196	R: fxd prec met flm 6.19 K ±1% 1/2 w	19701	MF7C T-O obd	1
0757-0799	R: fxd prec met flm 121 ohms ±1% 1/2 w	19701	MF7C T-O obd	1
0757-0823	R: fxd prec met flm 1820 ohms ±1% 1/2 w	19701	MF7C T-O obd	1
0811-1106	R: set matched prec ww (R5 4.870 K ±0.01%) (R6 1.020 K ±0.01%)	28480	0811-1106	1
0811-1534	R: fxd prec ww 120 ohms ±0.02% 1/4 w	28480	0811-1534	1
0811-1535	R: fxd prec ww 300.4 K ±0.2% 1/4 w	28480	0811-1535	1
0811-1539	R: fxd prec ww 5 ohms ±1% 1/2 w	#01686	E-20 obd	1
0811-1541	R: fxd prec ww 12 ohms ±1% 1/4 w	#01686	E-20 obd	1
0811-1545	R: fxd prec ww 6.0 ohms ±0.5% 1/8 w	28480	0811-1545	1
0811-1576	R: fxd prec 146 ohms ±1% 1/4 w	#01686	E-20 obd	1
1140-0047	Dial: digital readout for 10-turn pot	#000LA	3141-2 obd	1
1200-0038	Socket: 12 pin oven	02660	77-MIP-12TM-1005	1
1200-0044	Socket: TSTR	#07913	Type M7 (PB) obd	1
1251-2357	Connector: ac power cord receptacle	87930	H-1061-2	1
1400-0084	Holder: fuse extractor post type	75915	342014	1
1410-0069	Bushing: pot (CAL.)	28480	1410-0069	1
1410-0289	Bushing: range switch nylon	#28520	SB-437-5 obd	1
1450-0032	Holder: lamp front mtg 2 terminals	72619	137-8536-9	1
1450-0033	Lamp: pilot jewel 17/32 inch long	72619	137-937	1
1510-0009	Binding post: black (GUARD and ⏚)	28480	1510-0009	2
1510-0026	Assembly: binding post red (+ OUTPUT)	28480	1510-0026	1
1510-0027	Assembly: binding post black (- OUTPUT)	28480	1510-0027	1
1850-0098	TSTR: Ge PNP **	28480	1850-0098	1
1853-0001	TSTR: Si PNP **	28480	1853-0001	1
1854-0033	TSTR: Si NPN 2N3391	24446	2N3391	3

These code numbers are listed in the Supplement following the Code List of Manufacturers.

Table 6-2. Replaceable Parts (Cont'd)

-hp- PART NO.	DESCRIPTION	MFR	MFR PART NO.		TQ	RS
1854-0039	TSTR: Si NPN 2N3053	86684	2N3053		2	
1901-0045	Diode: Si 100 piv	04713	obd		4	
1902-0031	Diode: breakdown 12.7 v ± 5% 400 mw	01281	PS 18270A		2	
1902-0048	Diode: breakdown 6.81 v ± 5% 400 mw	07910	CD35658		1	
1902-3277	Diode: breakdown	07910	CD35836		1	
2100-0740	R: var ww 500 ohms ± 5%	75042	CT-106-2	obd	1	
2100-0783	R: var ww 200 ohms ± 5%	75042	CT-106-2	obd	2	
2100-1481	R: var 50 ohms +20% -10% 1 w	12697	76JA3CM13-2464		1	
2100-1751	R: var ww 10 ohms ± 10% 1 w	000LJ	0400	obd	1	
2100-1580	R: var ww 1 K ± 5% 1-1/2 w	73490	7216	obd	1	
2110-0033	Fuse: 3/4 amp 250 v	75915	F02A250V3/4A		1	
2140-0025	Lamp: incd 28 v 0.04 amp clear bulb	24446	327	obd	2	
3100-1715	Switch: rot w/o components	71590	Series 600	obd	1	
3101-0033	Switch: sl DPDT non-shorting 0.5 amp 125 vdc 3 amp 125 vac	42190	4633	obd	1	
5000-0700	Cover: side 3 x 11	28480	5000-0700		2	
5000-0711	Cover: bottom 5 x 11	28480	5000-0711		1	
5040-0700	Hinge: foot assembly	28480	5040-0700		2	
5060-0709	Cover: top 5 x 11	28480	5060-0709		1	
5060-0727	Assembly: foot third module	28480	5060-0727		2	
8120-1348	Assembly: cable power 7.5 feet long	70903	KH-4147	obd	1	
9100-1325	Transformer: power 50 to 1000 cycles	28480	9100-1325		1	
00735-00205	Panel: front	28480	00735-00201		1	
00735-00207	Panel: rear	28480	00735-00202		1	
00735-00601	Shield: top cover 2.125 inches x 4.215 inches	28480	00735-00601		1	
00735-00602	Shield: bottom cover 2.125 inches x 4.215 inches	28480	00735-00602		1	
00735-00603	Shield: top cover 4.875 inches x 4.215 inches	28480	00735-00603		2	
00735-01201	Bracket: oven mtg	28480	00735-01201		1	
00735-01202	Bracket: oven mtg	28480	00735-01202		1	
00735-61901	Assembly: switch function	28480	00735-61901		1	
00735-64101	Insulator	28480	00735-64101		1	
00735-66501	Assembly: pc board (A1)	28480	00735-66501		1	
00735-66502	Assembly: pc board (A2)	28480	00735-66502		1	
00735-66901	Oven (parts nsr)	28480	00735-66901		1	
00735-90002	Manual: operating and service	28480	00735-90001		1	

