Errata

Title & Document Type: **410C Electronic Voltmeter Operating and Service Manual**

Manual Part Number: **00410-90007**

Revision Date: **May 1974**

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HP References in this Manual

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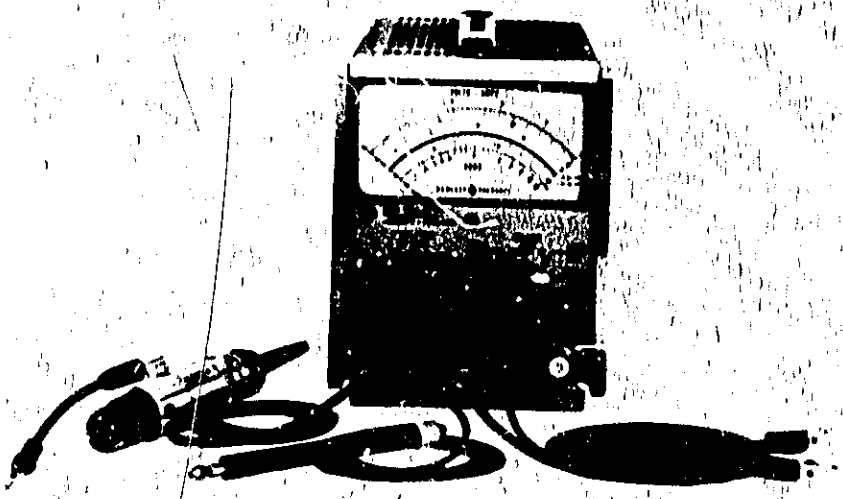
Agilent Technologies

OPERATING AND SERVICE MANUAL

ELECTRONIC VOLTMETER

410C



HEWLETT PACKARD

HP 410C

HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

MODEL 410C
ELECTRONIC VOLTMETER

Prefixed: 0982A

Appendix C, Manual Backdating Changes adapts this manual to Serials Prefixed: 311, 328, 339, 433, 532, 550, 807, 844, 952 and 982

WARNING

To help minimize the possibility of electrical fire or shock hazards, do not expose this instrument to rain or excessive moisture.

Manual Part Number 00410-90007

Microfiche Part Number 00410-90057

Printed: May 1974

HEWLETT PACKARD

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment [,except that in the case of certain components listed in Section I of this manual, the warranty shall be for the specified period] . During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by -hp-. Buyer shall prepay shipping charges to -hp- and -hp- shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to -hp- from another country.

Hewlett-Packard warrants that its software and firmware designated by -hp- for use with an instrument will execute its programming instructions when properly installed on that instrument. Hewlett-Packard does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HEWLETT-PACKARD SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HEWLETT-PACKARD SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

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

10/1/79

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HEWLETT PACKARD

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

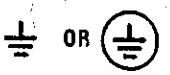
Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

SAFETY SYMBOLS

General Definitions of Safety Symbols Used On Equipment or In Manuals.

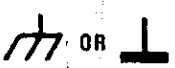
Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.

Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.

Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.



Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current (power line).

Direct current (power line).

Alternating or direct current (power line).

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

NOTE: The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Hewlett-Packard Model 410C Electronic Voltmeter can be used to measure dc voltage and dc current; ac voltage and resistance. Positive and negative dc voltages from 15 mV to 1500 V full scale and positive and negative dc currents from 1.5 μA to 150 mA can be measured full scale. Resistance from 10 Ω to 10 MΩ mid-scale can be measured with an accuracy of ± 5%; resistance from 0.2 Ω to 500 MΩ can be measured with reduced accuracy. The Model 410C Electronic Voltmeter specifications are given in Table 1-1.

1-3. With the Model 11036A detachable AC Probe, the Voltmeter can be used to measure ac voltage from 20 Hz to 700 MHz. From 20 Hz to 100 MHz, ac voltage from 0.5 to 300 V can be measured; from 100 MHz to 700 MHz, refer to Figure 3-5 for maximum ac voltage that can be applied to the AC Probe. For additional information on the AC Probe, refer to Paragraph 1-9.

1-4. INSTRUMENT AND MANUAL IDENTIFICATION.

1-5. Hewlett-Packard uses a two-section serial number consisting of a four-digit prefix and a five-digit suffix. The prefix and suffix are separated by a letter designating the country in which the instrument was manufactured. (A = U.S.A.; G = West Germany; J = Japan; U = United Kingdom.)

1-6. This manual applies to instruments with the serial prefix indicated on the title page. If changes have been made in the instrument since the printing of this manual, a "Manual Changes" supplement supplied with the manual will define these changes. Be sure to record these changes in your manual. Backdating information located in Appendix C adapts the manual to instruments manufactured prior to this printing. The manual part number is indicated on the title page.

1-7. ACCESSORIES AVAILABLE.

1-8. Accessories are available that extend the ac and dc measuring capabilities of the Voltmeter. A description of these accessories and their specifications is given below.

1-9. Model 11036A AC Probe. This accessory, when used with the Model 410C, permits ac voltage measurements from 0.5 V rms to 300 V rms, full scale over a frequency range of 20 Hz to 700 MHz. Reference calibration accuracy at 400 Hz (sinusoidal) is ± 3% of full scale. Frequency response is ± 10% from 20 Hz to 700 MHz, with indications obtainable to 3000 MHz. Frequency response at 100 MHz is within ± 2%. The Model 11036A responds to the positive-peak-above-average value of the signal applied. The Model 410C is calibrated to read in RMS volts, for sine wave inputs.

1-10. Model 11039A Capacitive Voltage Divider. This accessory (formerly the Model 452A) extends the ac voltage range of the Model 410C to 25 kV. The divider permits measurements of extremely high ac voltage such as encountered in dielectric heating equipment, etc., over a frequency range of 25 Hz to 20 MHz. A fixed gap is provided so that breakdown will occur if the applied voltage exceeds 28 kV at low frequencies. Voltage division is 1000:1, ± 3%, and input capacity is 15 pF. A Model 11018A Adapter is also required to connect the Model 11036A AC Probe to the shielded banana plug fitting of the divider.

1-11. Model 11040A Capacity Divider. This accessory (formerly the Model 453A) extends the ac voltage range of the Voltmeter to 2000 V rms. The divider is for use at frequencies above 10 kHz. Voltage division is 100:1, ± 1%, and input capacity is approximately 2 pF.

1-12. Model 11042A Precision T Connector. This accessory (formerly the Model 455A) is used for connecting the Model 11036A Probe across a 50 Ω transmission line using type N connectors. The T joint is such that connection of the probe into a transmission line will not cause a standing wave ratio greater than 1.1 at 500 MHz and 1.2 at 1000 MHz. With this device, measurement of power traveling through a transmission line may be made with reasonable accuracy to 1000 MHz. The usual precautions must be taken to provide accurate impedance matching and the elimination of standing waves along the line through which power is floating. By using a dummy load at the receiving end of this T joint power output of various devices can be measured. In many applications power going into a real load, such as an antenna, can be conveniently measured up to 1000 MHz with good accuracy.

1-13. Model 11043A Type N Connector. This accessory (formerly the Model 458A) allows the AC Probe to be connected to a 50 Ω coaxial line. The connector uses a male type N connector and a receptacle for receiving the probe. Terminating resistor is not included.

1-14. Model 11045A DC Divider. This accessory extends the maximum dc voltage range of the Model 410C to 30 kV. Voltage division is 100:1, ± 5%, and input resistance is 9900 MΩ. When used with the Model 410C input resistance is 10,000 MΩ. This probe offers maximum safety and convenience for measuring high voltages such as in television equipment, etc. The maximum current drain is 2.5 μA.

Table 1-1. Specifications.

DC VOLTMETER

Voltage Ranges: ± 15 mV to ± 1500 V full scale in 15, 50 sequence (11 ranges).

Accuracy: ± 2% of full scale on any range.

Input Resistance: 100 MΩ ± 1% of 500 mV range and above. 10 MΩ ± 3% on 15 mV, 50 mV, and 150 mV ranges.

DC AMMETER

Current Ranges: ± 1.5 μA to ± 150 mA full scale in 1.5, 5 sequence (11 ranges).

Accuracy: ± 3% of full scale on any range.

Input Resistance: Decreasing from 9 kΩ on 1.5 μA scale to approximately 0.3 Ω on the 150 mA scale.

Special Current Ranges: ± 1.5, ± 5, ± 15 nanoamps may be measured on the 15, 50, and 150 millivolt ranges using the voltmeter probe, with ± 5% accuracy and 10 mΩ input resistance.

OHMMETER

Resistance Range: Resistance from 10 Ω to 10 MΩ center scale (7 ranges).

Accuracy: Zero to midscale: ± 5% of reading or ± 2% of midscale, whichever is greater.
± 7% from midscale to scale value of 2.
± 8% from scale value of 2 to 3.
± 9% from scale value of 3 to 5.
± 10% from scale value of 5 to 10.

AMPLIFIER

Voltage Gain: 100 maximum.

AC Rejection: 3 dB at 1/2 Hz; approximately 66 dB at 50 Hz and higher frequencies for signals less than 1600 V peak or 30 times full scale, whichever is smaller.

Isolation: Impedance between common and chassis is > 10 MΩ in parallel with 0.1 μF. Common may be floated up to 400 V dc above chassis for dc and resistance measurements.

Output: Proportional to meter indication; 1.5 V dc at full scale, maximum current, 1 mA.

Output Impedance: Less than 3 Ω at dc.

Noise: Less than 0.5% of full scale on any range (p-p).

DC Drift: Less than 0.5% of full scale/year at constant temperature. Less than 0.02% of full scale/°C.

Overload Recovery: Recover from 100:1 overload in < 3 sec.

AC VOLTMETER

Ranges: 0.5 V full scale to 300 V in 0.5, 1.5, 5 sequence (7 ranges).

Accuracy: ± 3% of full scale at 400 Hz for sinusoidal voltages from 0.5 to 300 V rms. The AC Probe responds to the positive peak-above-average value of the applied signal.

Frequency Response: ± 2% from 100 Hz to 50 MHz (400 Hz ref.), 0% to -4% from 50 MHz to 100 MHz ± 10% from 20 Hz to 100 Hz and ± 1.5 dB from 100 MHz to 700 MHz.

Frequency Range: 20 Hz to 700 MHz.

Input Impedance: Input capacity 1.5 pF, input resistance > 10 MΩ at low frequencies. At high frequencies impedance drops off due to dielectric loss.

Safety: The probe body is grounded to chassis in the AC Function for safety. All ac measurements are referenced to chassis ground.

Meter: Individually calibrated taut band meter. Responds to positive peak-above-average. Calibrated in rms volts for sine wave input.

GENERAL

Maximum Input: (see Overload Recovery)
DC: 100 V on 15, 50 and 150 mV ranges; 500 V on 0.5 to 15 V ranges; 1600 V on higher ranges.
AC: 100 times full scale or 450 V peak, whichever is less.

Power: 115 or 230 V ± 10%, 48 to 440 Hz, 13 watts (20 watts with 11036A AC Probe).

Dimensions: 6 1/2 in. high (16.5 cm); 5 1/8 in. wide (13.01 cm); 11 in. deep (27.9 cm) behind panel. Fits 5060-0797 Rack Adapter and 1050 series combining cases.

Weight:
Net: 8 lbs. (4.0 kg)
Shipping: approximately 15 lbs. (6.35 kg)

Accessories Furnished: Detachable power cord, NEMA plug; -hp- Model 11036A AC Probe.

Option 02: -hp- Model 410C less AC Probe.

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, check for supplied accessories, and test the electrical performance of the instrument using the procedure outlined in Paragraph 5-5, Performance Tests. If there is damage or deficiency, see the warranty on the inside front cover of this manual.

2-3. INSTALLATION.

2-4. The -hp- Model 410C is transistorized except for one vacuum tube and requires no special cooling. However, the instrument should not be operated where the ambient temperature exceeds 55°C (140°F).

2-5. RACK MOUNTING.

2-6. The Model 410C is a submodular unit designed for bench use. However, when used in combination with other submodular units, it can be bench and/or rack mounted. The -hp- Combining Cases and Adapter Frame are designed specifically for this purpose.

2-7. Models 1051A and 1052A Combining Cases. The Combining Cases are full-module units which accept various combinations of submodular units. Being a full width unit, it can either be bench or rack mounted. An illustration of the Combining Case is shown in Figure 2-1. Instructions for installing the Model 410C are shown in Figure 2-2.

2-8. Rack Adapter Frame (-hp- Part No. 5060-0797). The adapter frame is a rack mounting frame that accepts various combinations of submodular units. It can be rack mounted only. An illustration of the adapter frame is given in Figure 2-3. Instructions are given below.

a. Place the adapter frame on edge of bench as shown in step 1, Figure 2-4.

b. Stack the submodular units in the frame as shown in step 2, Figure 2-4. Place the spacer clamps between instruments as shown in step 3, Figure 2-4.

c. Place spacer clamps on the two end instruments (see step 4, Figure 2-4) and push the combination into the frame.

d. Insert screws on either side of frame, and tighten until submodular instruments are tight in the frame.

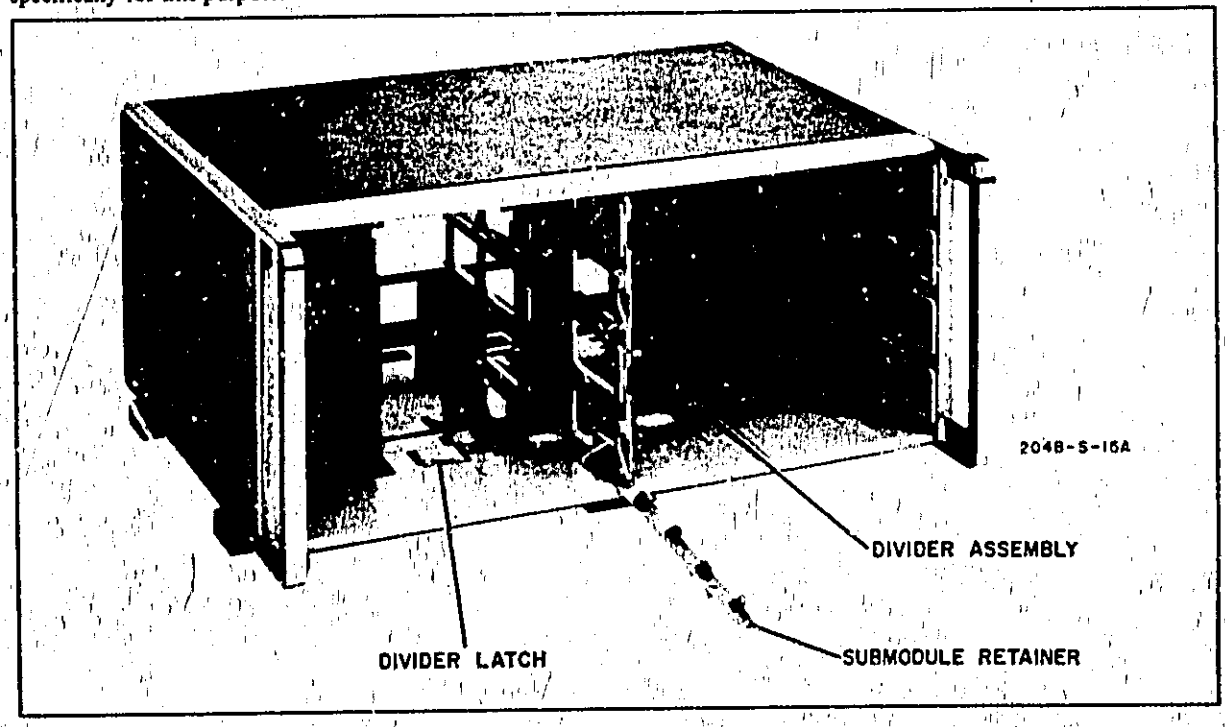


Figure 2-1. The Combining Case.

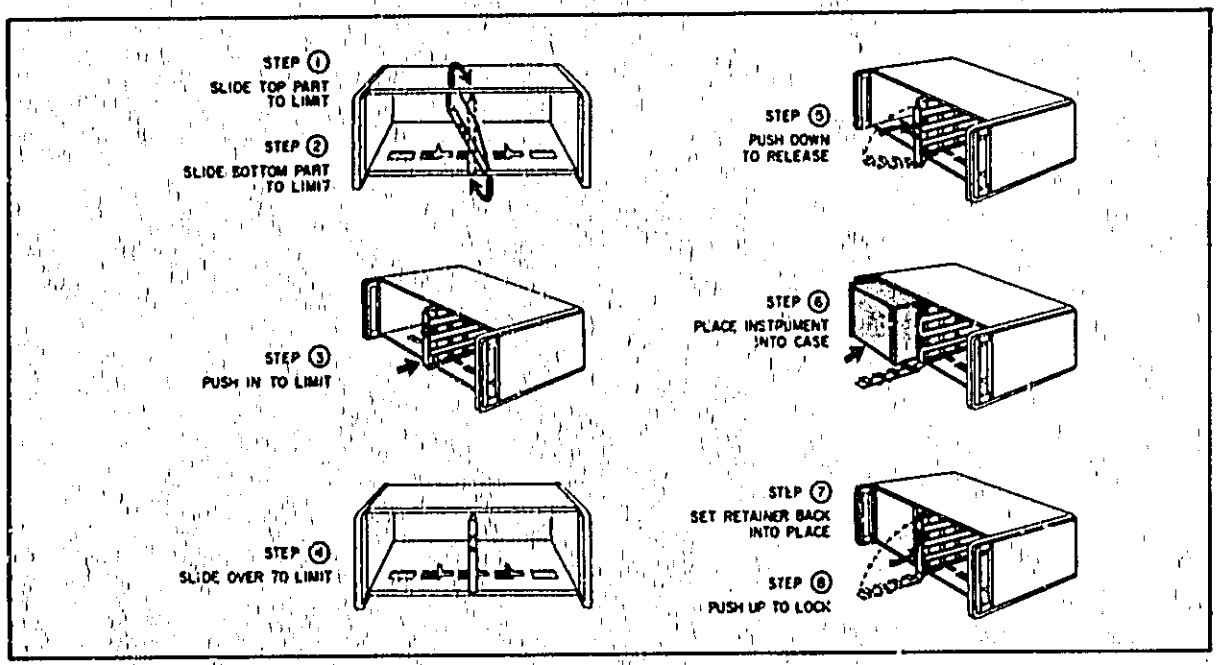


Figure 2-2. Steps to Place Instrument in Combining Case.

e. The complete assembly is ready for rack mounting.

2-9. THREE-CONDUCTOR POWER CABLE.

2-10. To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument panel and cabinet be grounded. All Hewlett-Packard instruments are equipped with a three-conductor power cable which grounds the instrument when plugged into an appropriate receptacle.

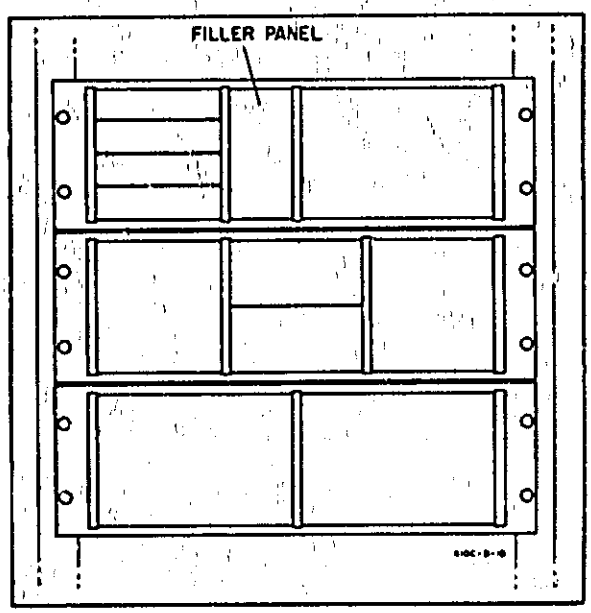


Figure 2-3. Adapter Frame Instrument Combination.

2-11. To preserve the protection feature when operating the instrument from a two-contact outlet, use three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

2-12. PRIMARY POWER REQUIREMENTS.

2-13. The Model 410C can be operated from either 115 or 230 V, 48 to 440 Hz. The instrument can be easily converted from 115 to 230 V operation. The SELECTOR switch, S2 a two-position slide switch located at the rear of the instrument, selects the mode of ac operation. The line voltage from which the instrument is set to operate appears on the slider of the switch. A 0.25 ampere, slo-blo fuse is used for both 115 and 230 V operation. If the Model 410C is operated at any frequency other than 60 Hz, perform chopper frequency adjust (Paragraph 5-31).

CAUTION

Do not change the setting of the line voltage switch when the voltmeter is operating.

2-14. Repackaging for Shipment.

2-15. The following paragraphs contain a general guide for repackaging of the instrument for shipment. Refer to Paragraph 2-16 if the original container is to be used; 2-17 if it is not. If you have any questions, contact your local -hp- Sales and Service Office. (See Appendix B for office locations.)

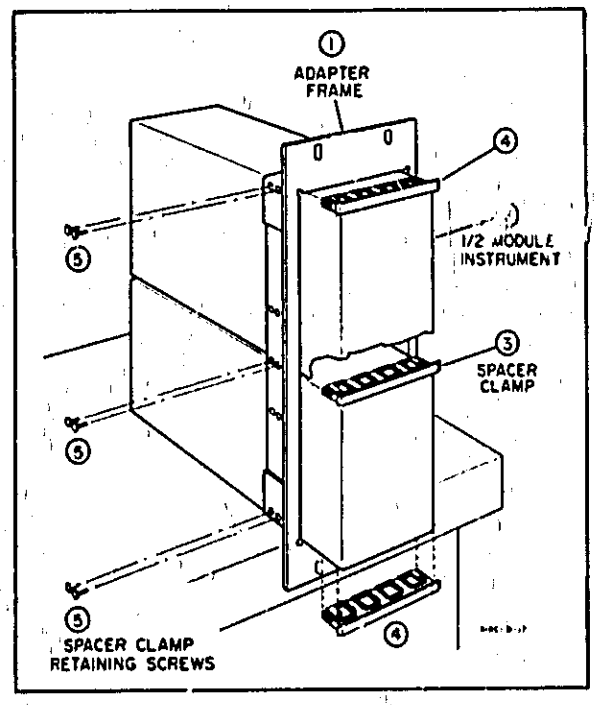


Figure 2-4. Two Half Modules in Rack Adapter.

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 indicate the service or repair to be performed; include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number, serial number and serial number prefix.

2-16. If the original container is to be used, proceed as follows:

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

b. Ensure that container is well sealed with strong tape or metal bands.

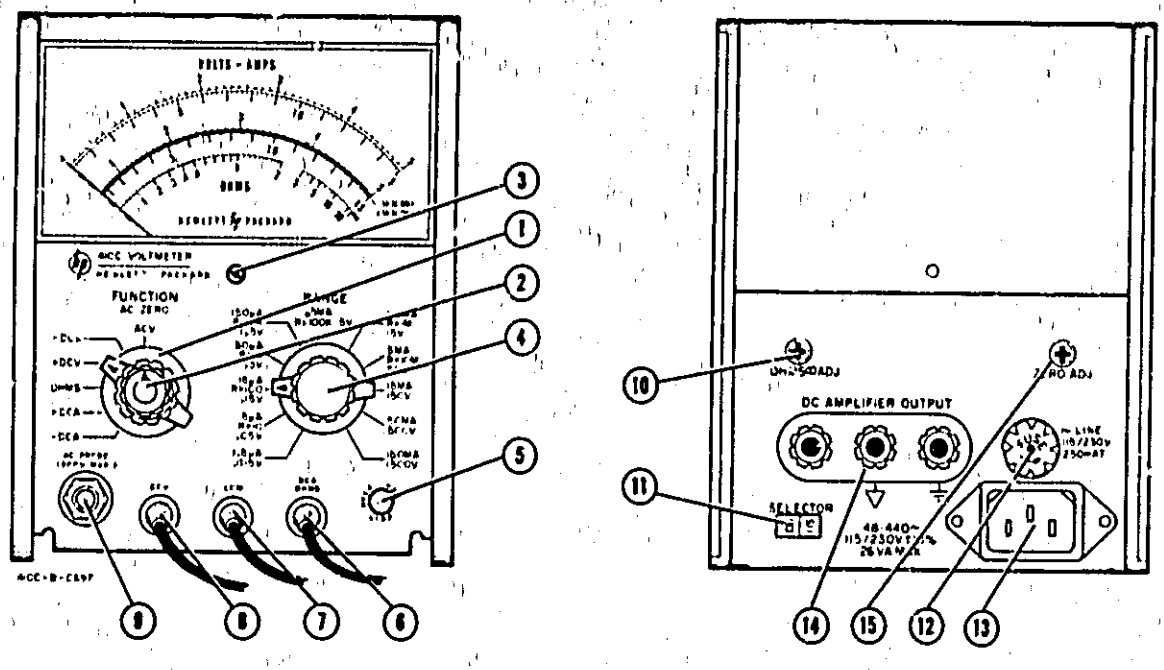
2-17. If original container is not to be used, proceed as follows:

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

b. Place packing material around all sides of instrument and protect panel face with cardboard strips.

c. Place instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

d. Mark shipping container with "DELICATE INSTRUMENT," "FRAGILE," etc.



(1) FUNCTION SELECTOR: This control is used for selecting type of measurement to be made. They are: ± DC Voltage, ± DC Current, AC Voltage, and resistance measurements.

(2) AC ZERO: This control provides adjustment for zero-setting the meter before making ac voltage measurements.

(3) MECHANICAL ZERO ADJUST: This adjustment mechanically zero-sets the meter prior to turning on Voltmeter.

(4) RANGE: This control selects the full scale meter range.

(5) AC POWER SWITCH: This pushbutton-lamp combination, when depressed, turns the instrument power on or off. The pushbutton glows when the Voltmeter power is on.

(6) DCA-OHMS: This lead is used in conjunction with the COM Lead to measure dc current or ohms. The FUNCTION SELECTOR determines which measurement is made.

(7) COM: This lead is used with the input leads for dc current, dc voltage, and resistance measurements. The COM Lead is normally floating; however, a shorting bar can be connected from the floating ground terminal to the chassis ground terminal on the DC AMPLIFIER OUTPUT connector. If a shorting bar is not used, the COM Lead is floating except when the FUNCTION SELECTOR is set to ACV.

(8) DCV: This lead is used in conjunction with the COM Lead to measure dc voltage.

(9) AC PROBE (300 V MAX): Receptacle for telephone-type plug of Model 11036A AC Probe. With probe connected, the Voltmeter may be used to make ac voltage measurements.

(10) ADJUST: This control is used to set meter pointer to before resistance measurements are made. Only periodic adjustment of this screwdriver adjustment is necessary.

(11) LINE VOLTAGE: This two-position slide switch sets the instrument to accept either 115 or 230 V ac primary power.

(12) FUSEHOLDER: The fuseholder contains a 0.25 ampere slow-blow fuse for both 115 V ac and 230 V ac modes of operation.

(13) AC POWER CONNECTOR: Accepts power cable supplied with the instrument.

(14) DC AMPLIFIER OUTPUT: Provides dc voltage output proportional to meter indication for driving external recorder. 1.5 V dc output for full scale meter deflection.

(15) ZERO ADJUST: This control is used to set meter pointer to zero when calibrating for dc and resistance measurements.

Figure 3-1. Front and Rear Panel Controls.

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. The Model 410C is used to measure ac and dc voltage, dc current, and resistance. All measurement inputs are located on the front panel; a dc output connector is located on the rear panel. Front panel controls and indicators are color coded. DC voltage, dc current and resistance knobs and indicators are in black; ac voltage controls and indicators are in red.

3-3. ADJUSTMENT OF MECHANICAL ZERO.

3-4. The procedure for adjustment of mechanical zero is given in Section V.

3-5. FRONT AND REAR PANEL DESCRIPTION.

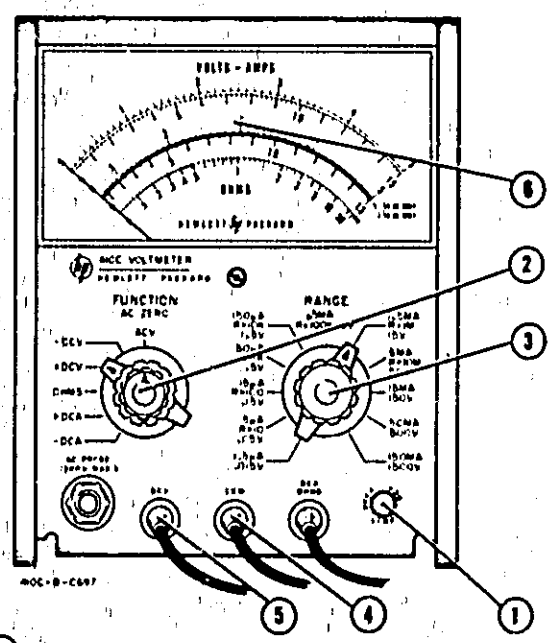
3-6. Figure 3-1 describes the function of all front and rear panel controls, connectors and indicators. The description of each control, connector and indicator is keyed to a drawing which accompanies the figure.

3-7. OPERATING PROCEDURES.

3-8. There are five operating procedures: DC Voltage Measurements, Figure 3-2; DC Current Measurements, Figure 3-3; AC Voltage Measurements, Figure 3-4; Resistance Measurements, Figure 3-7; and Measuring DC Current in Nano-amperes, Figure 3-8.

NOTE

Aging of the neon lamps in the chopper assembly can cause a change in chopper frequency which produces a slight oscillatory movement of meter pointer. If this oscillatory movement is observed, rotate Osc Freq Adj A3R5 (see Paragraph 5-31) in the ccw direction until oscillation of pointer stops.



(1) Depress the AC power switch (neon - switch combination).

(2) Set FUNCTION SELECTOR to polarity desired (+DCV or -DCV).

(3) Set RANGE to desired voltage position.

(4) Connect COM Lead to the ground of circuit under test.

(5) Touch DCV probe to test point.

(6) Read voltage on the VOLTS-AMPS scale.

NOTE

Aging of the neon lamps in the chopper assembly can cause a change in chopper frequency which produces a low amplitude oscillatory movement of the meter pointer. If the meter pointer oscillates, rotate A3R5 ccw until oscillation stops.

Figure 3-2. DC Voltage Measurements.

3-9. DC Voltage Measurements (Figure 3-2).

3-10. The Model 410C is normally floating; however, a shorting bar can be connected at the DC AMPLIFIER OUTPUT connector on the rear panel. When the instrument is floating, the COM Lead should not be connected to voltages greater than 400 V dc.

3-11. DC Current Measurements (Figure 3-3).

3-12. General instructions for the measurement of dc current are the same as those given for dc voltage measurements, Paragraph 3-9.

3-13. AC Voltage Measurements (Figure 3-4).

CAUTION

One side of almost all power distribution systems is grounded. Extreme caution must be used if direct measurement of power line voltages is attempted. If the ground clip lead is accidentally connected to the ungrounded side of the line, severe damage to the 410C is possible because of the short circuit created. Power line voltages can best be measured by using the probe tip only. Contacting the grounded power conductor will give a reading of 0 V while contacting the ungrounded lead will give full voltage reading.

3-14. Although the Model 410C indicates a full scale ac range of 500 V, the optional Model 11036A AC Probe should not be connected to ac voltages in excess of 300 V rms. AC voltage referenced to a dc voltage may be measured, but the AC Probe clip (alligator type) must be connected to the ground (⏚) of the circuit under test.

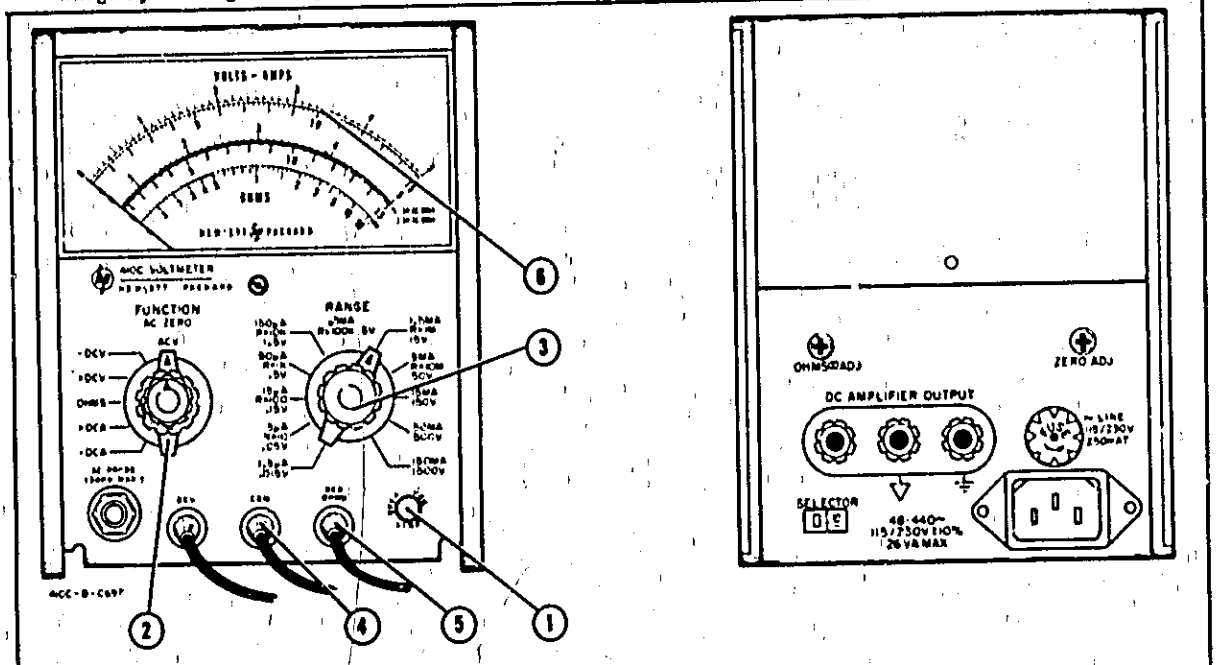
CAUTION

When measuring ac referenced to dc, the peak ac voltage plus dc voltage connected to the probe must not exceed 420 V.

3-15. Precautions When Measuring AC Voltage.