See introduction to this section

Supplement for Table 6-2

Parts for Mounting the Power Transistor, Q1

Figure 5-5 No. Designator	Description	-hp- Part No.	TQ
1	Transistor: socket	1200-0044	1
2	Nut: 3/32" by 1/4"	2260-0001	2
3	Solder lug: internal lock	0360-0016	1
4	Washer: split	2190-0003	1
5	Washer: flat	3050-0105	2
6	Insulator	1200-0081	2
7	Grommet (on serials prefixed 504-)	0400-0009	1
8	Insulator: anodized aluminum	00735-64101	1
9	Transistor: PNP	1850-0008	1
10	Washer: internal lock	2190-0004	1
11	Screw: 7/12 inches long	2200-0008	2
-	Silicone grease, heat transfer	8500-0050	-

CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U. S. A. Common	Any supplier of U. S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics & Corp.	Rochester, N. Y.
00267	Cinch Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Microlipo Co., Inc.	Valley Stream, N. Y.
00373	Garlock Inc.	Cherry Hill, N. J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N. J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S. C.
00866	Gor Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
00929	Microlab Inc.	Livingston, N. J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N. Y.
01009	Aiken Products Co.	Brockton, Mass.
01121	Allen-Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01670	Guardhood Bros. Silk Co.	New York, N. Y.
01930	Amerock Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N. Y.
02116	Wheelock Signals, Inc.	Long Branch, N. J.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N. J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
02875	Hudson Tool & Die Co.	Newark, N. J.
03508	G. E. Semiconductor Prod. Dept.	Syracuse, N. Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03818	Parker Seal Co.	Los Angeles, Calif.
03877	Transition Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N. J.
03954	Singer Co., Diehl Div. Fincrine Plan	Sumnyville, N. J.
04009	Arrow, Hart and Hegeman Electric Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N. J.
04062	Aero Electronic Inc.	Great Neck, N. Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S. C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.
04673	Dakota Engr. Inc.	Culver City, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Calif
04773	Automatic Electric Co	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P. M. Mo. Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05245	Components Corp.	Chicago, Ill.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.
05347	Illitonix, Inc.	San Mateo, Calif.
05397	Union Carbide Corp., Elect. Div.	New York, N. Y.
05574	Viking Ind. Inc.	Canoga Park, Calif.
05593	Ideal Electric Plastics Inc.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tillen Optical Co.	Roslyn Heights, Long Island, N. Y.
05729	Metro-Tel Corp.	Westbury, N. Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raytheon Corp.	Redwood City, Calif.
06175	Bausch and Lomb Optical Co.	Rochester, N. Y.
06407	E. T. A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N. Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N. H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Ariz.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
06940	Varian Assoc. Limac Div.	San Carlos, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N. Y.
07149	Filmohm Corp.	New York, N. Y.
07233	Cinch Graphik Co.	City of Industry, Calif.
07256	Silicon Transistor Corp.	Carle Place, N. Y.
07261	Avnet Corp.	Culver City, Calif.
07263	Fairchild Camera & Inst. Corp. Semiconductor Div.	Mountain View, Calif.
07327	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Bulcher Corp., The	Monterey Park, Calif.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Calif.
07700	Technical Wire Products Inc.	Cranford, N. J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.
07980	Hewlett-Packard Co., Boonton Radio Div.	Rockaway, N. J.
08145	U. S. Engineering Co.	Los Angeles, Calif.
08269	Blinn, Delbert Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08574	Lenisch Fastener Corp.	Los Angeles, Calif.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Calif.
08718	ITT Cannon Electric Int., Phoenix Div.	Phoenix, Arizona
08777	National Radio Lab. Inc.	Paramus, N. J.
08792	CBS Electronics Semiconductor Operations, Div of C. B. S. Inc.	Lowell, Mass.
08806	General Electric Co. Miniat. Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atchm Elect.	Burbank, Calif.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.,	Newton, Mass.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09922	Burndy Corp.	Norwalk, Conn.
10014	General Transistor Western Corp.	Los Angeles, Calif.
10411	Tu-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N. Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11242	Bay State Electronics Corp.	Waltham, Mass.
11317	Teledyne Inc., Microwave Div.	Palo Alto, Calif.
11314	National Seal	Downey, Calif.
11453	Precision Connector Corp.	Jamaica, N. Y.
11534	Duncan Electronics Inc.	Costa Mesa, Calif.
11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N. J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12040	National Semiconductor	Danbury, Conn.
12136	Philadelphia Handle Co.	Camden, N. J.
12261	Glove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc. Data System Div.	Albuquerque, N. M.
12697	Clarostat Mfg. Co.	Dover, N. H.
12728	Elmar Filter Corp.	W. Haven, Conn.
12859	Nippon Electric Co., Ltd	Tokyo, Japan
12881	Meter Electronics Corp.	Clark, N. J.
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13103	Thermalloy	Dallas, Texas
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Semi-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dubilier Electric Corp.	Newark, N. J.
14674	Corning Glass Works	Corning, N. Y.
14752	Electro Cube Inc.	San Gabriel, Calif.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Electronics Co.	New York, N. Y.
15287	Scionics Corp.	Northridge, Calif.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15558	Micron Electronics	Garden City, Long Island, N. Y.
15566	Amprobe Inst. Corp.	Lynbrook, N. Y.
15631	Cabletronics	Costa Mesa, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Ametek Inc.	Mt. View, Calif.
16037	Spruce Pine Mica Co.	Spruce Pine, N. C.
16179	Omni-Spectra Inc.	Farmington, Mich.
16352	Computer Diode Corp.	Lodi, N. J.
16585	Boots Aircraft Nut Corp.	Pasadena, Calif.
16688	Ideal Elec. Meter Co., Inc. De Jur Meter Div.	Brooklyn, N. Y.
16758	Delco Radio Div. of G.M. Corp.	Kokomo, Ind.
17109	Thermonetics Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
17554	Components Inc.	Biddeford, Me.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Calif.
17870	McGraw-Edison Co.	Manchester, N. H.
18042	Power Design Pacific Inc.	Palo Alto, Calif.
18083	Clevite Corp., Semiconductor Div.	Palo Alto, Calif.
18324	Signetics Corp.	Sunnyvale, Calif.
18476	Ty-Car Mfg. Co., Inc.	Hollision, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18583	Curtis Instrument, Inc.	Mt. Kisco, N. Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E. I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N. J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N. J.
19589	Corcon	Baldwin Park, Calif.
19644	LNC Electronics	Hatchreads, N. Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N. Y.
21335	Fafnir Bearing Co., The	New Britain, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D. C.
24455	G. E. Lamp Division	Nela Park, Cleveland, Ohio