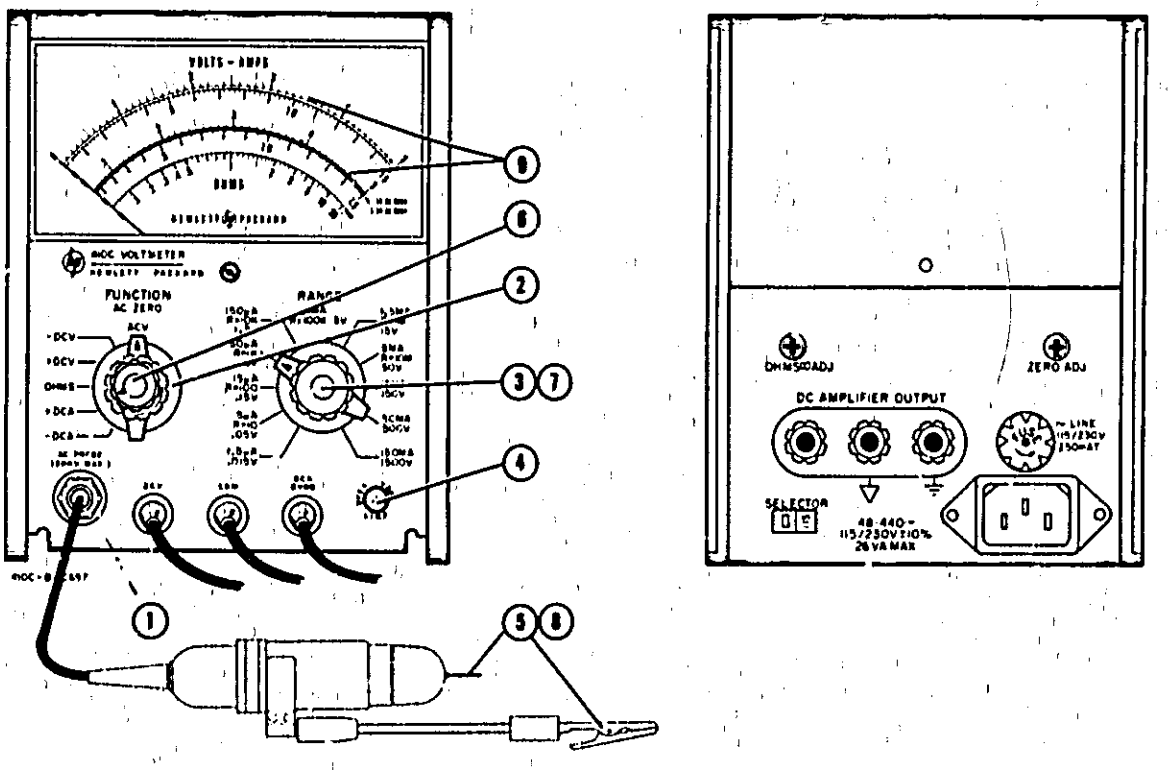
3-16. Special considerations must be kept in mind when making ac voltage measurements. These considerations are discussed in the following paragraphs.

3-17. General Consideration of Complex Waveforms. Waveforms containing appreciable harmonics or spurious voltages will introduce error in the meter indication since the meter has been calibrated to read rms values of true sine waves while the Model 11036A Probe is a peak-above-average responding device. The magnitude of error that may be expected when harmonics are present on the measured waveform is indicated in Table 3-1.



1. Depress the AC power switch (neon-switch combination).
2. Set FUNCTION SELECTOR to the polarity desired (+DCA or -DCA).
3. Set RANGE to desired current position.
4. Connect COM Lead to the ground of circuit under test.
5. Connect the DCA ohms probe to the circuit to be tested.
6. Read the current on the VOLTS-AMPS scale.

Figure 3-3. DC Current Measurements.



CAUTION

Connect AC ground clip and COM Lead to earth ground only when in AC FUNCTION.

(1) Connect the -hp- Model 11036A AC Probe to the Model 410C at the AC PROBE receptacle.

(2) Set FUNCTION SELECTOR to ACV. NOTE: COM and chassis are internally connected when the FUNCTION SELECTOR is set to ACV.

(3) Set RANGE to 0.5 V.

(4) Depress the AC power button (neon-switch combination) and allow 5 minute warmup.

(5) Short AC Probe Tip with Ground Clip.

(6) Adjust AC ZERO for a zero indication on the meter.

(7) Set RANGE to the desired voltage range.

(8) Connect AC Probe clip (alligator) to ground of circuit to be tested, and touch probe tip to test point. At lower frequencies COM Lead can be substituted for the AC Probe clip.

CAUTION

Before measuring voltages at frequencies above 100 MHz, refer to Figure 3-5 to determine the maximum amount of voltage that can be applied at that frequency.

(9) Read ac voltage on the VOLTS-AMPS scale. NOTE: When RANGE is on the 0.5 V and 1.5 V positions, use red meter scale.

Figure 3-4. AC Voltage Measurements.

Table 3-1. Possible Error when Measuring Voltage of Complex Waveforms.

Harmonic	True RMS Value	Voltmeter Indication
0	100	100
10% 2nd	100.5	90 to 110
20% 2nd	102	80 to 120
50% 2nd	112	75 to 150
10% 3rd	100.5	90 to 110
20% 3rd	102	87 to 120
50% 3rd	112	108 to 150

3-18. Voltage Measurements at Frequencies Below 50 Hertz. Voltage measurements at frequencies as low as 20 Hz may be made without loss of accuracy by removing the plastic nose on the Model 11036A and using in its place a 0.25 μF blocking capacitor in series with the exposed contact of the probe.

CAUTION

The gray insulating material around the AC Probe is polystyrene, a low-melting point material. It is not possible to solder to the contact which is exposed with the probe nose removed without destroying the polystyrene.

3-19. Voltage Measurement at High Frequencies. At frequencies above 100 MHz the distance between the point of voltage measurement and anode of the probe diode must be made as short as possible. If feasible, substitute a small disc type capacitor of approximately 50 pF for the removable tip on the probe. Solder one terminal of the button capacitor to the measurement point in the circuit and not to the probe contact. The probe contact (with tip removed) can then contact the other terminal of the capacitor for the measurement.

3-20. At frequencies above 100 MHz considerable voltage may be built up across ground leadsand along various parts of a grounding plane. Consequently, to avoid erroneous readings when measuring medium and high frequency circuits, use the ground clip lead on the shell of the probe to connect the circuit ground. In some cases at the higher frequencies it may be necessary to shorten the grounding lead on the probe.

3-21. For all measurements at higher frequencies, hold the molded nose of the probe as far from the external ground plane or from object at ground potential as can conveniently be done. Under typical conditions, this practice will keep the input capacitance several tenths of a pF lower than otherwise.

3-22. For measurements above approximately 250 MHz it is almost mandatory that measurements be made on voltages which are confined to coaxial transmission line circuits. For applications of this type, the Model 11036A Probe is particularly suitable because the physical configuration of the diode and probe is that of a concentric line, and with a few precautions it can be connected to typical coaxial transmission line circuits with little difficulty.

3-23. To connect the probe into an existing coaxial transmission line, cut the line away so the center conductor of the line is exposed through a hole large enough to clear the body of the probe. The nose of the probe should be removed for this type of measurement. Connect one terminal of a button-type capacitor of approximately 50 pF to the center conductor of the coaxial line so that the other terminal of the capacitor will contact the anode connection of the probe. A close-fitting metal shield or bushing should be arranged to ground the outer cylinder of the probe to

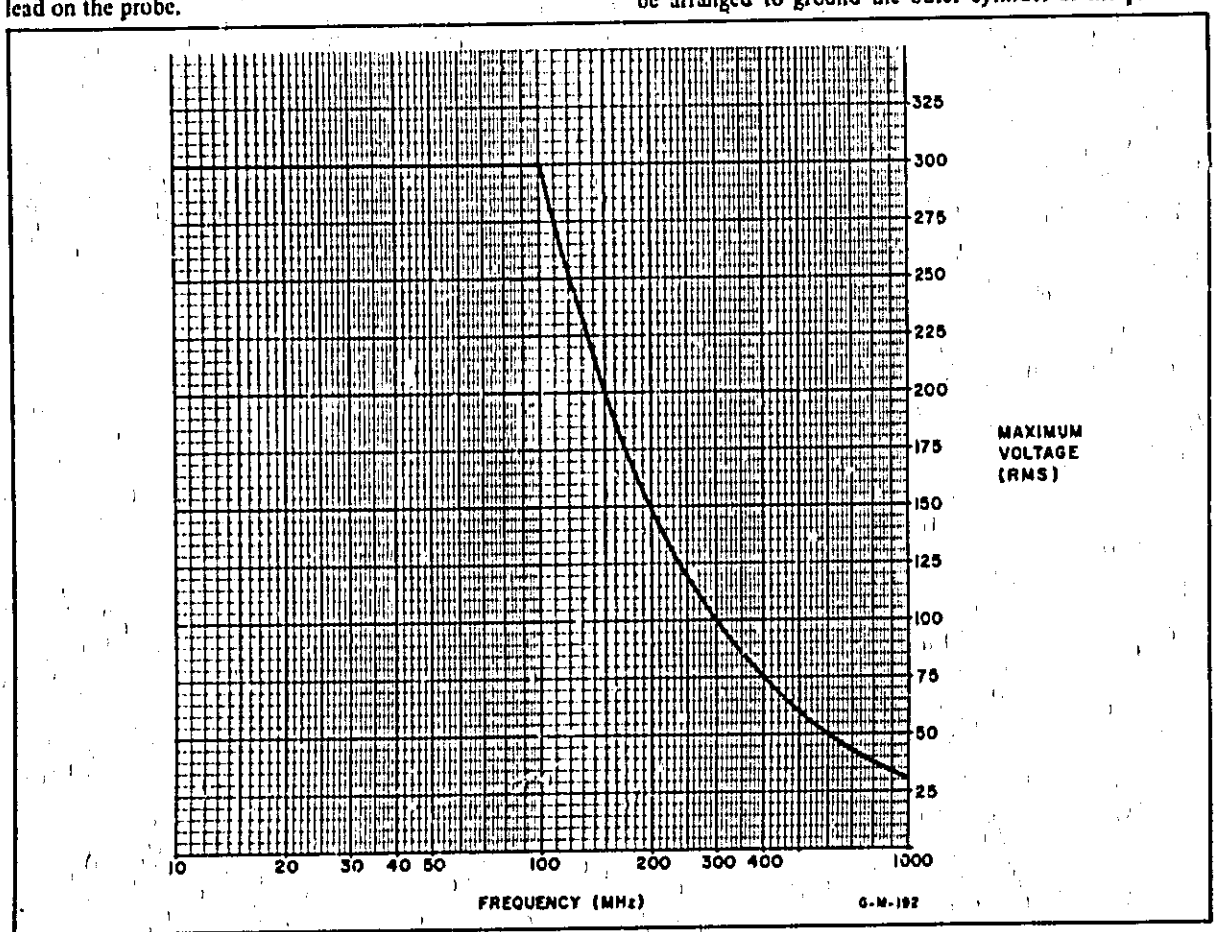


Figure 3-5. Maximum AC Voltage Chart for 11036A AC Probe.

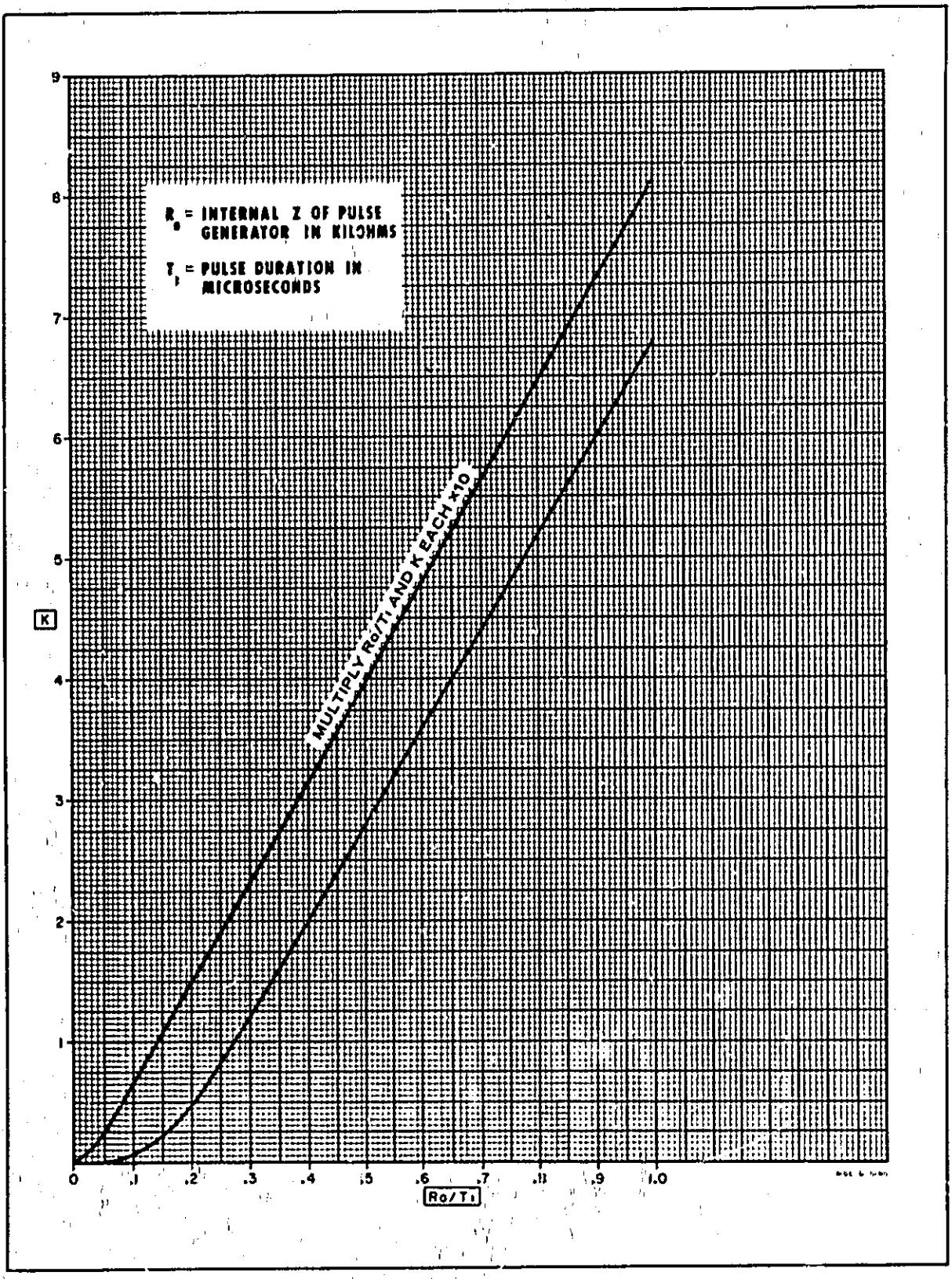


Figure 3-6. Graph Used in Calculation of Pulse Voltage Readings.

the outer conductor of the transmission line. This type of connection is likely to cause some increase in the standing wave ratio of the line at higher frequencies. The Model 11042A Probe T Connector is designed to do this job with SWR of less than 1.1 at 500 MHz (see Paragraph 1-12).

3-24. Effect of Parasitics on Voltage Readings. At frequencies above 500 MHz leads or portions of circuits often resonate at frequencies two, three, or four times the fundamental of the voltage being measured. These harmonics may cause serious errors in the meter reading. Owing to the resonant rise in the probe circuit at frequencies above 1000 MHz, the meter may be more sensitive to the harmonics than to the fundamental. To make dependable measurements at these frequencies, the circuits being measured must be free of all parasitics.

3-25. Effect of DC Present with AC Signal. When measuring an ac signal at a point where there is a high dc potential, such as at the plate of a vacuum tube, the high dc potential may cause small leakage current through the blocking capacitor in the tip of the Model 11036A AC Probe. When the ac signal under measurement is small, the error introduced into the reading can be significant. To avoid leakage, an additional capacitor with a dielectric such as mylar or polystyrene which has high resistance to leakage is required. (Use 5 pF or higher, and insert the capacitor between the point of measurement and the probe tip.)

3-26. Pulse Measurements.

3-27. Positive Pulses. The Model 11036A AC Probe is peak-above-average responding and clamps the positive peak value of the applied voltage. This permits the probe to be used to measure the positive voltage amplitude of a pulse, provided the reading obtained is multiplied by a factor determined from the following expression:

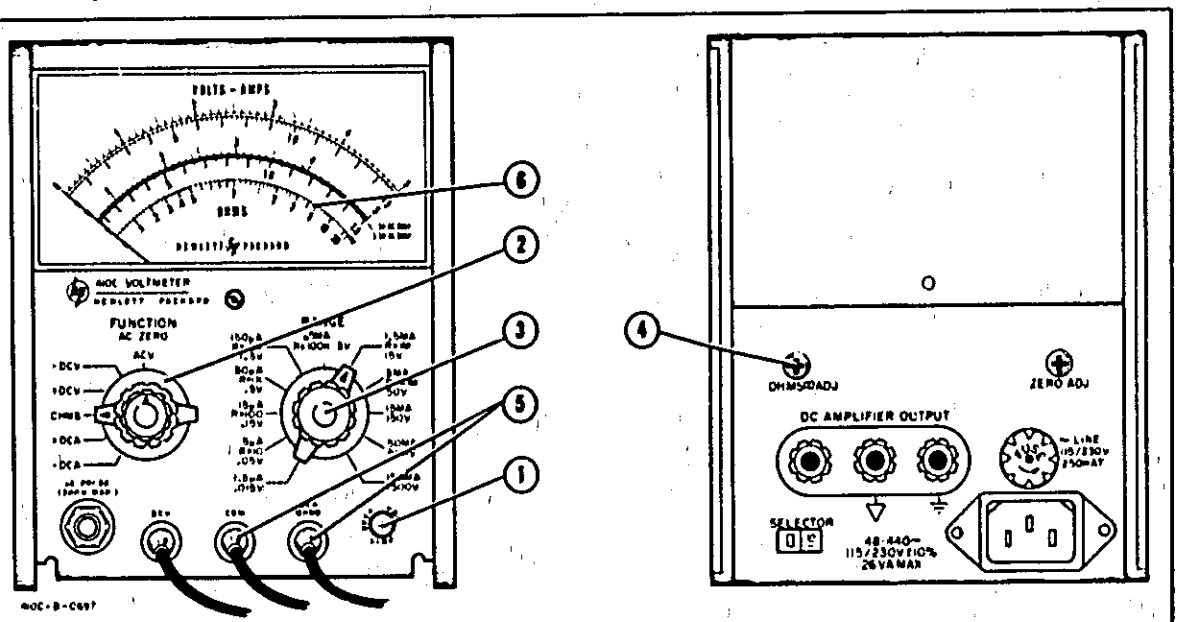
$$1.4\left(1+\frac{t_1}{t_2}+\frac{K}{PRF}\right)$$

t_1 is the duration of the positive portion of the voltage in microseconds.

t_2 is the duration of the negative portion of the voltage in microseconds.

K is a factor determined from the expression R_0/t_1 and the graph shown in Figure 3-6, where R_0 is the source impedance of the pulse generator in kilohms, and t_1 is the duration of the positive portion of the pulse in microseconds.

PRF is the pulse repetition frequency in pulses per second (pps).



Before making resistance measurements, remove power from circuit to be tested. Be sure to discharge capacitors to eliminate any residual voltage.

(1) Depress AC power switch (neon-switch combination).

(2) Set the FUNCTION SELECTOR to OHMS.

(3) Set RANGE to desired position.

(4) Adjust OHMS ADJ. control on rear panel to obtain an reading on the meter if necessary.

(5) Connect COM and DCA OHMS leads across circuit to component to be tested.

(6) Resistance is determined by multiplying the reading on the OHMS scale by the RANGE factor. EXAMPLE: If reading is 1.5 and factor is 10 K, then resistance equals 15 kΩ.

Figure 3-7. Resistance Measurements.

Suppose for example:

t_1 = 10 microseconds
t_2 = 990 microseconds
K = 0.45
PRF = 1000 pps

To find K, assuming R_O = 2 kΩ and t_1 = 10 microseconds: R_O/t_1 = 2/10 = 0.2. Locate 0.2 on the X axis of the graph shown as Figure 3-6, and read K where X and Y axes intersect the unmarked curve. If the ratio of R_O/t_1 were greater than 1, you would multiply the X and Y axes by 10, and use the curve marked "R_O/t_1 and K each X10."

Solving the expression for the multiplying factor,

$$1.4\left(1 + \frac{10}{990} + \frac{0.45}{1000}\right) =$$

$$1.4\ (1 + 0.01 + 0.00045) =$$

$$1.4\ (1.01045) =$$

$$1.41463$$

3-28. Negative Pulses.

3-29. In the case of a 10 microsecond negative pulse (t_2) and a pulse repetition frequency (PRF) of 1000 pps, t_1 would be 990 microseconds. Thus R_O/t_1 would be approximately 0, and from the graph it is seen that K is approximately 0. The expression would then reduce to

$$1.4\ (1 + \frac{990}{10})$$

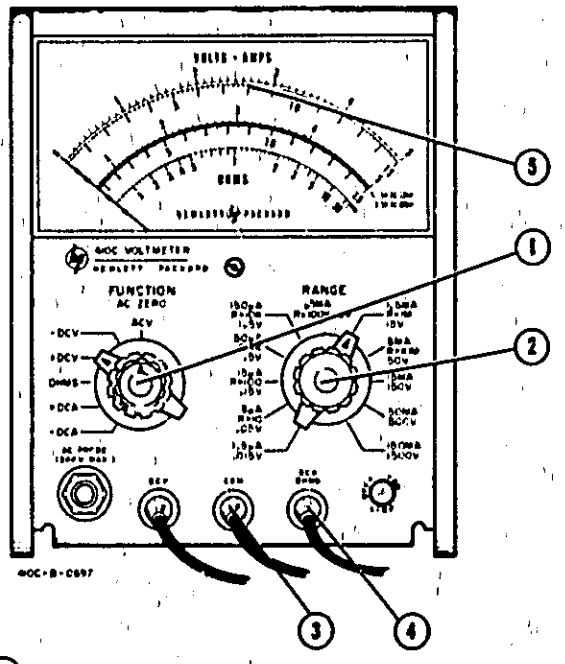
3-30. It can be seen that in the case of negative pulses of short duration much smaller readings will be obtained for an equivalent positive pulse. As a result, large multiplying factors must be used and unless the pulse voltage is large, these measurements may be impractical.

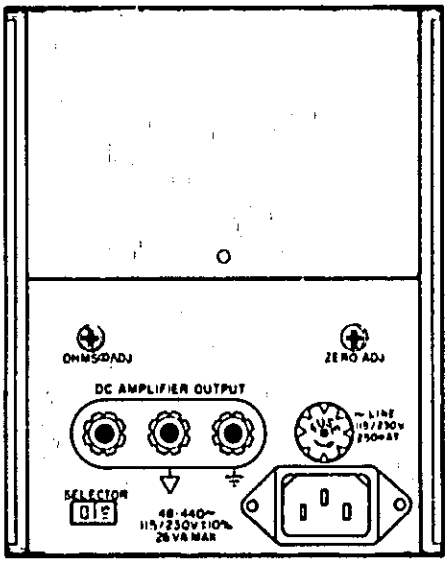
3-31. Measuring Resistance (Figure 3-7).

3-32. Before making resistance measurements, power must be removed from the circuit to be tested. Also, make sure capacitors are discharged to eliminate any residual voltage.

3-33. Measuring DC Nano-ampere Current (Figure 3-8).

3-34. The Model 410C can be used to measure nano-ampere leakage current in transistors and diodes. The three most sensitive dc voltage measurement ranges are used to measure dc nano-ampere currents.





(1) Set the FUNCTION SELECTOR to +DCV or -DCV (depending on direction of current flow).

(2) Set RANGE to desired range (0.015 V, 0.05 V, or 0.15 V range).

NOTE

0.015 V range = 1.5 nano-amperes range
0.05 V range = 5.0 nano-amperes range
0.15 V range = 15 nano-amperes range

(3) Connect the DCV lead to the circuit under test.

(4) Connect the COM lead to the circuit under test.

(5) Read nano-amperes from the meter on the VOLTS-AMPS scale (top two on meter) which corresponds to the range selected.

Figure 3-8. DC Nano-Ampere Current Measurements.

SECTION IV
THEORY OF OPERATION

4-1. OVERALL DESCRIPTION.

4-2. The Model 410C includes an input network, a modulator-amplifier-demodulator, and a meter circuit. A block diagram of the Model 410C is shown in Figure 4-1.

4-3. Signals to be measured are applied through the appropriate input lead to the input network. AC voltages are detected in the AC Probe, and therefore all signals to the input network are dc. The input network attenuates the dc signal to a level determined by RANGE and FUNCTION SELECTOR settings. The attenuated dc voltage is applied to the modulator which converts the dc to ac for amplification. The amplified ac signal is converted back to dc voltage in the demodulator and coupled to cathode follower V1B. The cathode follower output to the DC AMPLIFIER OUTPUT connector and meter circuit is a dc voltage proportional to the amplitude of the signal applied to the input. A portion of the voltage to the meter circuit is returned to the modulator as feedback. When the feedback voltage and attenuated dc voltage are nearly equal, the meter stabilizes.

4-4. CIRCUIT DESCRIPTION.

4-5. Input Network.

4-6. The input network includes a precision voltage divider, which by means of the FUNCTION SELECTOR and RANGE switches, provides a maximum of 15 mV at the modulator input regardless of the range set and signal applied. The ±DCA, ±DCV, OHMS, and ACV modes of operation are discussed below.

4-7. **DC Current Measurements.** Refer to Figure 5-16, throughout this explanation. The purpose of the input network is to provide proper attenuation of currents applied. Currents from 1.5 μA to 150 mA full scale are applied with input impedance decreasing from 9 kΩ on the 1.5 μA range to approximately 0.3 Ω on the 150 mA range.

4-8. The change in input impedance is varied by using dc current shunts in conjunction with RANGE switch A2S1. The dc voltage developed across these shunt resistors, when applied through the modulator-amplifier-demodulator network to the meter, provide a deflection on the meter proportional to the dc current being measured.

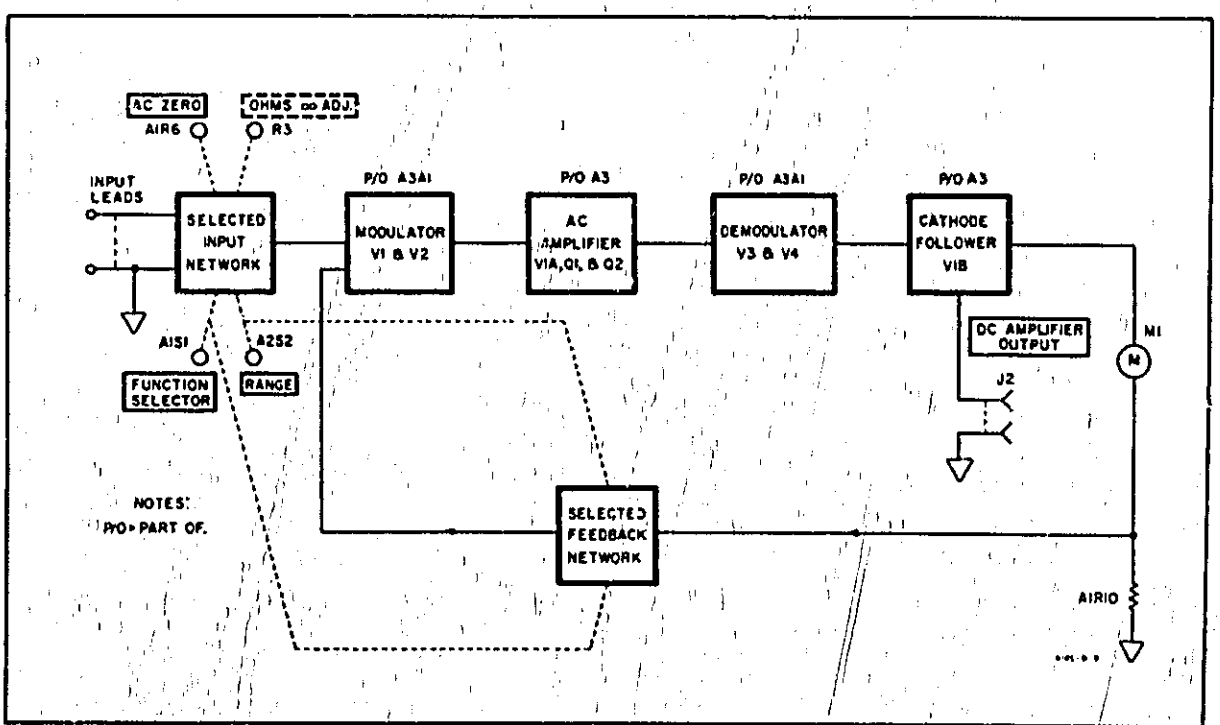


Figure 4-1. Block Diagram, Model 410C.

4-9. DC Voltage Measurements. Refer to Figure 5-17 throughout this explanation. The purpose of the input network is to accurately attenuate the input signal to a maximum of 15 mV at the modulator input. The network presents an input impedance of 10 MΩ on the three most sensitive ranges and 100 MΩ on all other ranges.

4-10. The resistor R1 (located in the DCV probe) in conjunction with resistors A2R10 through A2R26, provides the 10 MΩ input impedance required for the three most sensitive DCV ranges. Resistors A2R4 and A3R30 are shunted out of the circuit by the RANGE switch on the three most sensitive DCV ranges.

4-11. When using the eight less sensitive ranges, A2R4 and A3R30 are placed in series with R1 and A2R10 through A2R26 to present more than 100 MΩ impedance to the input.

4-12. A3R30 is used to calibrate full scale on the 1500 V range (see Paragraph 5-35).

4-13. Resistance Measurements. The purpose of the input network shown in Figure 5-18 is to place approximately 0.6 V dc source in series with a known (reference) resistance. The resistance to be measured is placed in parallel with the known resistance, which changes the voltage proportionally. The maximum changes in voltage applied to the modulator is 15 mV because of attenuation provided by A2R4, A3R30, and A1R2.

4-14. A dc current of approximately 60 mA is supplied at the junction of A2R22 and A2R23 through A7R10, R3, A2R2 and A2R1 to the input network. The OHMS ADJ., R3, sets the meter for full scale (∞). Resistor A2R1 is shorted out in the X1M position of the RANGE switch; resistors A2R1 and A2R2 are shorted out in the X10M range. The resistors A2R2 and/or A2R1 are electrically removed from the circuit to increase the voltage at the junction of A2R22 and A2R23. This is done to compensate for the loading of the attenuator (A2R4, A3R30, and A1R2) on these ranges.

4-15. AC Voltage Measurements. Refer to Figure 5-19 throughout this explanation. Voltage at the AC probe is converted to dc and applied to the input network. The input signal is attenuated to produce a maximum of about 15 mV at the modulator input. AC zero adjustment of meter pointer is made with the AC ZERO control.

4-16. Modulator-Demodulator.

4-17. Refer to the Amplifier Schematic, Figure 5-11, and to the Mechanical Analogy Schematic, Figure 4-2 throughout this explanation.

4-18. The input network applies approximately 15 mV dc, for full scale meter deflection (positive or negative, depending on the polarity of the voltage or current being measured) to the neon-photo-conductor chopper. Also applied to the opposite side of the chopper is the amplifier feedback voltage, which is of the same polarity and approximately 5 μV lower in amplitude than the input voltage. The modulator-chopper consists of two photoconductors, A3A1V1 and A3A1V2, which are alternately illuminated by two neon lamps, A3A1DS1 and A3A1DS2, respectively. The neon lamps are part of a relaxation oscillator whose frequency is controlled by A3R5. The oscillator frequency is nominally set to 100 Hz for operation from 60 Hz power line, or to 85 Hz for 50 Hz line. This frequency is selected so that it is not harmonically related to the power line frequency, precluding possible beat indications on the meter.

4-19. As the photoconductors are alternately illuminated by the neons, their respective resistances are low (conductive) when illuminated and high (non-conductive) when darkened. Therefore, the input voltage and feedback voltage are alternately applied to the input amplifier. The amplitude of the resultant signal to the amplifier is the voltage difference between the input and feedback voltages.

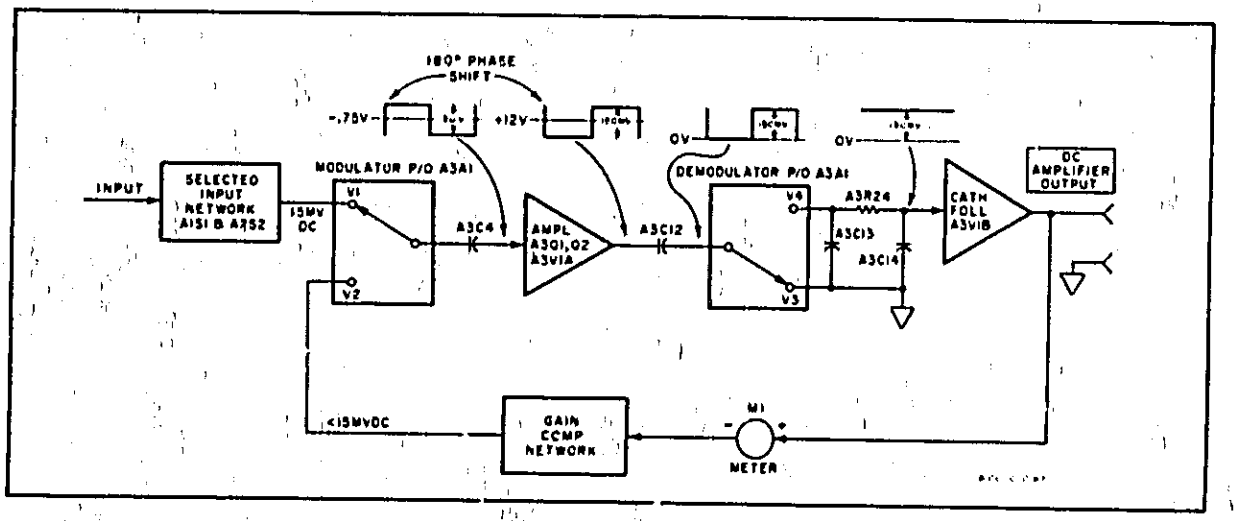


Figure 4-2. Modulator-Demodulator Mechanical Analogy.

4-20. The chopped dc signal is amplified by a three stage RC amplifier, consisting of A3V1A, A3Q1 and A3Q2. The amplified signal to the input of the demodulator-chopper is 180° out of phase with the output of the modulator-chopper.

4-21. The demodulator-chopper consists of two photoconductors, A3A1V3 and A3A1V4, which are alternately illuminated by neon lamps A3A1DS1 and A3A1DS2, respectively. Approximately 150 mV square wave is applied to the demodulator from the amplifier. Since the same neon lamps illuminate both the modulator and demodulator photoconductors, operation of the two choppers is synchronous. Therefore, when A3A1V1 is sampling the input voltage, A3A1V3 is clamping the amplified and inverted difference voltage to ground. Alternately, when A3A1V2 is sampling the feedback voltage, A3A1V4 is charging capacitors A3C13 and A3C14 to the peak value of the square-wave. These capacitors maintain this charge so long as the input voltage remains constant by virtue of having no discharge path and because they are being repetitively recharged by the demodulator.

4-22. Therefore, a dc potential, proportional to the difference between the input and feedback voltages, is applied to the grid of the cathode follower and subsequently to meter circuit and DC AMPLIFIER OUTPUT connector. A portion of the meter circuit voltage is fed back to the modulator. The meter stabilizes when the feedback voltage and input voltages are nearly equal.

4-23. The Feedback Network.

4-24. The feedback network drives the meter and determines the dc gain of the amplifier. The feedback is varied depending on the position of the FUNCTION and RANGE selectors. The different feedback configurations are discussed below.

4-25. Feedback Network for ±DCA, Ohms, and ±DCV. Figures 5-16, 5-17 and 5-18 show the feedback configuration for all positions of the FUNCTION SELECTOR except ACV. The meter is electrically inverted for ±DCV and ±DCA modes of operation. The DC OUTPUT ADJ., A6R20 sets the output voltage. The dc pot, A6R18 determines the amount of feedback to the modulator. The resistor A2R30 is in the circuit in the ± .015 DCV and ± 1.5 μA modes of operation, to decrease feedback and thus increase amplifier gain to compensate for the decrease in input signal to the modulator on these ranges.