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
24655	General Radio Co.	West Concord, Mass.
24681	Mencor Inc., Comp. Div.	Huntington, Ind.
24796	Patelco Inc.	San Juan Capistrano, Calif.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac/Hollister Co.	Hollister, Calif.
26992	Hamilton Watch Co.	Lancaster, Pa.
27251	Specialities Mfg. Co., Inc.	Stratford, Conn.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto Ontario, Canada
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	Sanborn Company	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & Systems Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66295	Willek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Birtley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Calif.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Calif.
71471	Cinema, Div. Aerovox Corp.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electric Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap. Div.	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Elect Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George H. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.
73734	Federal Screw Products Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Calif.
73957	Groov-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	H.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights Inc.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Loid Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phanostran Instrument and Electronic Co.	South Pasadena, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Div.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78474	Specialty Leather Prod. Co.	Newark, N.J.
78488	Thompson-Bremer & Co.	Chicago, Ill.
78671	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Calif.
78947	Utemite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Weedel Rout, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Any brand Tube meeting EIA Standards-Washington, DC.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Calif.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80883	Dimco Gray Co.	Dayton, Ohio
81030	International Instruments Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	
81483	International Rectifier Corp.	El Segundo, Calif.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Daily Controls, Div. Daily Wright Corp.	Walpetown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sprite Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp. Space & Defense System Div.	Paramus, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc. Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83014	Waldwell Corp.	Los Angeles, Calif.
83058	Cam Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Calif.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Calif.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83337	Tech Labs	Palisade's Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co. Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp. Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp. Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	TRW Capacitor Div.	Ogallala, Neb.
84970	Sankes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
85660	Morton Metals, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Div.	Harrison, N. J.
86928	Spectrum Mfg. Co.	Glendale, Calif.
87034	Marco Industries	Anaheim, Calif.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	San Francisco, Calif.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif.
89473	G. E. Distributing Corp.	Schenectady, N.Y.
89665	United Transformer Co.	Chicago, Ill.
90010	United Shoe Machinery Corp.	Beverly, Mass.
90179	US Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N. J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91146	ITT Cannon Elect, Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	M F Development Co.	Redwood City, Calif.
91886	Malco Mfg. Co., Inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Div.	Freeport, Ill
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co. Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Westbury Long Island, N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Palisades Park, N. J.
93410	Stevco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Calif.
93979	G. V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N. J.
94142	Phelps Dodge	Yonkers, N.Y.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N. J.
94197	Curtiss-Wright Corp. Electronics Div.	East Paterson, N. J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Co.	Brooklyn, N.Y.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95073	George A. Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.,	Dania, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N. J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West Inc.	Sunnyvale, Calif.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96306	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Caillon Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
96733	San Fernando Elect. Mfg. Co.	San Fernando, Calif.
96801	Thomson Ind. Inc.	Long Is., N.Y.
97464	Industrial Retaining Ring Co.	Irvington, N. J.
97539	Automatic & Precision Mfg.	Englewood, N. J.
97979	Reon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Tronics, Inc.	Jamaica, N.Y.
98159	Rubber Tech, Inc.	Gardena, Calif.
98220	Hewlett-Packard Co., Moseley Div.	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98376	Zero Mfg. Co.	Burbank, Calif.
98410	Etc Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
987..	Preco Div. of Hewlett-Packard Co.	Palo Alto, Calif.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99378	Allen Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N. J.
99934	Kenbrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp. Semiconductor Div.	El Monte, Calif.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

THE FOLLOWING HP VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

00008	Malco Tool and Die	Los Angeles, Calif.
00009	Willow Leather Products Corp.	Newark, N. J.
00010	ETA	England
00011	Precision Instrument Components Co.	Van Nuys, Calif.
00012	Hewlett-Packard Co., Colorado Springs	Colorado Springs, Colorado
00013	Rubber Eng. & Development	Hayward, Calif.
00014	A "N" D Mfg. Co.	San Jose, Calif.
00015	Coilton	Oakland, Calif.
00016	California Eastern Lab.	Burlington, Calif.
00017	S. H. Smith Co.	Los Angeles, Calif.

BACK DATING MANUAL CHANGES

MANUAL BACKDATING CHANGES

MODEL 735A

DC TRANSFER STANDARD

Manual Serial Prefixed: 547-

-hp- Part No. 00735-90002

This manual backdating sheet makes this manual applicable to earlier instruments. Instrument-component values that differ from those in the manual, yet are not listed in the backdating sheet, should be replaced using the part number given in the manual.

Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
504-	1	825-01015 and below	5
504-00150 and below	1, 2		
547-00200 and below	3		
825-00736 and below	4		

CHANGE #1

Figure 5-9. 735A Schematic and Section VI, Replaceable Parts
Delete the pre-regulator circuit consisting of A1Q5, A1CR8 and A1R13.

Section VI, Replaceable Parts
Change A1 etched circuit board from -hp- Part No. 00735-66501 Rev. B to 00735-66501 Rev. A. (Rev. B is recommended for replacement.)

Change T1 from -hp- Part No. 9100-1325 to -hp- Part No. 9100-1315. The current part is recommended for all replacements.

The large insulator under Q1 is changed from -hp- Part No. 00735-64101 to -hp- Part No. 1200-0077. The current part is recommended for all replacements.