4-26. Feedback Circuit for AC Voltage Measurements. Figure 5-19 shows the feedback configuration for the ACV position of the FUNCTION SELECTOR switch, A1S1. The resistors that are placed in the circuit by the RANGE switch program the amplifier gain to compensate for the non-linear response of the AC Probe. A6R16 and A6CR1 compensate the non-linear response of the AC Probe to the linear calibration of the upper meter scale on the 5 V range.

4-27. Power Supply.

4-28. Primary Power. Refer to Figure 5-9 throughout this explanation. Either 115 or 230 V ac power is connected through fuse F1 (0.25 amp slow-blow) and switch S1 to the primary of power transformer T1. Switch S2 connects T1 primaries in parallel for 115 V operation or in series for 230 V operation.

4-29. Unregulated and Zener Regulated Power Supply. Full wave rectifier CR1 and CR2 produces unregulated + 270 V, which is used to drive the photochopper neons. Unregulated + 175 V and + 140 V are tapped off and are used to provide B+ to the plates of A3V1B and A3V1A, respectively. Zener regulators A7CR6 and CR7 provide regulated + 38 V and - 9 V to bias A3Q1 and A3Q2. Filtering of the outputs is provided by the RC network consisting of A7R1 through A7R3 and C5A through C5D.

4-30. Series Regulated Power Supply. The output of the full wave rectifier CR3 and CR4 is regulated by transistor Q1, which is connected in series with the output. Zener diode A7CR8 provides reference voltage to the base of Q1. Regulated + 6 V is supplied to the filaments of A3V1A/B and the AC Probe diode A8V1. + 0.6 V is provided through A7R10 to R3, the OHMS ADJ. control. Filtering of the outputs is provided by C6A and C6B.

4-31. Standby Filament Supply. The filament tap (T1, pins 1 and 2) provides 6.0 V ac to the filament of the AC Probe diode, A8V1, so that the filament remains warm when the Model 410C is being used in modes of operation other than ACV. When FUNCTION selector A1S1 is switched to ACV, 6.0 V ac is removed from the filament and 6 V dc is applied. Therefore, the ACV mode is ready for immediate use, without waiting for the filament to warm up.

WARNING

Maintenance described herein is performed with power supplied to the instrument, and protective covers removed. Such maintenance should be performed only by service-trained personnel who are aware of the hazards involved (for example, fire and electrical shock). Where maintenance can be performed without power applied, the power should be removed.

Table 5-1. Recommended Test Equipment.

Instrument Type	Required Characteristics	Use	Recommended Model
Voltmeter Calibrator	Range: 0.015 to 300 V Frequency: DC and 400 Hz Accuracy: ± 0.3% ac ± 0.2% dc	AC and DC Accuracy Checks and Calibration Adjustments	hp- Model 738BR Voltmeter Calibrator
Oscillator	Frequency: 20 Hz to 10 MHz Output: 2.0 V	Frequency Response Test	hp- Model 652A Test Oscillator
DC Power Supply	Range: 0 to 10 V continuous	DC Ammeter Accuracy Tests	hp- Model 6214A DC Power Supply
DC Voltmeter	Range: 10 V Accuracy: ± 0.2%	Accuracy Tests; Power Supply Measurements; Troubleshooting	hp- Model 3440A/3443A Digital Voltmeter
Oscilloscope	Bandwidth: DC to 10 MHz Sweep: 0.1 μsec to 1 sec/div Sensitivity: 1 V/div	Amplifier Troubleshooting	hp- Model 180C/D with 1801A and 1820C plug-ins
VHF Signal Generator	Frequency: 10 MHz to 400 MHz Output: 1.0 V	Frequency Response Test	hp- Model 608E VHF Signal Generator
UHF Signal Generator	Frequency: 480 MHz to 700 MHz	Frequency Response Test	hp- Model 612A UHF Signal Generator
AC Voltmeter	Range: 120 V	Power Supply Measurements (ripple)	hp- Model 3400A RMS Voltmeter
Electronic Counter	Frequency Range: to at least 102 Hz	Chopper Frequency Adjust	hp- Model 5300A/5301A Electronic Counter
Ohmmeter	Range: 100 MΩ Accuracy: ± 5%	Troubleshooting	hp- Model 412A DC VTVM
Micro-Potentiometer	Frequency Range: 10 MHz to 700 MHz Output Voltage: 0.44 V rms Accuracy: NBS calibrated	Frequency Response Test	Ballantine Model 440 Micro-Potentiometer
Probe-T-Connector	For use with 50 ohm transmission line	Frequency Response Test	hp- Model 11042A Probe-T-Connector
Connector Adapter	Type N male to BNC female	Frequency Response Test	hp- Part No. 1250-0067
Connector Adapter	BNC to binding post	Frequency Response Test	hp- Part No. 10110A
Connector Adapter	Type "N" male to Type "N" female	Frequency Response Test	hp- Part No. 11501A
50 Ω termination	Frequency Range: 10 MHz to 700 MHz Low reflection	Frequency Response Test	hp- Part No. 908A
50 Ω feed-thru	Male BNC to female BNC	Performance Tests	hp- Model 11048C
Resistors: 10 MΩ 56 K 10 K 1 K 1.5 K 66 Ω 10 Ω	 Accuracy: ± 1% Accuracy: ± 1% Accuracy: ± 1% Accuracy: ± 1% Accuracy: ± 1% Accuracy: ± 1% Accuracy: ± 1%	 Performance Tests Performance Tests Performance Tests Chopper Frequency Adjust Performance Tests Performance Tests Performance Tests	 hp- Part No. 0730-0168 hp- Part No. 0730-0053 hp- Part No. 0727-0157 hp- Part No. 0727-0751 hp- Part No. 0730-0017 hp- Part No. 0811-0341 hp- Part No. 0727-0335

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains performance test procedures, adjustment and calibration procedures, troubleshooting procedures, circuit schematics and simplified schematics of each measurement function to aid in the troubleshooting process of the Model 410C Electronic Voltmeter.

5-3. TEST EQUIPMENT REQUIRED.

5-4. The test equipment required to maintain and adjust the Model 410C is listed in Table 5-1. Equipment having similar characteristics may be substituted for items listed.

5-5. PERFORMANCE TESTS.

5-6. The performance tests presented in this section are front panel operations designed to compare the Model 410C with its published specifications. These operations may be incorporated in periodic maintenance, post repair and incoming quality control checks. These operations should be conducted before any attempt is made at instrument calibration or adjustment. During performance tests, periodically vary the line voltage to the Model 410C, ± 10% on either 115 V or 230 V operation. A 1/2 hour warm-up period should be allowed before these tests are conducted.

5-7. Alternate Calibration Voltage Source.

5-8. Should it be necessary to use the -hp- Model 738AR Voltmeter Calibrator to conduct these Performance Tests, the arrangement described in Figure 5-1 will provide the necessary voltage values required. However, the -hp- Model 738BR Voltmeter Calibrator is the preferred instrument for these operations.

5-9. Mechanical Meter Zero.

a. Instrument must be turned off for two hours or install a short across meter terminals.

b. Rotate mechanical zero-adjustment screw on front panel clockwise until pointer reaches zero, moving up scale.

c. If for some reason the pointer should overshoot zero, repeat step b until desired results are obtained.

d. When pointer has been positioned at zero, rotate zero-adjust screw slightly counterclockwise to free it. If meter pointer moves to the left during this action, repeat steps b and d.

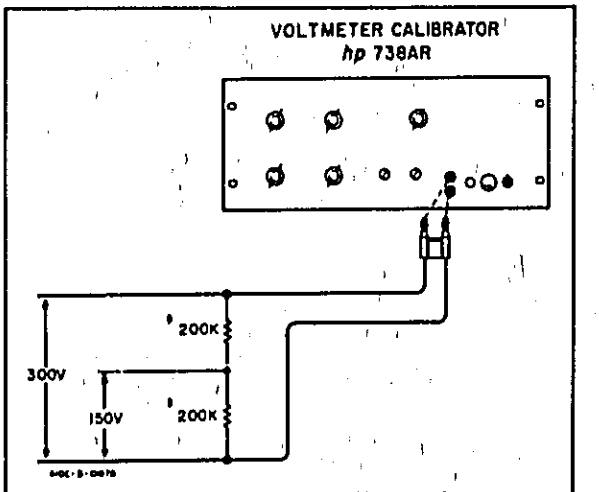


Figure 5-1. Alternate Calibration Voltage Source.

5-10. DC Voltmeter Operation.

5-11. Accuracy Test (DCV).

a. Short Model 410C DCV probe to COM lead; set pointer to zero using rear panel adjustment (ZERO ADJ).

b. Set the Model 410C FUNCTION SELECTOR to the +DCV position; RANGE switch to .015 V. Connect Model 410C DCV and COM cables to the Voltmeter Calibrator (-hp- Model 738BR) output terminals.

c. Adjust voltmeter calibrator and Model 410C to settings listed in Table 5-2.

Table 5-2. DCV Accuracy Test.

Model 410C Range Settings	Voltmeter Calibrator Settings Voltage	Model 410C Meter Readings
.015 V	± .015	.0147 to .0153 V
.05 V	± .05	.049 to .051 V
.15 V	± .15	.147 to .153 V
.5 V	± .5	.49 to .51 V
1.5 V	± 1.5	1.47 to 1.53 V
5 V	± 5	4.9 to 5.1 V
15 V	± 15	14.7 to 15.3 V
50 V	± 50	49 to 51 V
150 V	± 150	147 to 153 V
500 V	± 300	290 to 310 V
1500 V	± 300	270 to 330 V

Table 5-3. DCV Input Resistance Test.

Model 410C Range Settings	Voltmeter Calibrator Settings: Voltage	Model 3440/43A Voltage Readings	Model 410C R_{in}
.015 V	.015	0.7202 to 0.7801	10 MΩ ± 3%
.05 V	.05	0.7202 to 0.7801	10 MΩ ± 3%
.15 V	.15	0.7202 to 0.7801	10 MΩ ± 3%
.5 V	.5	1.333 to 1.394	100 MΩ ± 1%
1.5 V	1.5	1.333 to 1.394	100 MΩ ± 1%
5 V	5	1.333 to 1.394	100 MΩ ± 1%
15 V	15	1.333 to 1.394	100 MΩ ± 1%
50 V	50	1.333 to 1.394	100 MΩ ± 1%
150 V	150	1.333 to 1.394	100 MΩ ± 1%
500 V	300	0.800 to 0.863	100 MΩ ± 1%
1500 V	300	0.265 to 0.280	100 MΩ ± 1%

d. Model 410C should indicate readings within limits specified. If not, refer to Paragraph 5-33 for adjustment procedure.

5-12. Input Resistance Test (DCV).

a. Connect a digital voltmeter (-hp- 3440A/3443A) to the DC Amplifier Output. Set digital voltmeter range to 10 V.

b. Set 410C RANGE to .015 V, FUNCTION to +DCV.

c. Connect a voltmeter calibrator in series with a 10 MΩ ± 1% resistor (-hp- Part No. 0730-0168). Set calibrator output to +.015 V. Connect the calibrator and series resistor to the 410C DCV probe.

d. Adjust the calibrator and 410C to settings listed in Table 5-3. Digital voltmeter readings should be within the limits specified for each setting. If readings are not within limits, refer to Paragraph 5-37, Amplifier Output Calibration; recalibrate amplifier and repeat test.

5-13. DC Ammeter Operation.

5-14. Accuracy Test (DCA).

a. Figure 5-2 describes the test arrangement required for this operation.

b. Connect the Model 410C as shown in Figure 5-2; FUNCTION SELECTOR to +DCA; RANGE to 150 mA.

c. Use 56 Ω resistor for R1 and 10 Ω resistor for R2.

d. Adjust dc power supply to obtain reading on dc voltmeter specified in Table 5-4; change R_1 and R_2 according to Table 5-4.

e. Model 410C should read within limits specified in Table 5-4. If not, refer to Paragraph 5-33 for adjusment procedure.

5-15. Ohmmeter Operation.

5-16. Ohmmeter Accuracy Test.

a. A 10 Ω ± 1% resistor (-hp- Part No. 0727-0335) and a 10 M ± 1% resistor (-hp- Part No. 0730-0168) will be required for this test.

b. Set Model 410C FUNCTION SELECTOR to OHMS; RANGE to RX10.

c. Set pointer to ∞ using rear panel adjustment (OHMS ADJ) if required.

d. Connect COM and DCA OHMS cables across 10 Ω resistor.

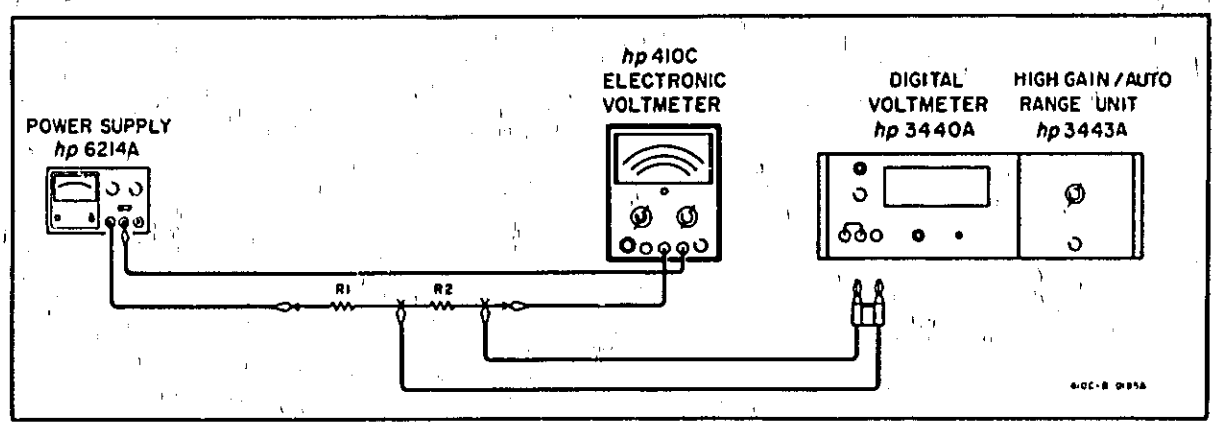


Figure 5-2. DC Ammeter Operation.

Table 5-4. DCA Accuracy Test.

Model 410C Range Settings	DC Voltmeter Readings	Model 410C Meter Readings	R_1 Ω	R_2 Ω
150 MA	1.4 V	136.5 to 144.5 MA	56	10
50 MA	.4 V	38.5 to 41.5 MA	56	10
15 MA	.14 V	13.55 to 14.55 MA	56	10
5 MA	.04 V	3.85 to 4.15 MA	56	10
1.5 MA	.014 V	1.35 to 1.45 MA	56	10
.5 MA	.004 V	0.385 to 0.415 MA	56	10
150 μA	1.38 V	133.5 to 142.5 μA	56 K	10 K
50 μA	0.46 V	44.5 to 47.5 μA	56 K	10 K
15 μA	0.138 V	13.35 to 14.25 μA	56 K	10 K
5 μA	0.046 V	4.45 to 4.75 μA	56 K	10 K
1.5 μA	0.014 V	1.36 to 1.45 μA	56 K	10 K

e. Meter should read 10 Ω (± 5%).

f. Set Model 410C RANGE to RX10M. Replace 10 Ω resistor with 10 MΩ resistor.

g. Meter should read 10 MΩ (± 5%).

h. If both of these ranges function properly, it can be assumed that the remainder will also. If meter does not function properly, refer to Paragraph 5-36 for adjustment procedure.

5-17. Amplifier Operation.

5-18. Amplifier Gain Test.

a. Connect Voltmeter Calibrator (-hp- Model 738BR) output to Model 410C DCV and COM cables.

b. Connect DC Voltmeter (-hp- Model 3440A/3443A) to DC AMPLIFIER OUTPUT on rear panel of Model 410C. Set DC Voltmeter RANGE to 10 V.

c. Set Model 410C FUNCTION SELECTOR to +DCV; RANGE to .015 V.

d. Adjust voltmeter calibrator for + .015 VDC output.

e. The dc voltmeter should read + 1.5 V. This will verify a gain of 100, where the gain equals $E_{DC\ out}/E_{DC\ in}$.

f. If dc voltmeter does not read at least 1.5 V, refer to Paragraph 5-37 for proper adjustment procedure.

5-19. Output Level Test.

a. A Voltmeter Calibrator (-hp- Model 738BR) and a DC Voltmeter (-hp- Model 3440A/3443A) will be required for this test.

b. Connect dc voltmeter to dc amplifier OUTPUT on Model 410C rear panel. Place ground lead between Model 410C circuit ground and earth ground terminals. Set dc voltmeter RANGE to 10 V.

c. Set Model 410C FUNCTION SELECTOR to +DCV; RANGE to 1.5 V.

d. Adjust Voltmeter Calibrator to provide + 1.5 V.

e. Model 410C and dc voltmeter should read 1.5 V.

f. If dc voltmeter does not read at least 1.5 V, refer to Paragraph 5-37 for proper adjustment procedure.

5-20. Amplifier Output Impedance Test.

a. Connect an external DC Voltmeter (-hp- Model 3440A/3443A) to Model 410C DC AMPLIFIER OUTPUT terminals on rear panel.

b. Set Model 410C FUNCTION SELECTOR to OHMS position; RANGE TO RX10K.

c. Record voltage indicated on external dc voltmeter for use as a reference.

d. Connect a 1.5 kΩ ± 1% resistor (-hp- Part No. 0730-0017) across Model 410C DC AMPLIFIER OUTPUT terminals. DC voltage recorded in step c above should not change more than 3 mV, indicating that dc amplifier output impedance is within the 3 Ω specification at dc.

5-21. Amplifier Noise Test.

a. Connect external DC Voltmeter (-hp- Model 3440A/3443A) to the DC AMPLIFIER OUTPUT of Model 410C.

b. Set the Model 410C FUNCTION SELECTOR to +DCV; RANGE to 1500 V.

c. Short the Model 410C DCV and COM cables. External dc voltmeter reading should be less than 7.5 mV.

d. Reset Model 410C RANGE to 1.5 V. DC Voltmeter should read less than 7.5 mV.

NOTE

If Model 410C DC OUTPUT is used for recording, the chopper frequency can be adjusted to minimize output noise. Refer to Paragraph 5-31.

5-22. Overload Recovery Test.

a. Connect Voltmeter Calibrator (-hp- Model 738BR) output to Model 410C DCV and COM cables.

b. Set Model 410C FUNCTION SELECTOR to +DCV; RANGE to .15 V.

c. Adjust voltmeter calibrator for +0.15 V dc; note reading on Model 410C.

d. Readjust voltmeter calibrator for + 15 VDC output; wait 5 seconds for complete saturation; then switch voltmeter calibrator back to + .15 VDC output. Note time required for meter to return to original position.

e. Recovery time should be less than 3 sec.

5-23. AC Rejection Test.

a. An Oscillator (-hp- Model 652A) and an RMS Voltmeter (-hp- Model 3400A) are required for this test.

b. Set 410C FUNCTION SELECTOR to -DCV; RANGE to .015 V.

c. Connect Oscillator output to Model 410C DCV and COM cables and input of rms voltmeter, Set rms voltmeter to read 10 V.

d. Adjust test oscillator to provide 3.18 V (4.5 V peak) reading on rms voltmeter at 50 Hz.

e. Model 410C should not read more than 2.25 mV verifying 66 dB ac rejection at 50 Hz.

f. Increase frequency to check ac rejection about 50 Hz.

g. Switch Model 410C FUNCTION SWITCH to +DCV and repeat steps e and f.

5-24. AC Voltmeter Operation.

CAUTION

When measuring ac voltages, do not permit ac ground jumper of Model 410C AC Probe to contact ungrounded side of ac source or serious damage to 410C will result.

5-25. AC Voltmeter Accuracy Test.

a. Set Model 410C RANGE to 0.5 V. Short the input of the AC Probe. Adjust ZERO vernier for zero pointer deflection.

b. Connect ACV probe to the Voltmeter Calibrator (-hp- Model 738BR).

c. Adjust voltmeter calibrator for 400 Hz rms output.

d. Set Model 410C FUNCTION SELECTOR to ACV; RANGE to 500 V.

e. Adjust the voltmeter calibrator to settings listed in Table 5-5. Model 410C should indicate readings within limits specified. If not, refer to Paragraph 5-38 for corrective action. Record Model 410C reading with 0.3 V input.

NOTE

The frequency response tests are performed using reference voltage obtained with 0.3 V input.

Table 5-5. AC Accuracy Test.

410C Range	Voltmeter Calibrator 400 Hz	Model 410C Readings
	Voltage Selection	
500 V	300	285 to 315 V
150 V	150	145.5 to 154.5 V
50 V	50	48.5 to 51.5 V
15 V	15	14.55 to 15.45 V
5 V	5	4.85 to 5.15 V
1.5 V	1.5	1.455 to 1.545 V
.5 V	0.5	0.485 to .515 V
.5 V	0.3	0.285 to .315 V

5-26. AC Voltmeter Low Frequency Response Test.

a. A Test Oscillator (-hp- Model 652A), a BNC-to-Binding Post Adaptor (-hp- Part No. 10110A) and a 50 Ω Feed-thru Termination (-hp- Part No. 11048C) are required for this test.

b. Connect Model 410C as shown in Figure 5-3.

c. Set Model 410C FUNCTION SELECTOR to ACV; RANGE to 0.5 V.

d. Set Test Oscillator frequency to 400 Hz, and adjust amplitude to give same 410C reading as recorded in Paragraph 5-25, step e, with 0.3 V input.

e. Set Test Oscillator REF SET to convenient level.

f. Adjust frequency of Test Oscillator to various cardinal points between 20 Hz and 10 MHz, resetting amplitude to reference level set in step e for each frequency. Model 410C readings should be the same as the reading set at 400 Hz in step d ± 10% from 20 Hz to 100 Hz and ± 2% from 100 Hz to 10 MHz.

5-27. AC Voltmeter High Frequency Response Test.

a. A VHF Signal Generator (-hp- Model 608E), a UHF Signal Generator (-hp- Model 612A), a Probe-T-Connector (-hp- Model 11042A), a Micropotentiometer (Ballantine Model 440), and a DC Voltmeter (-hp- Model 3440A/3443A) are required for this test. Figure 5-4 describes test arrangement to be used.

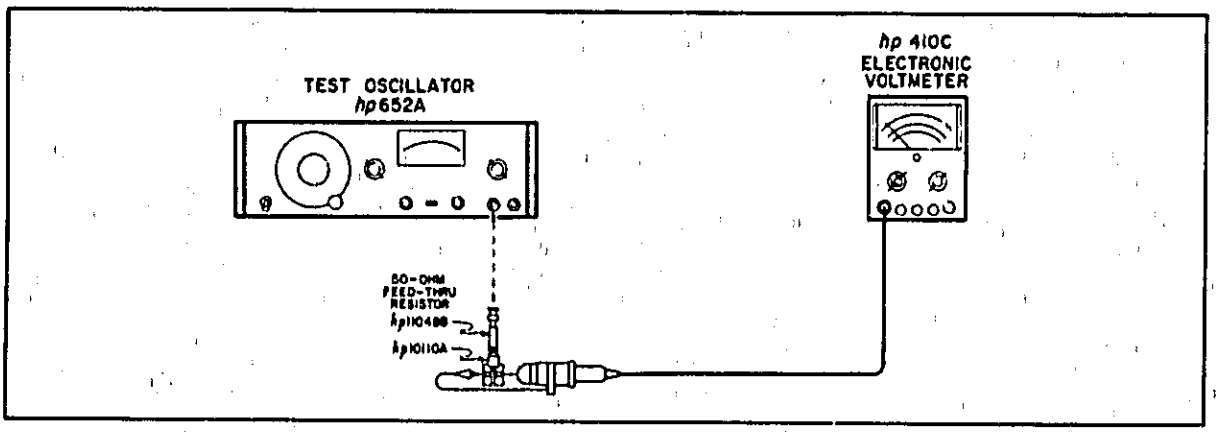


Figure 5-3. Low Frequency Response Test.

NOTE

The micropotentiometer must have the proper radial resistance and current rating to deliver 0.30 V at its output.

b. Set UHF oscillator output to provide output to Model 410C reading recorded in Paragraph 5-26, step f, with .3 V input; frequency to 10 MHz. Record dc voltmeter reading for reference.

c. Vary VHF oscillator frequency from 10 MHz to 480 MHz maintaining reference dc voltmeter reading by readjusting VHF oscillator output. Model 410C reading should be the same as the reading set at 400 Hz in Paragraph 5-26, step d, ± 2% at frequencies to 50 MHz, 0 to -4% from 50 MHz to 100 MHz and ± 1.5 dB at all higher specified frequencies.

d. Replace VHF oscillator with UHF oscillator in Figure 5-4. Repeat steps b and c for UHF oscillator output frequencies from 480 MHz to 700 MHz.

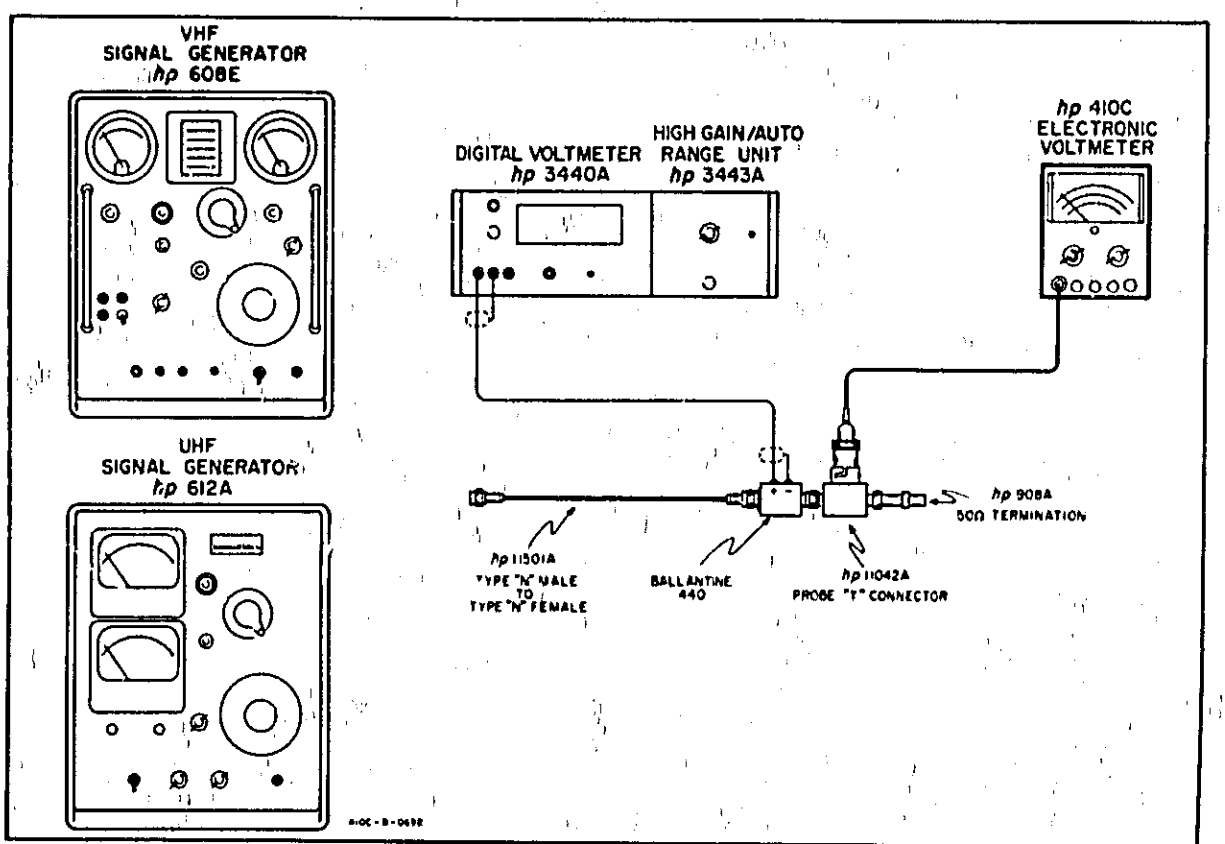


Figure 5-4. High Frequency Response Test.

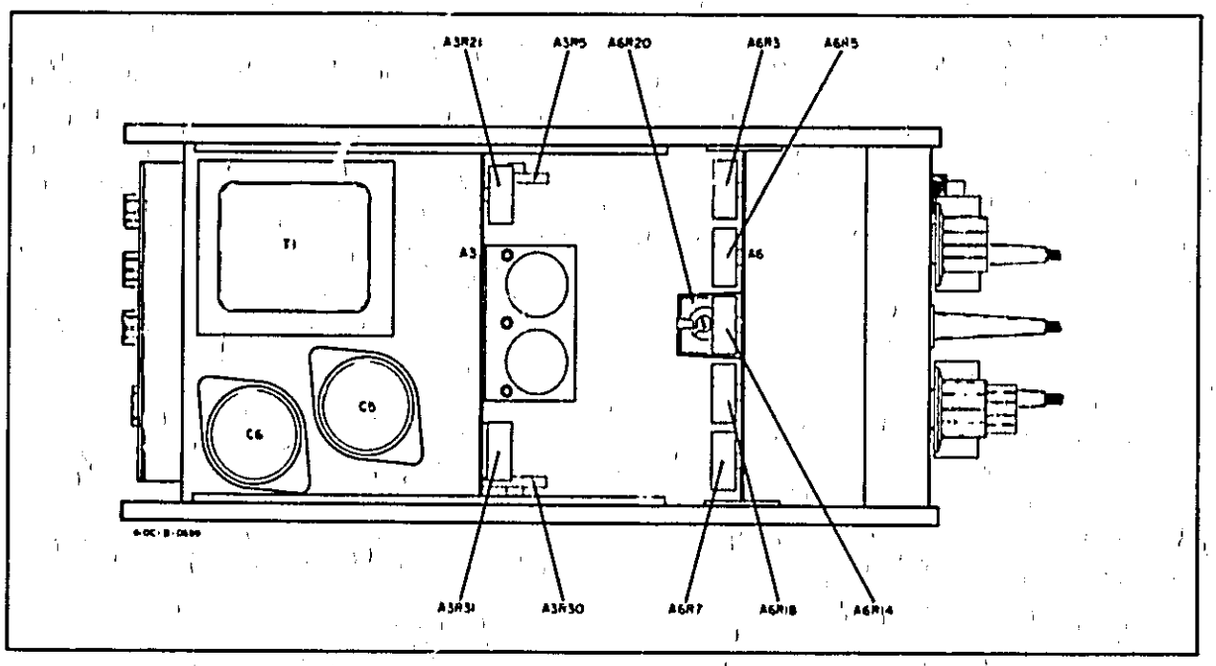


Figure 5-5. Adjustment Location.

5-28. ADJUSTMENT AND CALIBRATION PROCEDURE.

5-29. The following is a complete adjustment and calibration procedure for the Model 410C. These operations should be conducted only if it has previously been established by Performance Tests, Paragraph 5-5, that the Model 410C is out of adjustment. Indiscriminate adjustment of the internal controls to "refine" settings may actually cause more difficulty. If the procedures outlined do not rectify any discrepancy that may exist, and all connections and settings have been rechecked, refer to Paragraph 5-41, Troubleshooting, for possible cause and recommended corrective action.

5-30. Remove top and bottom covers and two side panels; refer to Figure 5-5 through this procedure for location of adjustments.

5-31. Chopper Frequency Adjust.

a. A Voltmeter Calibrator (-hp- Model 738BR), an Electronic Counter (-hp- Model 5300A/5301A), and an AC Voltmeter (-hp- Model 3400A) will be required for this operation.

b. Use ac voltmeter to verify Model 410C line voltage of 115 V. Chopper frequency will vary with line voltage variations.

c. Connect Model 410C, electronic counter, and voltmeter calibrator as shown in Figure 5-6.

d. Set Model 410C FUNCTION SELECTOR to +DCV; RANGE to 1.5 V.

e. Adjust voltmeter calibrator to supply + 5 V dc to the Model 410C.

f. Observe counter, and adjust A3R5 for a chopper frequency of 100 Hz (± 2 Hz) if operated on a 60 Hz line. If operated on 50 Hz line, adjust A3R5 for a chopper frequency of 85 Hz (± 2 Hz).

g. If line frequency is other than 50 or 60 Hz or if fine adjustment of chopper frequency is desired to minimize noise, connect ac voltmeter with RANGE for 0.01 V to Model 410C DC Amplifier OUTPUT.

h. Adjust A3R5 to give minimum voltage reading on ac voltmeter.

5-32. Power Supply Test.

a. Refer to Table 5-6 and Figure 5-8 for Power Supply test points and typical voltage values. Measure dc voltages between COM lead and designated location on A7.

Table 5-6. Power Supply Test.

Voltage	Location on A7 (Figure 5-8)	Tolerance
+ 175 V	903	± 30 V
+ 38 V	Junction of CR6 and R4	± 8.0 V
+ 6 V	926	± 0.6 V
- 9 V	Junction of CR7 and R7	± 1.8 V

b. Measure + 175 V ac ripple across 903 and COM with ac voltmeter (-hp- Model 3400A). RMS value of ripple should not exceed 5.0 mV.

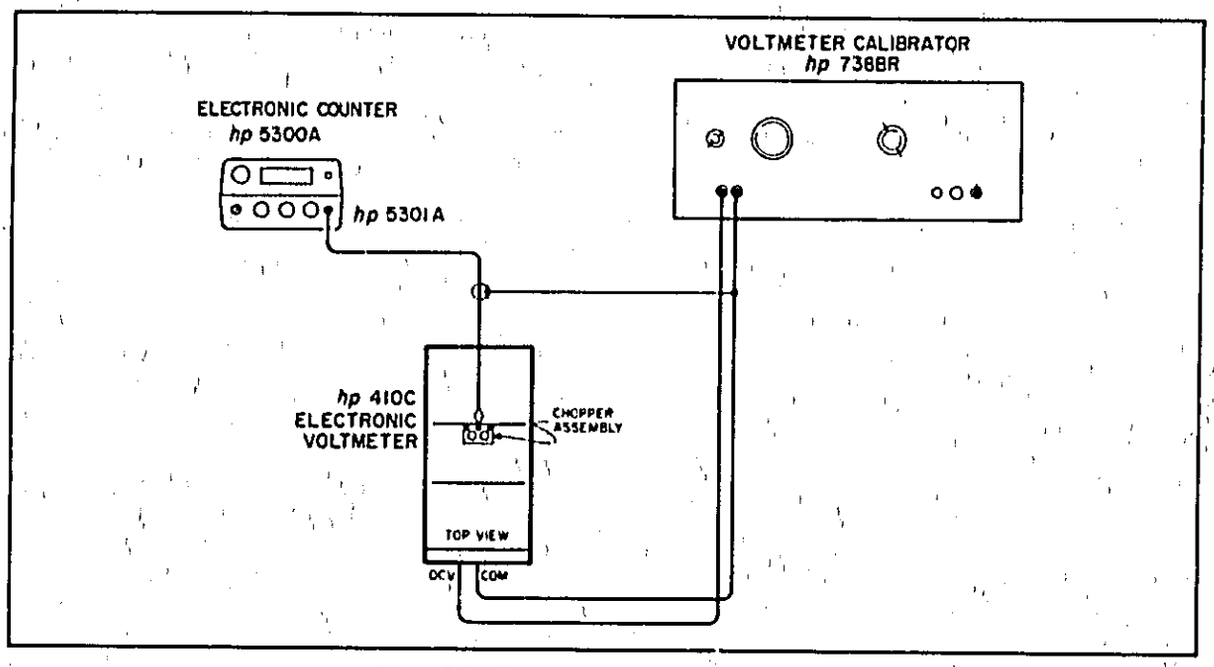


Figure 5-6. Chopper Frequency Adjust Setup.

5-33. DC Voltmeter Calibration.

5-34. DC Zero Adjustment and Bias.

a. Set Model 410C FUNCTION SELECTOR to +DCV and RANGE switch to 0.5 V.

b. Short DCV Cable to COM Cable.

c. Adjust A3R21 fully counterclockwise, then rotate about 20 degrees clockwise.

d. Adjust ZERO ADJ on rear panel for zero meter deflection. Switch to -DCV. If any deflection is observed, adjust ZERO ADJ to return meter pointer halfway back to zero. Check zero setting on all ranges for both +DCV and -DCV. Zero offset shall not exceed 1% in any case.

5-35. DC Full Scale Adjust.

a. Connect Model 410C DCV and COM cables to Voltmeter Calibrator (-hp- Model 738BR) output terminals.

b. Set Model 410C FUNCTION SELECTOR to the +DCV position; RANGE switch to 0.015 V.

c. Adjust voltmeter calibrator to settings listed in Table 5-7.

d. Select proper A6R18 setting which will provide best overall full scale readings for 0.015 V, 0.05 V and 0.15 V ranges. Adjust A3R30 for best overall full scale readings for ranges above 0.15 V.

NOTE

A6R18 must be adjusted before A3R30, because A6R18 affects all ranges and A3R30 only affects ranges above 0.15 V.

5-36. Ohmmeter Calibration.

a. Set Model 410C FUNCTION SELECTOR to OHMS; RANGE to RX10M.

b. Short OHMS and COM cables. Model 410C should read zero.

c. Vary Model 410C RANGE switch through remainder of OHMS settings. Meter should read zero, except at RX10 when meter should read about 0.1 Ω (resistance of leads).

d. Disconnect OHMS and COM cables. Set OHMS ADJ (rear panel) for ∞ reading. Check ∞ reading on all OHMS RANGE settings.

5-37. Amplifier Output Calibration.

a. A Voltmeter Calibrator (-hp- Model 738BR) and a DC Voltmeter (-hp- Model 3440A/3443A) are required for this calibration.

b. Set Model 410C FUNCTION SELECTOR to +DCV; RANGE to 5 V.

c. Adjust voltmeter calibrator to provide 5 V. Set dc voltmeter RANGE to 10 V.

Table 5-7. DCV Calibration Procedure.

Model 410C Range Settings	Voltmeter Calibrator Settings: Voltage	Model 410C Meter Readings	Adjustment
.015 V	.015	.0147 to .0153 V	A6R18
.05 V	.05	.049 to .051 V	A6R18
.15 V	.15	.147 to .153 V	A6R18
.5 V	.5	.49 to .51 V	A3R30
1.5 V	1.5	1.47 to 1.53 V	A3R30
5 V	5	4.9 to 5.1 V	A3R30
15 V	15	14.7 to 15.3 V	A3R30
50 V	50	49 to 51 V	A3R30
150 V	150	147 to 153 V	A3R30
500 V	300	290 to 310 V	A3R30
1500 V	300	270 to 330 V	A3R30

d. Connect Model 410C DCV probe and COM lead to output of voltmeter calibrator. Connect dc voltmeter to dc amplifier OUTPUT on Model 410C rear panel.

e. Adjust A6R20 to give 1.5 V reading on dc voltmeter.

NOTE

Amplifier output will provide a negative voltage for all negative dc and ac inputs. The AC Probe is designed to provide a negative dc voltage to Model 410C.

5-38. AC Voltmeter Calibration.

5-39. AC Zero Adjust.

a. Set Model 410C FUNCTION SELECTOR to ACV; RANGE to 0.5 V. Ensure full insertion of telephone plug from ac probe into Model 410C.

b. Set AC ZERO vernier on front panel to center of rotation.

c. Short Model 410C ac probe and ac probe common (short lead).

d. Adjust A3R31 for Model 410C approximately zero deflection.

e. Fine adjust AC ZERO vernier for Model 410C zero deflection.

5-40. AC Full Scale Adjust.

CAUTION

When measuring ac voltages, do not permit ac ground jumper of Model 410C ac probe to contact ungrounded side of ac source or serious damage to 410C will result.

a. Connect Model 410C ac probe to voltmeter calibrator output terminals. Set Model 410C FUNCTION SELECTOR to ACV; RANGE to 0.5 V.

b. Adjust voltmeter calibrator to settings listed in Table 5-8 at 400 Hz rms output.

c. Adjust potentiometers called for under "Adjustment" to provide Model 410C readings listed.

Table 5-8. AC Full Scale Adjust.

Model 410C Range	Voltmeter Calibrator AC Voltage Settings	Model 410C Reading ± 3%	Adjustment
.5 V	.50	.5 V	A6R3
1.5 V	1.5	1.5 V	A6R5
5 V	5	5 V	A6R7
*15 V	15	15 V	A6R14
*50 V	50	50 V	A6R14
*150 V	150	150 V	A6R14
*500 V	300	300 V	A6R14

*A6R14 is proper adjustment of Model 410C for RANGE settings from 15 V ac to 500 V ac. Select proper A6R14 setting which will provide best overall results for these ranges.

5-41. TROUBLESHOOTING PROCEDURE.

5-42. This section contains procedures designed to assist in the isolation of malfunctions. These procedures are based on a systematic analysis of the instrument circuitry in an effort to localize the problem. These operations should be undertaken only after it has been established that the difficulty cannot be eliminated by the Adjustment and Calibration Procedures, Paragraph 5-28. An investigation should also be made to insure that the trouble is not a result of conditions external to the Model 410C.

5-43. Conduct a visual check of the Model 410C for possible burned or loose components, loose connections, or any other obvious conditions which might suggest a source of trouble.

5-44. Table 5-9 contains a summary of the front-panel symptoms that may be encountered. It should be used in initial efforts to select a starting point for troubleshooting operations.

5-45. Figure 5-7 contains procedures which may be used as a guide in isolating malfunctions.

Table 5-9. Front Panel Troubleshooting Procedure.

Front Panel Symptom	Possible Cause
No meter deflection with input. ON-OFF lamp not glowing.	Check fuse (F1) on back panel.
In -DCV, pointer deflects 1/2 scale. In +DCV, pointer pegs downscale.	Check A3C5 (Figure 5-11).
In +DCV, pointer pegs downscale. In -DCV, pointer pegs upscale.	Check A3Q1, A3C6 or A3C12 (Figure 5-11).
Excessive jitter. Ohms function; all ranges except RX10M.	Check A2R2 (Figure 4-5).
*DCA mode out on 50 mA and 150 mA ranges.	Check A2R25 and A2R26 (Figure 4-3).
*If ∞ ADJ is effective in ranges from RX10 to RX1M, then shifts when RANGE switch is set to RX10M.	Check A2R2 (Figure 4-5).
DC ZERO shifts, range to range.	A3CR1, CR2 light sensitive.
AC ZERO will not adjust properly. Pointer responds to input variations.	Check A1R5, A1R6, A1R7 and A3R31 (Figure 4-6).
*Operates in DCV mode on ranges 0.015 V to 0.15 V, but fails on higher ranges.	Check A2R2 and A3R30.
DC amplifier output is + 1.5 V. Meter will not deflect full scale in DCV or DCA mode.	Check A6R21, A6R20, A6R1, A6R18 and A6R17 (Figure 4-4).
*Meter pegs upscale on all ranges. +DC Amplifier output is high regardless of mode of operation.	Check for open resistor in amplifier feedback loop or shorted A1R10 (Figure 5-11).
In ACV mode, pointer will not deflect full scale with proper input applied.	Refer to Paragraph 5-38.
Operates on all ranges in ACV mode except 5 V ac position.	Check A6R16 and A6CR1 (Figure 4-6).
Instrument inoperative in all modes. Meter has slight random drift pattern.	Check chopper assembly. Connect 1 MΩ resistor across A3A1V1. If photocell were open, meter will now respond to input. Use 100 K resistor across A3A1V3 to check DC - Modulator (Figure 5-10).
Meter oscillates full scale at rate of 5 - 10 Hz.	Check chopper assembly. Connect 1 MΩ resistor across A3A1V2. If photocell were open, instrument will now respond to input. Use 100 K resistor across A3A1V2 to check DC - Modulator (Figure 5-10).
No ac zero.	Check C1 for short to chassis (Figure 4-6). Check ac probe.
No deflection on OHMS; dc ranges operative.	Check OHMS and DCA lead for short to common at alligator clip.
0.5 and 1.5 VAC range will not track.	Check A8V1 (Figure 5-13). Substitute known good ac probe.
5 VAC range will not track.	Check A6CR1.

*Refer to (6), Figure 5-7.

5-46. The checks outlined in Figure 5-7 are not designed to measure 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. Amplifier gain may also vary slightly between instruments; therefore it should not be necessary to precisely duplicate waveforms or values described.

5-47. Refer to Figure 5-10 for typical waveforms encountered in the Model 410C. Waveforms represent signals which occur when instrument is operating during overdriven conditions (0.5 V dc input to 0.015 V RANGE).

5-48. Servicing Etched Circuit Boards.

5-49. The -hp- Model 410C has three etched circuit boards. Use caution when removing them to avoid damaging mounted components. The -hp- Part Number for the assembly is silk screened on the interior of the circuit board to identify it. Refer to Section VI for parts replacement and -hp- Part Number information.

5-50. The etched circuit boards are a plated-through type. The electrical connection between sides of the board 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.

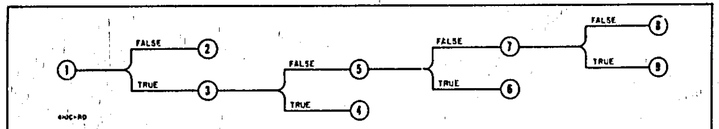
b. Circuit components can be removed by placing the soldering iron on the component lead on either side of the board and pulling up on lead. If a component is obviously damaged, clip leads as close to component as possible and then remove. Excess heat can cause the circuit and board to separate or cause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

c. Component lead hole should be cleaned 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).



(1) Check power supply voltage values using the procedure outlined in Paragraph 6-32. If voltages are correct, proceed to (2). If voltages are incorrect, proceed to (3).

(2) If malfunction appears in the power supply, and adjustment of the chopper frequency to 100 Hz does not reduce the error, refer to Figure 5-8 for further investigation. Check voltage and resistance values listed with Model 410C FUNCTION +DCV; RANGE 0.015 V; INPUT +0.015 V. When deviation is noted, trace circuit investigating for faulty component.

(3) With Model 410C FUNCTION SELECTOR to +DCV; RANGE 0.015 V; overdrive with a +0.5 V input. Measure the dc voltage at the DC AMPLIFIER OUTPUT on Model 410C rear panel. Output should be approximately +4.0 V. If this measurement is correct, disconnect source and short DCV probe and COM lead. If output is zero, proceed to (5); If not, proceed to (4).

(4) Trace circuit from pin 11, A3 to pin 2, A6. Use ohmmeter to check values of A6R21, A6R20, A6R17 and A6R1. Refer to Figure 5-11 for pertinent component values. Check pertinent dc voltages under conditions listed in NOTE No. 4.

(5) Measure the dc voltage at pin 1, A3. This voltage is typically 13 - 15 mV. If this voltage is correct, proceed to (1); If not, proceed to (6).

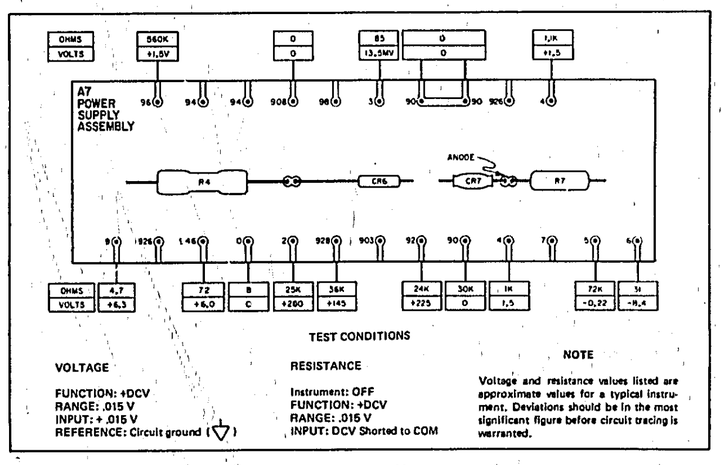
(6) Investigate switch circuit. Refer to asterisks in Table 5-9 for hints on how to troubleshoot switch circuit.

(7) Observe input voltage to demodulator (1) using an oscilloscope. Refer to Figure 5-10 for normal waveform under overdriven conditions specified. If waveform is normal, proceed to (8); If not, proceed to (9).

(8) Investigate the demodulator and cathode follower A1V3B. Refer to Figure 5-11 for typical voltage and parameter values under conditions listed in NOTE No. 4. Refer to Table 5-9 for method to check for open demodulator.

(9) Investigate the modulator and amplifier to include A1V1A, Q1 and Q2. Refer to Figure 5-11 for typical voltage and parameter values under conditions listed in NOTE No. 4. Refer to Table 5-9 for method to check for open modulator.

Figure 5-7. Troubleshooting Procedures.



TEST CONDITIONS

VOLTAGE

FUNCTION: +DCV
RANGE: .015 V
INPUT: + .015 V
REFERENCE: Circuit ground (⏚)

RESISTANCE

Instrument: OFF
FUNCTION: +DCV
RANGE: .015 V
INPUT: DCV Shorted to COM

NOTE

Voltage and resistance values listed are approximate values for a typical instrument. Deviations should be in the most significant figure before circuit tracing is warranted.

Figure 5-8. Power Supply Measurements.

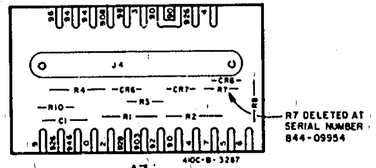
1. ——— — — — INDICATES AN ASSEMBLY. ALL COMPONENTS LOCATED ON AN ASSEMBLY ARE PREFIXED BY THE ASSEMBLY DESIGNATION (e.g., R3 ON ASSEMBLY A7 BECOMES A7R3).

2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IS IN OHMS.
   CAPACITANCE IS IN MICROFARADS.

3. ⏚ = EARTH GROUND, ⏚ = CHASSIS GROUND,
   ▽ = CIRCUIT COMMON (FLOATING GROUND)

4. (990) DENOTES WIRE COLOR USING STANDARD COLOR CODE. (e.g. 9 = WHITE, 8 = GRAY, 0 = BLACK.)

5. ▭ INDICATES FRONT PANEL LOCATION
   ▭ INDICATES REAR PANEL LOCATION.



A7

hp Part No 410C-65E

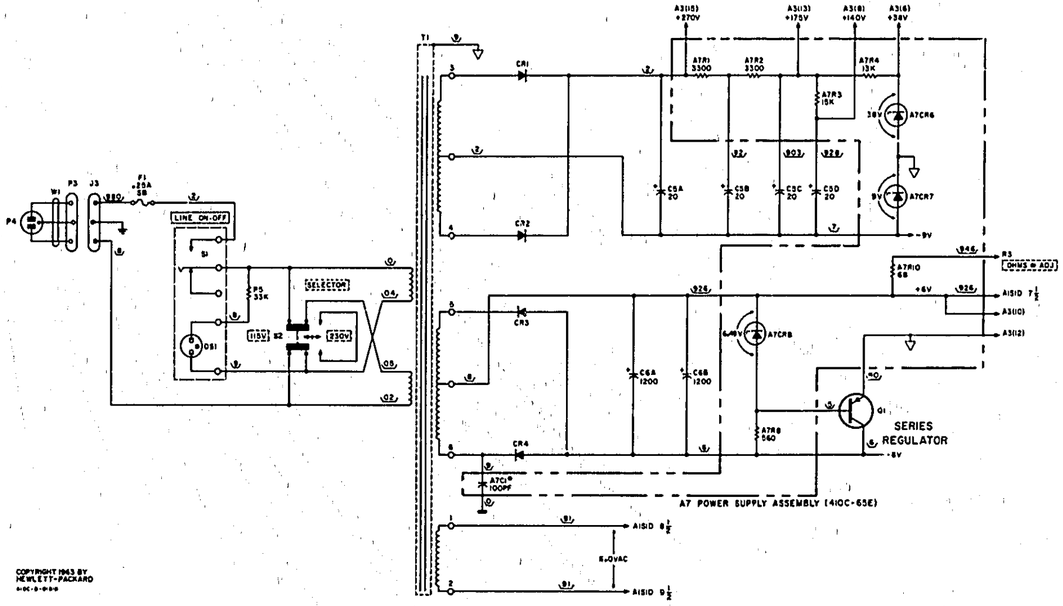


Figure 5-9. Power Supply Schematic.

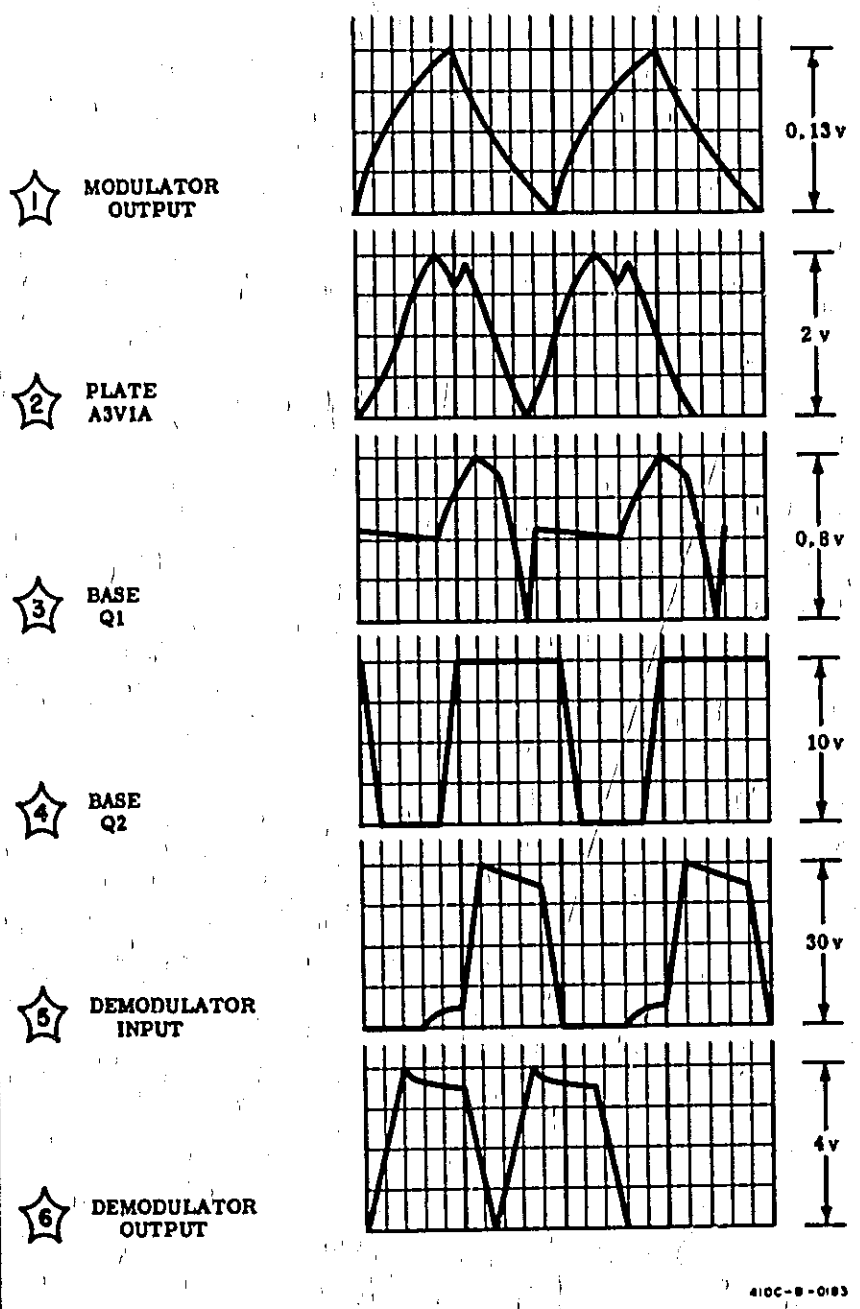


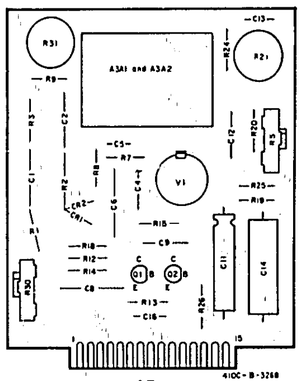
Figure 5-10. Typical Amplifier Waveforms.

NOTES

1. A3A1V1 AND A3A1V3 ARE LIGHTED SIMULTANEOUSLY BY A3A1DS1, AND A3A1V2 AND A3A1V4 ARE LIGHTED BY A3A1DS2.
2. UNLESS OTHERWISE NOTED:
   RESISTANCE IS IN OHMS.
   CAPACITANCE IS IN MICROFARADS.
3. SWITCHES ARE SHOWN IN FULLY CCW POSITIONS.
4. DC VOLTAGES SHOWN ARE TYPICAL UNDER THE FOLLOWING CONDITIONS:

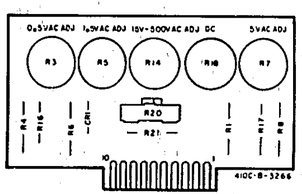
   FUNCTION: +DCV
   RANGE: 1.5 V
   INPUT: + 1.5 V

5. ——— — — ——— INDICATES AN ASSEMBLY. ALL COMPONENTS LOCATED ON AN ASSEMBLY ARE PREFIXED BY THE ASSEMBLY DESIGNATION (e.g., R3 ON ASSEMBLY A7 BECOMES A7R3.)
6. — — — — — — INDICATES SUBASSEMBLY.
7. ———————— INDICATES DC FEEDBACK.
8. P/O = PART OF.
9. ▭ INDICATES FRONT PANEL LOCATION.
   ▭ INDICATES SCREWDRIVER ADJUST.
10. ○ INDICATES PANEL ADJUST.
    ⊘ INDICATES SCREWDRIVER ADJUST.
11. ⏚ = EARTH GROUND, ⏚ = CHASSIS GROUND, ▽ = CIRCUIT COMMON (FLOATING GROUND)
12. 935 DENOTES WIRE COLOR USING STANDARD COLOR CODE. (e.g. 9 = WHITE, 3 = ORANGE, 5 = GREEN.)
13. ✱ = OPTIMUM VALUE SELECTED AT FACTORY, AVERAGE VALUE SHOWN.
14. ⋕ VOLTAGE IS DEPENDENT ON LOAD INTRODUCED BY EXTERNAL VOLTMETER.
15. ⊹ VOLTAGE VARIES ACCORDING TO INDIVIDUAL TUBE.
16. ⋕ PIN 8 IS REFERENCE. VOLTAGE VARIES ACCORDING TO INDIVIDUAL TUBE.



A3

hp Part No. 410C-65A



A6

hp Part No. 410C-65B

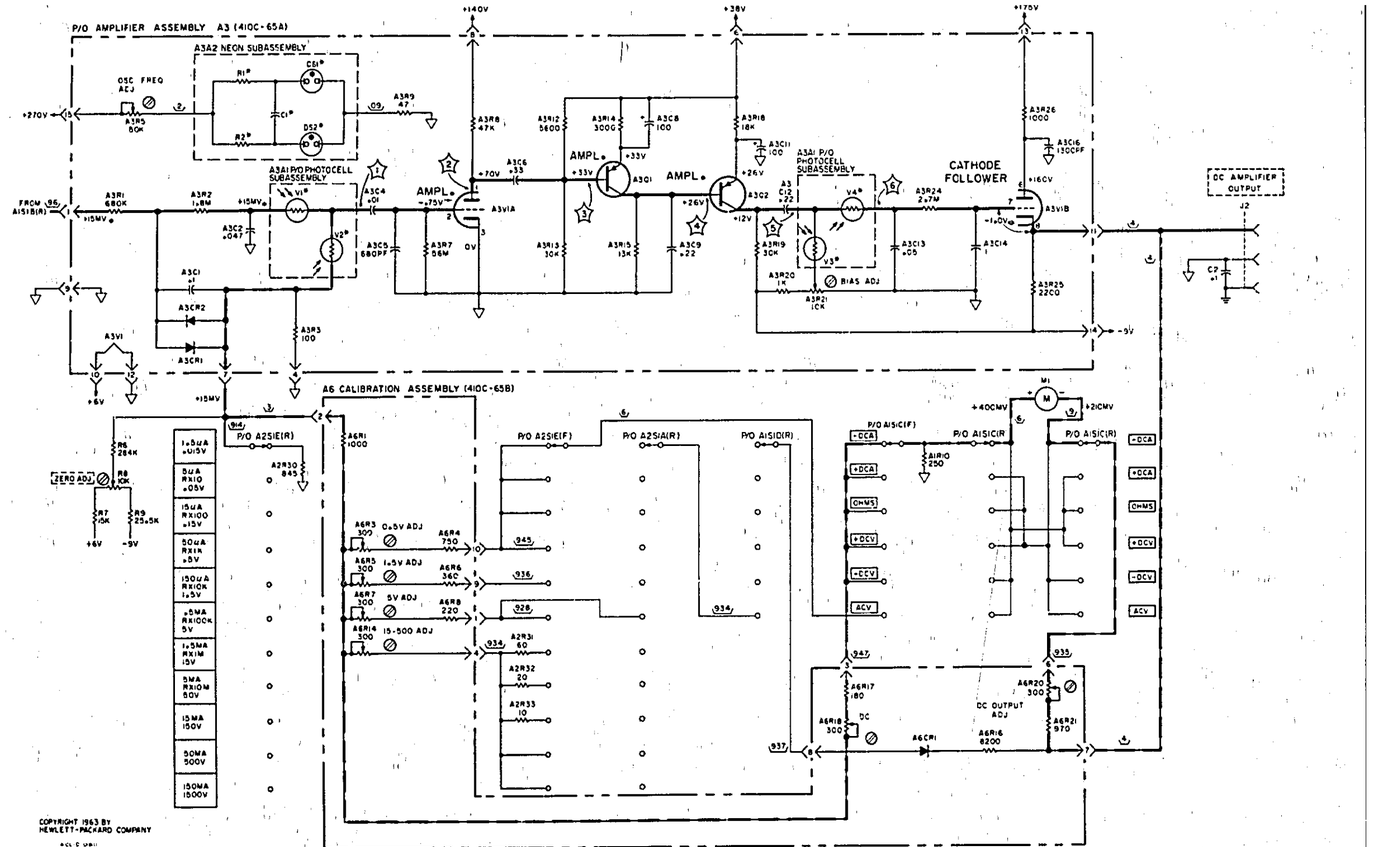


Figure 5-11. Amplifier Schematic.

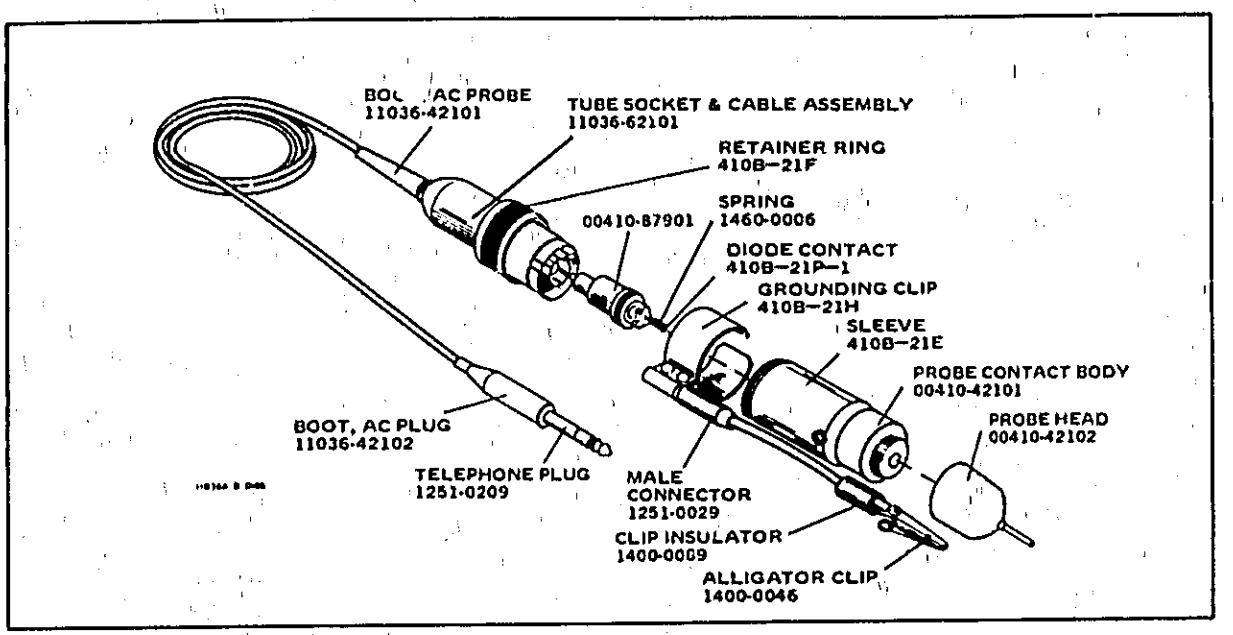
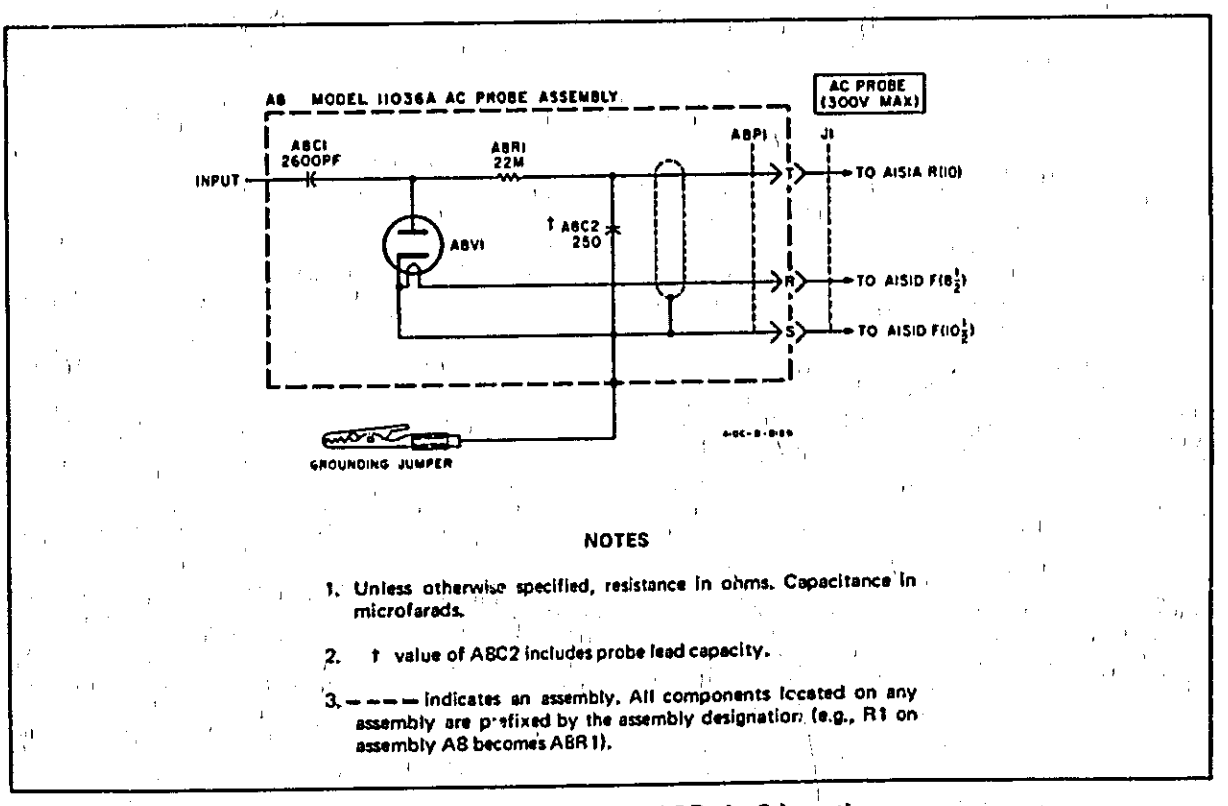


Figure 5-12. Model 11036A AC Probe (Exploded View).



NOTES

1. Unless otherwise specified, resistance in ohms. Capacitance in microfarads.
2. † value of A8C2 includes probe lead capacity.
3. – – – – indicates an assembly. All components located on any assembly are prefixed by the assembly designation (e.g., R1 on assembly A8 becomes A8R1).

Figure 5-13. Model 11036A AC Probe Schematic.

NOTES

1. SWITCHES ARE SHOWN IN FULL CCW POSITIONS.
2. P/O = PART OF.
3. CAPACITANCE IN MICROFARADS AND RESISTANCE IN OHMS, UNLESS OTHERWISE SPECIFIED.
4. ⏚ = EARTH GROUND, ⏛ = CHASSIS GROUND, ▽ = CIRCUIT COMMON (FLOATING GROUND).
5. ——— INDICATES CIRCUIT GROUND BUS.
6. ○ INDICATES PANEL ADJUST: ⊘ INDICATES SCREWDRIVER ADJUST.
7. \937/ INDICATES WIRE COLOR USING STANDARD COLOR CODE. (e.g., 9 = WHITE, 3 = ORANGE, 7 = VIOLET.)
8. ✱ OPTIMUM VALUE SELECTED AT FACTORY. AVERAGE VALUE SHOWN.
9. ▭ INDICATES FRONT PANEL LOCATION.
   ▭ INDICATES REAR PANEL LOCATION.

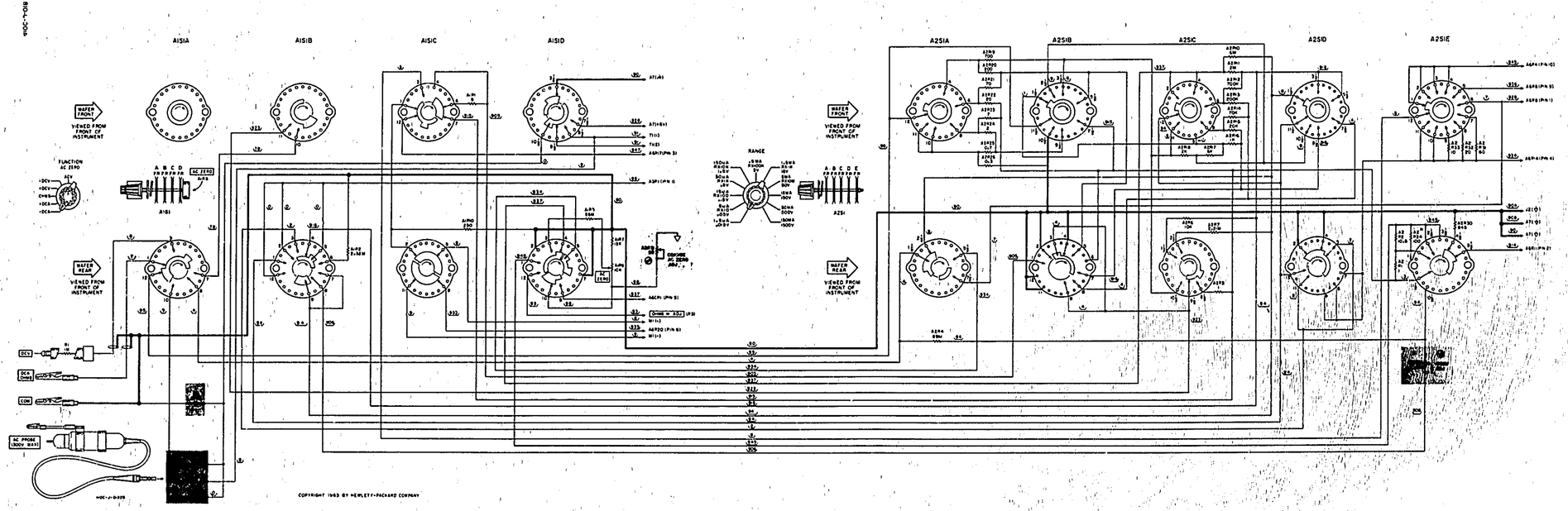


Figure 5-14. Range and Function Switching (Pictorial).