CHANGE #2

Figure 5-9 and Section VI
Change A2R6 to -hp- Part No. 2100-0783 and A2R7* to -hp- Part No. 0698-3406. The current part is recommended for all replacements.

CHANGE #3

Section VI, Replaceable Parts
A2R2 will have the same description but change -hp- Part No. 2100-1555. The current part number is advised for all replacements.

CHANGE #4

Section VI, Replaceable Parts
Change: Panel: Front to -hp- Part No. 00735-00201.
Change: Dial Assy to -hp- Part No. 1140-0022.
Add: DS2; 2140-0025, Lamp, 28 V

CHANGE #5

Section VI, Replaceable Parts
Change J1 to -hp- Part No. 1251-0148.
Change V1 to -hp- Part No. 8120-0078.
Change Panel: rear to -hp- Part No. 00735-00202.

MANUAL CHANGES

MODEL 735A

DC TRANSFER STANDARD

Manual Part No. 00735-90002

► New or Revised Item

ERRATA

Cover Page. Change Serials Prefixed "950" to read "948".

Page 3-1. ③ Add: On later models a lever to the right of the dial assembly is depressed to lock dial.

Page 5-9. On later models A3 pin 3 (TP1) has been moved from base of A3Q1 to base of A3Q4. Change A1 pin 2 (at collector of Q2) to A1 pin 7.

Page 6-2. Change C2, C3 to 0160-0904; C: .05 microfarad 1 K vdcw. Change R6, R9 to 2100-1771; R8 to 2100-1772.

Page 6-5. Change 2110-0033 to agree with F1 in Table 6-2.

CHANGE NO. 1: FOR SERIAL NO. 948-01016 AND GREATER.

Page 6-3. Change S2 Part No. to 3101-1234. Add 5020-0700, spacer, under MISC.

Page 6-5. Add 5020-0700, spacer; MFGR is 28480.

CHANGE NO. 2: FOR SERIAL NO. 976-01106 AND GREATER.

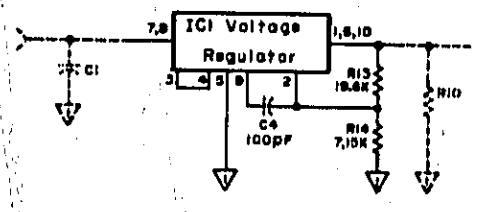
Page 5-9. Change schematic to reflect new values listed below.

Page 6-2. Change A1C2 to 0180-2166; 120 microfarad, 100 V. Change A1C3 to 0180-1743; C: fxd, tant 0.1 microfarad, 35 V. Change A1R4 to 0698-4633; 2.10 K, 1/4 W, 1%. Change A1R8 to 0687-4721; 4.7 K. Change A1CR5 and CR6 to 1902-0029; 12.1 V.

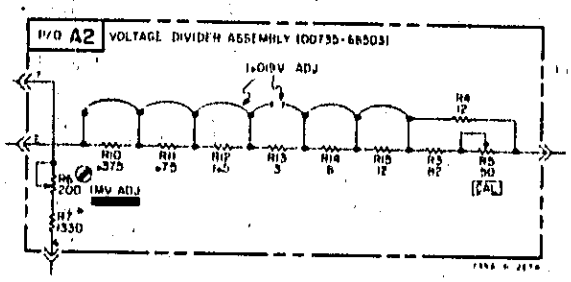
CHANGE NO. 3: FOR SERIAL NO. 976-01186 AND GREATER.

► **Page 5-4.** Paragraph 5-14d. In place of adjusting A2R2, substitute: "...remove or replace shorting links as necessary ...".

Page 5-9. Change A1R2 to 976 ohms. Change A1 schematic as shown:



► **Page 5-9.** Change A2 schematic as shown:



► **Page 6-2.** Add A1C4; 0140-0176; C: fxd 100 pF. Change A1CR7 to 5080-9034; Diode: breakdown 6.2 V. Add A1IC1; 1820-0196; IC: Voltage Regulator. Change A1R2 to 0698-4882; R: fxd 976 ohms 1/2 W 1% MF. Change A1R4 to 0757-0823; R: fxd 1.82 K 1/2 W 1% MF. Change A1R13 to 0698-3157; R: fxd 19.6 K 1/4 W 1% MF. Change A1R14 to 4471; R: fxd 7.15 K 1/4 W 1% MF. Delete Q5, . Change A2 Part No. to 00735-66503.