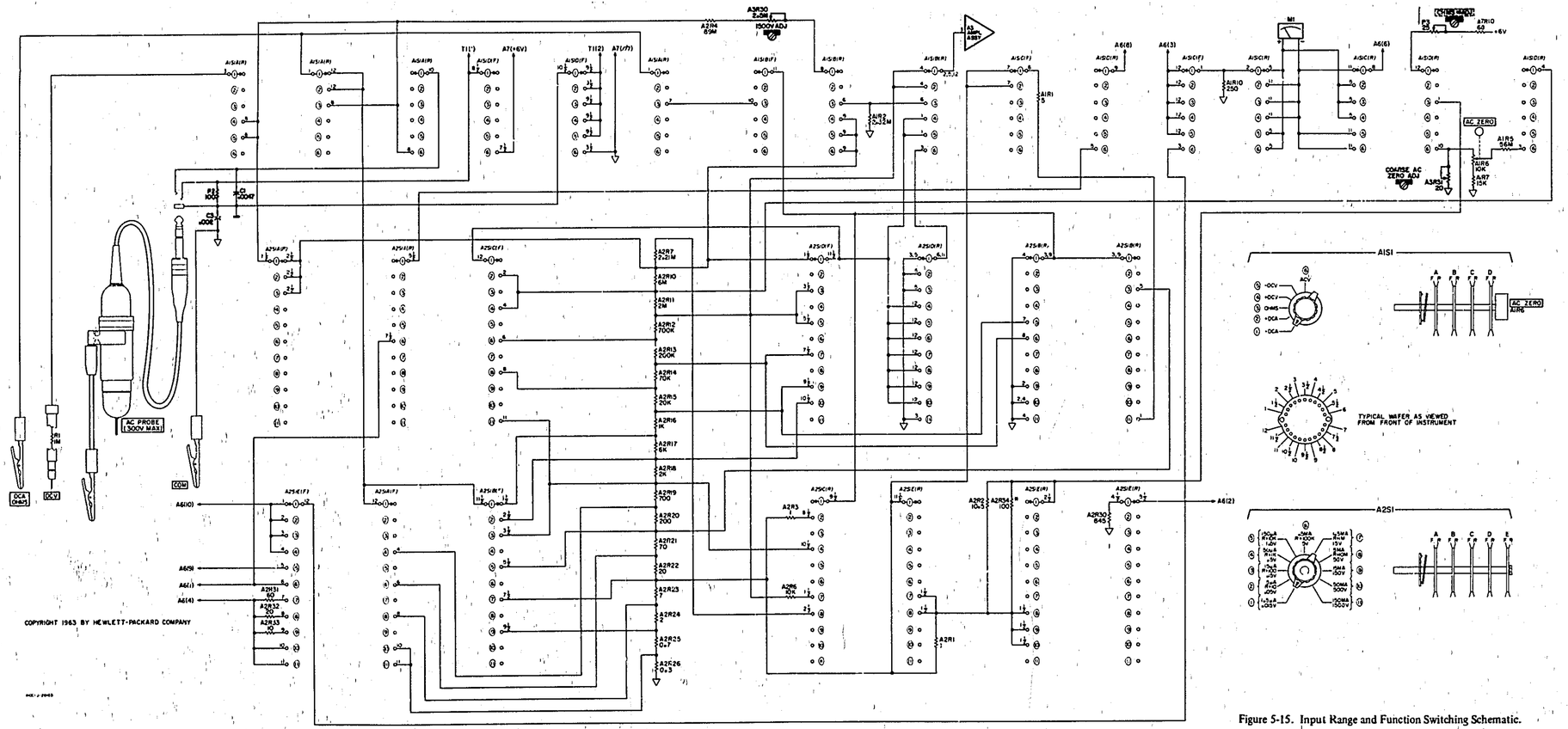


Figure 5-15. Input Range and Function Switching Schematic.

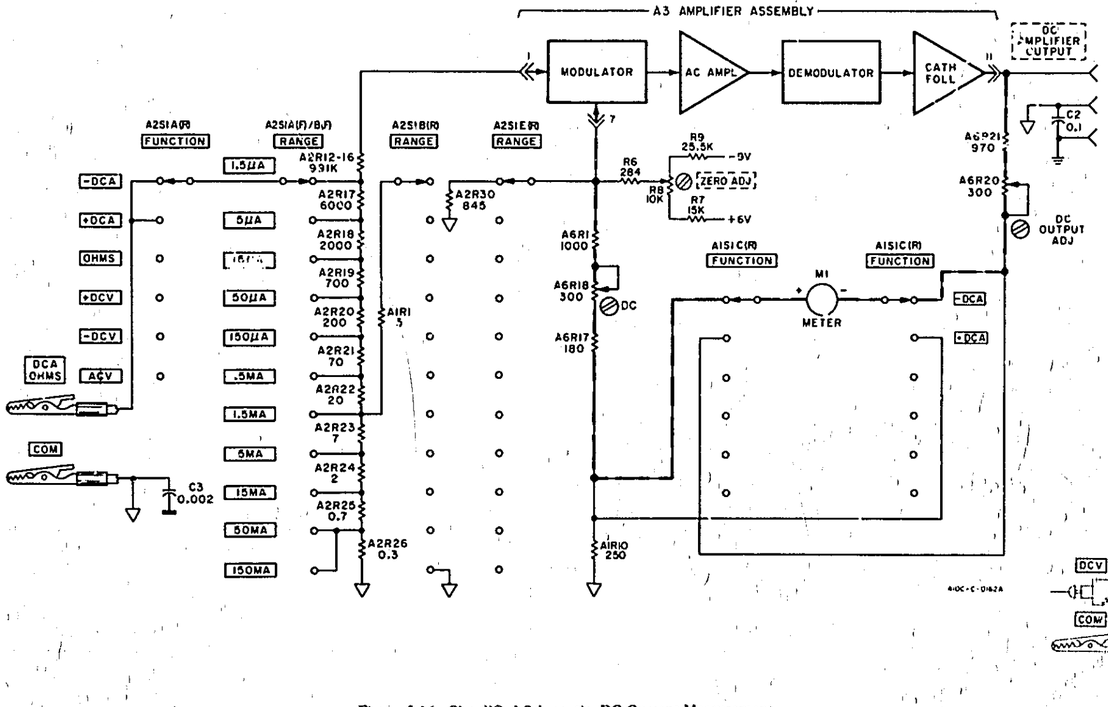


Figure 5-16. Simplified Schematic, DC Current Measurement.

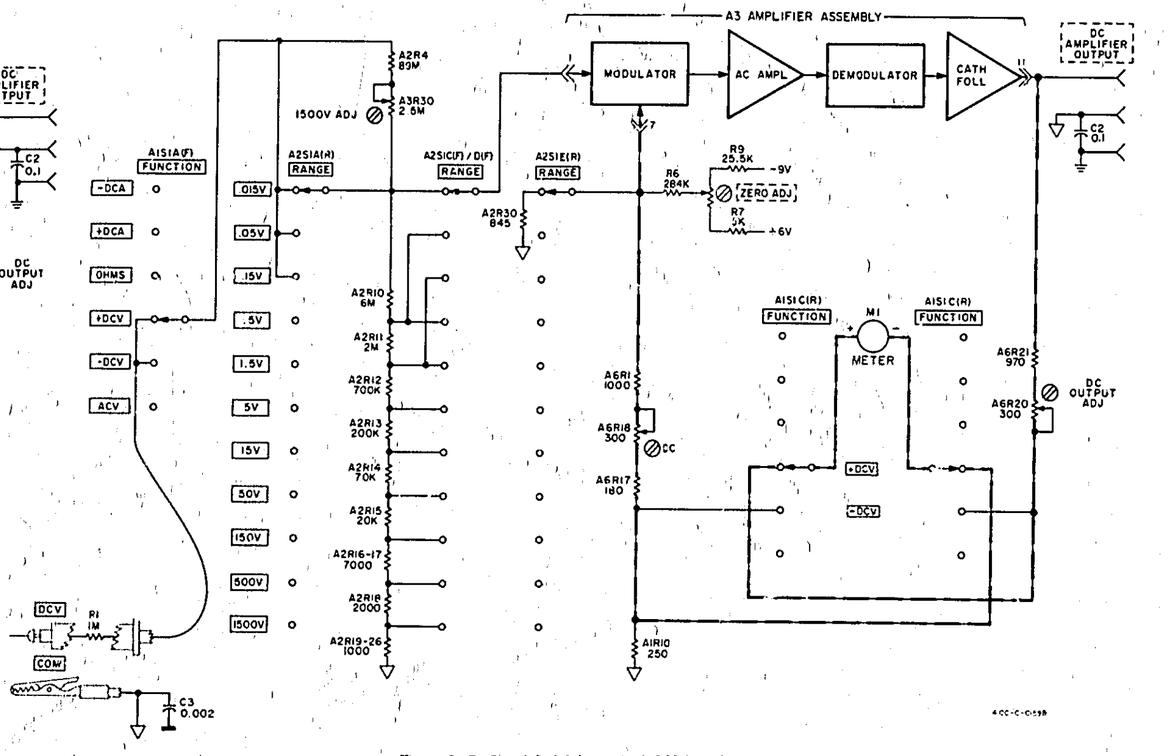


Figure 5-17. Simplified Schematic, DC Voltage Measurements.

Figure 5-16. Simplified Schematic, DC Current Measurement.
Figure 5-17. Simplified Schematic, DC Voltage Measurements.

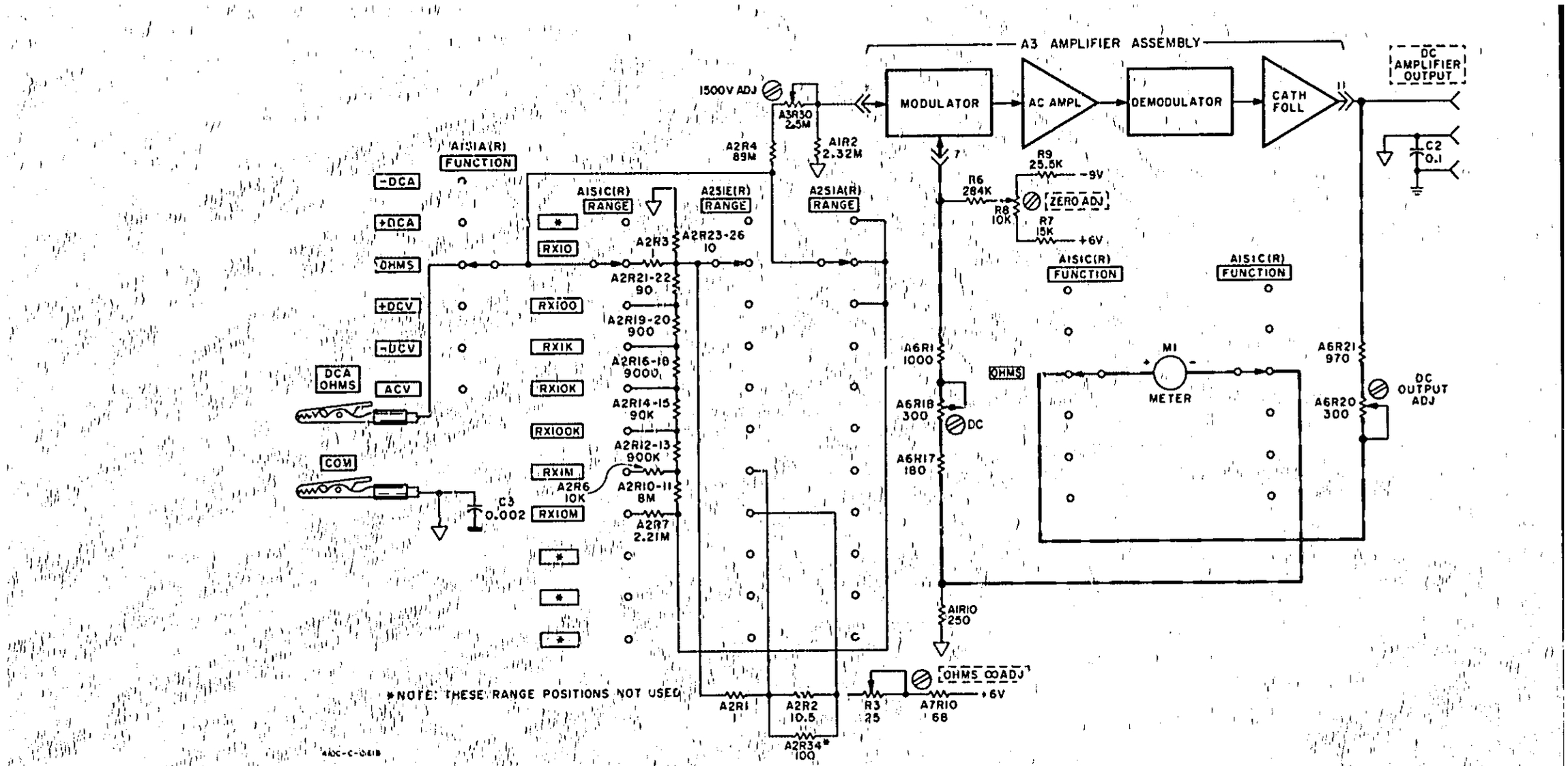


Figure 5-18. Simplified Schematic, Resistance Measurement.

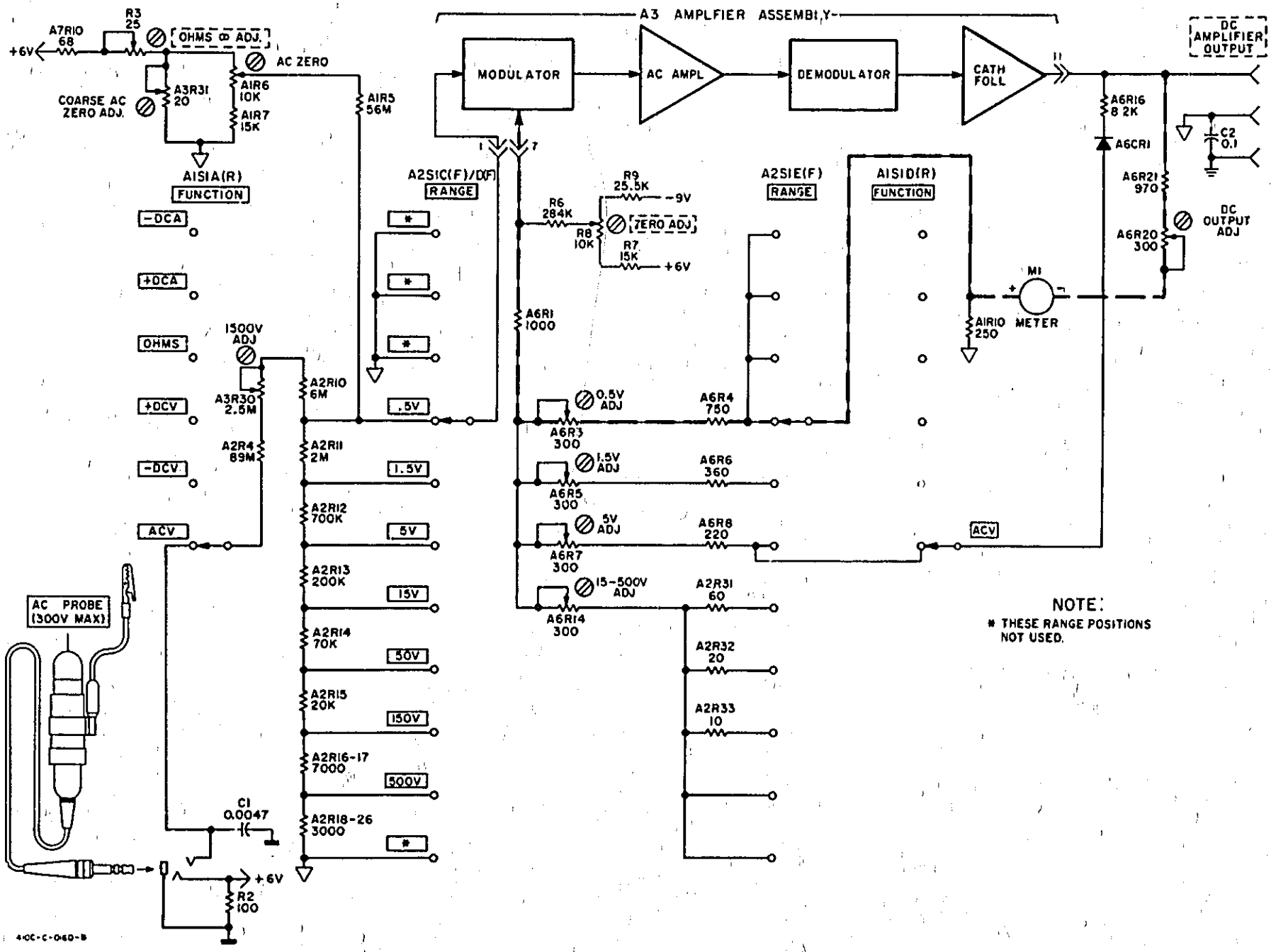


Figure 5-19. Simplified Schematic, AC Voltage Measurement.

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alpha-numerical 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 alpha-numerical 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 list of manufacturers in Appendix).

c. Manufacturer's part number.

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

6-3. ORDERING INFORMATION.

6-4. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office (see lists at rear of this manual for addresses). Identify parts by their Hewlett-Packard part numbers.

6-5. Non-Listed Parts.

6-6. 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.

ABBREVIATIONS

Ag	silver	Hz	hertz (cycle(s) per second)	NPO	negative positive zero (zero temperature coefficient)	sl	slide
Al	aluminum	ID	inside diameter	ns	nanosecond(s) = 10^{-9} seconds	SPDT	single pole double throw
A	ampere(s)	impg	impregnated	nsr	not separately replaceable	SPST	single pole single throw
Au	gold	incd	incandescent	Ω	ohm(s)	Ta	tantalum
C	capacitor	ins	insulation(ed)	obd	order by description	TC	temperature coefficient
cer	ceramic	kΩ	kilohm(s) = 10^{+3} ohms	OD	outside diameter	TiO_2	titanium dioxide
coef	coefficient	kHz	kilohertz = 10^{+3} hertz	P	peak	tog	toggle
com	common	L	inductor	pA	picoampere(s)	tol	tolerance
comp	composition	lin	linear taper	pc	printed circuit	trim	trimmer
conn	connection	log	logarithmic taper	pF	picofarad(s) 10^{-12} farads	TSTR	transistor
dep	deposited	mA	milliampere(s) = 10^{-3} amperes	piv	peak inverse voltage	V	volt(s)
DPDT	double pole double-throw	MHz	megahertz = 10^{+6} hertz	p/o	part of	vacw	alternating current working voltage
DPST	double pole single-throw	MΩ	megohm(s) = 10^{+6} ohms	pos	position(s)	var	variable
elect	electrolytic	met flm	metal film	poly	polystyrene	vdcw	direct current working voltage
encap	encapsulated	mfr	manufacturer	pot	potentiometer	W	watt(s)
F	farad(s)	ms	millisecond	p-p	peak-to-peak	w/	with
FET	field effect transistor	mtg	mounting	ppm	parts per million	wiv	working inverse voltage
fxd	fixed	mV	millivolt(s) = 10^{-3} volts	prec	precision (temperature coeffient, long term stability and/or tolerance)	w/o	without
GaAs	gallium arsenide	μF	microfarad(s)	R	resistor	ww	wirewound
GHz	gigahertz = 10^{+9} hertz	μs	microsecond(s)	Rh	rhodium	*	optimum value selected at factory, average value shown (part may be omitted)
gd	guard(ed)	μV	microvolt(s) = 10^{-6} volts	rms	root mean square	**	no standard type number assigned selected or special type
Ge	germanium	my	Mylar®	rot	rotary		
gnd	ground(ed)	nA	nanoampere(s) = 10^{-9} amperes	Se	selenium		
H	henry(ies)	NC	normally closed	sect	section(s)		
Hg	mercury	Ne	neon	Si	silicon		
		NO	normally open				

® Dupont de Nemours

DECIMAL MULTIPLIERS

Prefix	Symbols	Multiplier	Prefix	Symbols	Multiplier
tera	T	10^{12}	centi	c	10^{-2}
giga	G	10^{9}	milli	m	10^{-3}
mega	M or Meg	10^{6}	micro	μ	10^{-6}
kilo	K or k	10^{3}	nano	n	10^{-9}
hecto	h	10^{2}	pico	p	10^{-12}
deca	da	10^{1}	femto	f	10^{-15}
deci	d	10^{-1}	atto	a	10^{-18}

DESIGNATORS

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

STD-8-2734

Table 6-1. Replaceable Parts

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A1	410C-19B			Switch Assembly: Selector	-hp-	
R1	0727-0004		1	R: fxd C film 5 Ω ±1% 1/2 W	94459	CVS
R2	0727-0480		1	R: fxd C film 2.32 MΩ ±1% 0.5 W	94459	CVF
R3, R4				Not assigned		
R5	0687-5661		2	R: fxd comp 56 MΩ ±10% 1/2 W	01121	EB5661
R6	2100-0389		1	R: var ww lin 10 kΩ ±10% 5 W	-hp-	
R7	0687-1531		1	R: fxd comp 15 kΩ ±10% 1/2 W	01121	EB1531
R8, R9				Not assigned		
R10	0727-0479		1	R: fxd C film 250 Ω ±1% 1/2 W	94459	CVF
S1	3100-0383		1	Switch: rotary 4-section 6-position (FUNCTION)	76854	obd
A2	410C-19A			Switch Assembly: Range	-hp-	
R1	0728-0004		2	R: fxd C film 1 Ω ±1% 1/2 W	94459	CVF
R2	0727-0955		1	R: fxd C film 10.5 Ω ±1% 1/2 W	94459	CVF
R3	0728-0004			R: fxd C film 1 Ω ±1% 1/2 W	94459	CVF
R4	0733-0018		1	R: fxd C film 69 MΩ ±1% 2 W	03888	HV2000
R5				Not assigned		
R6	0687-1031		1	R: fxd comp 10 kΩ ±10% 1/2 W	01121	EB1031
R7	0727-0478		1	R: fxd C film 2.21 MΩ ±1% 1/2 W	94459	CVF
R8, R9				Not assigned		
R10	0730-0176		1	R: fxd 6 MΩ ±0.5% 1 W	94459	CVC
R11	0727-0459		1	R: fxd C film 2 MΩ ±0.5% 1 W	01295	CD1R
R12	0727-0458		1	R: fxd C film 700 kΩ ±0.5% 1/2 W	94459	CVF
R13	0727-0457		1	R: fxd C film 200 kΩ ±1% 1/2 W	94459	CVF
R14	0727-0456		1	R: fxd C film 70 kΩ ±0.5% 1/2 W	94459	CVF
R15	0727-0455		1	R: fxd C film 20 kΩ ±0.5% 1/2 W	94459	CVF
R16	0727-0451		1	R: fxd C film 1000 Ω ±0.5% 1/2 W	94459	CVF
R17	0727-0454		1	R: fxd C film 6000 Ω ±0.5% 1/2 W	94459	CVF
R18	0727-0453		1	R: fxd C film 2000 Ω ±0.5% 1/2 W	94459	CVF
R19	0727-0452		1	R: fxd C film 700 Ω ±0.5% 1/2 W	94459	CVF
R20	0727-0450		1	R: fxd C film 200 Ω ±0.5% 1/2 W	94459	CVF
R21	0727-0449		1	R: fxd C film 70 Ω ±1% 1/2 W	94459	CVF
R22	0727-0448		2	R: fxd C film 20 Ω ±1% 1/2 W	94459	CVF
R23	0727-0446		1	R: fxd C film 7 Ω ±1% 1/2 W	94459	CVS
R24	0727-0445		1	R: fxd C film 2 Ω ±1% 1/2 W	94459	CVS
R25	410C-26B		1	R: fxd 0.7 Ω	-hp-	
R26	410C-26A		1	R: fxd 0.3 Ω	-hp-	
R27 thru R29				Not assigned		
R30	0727-0701		1	R: fxd C film 845 Ω ±1% 1/2 W	94459	CVF
R31	0727-0031		1	R: fxd C film 60 Ω ±1% 1/2 W	01295	DC1/2PR
R32	0727-0448			R: fxd C film 20 Ω ±1% 1/2 W	94459	CVF
R33	0727-0948		1	R: fxd C film 10 Ω ±1% 1/2 W	94459	CVF
R34**	0687-1011		1	R: fxd comp 100 Ω ±10% 1/2 W	01121	EB1011
S1	3100-0382		1	Switch: rotary 5-section 11-position (RANGE)		
A3	410C-65A			Assembly: Amplifier	-hp-	
A1	1990-0020			Assembly: Chopper Block	-hp-	
V1 thru V4				Not separately replaceable, part of Chopper Assembly (1990-0020)		

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A3 (Cont'd)						
A2	1990-0207			Assembly: Lamp	-hp-	
C1				Not separately replaceable, part of Lamp Assembly (1990-0207)		
DS1, DS2				Not separately replaceable, part of Lamp Assembly (1990-0207)		
R1, R2				Not separately replaceable, part of Lamp Assembly (1990-0207)		
C1	0160-2641		1	C: fxd poly 0.1 μF ±10% 50 vdcw	56289	P136073
C2	0160-3116		1	C: fxd poly 0.047 μF ±10% 50 vdcw	56289	P136049
C3				Not assigned		
C4	0160-0161		1	C: fxd my 0.01 μF 200 vdcw	56289	192P10392
C5	0140-0208		1	C: fxd mica 680 pF ±5% 300 vdcw	00853	obd
C6	0160-2128		1	C: fxd my 0.33 μF ±20% 200 vdcw	72354	F307C334M
C7				Not assigned		
C8	0180-0039		1	C: fxd Al elect 100 μF 12 vdcw	56289	D32697
C9	0160-3366		2	C: fxd my 0.22 μF ±20% 100 vdcw	72354	F307C224M
C10				Not assigned		
C11	0180-1819		1	C: fxd Al elect 100 μF 50 vdcw	56289	30D107G050DH2
C12	0160-3366			C: fxd my 0.22 μF ±20% 100 vdcw	72354	F307C224M
C13	0150-0096		1	C: fxd cer 0.05 μF 100 vdcw	72982	845-X5V-5032
C14	0170-0018		1	C: fxd my 1 μF ±5% 200 vdcw	84411	HEW-4
C15				Not assigned		
C16	0140-0154		1	C: fxd mica 1300 pF ±5% 500 vdcw	14655	RCM15E101K
CR1, CR2	1901-0156		1	Diode: Si 50 mA	03877	SG3288
Q1, Q2	1853-0020		2	TSTR: Si PNP	-hp-	
R1	0687-6841		1	R: fxd comp 680 kΩ ±10% 1/2 W	01121	EB6841
R2	0687-1851			R: fxd comp 1.8 MΩ ±10% 1/2 W	01121	EB1851
R3	0811-0998		1	R: fxd comp 100 Ω ±1% 1/4 W	-hp-	
R4				Not assigned		
R5	2100-0760		1	R: var comp lin 50 kΩ ±30% 1/4 W	71590	Series 5 Type 70-1
R6				Not assigned		
R7	0687-5661			R: fxd comp 56 MΩ ±10% 1/2 W	01121	EB5661
R8	0687-4731		1	R: fxd comp 47 kΩ ±10% 1/2 W	01121	EB4731
R9	0687-4701		1	R: fxd comp 47 Ω ±10% 1/2 W	01121	EB4701
R10, R11				Not assigned		
R12	0757-0164		1	R: fxd met film 5600 Ω ±2% 1/2 W	07115	C20
R13	0757-0166		2	R: fxd met film 30 kΩ ±2% 1/2 W	07115	C20
R14	0757-0163		1	R: fxd met film 3000 Ω ±2% 1/2 W	07115	C20
R15	0757-0165		1	R: fxd met film 13 kΩ ±2% 1/2 W	07115	C20
R16, R17				Not assigned		
R18	0757-0091		1	R: fxd met film 18 kΩ ±2% 1/2 W	07115	C20
R19	0757 0166			R: fxd met film 30 kΩ ±2% 1/2 W	07115	C20
R20	0687-1021		3	R: fxd comp 1000 Ω ±10% 1/2 W	01121	EB1021
R21	2100-0396		1	R: var ww lin 10 kΩ ±20% 1 W	79727	E870PAB
R22, R23				Not assigned		
R24	0687-2751		1	R: fxd 2.7 MΩ ±10% 1/2 W	01121	EB2751
R25	0687-2221		1	R: fxd comp 2.2 kΩ ±10% 1/2 W	01121	EB2221
R26	0687-1021			R: fxd comp 1000 Ω ±10% 1/2 W	01121	EB1021
R27 thru R29				Not assigned		
R30	2100-0413		1	R: var comp lin 2.5 MΩ ±20% 1/4 W	71590	Series 5 Type 70-1

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A3 (Cont'd)						
R31	2100-0227		1	R: var ww lin 20 Ω ±10% 1 W	-hp-	
V1	1932-0027		1	Tube: electron 12AT7 dual triode	80131	12AT7
A4, A5				Not assigned		
A6	410C-65B			Assembly: Calibration	-hp-	
CR1	1901-0026		1	Diode: Si 50 mA	03332	D3C72
R1	0727-0751		1	R: fxd C film 1000 Ω ±1% 1/2 W	94459	CVF
R2				Not assigned		
R3	2100-0394		6	R: var ww lin 300 Ω ±20% 1 W	11236	Series 110
R4	0727-0747		2	R: fxd C film 750 Ω ±1% 1/2 W	94459	CVF
R5	2100-0394			R: var ww lin 300 Ω ±20% 1 W	11236	Series 110
R6	0728-0011		1	R: fxd C film 360 Ω ±1% 1/2 W	94459	CVF
R7	2100-0394			R: var ww lin 300 Ω ±20% 1 W	11236	Series 110
R8	0728-0010		1	R: fxd C film 220 Ω ±1% 1/2 W	94459	CVS
R9 thru R13				Not assigned		
R14	2100-0394			R: var ww lin 300 Ω ±20% 1 W	11236	Series 110
R15				Not assigned		
R16	0758-0048		1	R: fxd met film 8200 Ω ±5% 1/2 W	07115	C20
R17	0727-0866		1	R: fxd C film 180 Ω ±1% 1/2 W	94459	CVF
R18	2100-0394			R: var ww lin 300 Ω ±20% 1 W	11236	Series 110
R19				Not assigned		
R20	2100-0395		1	R: var comp lin 300 Ω ±20% 1/4 W	71590	Series 5 Type 70-1
R21	0727-0475		1	R: fxd C 970 Ω ±0.5% 1/2 W	94459	CD1/2MR
A7	410C-65E			Assembly: Power Supply	-hp-	
C1*	0140-0041		1	C: fxd mica 100 pF ±5% 500 vdcw	04062	RCM15E101J
CR1 thru CR5				Not assigned		
CR6	1902-0026		1	Diode: breakdown 36.5 V ±10% 0.4 W	04713	SZ10939-343
CR7	1902-0681		1	Diode: breakdown 9.09 V ±10% 500 mW	04713	SZ12385
CR8	5080-9050		1	Diode: breakdown 6.49 V ±5% 0.4 W	-hp-	
J4	1251-0213		1	Connector: 15 pin PC	95354	SD-615W(125)
R1, R2	0764-0003		2	R: fxd met film 3300 Ω ±5% 2 W	07115	C42S
R3	0758-0018		1	R: fxd met film 15 kΩ ±5% 1/2 W	07115	C20
R4	0764-0026		1	R: fxd met film 13 kΩ ±5% 2 W	07115	C42S
R5, R6				Not assigned		
R7				Deleted in serial number 844-09954 and up		
R8	0758-0002		1	R: fxd met film 560 Ω ±5% 1/2 W	07115	C20
R9				Not assigned		
R10	0758-0083		1	R: fxd met film 68 Ω ±5% 1/2 W	07115	C20
A8	11036A			Assembly: AC Probe (-hp- Model 11036A, complete)	-hp-	
C1				Not separately replaceable, part of AC Probe (11036A)		
C2				Not separately replaceable, part of AC Probe (11036A)		
P1	1251-0209		1	Plug: telephone 3 conductor	82389	2P-1297

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A8 (Cont'd)						
R1				Not separately replaceable, part of AC Probe (11036A)		
V1	J0410-87901			Tube: electron diode	-hp-	
C1	0170-0021		1	C: fxd my 4700 pF ±10% 400 vdcw	84411	620SJ0047
C2	0170-0022		1	C: fxd my 0.1 μF ±10% 600 vdcw	56875	HEW-17
C3	0150-0023		1	C: fxd cer 2000 pF ±20% 1000 vdcw	56289	19C203A
C4				Not assigned		
C5	0180-0025		1	C: fxd Al elect 4x20 μF +50% -10% 450 vdcw	00853	Type PLI
C6	0180-0153		1	C: fxd Al elect 2x1200 μF +100% -10% 20 vdcw	00853	4S4039
CR1, CR2	1901-0036		1	Diode: Si 300 mA	01841	obd
CR3, CR4	1901-0049		1	Diode: Si 500 mA	86684	34934
DS1	2140-0244		1	Light indicator: A1H neon (p/o S3)	87034	A1H
F1	2110-0201		1	Fuse: cartridge slow-blow 0.25 A 125 V	-hp-	
J1	1251-0200		1	Jack: telephone 3 conductor	82389	3J-1291
J2				Assembly: DC AMPLIFIER OUTPUT (see MISCELLANEOUS for Part Nos.		
J3	1251-2357		1	Connector: power cord receptacle	82389	EAC-301
M1	1120-0317		1	Meter: 0-1 mA	-hp-	
Q1	1853-0063		1	TSTR: Si PNP	04713	SJ1528
R1	0727-0274		1	R: fxd C film 1 MΩ ±1% 1/2 W	94459	CVF
R2	0758-0086		1	R: fxd met film 100 Ω ±5% 1/4 W	07115	C07
R3	2100-0415		1	R: var ww lin 25 Ω ±10% 2 W	08884	FFF-1
R4				Not assigned		
R5	0687-3331		1	R: fxd comp 33 kΩ ±10% 1/2 W	01121	EB3331
R6	0727-0231		1	R: fxd C film 284 kΩ ±0.5% 1/2 W	91637	DCS1/2
R7	0727-0168		1	R: fxd C film 15 kΩ ±1% 1/2 W	91637	DCS1/2-15
R8	2100-1567		1	R: var ww 10 kΩ ±10% 2 W	11236	117
R9	0727-0180		1	R: fxd C film 25.5 kΩ ±1% 1/2 W	91637	DCS1/2-15
S1	3101-1248		1	Switch: SPST pushbutton (Line)	29207	53-55480-121-A1H
S2	3101-1234		1	Switch: DPDT slide (Selector)		
T1	9100-0174		1	Transformer: power	-hp-	
W1	8120-1348		1	Cable: power 3 conductor 7-1/2 ft. long w/NEMA plug	-hp-	
XQ1	1200-0044		1	Socket: transistor TO-3	97913	M7(PB)
				MISCELLANEOUS		
	1220-0066		1	Shield: tube	54252	319A-2
	1490-0088		1	Clip: ground	71785	422-11-11-095
	1510-0006		1	Binding post: black (p/o J2)	-hp-	
	1510-0007		2	Binding post: red (p/o J2)	-hp-	

Table 6-2. Replaceable Hardware

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
	11036-42102		1	Boot: AC plug (p/o 11036A)	-hp-	
	11036-42101		1	Boot: AC probe (p/o 11036A)	-hp-	
	412A-83A		3	Boot: cable	-hp-	
	410C-12A		1	Bracket: connector (used with A3 connector)	-hp-	
	410C-12B		1	Bracket: switch (used with A6 connector)	-hp-	
	00410-01202		2	Bracket: cover retainer	-hp-	
	1200-0081		2	Bushing: insulator (used with Q1)	26365	974 Special
	1410-0091		2	Bushing: panel (used with A1S1 and A2S2)	28520	SB-457-4
	0400-0019		3	Bushing: strain relief	-hp-	
	410C-1A		1	Chassis: transformer	-hp-	
	1400-0046		1	Clip: alligator (P/O 11036A)	-hp-	
	410B-21H		1	Clip: grounding (P/O 11036A)	-hp-	
	1251-0029		1	Connector: male (P/O 11036A)	-hp-	
	410B-21P		1	Contact: Diode (p/o 11036A)	-hp-	
	3130-0038		1	Coupler: swivel	45255	10X20X1
	5000-8565		1	Cover: side	-hp-	
	00410-64102		1	Cover: top (requires 2 brackets 00410-01202)	-hp-	
	5000-8577		1	Cover: bottom	-hp-	
	5060-0727		2	Foot assembly	-hp-	
	5060-0703		2	Frame: side	-hp-	
	5040-0700		2	Hinge (used with tilt stand)	-hp-	
	1400-0084		1	Holder: fuse	75915	342014
	1400-0085		1	Insulator: clip (P/O 11036A)	-hp-	
	0340-0086		1	Insulator: binding post double	-hp-	
	0340-0091		1	Insulator: binding post triple	-hp-	
	1520-0001		2	Insulator: capacitor (used with C1 - C2)	56137	XP
	0340-0007		1	Insulator: ceramic standoff	71590	obd
	0370-0112		1	Knob: black bar concentric	-hp-	
	0370-0113		1	Knob: black bar w/arrow	-hp-	
	0370-0114		1	Knob: red w/arrow	-hp-	
	0360-0016		1	Lug: solder lock #4	78452	718
	0360-0007		4	Lug: solder #10	78189	2501-10-00
	0360-0042		2	Lug: solder 90°	79963	obd
	2260-0001		4	Nut: hex 4-40 x 1/4 in.	-hp-	
	2420-0001		4	Nut: hex 6-32 x 5/16 in. w/lock	83385	obd
	2820-0001		3	Nut: hex 10-32 x 3/8 in.	73743	obd
	2950-0006		3	Nut: hex 1/4-32 x 3/8 in.	73734	9000
	2950-0001		3	Nut: hex 3/8-32 x 1/2 in.	73743	obd
	2950-0037		1	Nut: hex 1/2-16 x 11/16 in.	75915	obd
	2950-0038		1	Nut: hex 1/2-24 x 11/16 in.	75915	903-12
	0590-0039		4	Nut: speed 6-32	78553	C6800-632-1
	0590-0052		2	Nut: speed 6-32	78553	C8020-632-2
	00410-00211		1	Panel: front	-hp-	
	00410-00202		1	Panel: rear	-hp-	
	410C-41A		1	Plate: insulator (used with A1S1 and A2S2)	-hp-	
	1200-0043		1	Plate: insulator (used with Q1)	71785	294457
	1251-0209		1	Plug: telephone (p/o 11036A)	82389	2P-1297
	00410-42101		1	Probe: contact body (P/O 11036A)	-hp-	
	00410-42102		1	Probe head (P/O 11036A)	-hp-	
	410B-21F		1	Ring: retainer (p/o 11036A)	-hp-	
	2200-0008		2	Screw: machine 4-40 x 3/8 in. RH	80120	obd
	2200-0014		2	Screw: machine 4-40 x 5/16 in. RH	80120	obd
	2370-0001		20	Screw: machine 6-32 x 1/4 in. RH	80120	obd

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

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
	2390-0007		4	Screw: machine 6-32 x 5/16 in. BH w/lock	83385	obd
	2370-0002		8	Screw: machine 6-32 x 3/8 in. FH	80120	obd
	2370-0003		2	Screw: machine 6-32 x 1/2 in. FH	80120	obd
	410B-21E		1	Sleeve (p/o 11036A)	-hp-	
	1460-0006		1	Spring: diode contact (p/o 11036A)	91260	obd
	1490-0031		1	Stand: tilt	91260	obd
	410C-66A		2	Support: circuit board (used with A3)	-hp-	
	410C-21D		1	Test lead assembly: COM	-hp-	
	410C-21C		1	Test lead assembly: DCA-OHMS	-hp-	
	410C-21A		1	Test lead assembly: DCV (includes R1)	-hp-	
	5020-6852		1	Trim: meter	-hp-	
	11036-62101		1	Tube: socket and cable assembly (p/o 11036A)	-hp-	
	3050-0066		2	Washer: flat #6	73734	obd
	3050-0067		3	Washer: flat 3/8 in. ID	73734	obd
	0900-0016		1	Washer: fuse holder	76680	622710
	2190-0005		2	Washer: lock #4 external	80120	obd
	2190-0004		2	Washer: lock #4 internal	78189	SF1904
	2190-0003		2	Washer: lock #4 split	83385	obd
	2190-0047		30	Washer: lock #6 countersunk	78189	obd
	2190-0011		2	Washer: lock #10 internal	78189	1910
	2190-0028		2	Washer: lock #10 int/ext	78189	4010-18-00
	2190-0027		3	Washer: lock 1/4 in. internal	78189	1914
	2190-0022		4	Washer: lock 3/8 in. ID	78189	1920
	2190-0037		2	Washer: lock 1/2 in. internal	78189	1224-08
	1400-0090		1	Washer: Neoprene	75915	901-2

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.
00287	Cemco, Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Mictron, 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.
00809	Croven, Ltd.	Whitby, Ontario, Canada
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S. C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Cal.
00928	Microlab Inc.	Livingston, N. J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N. Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Cal.
01281	TRW Semiconductors, Inc.	Lawndale, Cal.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co	Alliance, Ohio
01538	Small Parts Inc.	Los Angeles, Cal.
01589	Pacific Relays, Inc.	Van Nuys, Cal.
01670	Gudebrod Bros. Silk Co.	New York, N.Y.
01930	Amerock Corp.	Rockford, Ill.
01960	Pulse Engineering Co	Santa Clara, Cal.
02114	Ferroxcube Corp. of America	Saugerties, N. Y.
02116	Wheelock Signals, Inc.	Long Branch, N. J.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Cal.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Division	Somerville, N. J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Cal.
02875	Hudson Tool & Die	Newark, N. J.
03296	Nylon Molding Corp.	Springfield, 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, Cal.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N. J.
03954	Singer Co., Diehl Div., Finderne Plant	Somerville, N. J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taruus Corp.	Lambertville, N. J.
04062	Arco Electronic Inc.	Great Neck, N. Y.
04217	Essex Wire	Los Angeles, Cal.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S. C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Palo Alto Division of Hewlett-Packard Co.	Palo Alto, Cal.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Cal.
04673	Dakota Engr. Inc.	Culver City, Cal.
04713	Motorola Inc. Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Cal.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Cal.
04813	Precision Coil Spring Co.	El Monte, Cal.
04870	P. M. Motor Company	Westchester, Ill.
04918	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Cal.
05277	Westinghouse Electric Corp. Semiconductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Cal.
05397	Union Carbine Corp., Elect. Div.	New York, N. Y.
05574	Viking Ind. Inc.	Canoga Park, Cal.
05583	Icore Electro-Plastics Inc.	Sunnyvale, Cal.
05616	Cosmo Plastic f/c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N. Y.
05729	Metro-Tel Corp.	Westbury, N. Y.
05783	Stewart Engineering Co.	Santa Cruz, Cal.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Cal.
06175	Bausch and Lomb Optical Co.	Rochester, N. Y.
06402	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., Aziz Div.	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Cal.
06980	Varian Assoc. Etmac Div.	San Carlos, Cal.
07088	Kelvin Electric Co.	Van Nuys, Cal.
07126	Digitran Co.	Pasadena, Cal
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, Cal.
07256	Silicon Transistor Corp.	Carle Place, N. Y.
07261	Avnet Corp.	Culver City, Cal.
07263	Fairchild Camera & Inst. Corp., Semiconductor Div.	Mountain View, Cal.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp, The	Monterey Park, Cal.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Cal.
07700	Technical Wire Products Inc.	Cranford, N. J.
07828	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Cal.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Cal.
07980	Hewlett-Packard Co., New Jersey Division	Rockaway, N. J.
08145	U. S. Engineering Co.	Los Angeles, Cal.
08289	Blinn, Delbert Co.	Pomona, Cal.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Cal.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Cal.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N. J.
08792	CBS Electronics Semiconductor Operations, Div. of CBS Inc	Lowell, Mass.
08806	General Electric Co., Miniature Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Cal.
09097	Electronic Enclosures Inc.	Los Angeles, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Cal.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co of Canada, Ltd.	Toronto, Ontario, Canada
09785	Pennsylvania Florocarbon Clifton Heights, Penn.	
09922	Burndy Corp.	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Cal.
10411	Ti-Tal, Inc.	Berkeley, Cal.
10646	Carborundum Co.	Niagara Falls, N. Y.
11236	CTS of Berne, Inc.	Berne, Ind
11237	Chicago Telephone of California, Inc.	So. Pasadena, Cal
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Cal
11314	National Seal	Downey, Cal
11453	Precision Connector Corp.	Jamaica, N. Y.
11534	Duncan Electronics Inc.	Costa Mesa, Cal.
11711	General Instrument Corp., Semiconductor Division Products Group	Newark, N. J.
11717	Imperial Electronic, Inc.	Buena Park, Cal.
11870	Melabs, Inc.	Palo Alto, Cal.
12301	Philadelphia Handle Co	Camden, N. J.
12361	Grove 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	Metex Electronics Corp.	Clark, N. J.
12930	Delta Semiconductive Inc.	Newport Beach, Cal.
12954	Dickson Electronics Corp	Scottsdale, Arizona
13019	Airco Supply Co., Inc.	Witchita, Kansas
13061	Wilco Products	Detroit, Mich.
13103	Thermalloy	Dallas, Texas
13327	Solitron Devices Inc.	Tappan, N. Y.
13396	Telefunken (Gmbil)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Cal.
14193	Calif. Resistor Corp.	Santa Monica, Cal.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, a Div. of Int. Telephone and Telegraph Corporation	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, Cal
14960	Williams Mfg. Co.	San Jose, Cal
15106	The Sphere Co., Inc.	Little Falls, N. J.
15203	Webster Electronics Co	New York, N. Y.
15287	Setonics Corp	Northridge, Cal.
15291	Adjustable Bushing Co	N. Hollywood, Cal
15558	Micron Electronics, Garden City, Long Island, N. Y.	
15566	Amprobe Inst. Corp.	Lynbrook, N. Y.
15631	Cabletronics	Costa Mesa, Cal
15772	Twentieth Century Coil Spring Co	Santa Clara, Cal
15801	Fenwal Elect. Inc.	Framingham, Mass
15818	Ameleo Inc.	Mountain View, Cal
16037	Spruce Pine Mica Co.	Spruce Pine, N. C.
16179	Omni-Spectra Inc.	Detroit, Ill
16352	Computer Diode Corp.	Lodi, N. J.
16554	Electroid Co.	Union, N. J.
16585	Boots Aircraft Nut Corp.	Pasadena, Cal
16688	Ideal Prec. 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, Cal.
17474	Tranex Company	Mountain View, Cal
17675	Hamlin Metal Products Corp	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Cal
17856	Siliconix Inc.	Sunnyvale, Cal.
17870	McGraw-Edison Co.	Manchester, N. H.
18042	Power Design Pacific Inc.	Palo Alto, Cal.
18083	Clevite Corp Semiconductor Div.	Palo Alto, Cal.
18324	Signetics Corp	Sunnyvale, Cal.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18565	Chomerics	Plainville, Mass.
18583	Curtis Instrument, Inc.	Mt. Kisco, N. Y.
18612	Vishay Instruments Inc.	Malvern, Pa
18873	E. I. DuPont and Co., Inc.	Wilmington, Del.
18881	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp, Navigation & Control Div.	Teterboro, N. J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison	West Orange, N. J.
19589	Concoa	Baldwin Park, Cal.

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CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
19644	LRC Electronics	Horseheads, N. Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N. Y.
21355	Fafnir Bearing Co., The	New Britian, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
21020	General Reed Co.	Methuchen, N.J.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division, Nela Park	Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp Div.	Huntington, Ind.
26365	Gries Reproducer Corp	New Rochelle, N. Y.
26462	Grobert File Co. of America, Inc.	Carlstadt, N.J.
26851	Compar, Hollister Co.	Hollister, Cal.
26992	Hamilton Watch Co.	Lancaster, Pa.
23480	Hewlett-Packard Co.	Palo Alto, Cal.
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.
36186	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.
40931	Honeywell Inc.	Minneapolis, Minn.
42190	Muter Co.	Chicago, Ill.
43890	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	HP Co., Med. Elec. Div.	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 & System Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
58474	Superior Elect. Co.	Bristol, Conn.
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	Wiltek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Reverse 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 Electric Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincey, 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, Cal.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Cal.
71471	Cinema, Div. Aerovox Corp.	Burbank, Cal.
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	Electro 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 Division	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, Cal.
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 Berkman Inst., Inc.	Fullerton, Cal.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Cal.
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 K. 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, Cal.
73957	Groove-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	B.F. Products Division of Amphenol-Borg Electronic 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	JTS Knights, Inc.	Sandwich, Ill.
75382	Kulka Electric Corp.	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Cal.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Cal.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Cal.
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, Cal.
77075	Pacific Metals Co.	San Francisco, Cal.
77221	Phaostron Instrument and Electronic Co.	So. Pasadena, Cal.
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 Division	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77968	Rubbercraft Corp. of Calif.	Torrance, Cal.
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.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Cal.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78789	Transformer Engineers	San Gabriel, Cal.
78947	Ucinite Co.	Newtonville, Mass.
79136	Walden Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, 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.
80033	Prestole Corp.	Toledo, Ohio
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Standard tube or semi-conductor device, any manufacturer.	
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, Cal.
80411	Arco Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Cal.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80313	Dimco Gray Co.	Dayton, Ohio
81030	International Inst. Inc.	Orange, Conn.
81075	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Cal.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	
81483	International Rectifier Corp.	El Segundo, Cal.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Darry Controls, Div. Darry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti 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 Systems Div.	Paramus, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod., Inc. Electronic Tube Division	Emporium, Pa.
82376	Aatron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc., Spencer Products	Attleboro, Mass.
82768	Philips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Cal.
83058	Carr 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, Cal.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mandelein, Ill.
83324	Rosan Inc.	Newport Beach, Cal.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisades 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 Ind., & Radio Co.	Lodi, N.J.
84171	Arco Electronics, Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Cal.
84411	TRW Capacitor Div.	Ogallala, Neb.

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From: Handbook Supplements H4-1 Dated January 1970

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
84870	Barker Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Cal.
85474	R.M. Bracamonte & Co.	San Francisco, Cal.
85660	Koiled Kords, Inc.	Ramdea, Conn.
85811	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 Division	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Cal.
87034	Marco Industries	Anaheim, Cal.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Cal.
87664	Van Waters & Rogers Inc.	San Francisco, Cal.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88688	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Cal.
89473	G.E. Distributing Corp.	Schenectady, N.Y.
89479	Security Co.	Detroit, Mich.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	U.S. Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90365	Belleville Speciality Tool Mfg., Inc.	Belleville, Ill.
90763	United Carr Fastener Corp.	Chicago, Ill.
90970	Bearing Engineering Co.	San Francisco, Cal.
91146	ITT Cannon Elect. Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Cal.
91345	Miller Dial & Nameplate Co.	El Monte, Cal.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91673	Epiphone Inc.	New York, N.Y.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Cal.
91886	Malco Mfg., Inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Division	Freeport, Ill.
91961	Nahm-Brue, Spring Co.	Oakland, Cal.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Eigeet Optical Co., Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Westbury, L.I., N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Philiadea Park, N.J.
93410	Stamco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Cal.
93919	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
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 Patterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Co.	Brooklyn, N.Y.
94662	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95146	Alco Elect. Mfg. Co.	Lawrence, Mass.
95236	Allied Products Corp.	Diania, 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.
95986	Remon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96047	Microwave Assoc., West. Inc.	Sunnyvale, Cal.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt Carmel, Ill.
96296	Solar Mfg. Co.	Los Angeles, Cal.
96296	Micro-switch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Cal.
96508	Xcelite, Inc.	Orchard Park, N.Y.
96733	San Fernando Elec. Mfg. Co.	San Fernando, Cal.
96881	Thomson Ind. Inc.	Long Island, 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 Teck, Inc.	Gardena, Cal.
98220	Hewlett-Packard Co., Medical Elec. Div.	Pasadena, Cal.
98278	Microdot, Inc.	So. Pasadena, Cal.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98376	Zero Mfg. Co.	Burbank, Cal.
98410	Etc Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Paeco Division of Hewlett-Packard Co.	Palo Alto, Cal.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Cal.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Cal.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Cal.
99707	Control Switch Division, Controls Co. of America	El Segundo, Cal.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp	Whippany, N.
99934	Rembrandt, Inc.	Boston, Ma
99942	Hoffman Electronics Corp., Semiconductor Division	El Monte, Ca
99957	Technology-Instrument Corp. of California	Newbury Park, Cal.

The following HP Vendors have no number assigned in the latest supplement to the Federal Supply Code for Manufacturers Handbook.

0000F	Malco Tool and Die	Los Angeles, Calif.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Comp. Co.	Van Nuys, Cal.
000CS	Hewlett-Packard Co., Colorado Springs Div.	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Cal.
000NN	A "N" D Mfg. Co.	San Jose, Cal.
000QQ	Cooltron	Oakland, Cal.
000WW	California Eastern Lab	Burlington, Cal.
000YY	S.K. Smith Co.	Los Angeles, Cal.

MANUAL BACKDATING CHANGES

MODEL 410C

ELECTRONIC VOLTMETER

Manual Serial Prefixed: 0982A
-hp- Part No. 00410-90007

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
311-	1 thru 15
328-	2 thru 15
339-	3 thru 15
344-	4 thru 15
443-	6 thru 15
532-	7 thru 15
550-05300 and below	8 thru 15

Instrument Serial Prefix	Make Manual Changes
550- and below	9 thru 15
807- and below	10 thru 15
844- and below	11 thru 15
982-12403 and below	12 thru 15
0982A14403 and below	13 thru 15
0982A15003 and below	14, 15
0982A15453 and below	15

CHANGE 1

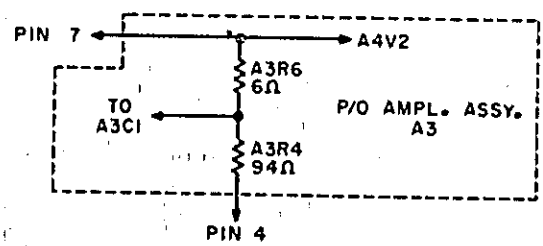
Under Table of Replaceable Parts:
Delete: A1R7; Resistor, fixed, 15 kΩ; -hp- Part No. 0687-1531.
Add: A1R7; Resistor, fixed, 22 kΩ; -hp- Part No. 0758-0020.
Delete: A2R2; Resistor, fixed, 10.5 Ω; -hp- Part No. 0727-0955.
Add: A2R2; Resistor, fixed, 6 MΩ; -hp- Part No. 0727-0460.
Delete: A2R10; Resistor, fixed, 6 MΩ; -hp- Part No. 0730-0076.
Add: A2R10; Resistor, fixed, 10.8 Ω; -hp- Part No. 0728-0003.

Figure 5-13, RANGE and FUNCTION Switching (Pictorial):
Change A1R7 from 15 kΩ to 22 kΩ.
Change A2R2 from 10.5 Ω to 6 MΩ.
Change A2R10 from 6 MΩ to 10.8 Ω.

CHANGE 2

Under Table of Replaceable Parts:
Delete: A3R3; Resistor, fixed, 100 Ω; -hp- Part No. 410C-26D.
Add: A3R4; Resistor, fixed, 94 Ω; -hp- Part No. 0727-0470.
Add: A3R6; Resistor, fixed 6 Ω; -hp- Part No. 410C-26C.

Figure 5-10, Amplifier Schematic:
Change:



CHANGE 3

Under Table of Replaceable Parts:
Delete: S3; Switch, pushbutton w/pilot light; -hp- Part No. 3101-0100.
Delete: DS1; Light, indicator, A1C neon; -hp- Part No. 1450-0106.
Delete: R5; Resistor, fixed, 68 kΩ; -hp- Part No. 0687-6831.

Add: S3; Switch, pushbutton; -hp- Part No. 3130-0054.
Add: DS1; Light, indicator, NE-2H neon; -hp- Part No. 1450-0048.
Add: Bushing, panel; -hp- Part No. 5020-0883.
Add: Actuator, AC switch; -hp- Part No. 5040-0918.
Add: Bracket; AC switch; -hp- Part No. 410C-12C.
Add: R5; Resistor, fixed, 33 kΩ -hp- Part No. 0687-3331.

NOTE

Later Models 410C (Serial Prefix 344 and above) use the -hp- Part No. 3101-0100, pushbutton switch w/pilot light for increased reliability. It is recommended that this improved switch-pilot light assembly be used for replacement, in case of failure of the older type switch. Refer to -hp- Service Note P-3101-0100 for modification instructions.

CHANGE 4

Under Table of Replaceable Parts:
Delete: CR7; Diode, Breakdown Junction, 9 V 1.5 W; -hp- Part No. 1902-0327.
Add: A7CR7, Diode, Breakdown Junction, 9 V, 0.4 W; -hp- Part No. 1902-0037.

Figure 5-8, Power Supply Schematic:
Change CR7 to A7CR7. This designates that this diode is part of the Power Supply Assembly, A7.

NOTE

Later Models 410C (Serial Prefix 433 and above) use the 1.5 watt breakdown diode (-hp- Part No. 1902-0327) for increased reliability. It is recommended that earlier models be modified accordingly, in case of failure of the 0.4 watt diode.

CHANGE 5

Under Table of Replaceable Parts:
Delete: Q1; Transistor, PNP Germanium; -hp- Part No. 1850-0098.
Add: Q1; Transistor, PNP Germanium; -hp- Part No. 1850-0094.

NOTE

Later Models 410C (Serial Prefix 433 and above) use the -hp- Part No. 1850-0098 for increased reliability. It is recommended that earlier models be modified accordingly, in case of failure of the earlier type transistor. Refer to -hp- Service Note 410C-3 for modification instructions.

CHANGE 6

Under Table of Replaceable Parts:
Delete: A3R20; Resistor, fixed, 1 kΩ; -hp- Part No. 0687-1021.
Add: A3R20; Resistor, fixed, 10 kΩ; -hp- Part No. 0686-1035.

Figure 5-10, Amplifier Schematic:
Change A3R20 from 1 kΩ to 10 kΩ.

NOTE

Later Models 410C (Serial Prefix 433 and above) use a 1 kΩ resistor for A3R20 to increase the meter zero adjustment (A3R21). It is recommended that earlier models be modified accordingly, in case of zero adjustment problem. Refer to -hp- Service Note 410C-1 for modification instructions.

CHANGE 7

Section VI, Table of Replaceable Parts:
Delete: C2; Capacitor: fxd, 0.1 μF -hp- Part No. 0170-0022.
Add: C2; Capacitor: fxd, 0.1 μF -hp- Part No. 0160-0001.
Add: R6; Resistor: fxd, 284 kΩ -hp- Part No. 0727-0231.
Add: R7, Resistor. fxd, 15 kΩ -hp- Part No. 0727-0168.
Add: R8; Resistor: variable, 10 kΩ -hp- Part No. 2100-1567.
Add: R9; Resistor: fxd, 25.5 kΩ -hp- Part No. 0727-0180.

Figures 3-1, 3-2, 3-3, 3-4, 3-7, 3-8:
Delete:

Figures 4-3, 4-4, 4-5, 4-6:
Delete:

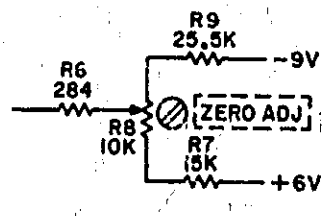
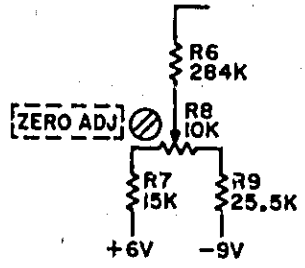


Figure 5-11, Amplifier Schematic:
Delete:



Page 5-1, Paragraph 5-11a:
Short Model 410C DCV probe to COM lead; pointer should read zero. If not, refer to Paragraph 5-33 for adjustment procedure.

Page 5-8, Paragraph 5-34c:
Adjust A3R21 for zero meter deflection.

Page 5-8, Paragraph 5-34c:
Switch to -DCV. If any deflection is observed, adjust A3R21 to return meter pointer halfway back to zero. Check zero setting on all ranges for both +DCV and -DCV. Zero offset shall not exceed 1% in any case.

NOTE

Later Models 410C (Serial Prefix 550 and above) use the ZERO ADJUST on the rear panel for increased accuracy for DC ZERO ADJUSTMENT. It is recommended that earlier models be modified accordingly. Refer to -hp- Service Note 410C-6 for modification instructions.

CHANGE 8

Section VI, Table of Replaceable Parts:
Delete: A3C11; Capacitor: fxd, 100 μF, 25 vdcw -hp- Part No. 0180-0094.
Add: A3C11; Capacitor: fxd, 100 μF, 50 vdcw -hp- Part No. 0180-1819.

NOTE

Later Models 410C (Serial No's. 550 05301 and above use a 50 vdcw capacitor (-hp- Part No. 0180-1819) to ensure that the voltage rating of the capacitor is not exceeded. It is recommended that earlier models be modified accordingly in case of failure of the 25 vdcw capacitor.

CHANGE 9

Section VI, Table of Replaceable Parts:
Delete: A3C1 -hp- Part No. 0160-2641.
A3C2 -hp- Part No. 0160-3116.
Add: A3C1 -hp- Part No. 0170-0030.
A3C2 -hp- Part No. 0170-0077.

CHANGE 10

Figure 5-9, Power Supply Schematic:
Add A7R7, 1100 Ω between anode of A7CR7 and base of Q1.
Change value of A7R8 to 1200 Ω.

Section VI, Table of Replaceable Parts:
Add A7R7 R: fxd met flm 1100 Ω $\pm$ 5% 1/2W -hp- Part No. 0758-0069.
Change A7R8 to 1200 Ω -hp- Part No. 0758-0070.

CHANGE 11

Section VI, Table of Replaceable Parts:
Change F1 to -hp- Part No. 2110-0018.
Change J3 to -hp- Part No. 1251-0148.
Change S1 to -hp- Part No. 3101-0100.
Change S2 to -hp- Part No. 3101-0033.
Change W1 to -hp- Part No. 8120-0078.

The following -hp- Part No's. concern color conversion and apply to earlier "blue" colored instruments. Part No's. for "brown" instruments are listed in Table 6-1.

Panel: Front	410C-2A
Panel: Rear	410C-2C
Cover: Side	5000-0703
Cover: Bottom	5060-0714
Trim: Meter	5020-5388

CHANGE 12

On instruments with Serial No's. 982-12404 and greater, rear panel markings were changed to conform to I.E.C. standards (No. 66), except on 410C-H60 instruments.

CHANGE 13

Section VI, Table of Replaceable Parts:
A3Q1 and Q2 were changed to silicon transistors -hp- Part No. 1853-0020. These parts should be used for all replacement. To modify earlier models, simply replace both Q1 and Q2 with the silicon part.

CHANGE 14

Section VI, Table of Replaceable Parts:
Series Regulator Tstr Q1 was changed to silicon -hp- Part No. 1853-0063. This part should be used for all replacement.

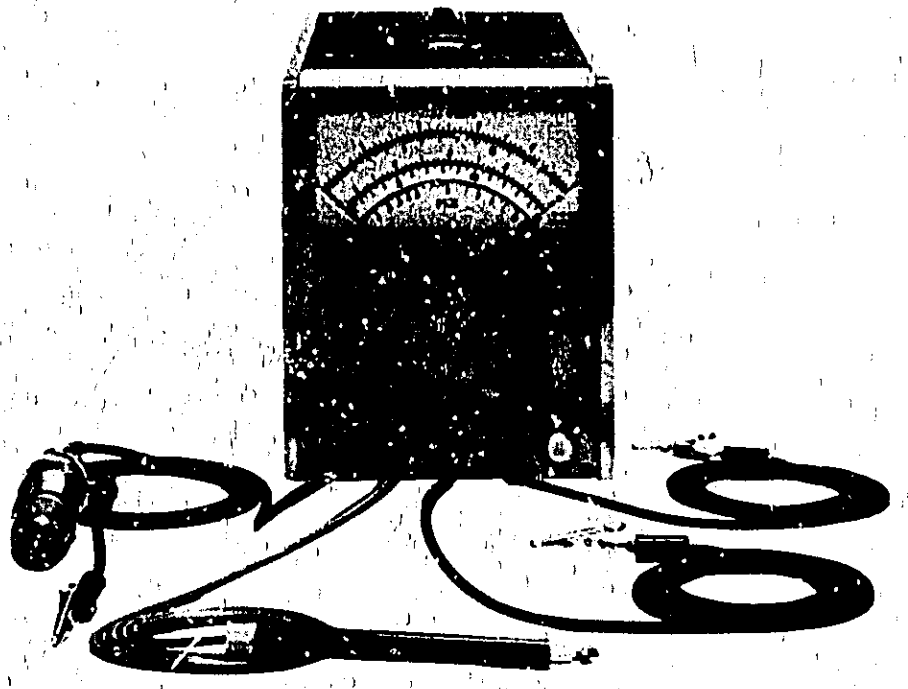
CHANGE 15

Section VI, Table of Replaceable Parts:
A7CR8 is changed to -hp- Part No. 5080-9050. This part no. is a hand selected component and should be used for all replacement.

OPERATING AND SERVICE MANUAL

ELECTRONIC VOLTMETER

410C



HEWLETT PACKARD

410C

HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

MODEL 410C ELECTRONIC VOLTMETER

Serials Numbers: 0982A22339 and Above

NOTICE

For those instruments with serial numbers 0982A22338 and below, refer to Manual Part No. 00410-90007.

WARNING

To help minimize the possibility of electrical fire or shock hazards, do not expose this instrument to rain or excessive moisture.

Manual Part No. 00410-90009

Microfiche Part No. 00410-90059

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

Printed: March 1981

HEWLETT PACKARD

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment [,except that in the case of certain components listed in Section I of this manual, the warranty shall be for the specified period] . During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by -hp-. Buyer shall prepay shipping charges to -hp- and -hp- shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to -hp- from another country.

Hewlett-Packard warrants that its software and firmware designated by -hp- for use with an instrument will execute its programming instructions when properly installed on that instrument. Hewlett-Packard does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HEWLETT-PACKARD SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HEWLETT-PACKARD SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

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

10/1/79

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HEWLETT PACKARD

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

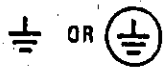
Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

SAFETY SYMBOLS

General Definitions of Safety Symbols Used On Equipment or In Manuals.

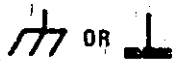
Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.

Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.

Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.



Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current (power line).

Direct current (power line).

Alternating or direct current (power line).

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

NOTE: The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

SECTION 1
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Hewlett-Packard Model 410C Electronic Voltmeter can be used to measure dc voltage, dc current, ac voltage, and resistance. Positive and negative dc voltages from 15 mV to 1500 V full scale and positive and negative dc currents from 1.5 μA to 150 mA full scale can be measured. Resistance from 10 Ω to 10 MΩ mid-scale can be measured with an accuracy of ± 5%; resistance from 0.2 Ω to 500 MΩ can be measured with reduced accuracy. The Model 410C Electronic Voltmeter specifications are given in Table 1-1.

1-3. With the Model 11036A detachable AC Probe, the Voltmeter can be used to measure ac voltage from 20 Hz to 700 MHz. AC Voltages from 0.5 to 300 V can be measured in the 20 Hz to 100 MHz range. Refer to Figure 1-5 for maximum voltage that can be applied to the AC Probe for the 100 MHz to 700 MHz range. For additional information on the AC Probe, refer to Paragraph 1-9.

1-4. INSTRUMENT AND MANUAL IDENTIFICATION.

1-5. Hewlett-Packard uses a two-section serial number consisting of a digit prefix and a five-digit suffix. The prefix and suffix are separated by a letter designating the country in which the instrument was manufactured. (A = U.S.A.; G = Germany; J = Japan; U = United Kingdom.)

1-6. This manual applies to instruments with the serial prefix indicated on the title page. If changes have been made in the instrument since the printing of this manual, a "Manual Changes" supplement supplied with the manual will define these changes. Be sure to record these changes in your manual. Backdating information located in Appendix C adapts the manual to instruments manufactured prior to this printing. The manual part number is indicated on the title page.

1-7. ACCESSORIES AVAILABLE.

1-8. Accessories are available that extend the ac and dc measuring capabilities of the Voltmeter. A description of these accessories and their specifications is given below.

1-9. Model 11036A AC Probe.

1-10. This accessory, when used with the Model 410C, permits ac voltage measurements over a frequency range of 20 Hz to 700 MHz. Refer to Figure 3-5 for the maximum RMS voltages that can be applied to the A... probe in this frequency range. Reference calibration accuracy at 400 Hz (sinusoidal) is ± 3% of full scale. Frequency response is ± 10% from 20 Hz to 700 MHz, with indications obtainable to 3000 MHz. Frequency response at 100 MHz is within ± 2%. The Model 11036A responds to the positive-peak-above-average value of the signal applied. The Model 410C is calibrated to read in RMS volts, for sine wave inputs.

1-11. Model 11040A Capacity Divider.

1-12. This accessory (formerly the Model 453A) extends the ac voltage range of the Voltmeter to 2000 V rms. The divider is for use at frequencies above 10 kHz. Voltage division is 100:1 ± 1%, and input capacity is approximately 2 pF.

1-13. Model 11042A Probe T Connector.

1-14. This accessory (formerly the Model 455A) is used for connecting the Model 11036A Probe across a 50 Ω transmission line using type N connectors. The T joint is such that connection of the probe into a transmission line will not cause a standing wave ratio greater than 1.1 at 500 MHz and 1.2 at 1000 MHz. With this device, measurement of power traveling through a transmission line may be made with reasonable accuracy to 1000 MHz. The usual precautions must be taken to provide accurate impedance matching and the elimination of standing waves along the line through which power is floating. By using a dummy load at the receiving end of this T joint power output of various devices can be measured. In many applications power going into a real load, such as an antenna, can be conveniently measured up to 1000 MHz with good accuracy.

1-15. Model 11043A Type N Connector.

1-16. This accessory (formerly the Model 458A) allows the AC Probe to be connected to a 50 Ω coaxial line. The connector uses a male type N connector and a receptacle for receiving the probe. Terminating resistor is not included.

1-17. Model 11045A DC Divider.

1-18. This accessory extends the maximum dc voltage range of the Model 410C to 30 kV. Voltage division is 100:1, ± 5%, and input resistance is 9900 MΩ. When

used with the Model 410C input resistance is 10,000 MΩ. This probe offers maximum safety and convenience for measuring high voltages such as in television equipment, etc. The maximum current drain is 2.5 μA.

Table 1-1. Specifications.

DC VOLTMETER

Voltage Ranges: 15 mV to ± 1500 V full scale in 0.5, 1.5, 5 sequence (11 ranges).

Accuracy: ± 2% of full scale on any range.

Input Resistance: 100 MΩ ± 1% of 500 mV range and above. 10 MΩ ± 3% on 15 mV, 50 mV, and 150 mV ranges.

DC AMMETER

Current Ranges: ± 1.5 μA to ± 150 mA full scale in 1.5, 5 sequence (11 ranges).

Accuracy: ± 3% of full scale on any range.

Input Resistance: Decreasing from 9 kΩ on 1.5 μA scale to approximately 0.3 Ω on the 150 mA scale.

Special Current Ranges: ± 1.5, ± 5, ± 15 nanoamps may be measured on the 15, 50, and 150 millivolt ranges using the voltmeter probe, with ± 5% accuracy and 10 MΩ input resistance.

OHMMETER

Resistance Range: Resistance from 10 Ω to 10 MΩ center scale (7 ranges).

Accuracy: Zero to midscale: ± 5% of reading or ± 2% of midscale, whichever is greater.
± 7% of reading from midscale value of 2.
± 8% of reading from scale value of 2 to 3.
± 9% of reading from scale value of 3 to 5.
± 10% of reading from scale value of 5 to 10.

AMPLIFIER

Voltage Gain: 100 maximum.

AC Rejection: 3 dB at ½ Hz; approximately 66 dB at 60 Hz and higher frequencies for signals less than 1600 V peak or 30 times full scale, whichever is smaller.

Isolation: Impedance between common and chassis is > 10 MΩ in parallel with 0.1 μF. Common maybe floated up to 400 V dc above chassis for dc and resistance measurements.

Output: Proportional to meter indication; 1.5 V dc at full scale, maximum current, 1 mA.

Output Impedance: Less than 3 Ω at dc.

Noise: Less than 0.5% of full scale on any range (p - p).

DC Drift: Less than 0.5% of full scale/year at constant temperature. Less than .05% of full scale/°C.

Overload Recovery: Recover from 100:1 overload in < 3 sec.

AC VOLTMETER

Ranges: 0.5 V full scale to 300 V in 0.5, 1.5, 5 sequence (7 ranges).

Accuracy: ± 3% of full scale at 400 Hz for sinusoidal voltages from 0.5 to 300 V rms. The AC Probe responds to the positive peak-above-average value of the applied signal.

Frequency Response: ± 2% from 100 Hz to 50 MHz (400 Hz ref.), ± 4% from 50 MHz to 100 MHz ± 10% from 20 Hz to 100 Hz and ± 1.5 dB from 100 MHz to to 700 MHz.

Frequency Range: 20 Hz to 700 MHz.

Input Impedance: Input capacity 1.5 pF, input resistance > 10 MΩ at low frequencies. At high frequencies impedance drops off due to dielectric loss.

Safety: The probe body is grounded to chassis in the AC Function for safety. All ac measurements are referenced to chassis ground.

Meter: Individually calibrated taut band meter. Responds to positive peak-above-average. Calibrated in rms volts for sine wave input.

GENERAL

Maximum Input: (see Overload Recovery)
DC: 100 V on 15, 50 and 150 mV ranges; 500 V on 0.5 to 15 V ranges; 1600 V on higher ranges.
AC: 100 times full scale or 450 V peak, whichever is less.

Power: 115 or 230 V ± 10%, 48 to 440 Hz, 10 watts (17 watts with 11036A AC Probe).

Dimensions: 6½ in. high (16.5 cm); 5 1/8 in. wide (13.01 cm); 11 in. deep (27.9 cm) behind panel. Fits 5060-0797 Rack Adapter and 1050 series combining cases.

Weight:
Net: 7.5 lbs. (3.4 kg)
Shipping: approximately 14.5 lbs. (6.58 kg)

Accessories Furnished: Detachable power cord, NEMA plug; -hp- Model 11036A AC Probe.

Option 002: -hp- Model 410C less AC Probe.

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, check for supplied accessories, and test the electrical performance of the instrument using the procedure outlined in Paragraph 5-5, Performance Tests. If there is damage or deficiency, see the warranty on the page following the title page of this manual.

2-3. INSTALLATION.

2-4. The -hp- Model 410C is solid state and requires no special cooling. However, the instrument should not be operated where the ambient temperature exceeds 55°C (140°F).

2-5. RACK MOUNTING.

2-6. The Model 410C is a submodular unit designed for bench use. However, when used in combination with other submodular units, it can be bench and/or rack mounted. The -hp- Combining Cases and Adapter Frame are designed specifically for this purpose.

2-7. Models 1051A and 1052A Combining Cases.

2-8. The Combining Cases are full-module units which accept various combinations of submodular units. Being a full width unit, it can either be bench or rack mounted. An illustration of the Combining Case is shown in Figure 2-1. Instructions for installing the Model 410C are shown in Figure 2-2.

2-9. Rack Adapter Frame (-hp- Part Number 5060-8762).

2-10. The adapter frame is a rack mounting frame that accepts various combinations of submodular units. It can be rack mounted only. An illustration of the adapter frame is given in Figure 2-3. Instructions are given below.

a. Place the adapter frame on edge of bench as shown in step 1, Figure 2-4.

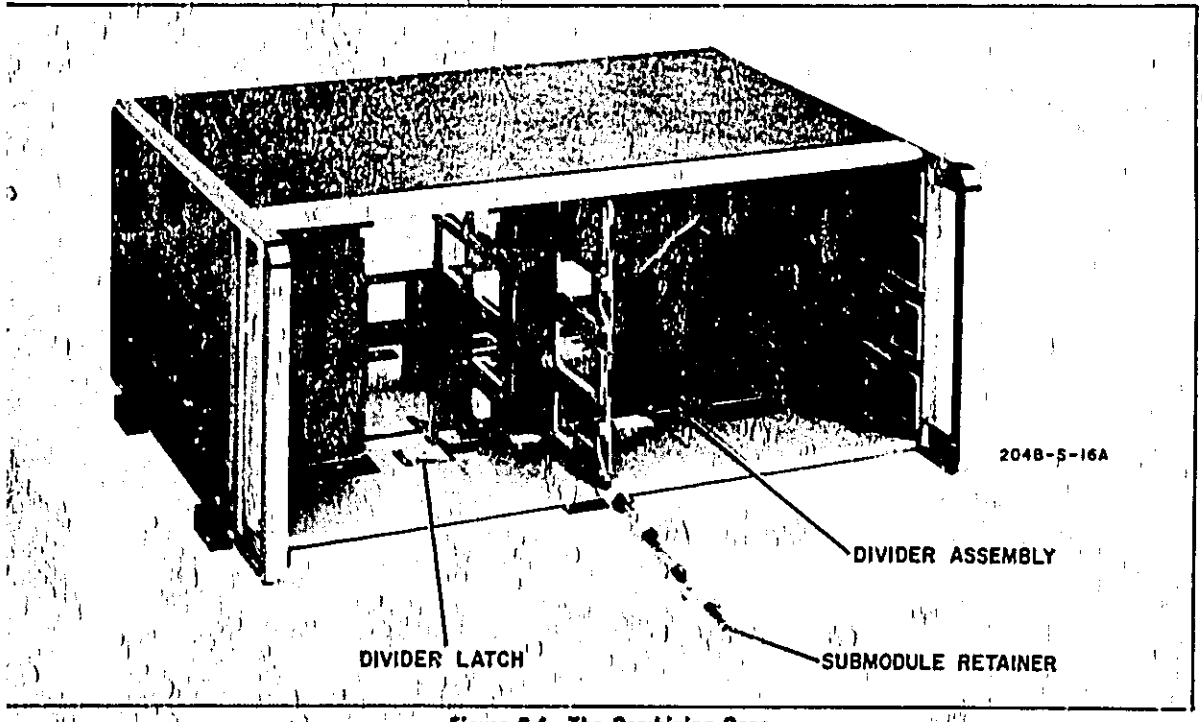


Figure 2-1. The Combining Case.

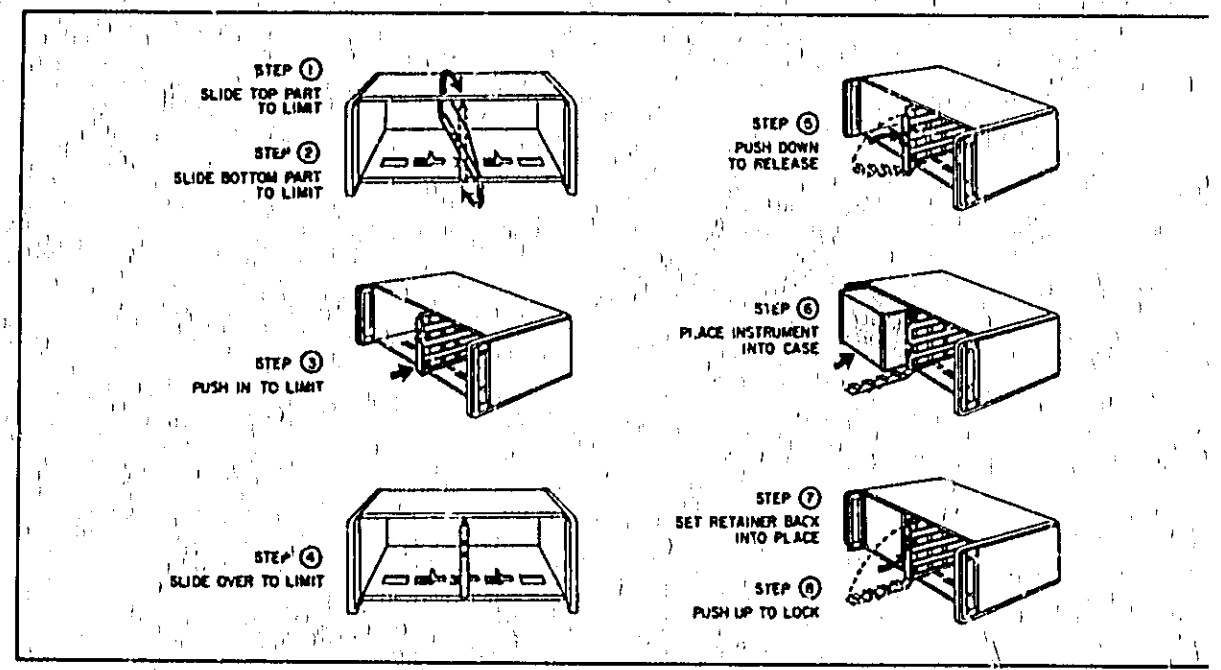


Figure 2-2. Steps to Place Instrument in Combining Case.

b. Stack the submodular units in the frame as shown in step 2, Figure 2-4. Place the spacer clamps between instruments as shown in step 3., Figure 2-4.

c. Place spacer clamps on the two end instruments (see step 4, Figure 2-4) and push the combination into the frame.

d. Insert screws on either side of frame, and tighten until submodular instruments are tight in the frame.

e. The complete assembly is ready for rack mounting.

2-11. THREE-CONDUCTOR POWER CABLE.

WARNING

To protect operating personnel from electric shock, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument panel and cabinet be grounded. All Hewlett-Packard instruments are equipped with a three conductor power cable which grounds the instrument when plugged into an appropriate receptacle.

2-12. To preserve the protection feature when operating the instrument from a two-contact outlet, use three-prong to two-prong adapter and connect the green pigtail on the adapter to an adequate ground.

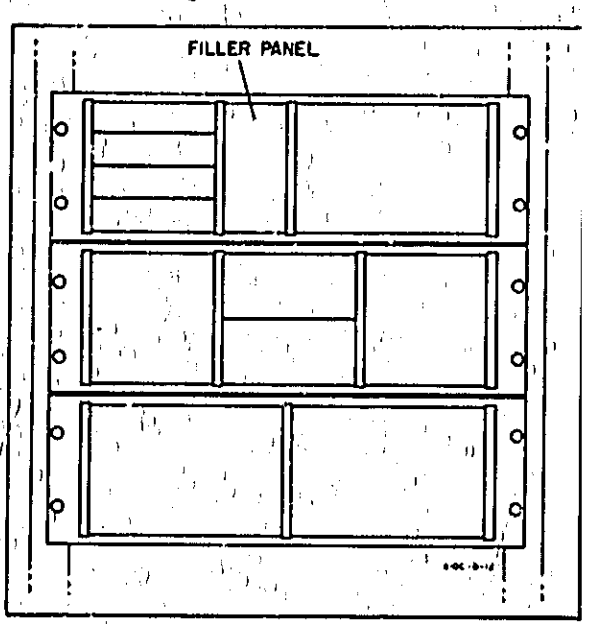


Figure 2-3. Adapter Frame Instrument Combination.

2-13. PRIMARY POWER REQUIREMENTS.

2-14. The Model 410C can be operated from either 115 or 230 V, 48 to 440 Hz. The instrument can be easily converted from 115 to 230 V operation. The SELECTOR switch, S2 a two-position slide switch located at the rear of the instrument, selects the mode of ac operation. The line voltage from which the instrument is set

o operate appears on the slider of the switch. A 0.25 ampere, slo-blo fuse is used for both 115 and 230 V operation.

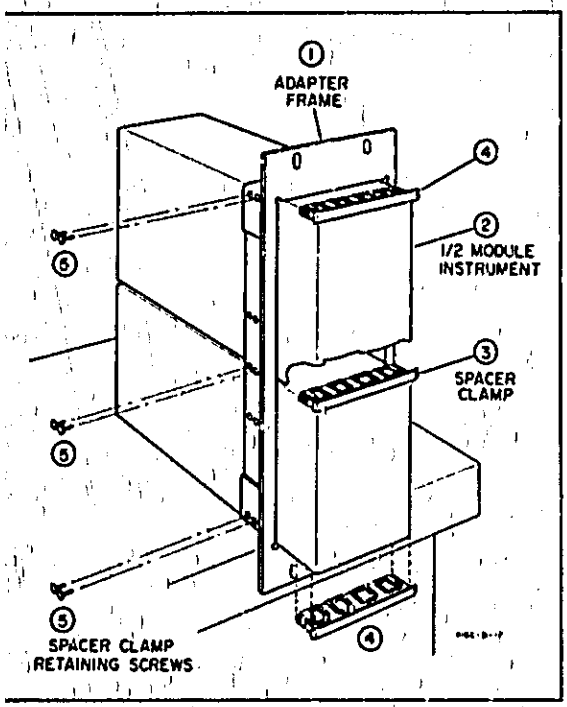


Figure 2-4. Two Half Modules in Rack Adapter.

CAUTION

Do not change the setting of the line voltage switch when the voltmeter is operating.

2-15. Repacking for Shipment.

2-16. The following paragraphs contain a general guide for repackaging of the instrument for shipment. Refer to Paragraph 2-17 if the original container is to be used; 2-18 if it is not. If you have any questions, contact your local -hp- Sales and Service Office (See Appendix B for office locations.)

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 indicate the service or repair to be performed; include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number, serial number and serial number prefix.

2-17. If the original container is to be used, proceed as follows:

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

b. Ensure that container is well sealed with strong tape or metal bands.

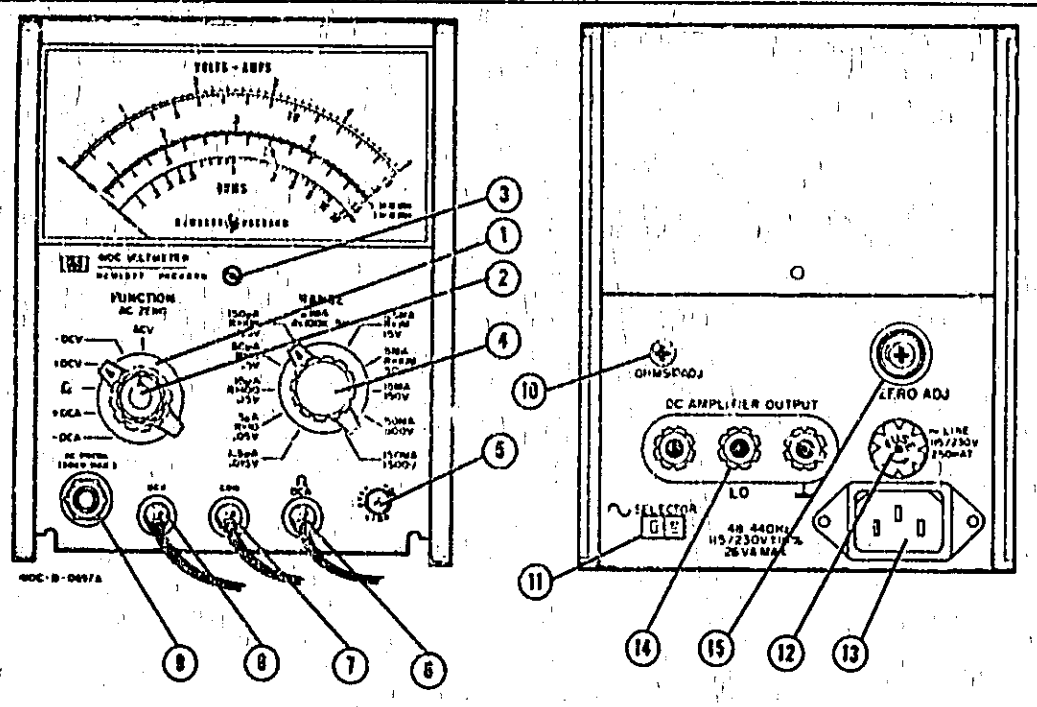
2-18. If original container is not to be used, proceed as follows:

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

b. Place packing material around all sides of instrument and protect panel face with cardboard strips.

c. Place instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

d. Mark shipping container with "DELICATE INSTRUMENT," "FRAGILE," etc.



(1) FUNCTION SELECTOR: This control is used for selecting type of measurement to be made. There are: ± DC Voltage, ± DC Current, AC Voltage, and resistance measurements.

(2) AC ZERO: This control provides adjustment for zero-setting the meter before making ac voltage measurements.

(3) MECHANICAL ZERO ADJUST: This adjustment mechanically zero-sets the meter prior to turning on Voltmeter.

(4) RANGE: This control selects the full scale meter range.

(5) AC POWER SWITCH: This pushbutton-lamp combination, when depressed, turns the instrument power on or off. The pushbutton glows when the Voltmeter power is on.

(6) DCA-OHMS: This lead is used in conjunction with the COM Lead to measure dc current or ohms. The FUNCTION SELECTOR determines which measurement is made.

(7) COM: This lead is used with the input leads for dc current, dc voltage, and resistance measurements. The COM Lead is normally floating; however, a shorting bar can be connected from the floating ground terminal to the chassis ground terminal on the DC AMPLIFIER OUTPUT connector. If a shorting bar is not used, the COM Lead is floating except when the FUNCTION SELECTOR is set to ACV.

(8) DCV: This lead is used in conjunction with the COM Lead to measure ± dc voltage.

(9) AC PROBE (300 V MAX): Receptacle for telephone-type plug of Model 11036A AC Probe. With probe connected, the Voltmeter may be used to make ac voltage measurements.

(10) ∝ ADJUST: This control is used to set meter pointer to ∝ before resistance measurements are made. Only periodic adjustment of this screwdriver adjustment is necessary.

(11) LINE VOLTAGE: This two-position slide switch sets the instrument to accept either 115 or 230 V ac primary power.

(12) FUSEHOLDER: The fuseholder contains a 0.25 ampere slow-blow fuse for both 115 V ac and 230 V ac modes of operation.

(13) AC POWER CONNECTOR: Accepts power cable supplied with the instrument.

(14) DC AMPLIFIER OUTPUT: Provides dc voltage output proportional to meter indication for driving external recorder. 1.5V dc output for full scale meter deflection.

(15) ZERO ADJUST: This control is used to set meter pointer to zero when calibrating for dc and resistance measurements.

NOTE

In some older 410C's there is no "zero adjust pot". It is however possible, to use pot A3R6 (see Figures 5-4 and 5-5) to set the meter pointer to zero. Pot A3R6 is located close to the top cover of the instrument and can be accessed with a small screwdriver. This note is only applicable if the new amplifier board 00410-66502 is retrofitted in an older 410C.

Figure 3-1. Front and Rear Panel Controls.

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section presents operating instructions for using the -hp- Model 410C Analog Voltmeter. Refer to Figure 3-1 for the following discussion.

3-3. The 410C is capable of measuring dc voltages up to 1500 V dc, dc currents to 150 mA, and resistances up to 10 M (center of scale). Also, ac voltages of up to 300 V ac can be measured by using the 11036A AC PROBE.

3-4. FRONT AND REAR PANEL DESCRIPTION.

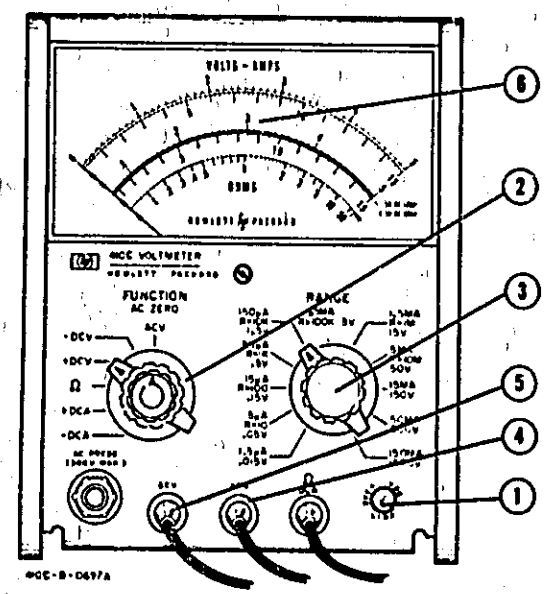
3-5. Figure 3-1 contains a brief description and a location layout of the front and rear panel controls and connectors.

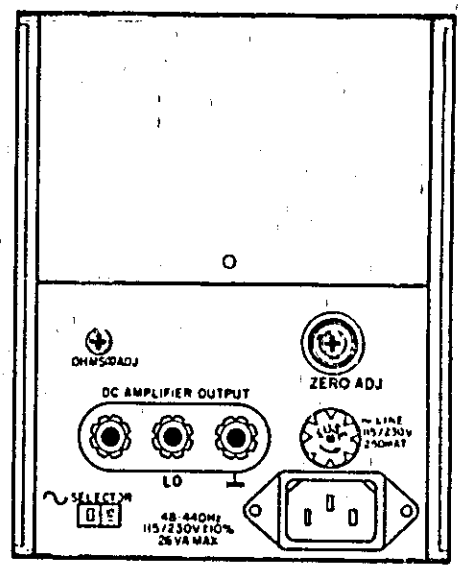
3-6. OPERATING PROCEDURES.

3-7. Before operating the 410C from the AC line verify that the line voltage selector switch, located on the rear panel of the instrument, is matched to the line voltage being used. Proceed to apply power. Turn the instrument on by depressing the ac power switch. The ac power switch will glow internally when the voltmeter power is on. If ac voltage measurements are to be made, plug the Model 11036A AC PROBE assembly into the AC PROBE receptacle (instrument front panel) and allow a minimum of five minutes warmup time.

3-8. DC Voltage Measurements.

3-9. Instructions for measuring dc voltages are given in Figure 3-2.





(1) Depress the AC power switch (lamp - switch combination).

(2) Set FUNCTION SELECTOR to polarity desired (+ DCV or -DCV).

(3) Set RANGE to desired voltage position.

(4) Connect COM Lead to the ground of circuit under test.

(5) Touch DCV probe to test point.

(6) Read voltage on the appropriate VOLTS-AMPS scale.

Figure 3-2. DC Voltage Measurements.

CAUTION

The COM lead of the Model 410C is normally floating. A shorting bar can be connected at the DC AMPLIFIER OUTPUT connector, on the instrument back panel, to connect the COM lead to earth ground. If the 410C is allowed to float, the COM lead must not be connected to voltages greater than 400 V dc.

3-10. DC Current Measurements.

3-11. General instructions for measuring dc current are given in Figure 3-3.

3-12. Measuring DC Nano-Ampere Currents.

3-13. The three most sensitive dc voltage measurement ranges may be used to measure dc nano-ampere currents. Figure 3-4 describes this operation.

3-14. Resistance Measurements.

3-15. The procedure for making resistance measurements is given in Figure 3-5.

3-16. Before making in-circuit resistance measurements be certain that power has been removed from the circuit under test. All capacitors should be discharged to eliminate residual voltages.

3-17. AC Voltage Measurements (Figure 3-6).

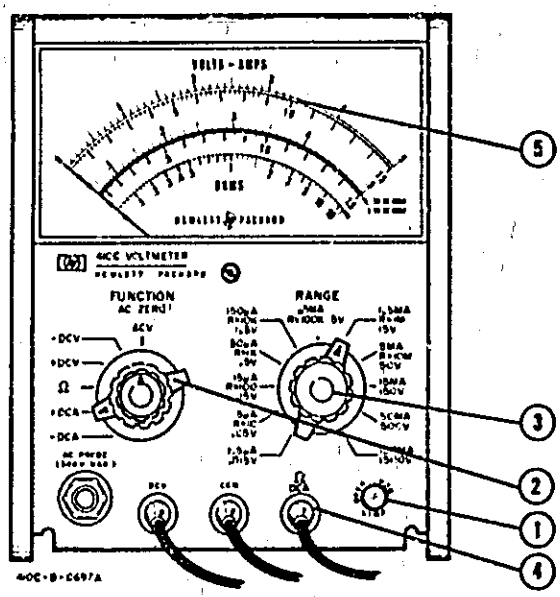
CAUTION

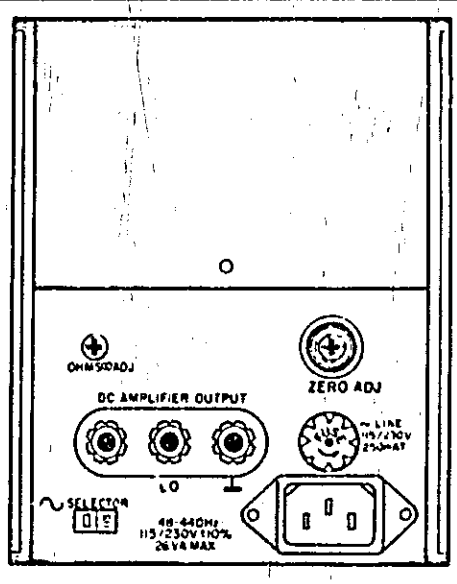
One side of almost all power distribution systems is grounded. Extreme caution must be used if direct measurement of power line voltages is attempted. If the ground clip lead is accidentally connected to the ungrounded side of the line, severe damage to the 410C is possible because of the short circuit created. Power line voltages can best be measured by using the probe tip only. Contacting the grounded power conductor will give a reading of 0 V while contacting the ungrounded lead will give full voltage reading.

3-18. Although the Model 410C indicates a full scale ac range of 500 V, the optional Model 11036A AC Probe should not be connected to ac voltages in excess of 300 V rms. AC voltage referenced to a dc voltage may be measured, but the AC Probe clip (alligator type) must be connected to the ground (⏚) of the circuit under test.

CAUTION

When measuring ac referenced to dc, the peak ac voltage plus dc voltage connected to the probe must not exceed 420 V.





(1) Depress the AC power switch (lamp-switch combination).

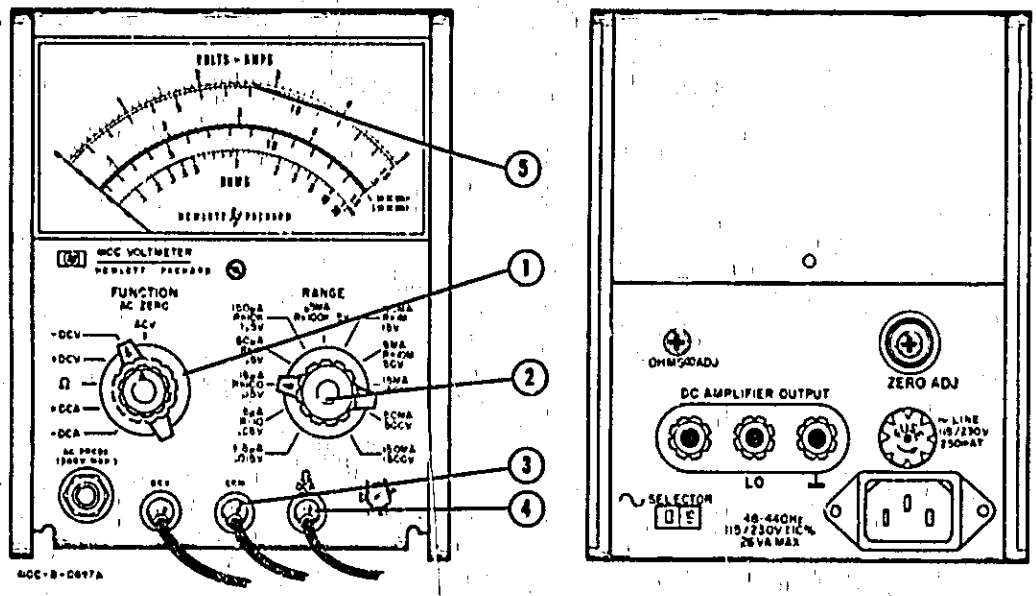
(2) Set FUNCTION SELECTOR to the polarity desired (+ DCA or - DCA).

(3) Set RANGE to desired current position.

(4) Connect the COM lead and the DCA/ohms probe in series with the circuit under test.

(5) Read the current on the VOLTS-AMPS scale.

Figure 3-3. DC Current Measurements.



(1) Set the FUNCTION SELECTOR to +DCV or -DCV (depending on direction of current flow).

(2) Set RANGE to desired range (0.015 V, 0.05 V, or 0.15V range).

NOTE

0.015 V range = 1.5 nano-amperes range
0.05 V range = 5.0 nano-amperes range
0.15 V range = 15 nano-amperes range

(3) Connect the DCV lead to the circuit under test.

(4) Connect the COM lead to the circuit under test.

(5) Read non-amperes from the meter on the VOLTS-AMPS scale (top two on meter) which corresponds to the range selected.

Figure 3-4. DC Nano-Ampere Current Measurements.

3-19. Precautions When Measuring AC Voltage.

3-20. Special considerations must be kept in mind when making ac voltage measurements. These considerations are discussed in the following paragraphs.

3-21. **General Consideration of Complex Waveforms.** Waveforms containing appreciable harmonics or spurious voltages will introduce error in the meter indication since the meter has been calibrated to read rms values of true sine waves while the Model 11036A Probe is a peak-above-average responding device. The magnitude of error that may be expected when harmonics are present on the measured waveform is indicated in Table 3-1.

Table 3-1. Possible Error when Measuring Voltage of Complex Waveforms.

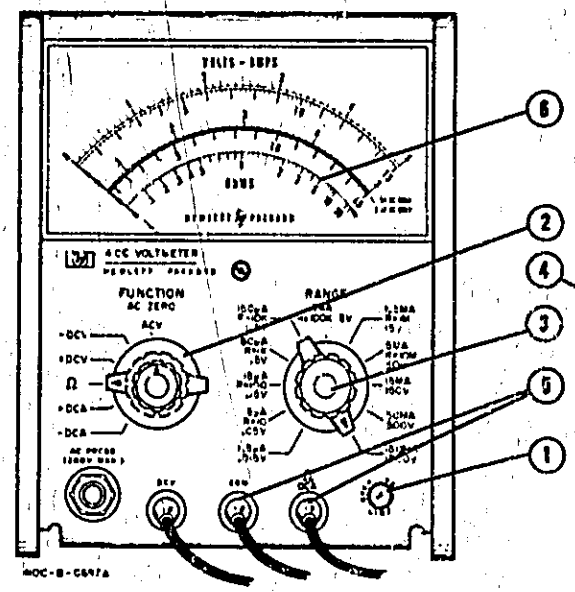
Harmonic	True RMS Value	Voltmeter Indicator
0	100	100
10% 2nd	100.5	90 to 110
20% 2nd	102	80 to 120
50% 2nd	112	75 to 150
10% 3rd	100.5	90 to 110
20% 3rd	102	87 to 120
50% 3rd	112	108 to 150

3-22. **Voltage Measurements at Frequencies Below 50 Hertz.** Voltage measurements at frequencies as low as 20 Hz may be made without loss of accuracy by removing the plastic probe head of the Model 11036A and using in its place a 0.25 μF blocking capacitor in series with the exposed contact of the probe.

CAUTION

The gray insulating material around the AC Probe is polystyrene, a low-melting point material. It is possible to solder to the contact which is exposed with the probe nose removed without destroying the polystyrene.

3-23. **Voltage Measurement at High Frequencies.** At frequencies above 100 MHz the distance between the point of voltage measurement and anode of the probe diode must be made as short as possible. If feasible, substitute a small disc type capacitor of approximately 50 pF for the removable tip on the probe. Solder one terminal of the button capacitor to the measurement point in the circuit and not to the probe contact. The probe contact (with tip removed) can then contact the other terminal of the capacitor for the measurement.



Before making resistance measurements, remove power from circuit to be tested. Be sure to discharge capacitors to eliminate any residual voltage.

1. Depress AC power switch (lamp-switch combination).
2. Set the FUNCTION SELECTOR to OHMS.
3. Set RANGE to desired position.
4. Adjust OHMS ∞ ADJ. control on rear panel to obtain an ∞ reading on the meter if necessary.
5. Connect COM and DCA OHMS leads across the circuit component to be tested.
6. Resistance is determined by multiplying the reading on the OHMS scale by the RANGE factor. EXAMPLE: If reading is 1.5 and factor is 10 K, then resistance equals 15kΩ.

Figure 3-5. Resistance Measurements.

3-24. At frequencies above 100 MHz considerable voltage may be built up across ground leads and along various parts of a grounding plane. Consequently, to avoid erroneous readings when measuring medium and high frequency circuits, use the ground clip lead on the shell of the probe to connect the circuit ground. In some cases at the higher frequencies it may be necessary to shorten the grounding lead on the probe.

3-25. For all measurements at higher frequencies, hold the molded nose of the probe as far from the external ground place or from object at ground potential as can conveniently be done. Under typical conditions, this practice will keep the input capacitance several tenths of a pF lower than otherwise.

3-26. For measurements above approximately 250 MHz it is almost mandatory that measurements be made on voltages which are confined to coaxial transmission line circuits. For applications of this type, the Model 11036A Probe is particularly suitable because the physical configuration of the diode and probe is that of a concentric line, and with a few precautions it can be connected to typical coaxial transmission line circuit with little difficulty.

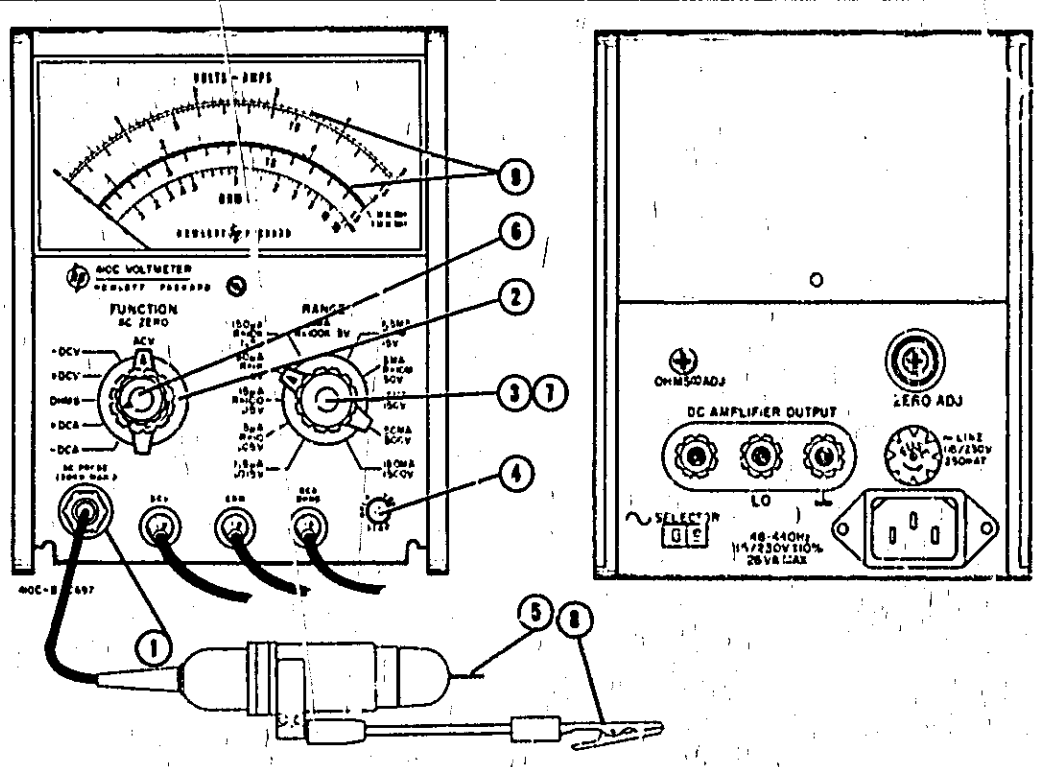
3-27. To connect the probe into an existing coaxial transmission line, cut the line away so the center conductor of the line is exposed through a hole large enough to clear the body of the probe. The nose of the probe should be removed for this type of measurement. Connect one terminal of a button-type capacitor of approximately 50 pF to the center conductor of the coaxial line so that the other terminal of the capacitor will contact the anode connection of the probe. A close-fitting metal shield or bushing should be arranged to ground the outer cylinder of the probe to the outer conductor of the transmission line. This type of connection is likely to cause some increase in the standing wave ratio of the line at higher frequencies. The Model 11042A Probe T Connector is designed to do this job with SWR of less than 1.1 at 500 MHz (see Paragraph 1-13).

3-28. **Effect of Parasitics on Voltage Readings.** At frequencies above 500 MHz leads or portions of circuits often resonate at frequencies two, three, or four times the fundamental of the voltage being measured. These harmonics may cause serious errors in the meter reading. Owing to the resonant rise in the probe circuit at frequencies above 1000 MHz, the meter may be more sensitive to the harmonics than to the fundamental. To make dependable measurements at these frequencies, the circuits being measured must be free of all parasitics.

3-29. Effect of DC Present with AC Signal. When measuring an ac signal at a point where there is a high dc potential, such as at the plate of a vacuum tube, the high dc potential may cause small leakage current through the blocking capacitor in the tip of the Model 11036A AC Probe. When the ac signal under measurement is small, the error introduced into the reading can be significant. To avoid leakage, an additional capacitor with a dielectric such as mylar or polystyrene which has high resistance to leakage is required. (Use 5 pF or higher, and insert the capacitor between the point of measurement and the probe tip).

3-30. Pulse Measurements.

3-31. Positive Pulses. The Model 11036A AC Probe is peak-above-average responding and clamps the positive peak value of the applied voltage. This permits the



CAUTION

Connect AC ground clip and COM Lead to earth ground only when in AC FUNCTION.

1. Connect the -hp- Model 11036A AC Probe to the Model 410C at the AC PROBE receptacle.
2. Set FUNCTION SELECTOR to ACV. NOTE: COM and chassis are internally connected when the FUNCTION SELECTOR is set to ACV.
3. Set RANGE to 0.5 V.
4. Depress the AC power button (lamp-switch combination) and allow 5 minute warmup.
5. Short AC Probe Tip with Ground Clip.
6. Adjust AC ZERO for a zero indication on the meter.
7. Set RANGE to the desired voltage range.
8. Connect AC Probe clip (alligator) to ground of circuit to be tested, and touch probe tip to test point. At lower frequencies COM Lead can be substituted for the AC Probe clip.

CAUTION

Before measuring voltages at frequencies above 100 MHz, refer to Figure 3-7 to determine the maximum amount of voltage that can be applied at that frequency.

9. Read ac voltage on the VOLTS-AMPS scale. NOTE: When RANGE is on the 0.5 V and 1.5 V positions, use red meter scale.

Figure 3-6. AC Voltage Measurements.

probe to be used to measure the positive voltage amplitude of a pulse, provided the reading is multiplied by a factor determined from the following expression:

$$1.4\left(1+\frac{t_1}{t_2}+\frac{K}{PRF}\right)$$

t_1 is the duration of the positive portion of the voltage in microseconds.

t_2 is the duration of the negative portion of the voltage in microseconds.

K is a factor determined from the expression R_O/t_1 and the graph shown in Figure 3-8, where R_O is the source impedance of the pulse generator in kilohms, and t_1 is the duration of the positive portion of the pulse in microseconds.

PRF is the pulse repetition frequency in pulses per second (pps).

Suppose for example:

t_1 = 10 microseconds
t_2 = 990 microseconds
K = 0.45
PRF = 1000 pps

To find K, assuming R_O = 2 kΩ and t_1 = 10 microseconds: $R_O/t_1 = 2/10 = 0.2$. Locate 0.2 on the X axis of the graph shown as Figure 3-8, and read K where X and Y axes intersect the unmarked curve. If the ratio of R_O/t_1 were greater than 1, you would multiply the X and Y axes by 10, and use the curve marked "R_O/t_1 and K each X10."

Solving the expression for the multiplying factor.

$$1.4\left(1+\frac{10}{990}+\frac{0.45}{1000}\right)$$

$$1.4\ (1 + 0.01 + 0.00045) =$$

$$1.4\ (1.01045) = 1.41463$$

3-32. Negative Pulses.

3-33. In the case of a 10 microsecond negative pulse (t_2) and a pulse repetition frequency (PRF) of 1000 pps, t_1 would be 990 microseconds. Thus R_O/t_1 would be approximately 0, and from the graph it is seen that K is approximately 0. The expression would then reduce to

$$1.4\left(1+\frac{990}{10}\right)$$

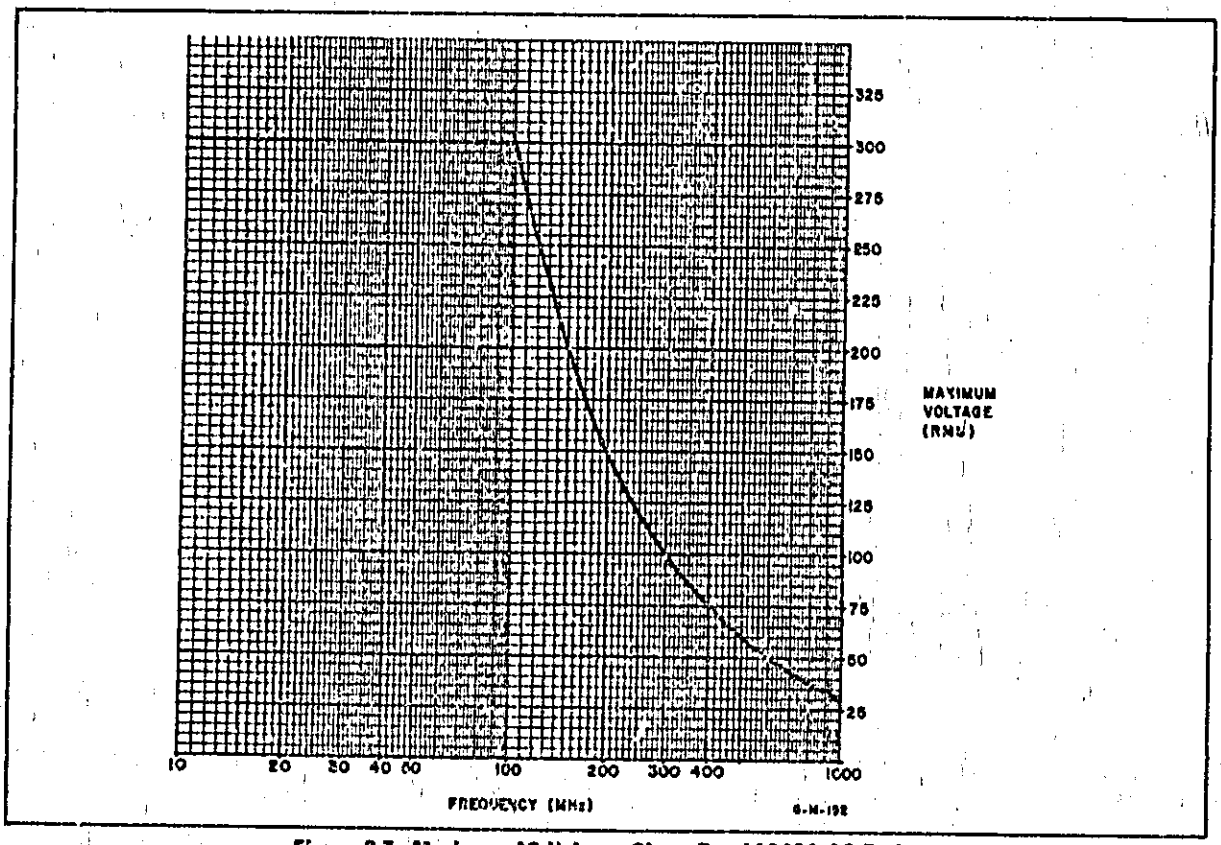


Figure 3-7. Maximum AC Voltage Chart For 11038A AC Probe.

3-34. It can be seen that in the case of negative pulses of short duration much smaller readings will be obtained for an equivalent positive pulse. As a result, large multiplying factors must be used and unless the pulse voltage is large, these measurements may be impractical.

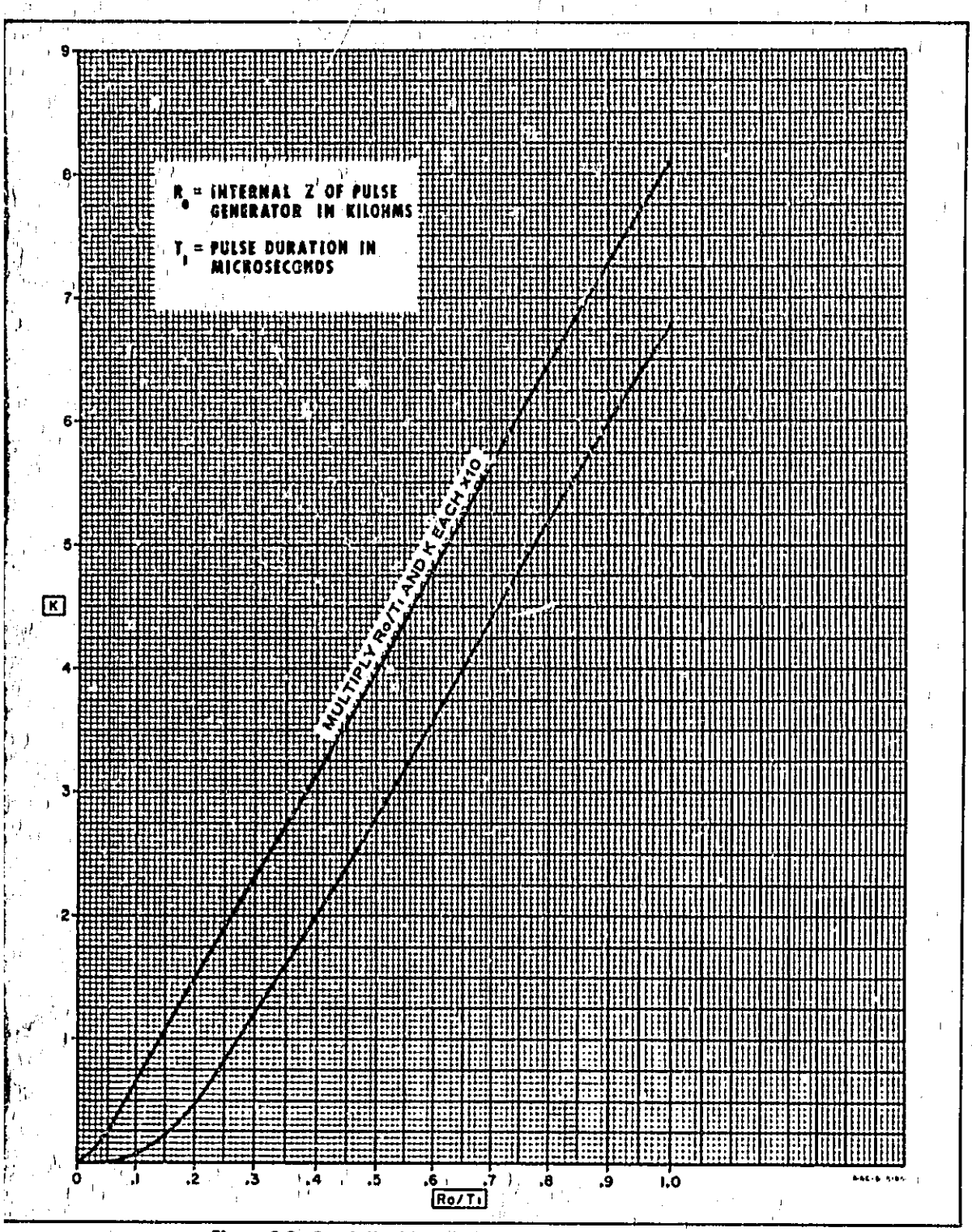


Figure 3-8. Graph Used In Calculations Of Pulse Voltage Readings.

SECTION IV

THEORY OF OPERATION

4-1. GENERAL DESCRIPTION (FIGURE 4-1).

4-2. The -hp- Model 410C Analog Voltmeter is comprised of four basic blocks: (1) the Input Switching and Attenuator Network, (2) a FET Input Amplifier, (3) Meter and Feedback circuit, and (4) the Power Supply. Figure 4-1 is a basic block diagram of the Model 410C.

4-3. The signal inputs to the Input Switching and Attenuator Network are made through the appropriate input leads. AC voltages are rectified in the AC Probe, therefore all signals applied to the input network are dc. The input network attenuates the dc signal to a level determined by the RANGE and FUNCTION SELECTOR settings. The attenuated dc voltage is amplified to provide drive for the meter circuit. The output of the amplifier is a dc voltage proportional to the amplitude of the signal being measured. This output is also available on the instrument's back panel DC AMPLIFIER OUTPUT connector. A portion of the meter circuit voltage is returned to the amplifier as feedback. The gain of the amplifier is therefore determined by the feedback circuit.

4-4. CIRCUIT DESCRIPTION.

4-5. Input Switching and Attenuator.

4-6. The input network accurately attenuates the input voltage to a maximum of 15 mV at the amplifier input. This input network (resistors A3R30, A2R4, and A2R10 through A2R26) in conjunction with R1 (located in the DCV probe) presents an input impedance of 10 megohms on the three most sensitive ranges (DCV) and 100 megohms on the eight less sensitive ranges. (DCV and ACV).

4-7. Amplifier (Figure 5-8).

4-8. The amplifier in the Model 410C consists of a FET differential pair (Q1) and a low drift op amp (U1). The FET input circuit ensures that the input impedance of the amplifier is approximately 10^{12} ohms. The amplifier operates in the non-inverting mode with the feedback network (connected to inverting input) setting the gain of the amplifier (see Figure 4-1). The output of the amplifier drives meter M1 and is also applied to the DC AMPLIFIER OUTPUT connector (J2) located on the instrument's back panel.

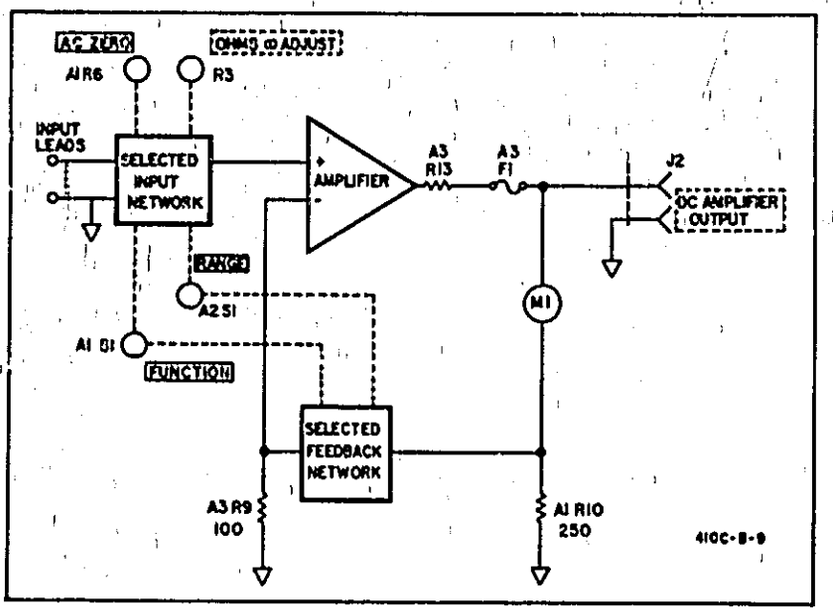


Figure 4-1. Block Diagram, Model 410C.

4-9. The input circuit protection diodes, CR1 and CR2, will conduct if too high a voltage is applied to the terminals for the selected range. Variable resistor A3R6 is the amplifier's DC Zero adjustment pot (see Paragraph 5-32). Variable resistor A3R12 is used during calibration to adjust the current to the input FET stage (see Paragraph 5-30).

4-10. The power supply voltages appearing at pins 8, 10, 13, and 15 are not used with the FET/op amp A3 Amplifier assembly (00410-66502). These voltages are required if the older Modulator/Demodulator A3 assembly is used (410C-65A). Resistor R18 is a dummy load for the +6 volts that was used for the vacuum tube filament on the 410C-65A board.

4-11. **DC Current Measurements (Figure 5-13).** The purpose of the input network is to provide proper attenation of currents applied. Currents from 1.5 μA to 150mA full scale are applied with input impedance decreasing from 9 kΩ on the 1.5 μA range to approximately 0.3 Ω on the 150 mA range.

4-12. The change in input impedance is varied by using dc current shunts in conjunction with RANGE switch A2S1. The dc voltage developed across these shunt resistors is amplified and applied to the meter, to provide a deflection on the meter proportional to the dc current being measured.

4-13. **DC Voltage Measurements (Figure 5-14).** The purpose of the input network is to accurately attenuate the input signal to a maximum of 15 mV at the amplifier input. The network presents an input impedance of 10 MΩ on the three most sensitive ranges and 100 MΩ on all other ranges.

4-14. Resistor R1 (located in the DCV probe) in conjunction with resistors A2R10 through A2R26, provides the 10 MΩ input impedance required for the three most sensitive DCV ranges. Resistors A2R4 and A3R30 are shunted out of the circuit by the RANGE switch on the three most sensitive DCV ranges.

4-15. When using the eight less sensitive ranges, A2R4 and A3R30 are placed in series with R1 and A2R10 through A2R26 to present more than 100 MΩ impedance to the input.

4-16. A3R30 is used to calibrate full scale on the 1500 V range (see Paragraph 5-33).

4-17. **Resistance Measurements (Figure 5-15).** The purpose of the input network is to place an approximately 0.6V dc source in series with a known (reference) resistance. The resistance to be measured is placed in parallel with the known resistance, which changes the voltage proportionally. The maximum changes in voltage applied to the modulator is 15 mV because of attenuation provided by A2R4, A3R30, and A1R2.

4-18. A dc current of approximately 60 mA is supplied at the junction of A2R22 and A2R23 through A7R10, R3, A2R2 and A2R1 to the input network. The OHMS ∝ ADJ., R3, sets the meter for full scale (∝). Resistor A2R1 is shorted out in the X1M position of the RANGE switch; resistors A2R1 and A2R2 are shorted out in the X10M range. The resistors A2R2 and/or A2R1 are electrically removed from the circuit to increase the voltage at the junction of A2R22 and A2R23. This is done to compensate for the loading of the attenuator (A2R4, A3R30, and A1R2) on these ranges.

4-19. **AC Voltage Measurements (Figure 5-16).** AC voltages are rectified in the AC Probe and applied to the input network. The input signal is attenuated to produce a maximum of about 15 mV at the amplifier input. AC zero adjustment of meter pointer is made with the AC ZERO control.

4-20. The Feedback Network.

4-21. The feedback network drives the meter and determines the dc gain of the amplifier. The feedback is varied depending on the position of the FUNCTION and RANGE selectors. The different feedback configurations are discussed in paragraphs 4-22 and 4-23.

4-22. **Feedback Network for ±DCA, Ohms, and ±DCV.** Figures 5-13, 5-14 and 5-15 show the feedback configuration for all positions of the FUNCTION SELECTOR except ACV. The meter is electrically inverted for ±DCV and ±DCA modes of operation. The DC OUTPUT ADJ., A6R20 sets the output voltage. The dc pot, A6R18 determines the amount of feedback to the amplifier. The resistor A2R30 is in the circuit in the ± .015 DCV and ± 1.5 μA modes of operation to decrease feedback. This increases the amplifier's gain to compensate for the decrease in input signal to the amplifier on these ranges.

4-23. **Feedback Circuit for AC Voltage Measurements.** Figure 5-16 shows the feedback configuration for the ACV position of the FUNCTION SELECTOR switch, A1S1. The resistors that are placed in the circuit by the RANGE switch, program the amplifier gain to compensate for the non-linear response of the AC Probe. A6R16 and A6CR1 compensate the non-linear response of the AC Probe to the linear calibration of the upper meter scale on the 5 V range.

4-24. Power Supply.

4-25. **Primary Power (Figure 5-7).** Either 115 or 230 V ac power is connected through fuse F1 (0.25 amp slow-blow) and switch S1 to the primary of power transformer T1. Switch S2 connects T1 primaries in parallel for 115V operation or in series for 230 V operation.

4-26. Unregulated and Zener Regulated Power Supply with 410-65A A3 Assembly. The full-wave rectifier circuit consisting of CR1 and CR2 produces unregulated +270 V which is used to drive the photochopper neons. Unregulated +175 V and +140 V are tapped off and used to provide B+ for the plates of A3V1B and A3V1A, respectively. Zener regulators A7CR6 and CR7 provide regulated +38 V and −9 V to bias A3Q1 and A3Q2. Filtering of the outputs is provided by the RC network consisting of A7R1 through A7R3 and C5A through C5D.

4-27. Unregulated and Zener Regulated Power Supply with 00410-66502 A3 Assembly. Plus 38 V and −9 V are the only voltages used by the FET/op amp A3 Amplifier Assembly. A 20 V zener and a 4.75 V zener on the A3 board are used to provide regulated voltages for Q1 and U1.

4-28. Series Regulated Power Supply. The output of the full wave rectifier CR3 and CR4 is regulated by transistor Q1, which is connected in series with the output. Zener diode A7CR8 provides reference voltage to the base of Q1. Regulated + 6 V is supplied to the filaments of A3V1A/B and the AC Probe diode A8V1. Plus 0.6 V is provided through A7R10 to R3, the OHMS Ω ADJ. control. Filtering of the outputs is provided by C6A and C6B.

4-29. Standby Filament Supply. The filament tap (T1, pins 1 and 2) provides 6.0 V ac to the filament of the AC Probe diode, A8V1, so that the filament remains warm when the Model 410C is being used in modes of operation other than ACV. When FUNCTION selector A1S1 is switched to ACV, 6.0 V ac is removed from the filament and 6 V dc is applied. Therefore, the ACV mode is ready for immediate use, without waiting for the filament to warm up.

WARNING

Maintenance described herein is performed with power supplied to the instrument, and protective covers removed. Such maintenance should be performed only by service-trained personnel who are aware of the hazards involved (for example, fire and electrical shock). Where maintenance can be performed without power applied, the power should be removed.

SECTION V

MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains performance test procedures, adjustment and calibration procedures, troubleshooting procedures, circuit schematics and simplified schematics of each measurement function to aid in the troubleshooting process of the Model 410C Electronic Voltmeter.

5-3. TEST EQUIPMENT REQUIRED.

5-4. The test equipment required to maintain and adjust the Model 410C is listed in Table 5-1. Equipment having similar characteristics may be substituted for items listed.

5-5. PERFORMANCE TESTS.

5-6. The performance tests presented in this section are front panel operations designed to compare the Model 410C with its published specifications. These operations may be incorporated in periodic maintenance, post repair and incoming quality control checks. These operations should be conducted before any attempt is made at instrument calibration or adjustment. During performance tests, periodically vary the line voltage to the Model 410C, ± 10% on either 115 V or 230 V operation. A 1/2 hour warm-up period should be allowed before these tests are conducted.

Table 5-1. Recommended Test Equipment.

Instrument Type	Required Characteristics	Use	Recommended Model
DC Voltage Standard	Range: 0.015 to 300 V Accuracy: ± 0.2% dc	DC Accuracy Checks and Calibration Adjustments	Systron - Donner Model M107
AC Calibrator with High Voltage Amplifier	Frequency: 20 Hz to 100 kHz Output: .5 V to 300 V	AC Voltmeter Accuracy Test	-hp- Model 745 and 746 AC Calibrator and High Voltage Amplifier
Oscillator	Frequency: 20 Hz to 10 MHz Output: 2.0 V	Frequency Response Test	-hp- Model 652A Test Oscillator
DC Power Supply	Range: 0 to 10 V Continuous	DC Ammeter Accuracy Tests	-hp- Model 6214A DC Power Supply
Digital Multimeter	Range: 20mV-200V,DC;10V RMS,AC Accuracy: ± 0.2%	Accuracy Tests: Power Supply Measurements: Troubleshooting	-hp- Model 3466A Digital Voltmeter
VHF Signal Generator	Frequency: 10 MHz to 400 MHz Output: 1.0 V	Frequency Response Test	-hp- Model 608E VHF Signal Generator
UHF Signal Generator	Frequency: 480 MHz to 700 MHz	Frequency Response Test	-hp- Model 612A UHF Signal Generator
Micro-Potentiometer	Frequency Range: 10 MHz 700 MHz Output Voltage: 0.44 V rms Accuracy: NBS Calibrated	Frequency Response Test Micro-Potentiometer	Ballantine Model 440
Probe-T-Connector	For use with 50 ohm transmission line	Frequency Response Test	-hp- Model 11042A Probe-T-Connector
Connector Adapter	Type N Male to BNC Female	Frequency Response Test	-hp- Part Number 1250-0067
Connector Adapter	BNC to Binding Post	Frequency Response Test	-hp- Part Number 10110A
Connector Adapter	Type "N" Male to Type "N" Female	Frequency Response Test	-hp- Part Number 11501A
50 Ω Termination	Frequency Range: 10 MHz to 700 MHz Low Reflection	Frequency Response Test	-hp- Part Number 908A
50 Ω Feed-Thru	Male BNC to Female BNC	Performance Tests	-hp- Model 11048C
Resistors: 10 MΩ 58 K 10 K 1.5 K 56 Ω 10 Ω	 Accuracy: ± 1% Accuracy: ± 1% Accuracy: ± 1% Accuracy: ± 1% Accuracy: ± 1% Accuracy: ± 1%	 Performance Tests Performance Tests Performance Tests Performance Tests Performance Tests Performance Tests	 -hp- Part Number 0730-0168 -hp- Part Number 0730-0053 -hp- Part Number 0727-0157 -hp- Part Number 0730-0017 -hp- Part Number 0811-0341 -hp- Part Number 0727-0335

5-7. Mechanical Meter Zero.

a. Instrument must be turned off for a few minutes or install a short across the meter terminals.

b. Rotate mechanical zero-adjustment screw on front panel clockwise until pointer reaches zero, moving up scale.

c. If for some reason the pointer should overshoot zero, repeat step b until desired results are obtained.

d. When pointer has been positioned at zero, rotate zero-adjust screw slightly counterclockwise to free it. If meter pointer moves to the left during this action, repeat steps b and d.

WARNING

Hazardous voltages used in some of the following tests.

5-8. DC Voltmeter Operation.

5-9. Accuracy Test (DCV).

a. Short Model 410C DCV probe to COM lead; set pointer to zero using rear panel adjustment (ZERO ADJ).

b. Set the Model 410C FUNCTION SELECTOR to the + DCV position; RANGE switch to .015 V. Connect Model 410C DCV and COM cables to the DC Standard output Terminals.

c. Adjust DC Standard and Model 410C to settings listed in Table 5-2.

Table 5-2. DCV Accuracy Test.

Model 410C Range Settings	DC Standard Settings Voltage	Model 410C Meter Readings
.015 V	± .015	.0147 to.0153 V
.05 V	± .05	.049 to .051 V
.15 V	± .15	.147 to .153 V
.5 V	± .5	.49 to .51 V
1.5 V	± 1.5	1.47 to 1.53 V
5 V	± 5	4.9 to 5.1 V
15 V	± 15	14.7 to 15.3 V
50 V	± 50	49 to 51 V
150 V	± 150	147 to 153 V
500 V	± 300	290 to 310 V
1500 V	± 300	270 to 330 V

d. Model 410C should indicate readings within limits specified. If not, refer to Paragraph 5-26 for adjustment procedure.

5-10. Input Resistance Test (DCV).

a. Connect a digital voltmeter (-hp- 3466A) to the DC Amplifier Output. Set digital voltmeter range to 10 V.

b. Set 410C RANGE to .015 V, FUNCTION to + DCV.

c. Connect the DC Standard in series with a 10 MΩ ± 1% resistor (-hp- Part Number 0730-0168). Set the DC Standard output to + .015 V. Connect the Standard and series resistor to the 410C DCV probe.

d. Adjust the calibrator and 410C to settings listed in Table 5-3. Digital voltmeter readings should be within the limits specified for each setting. If readings are not within limits, refer to Paragraph 5-35, Amplifier Output Calibration; recalibrate amplifier and repeat test.

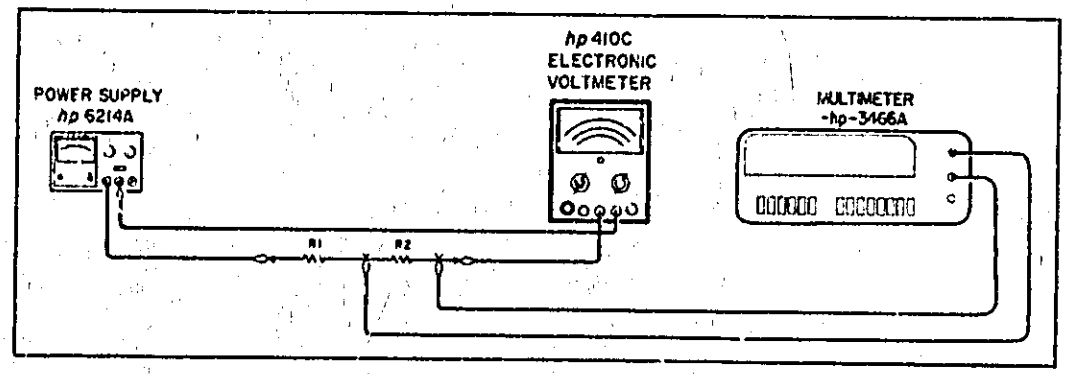


Figure 5-1. DC Ammeter Operation.

Table 5-3. DCV Input Resistance Test.

Model 410C Range Settings	DC Standard Voltage	Model 3466A Voltage Readings	Model 410C R_{in}
.015 V	.015	0.7202 to 0.7801	10 MΩ ± 3%
.05 V	.05	0.7202 to 0.7801	10 MΩ ± 3%
.15 V	.15	0.7202 to 0.7801	10 MΩ ± 3%
.50 V	.50	1.333 to 1.394	100 MΩ ± 1%
1.5 V	1.5	1.333 to 1.394	100 MΩ ± 1%
5 V	5	1.333 to 1.394	100 MΩ ± 1%
15 V	15	1.333 to 1.394	100 MΩ ± 1%
50 V	50	1.333 to 1.394	100 MΩ ± 1%
150 V	150	1.333 to 1.394	100 MΩ ± 1%
500 V	300	0.800 to 0.863	100 MΩ ± 1%
1500 V	300	0.265 to 0.280	100 MΩ ± 1%

5-11. DC Ammeter Operation.

5-12. Accuracy Test (DCA).

a. Figure 5-1 describes the test arrangement required for this operation.

b. Connect the Model 410C as shown in Figure 5-1; FUNCTION SELECTOR to + DCA; RANGE to 150 mA.

c. Use 56 Ω resistor for R1 and 10 Ω resistor for R2.

d. Adjust dc power supply to obtain reading on dc voltmeter specified in Table 5-4; change R_1 and R_2 according to Table 5-4.

e. Model 410C should read within limits specified in Table 5-4. If not, refer to Paragraph 5-26 for adjustment procedure.

5-13. Ohmmeter Operation.

5-14. Ohmmeter Accuracy Test.

a. A 10 Ω ± 1% resistor (-hp- Part Number 0727-0335) and a 10 M ± 1% resistor (-hp- Part Number 0730-0168) will be required for this test.

b. Set Model 410C FUNCTION SELECTOR to OHMS; RANGE to RX10.

c. Set pointer to ∞ using rear panel adjustment (OHMS ADJ) if required.

d. Connect COM and DCA OHMS cables across 10 Ω resistor.

e. Meter should read 10 Ω (± 5%).

f. Set Model 410C RANGE to RX10M. Replace 10 Ω resistor with 10 MΩ resistor.

g. Meter should read 10 MΩ (± 5%).

h. If both of these ranges function properly, it can be assumed that the remainder will also. If meter does not function properly, refer to Paragraph 5-26 for adjustment procedure.

5-15. Amplifier Operation.

5-16. Amplifier Gain Test.

a. Connect the DC standard output to Model 410C DCV and COM cables.

Table 5-4. DCA Accuracy Test.

Model 410C Range Settings	DC Voltmeter Readings	Model 410C Meter Readings	R_1 Ω	R_2 Ω
150 MA	1.4 V	135.5 to 144.5 MA	56	10
50 MA	.4 V	38.5 to 41.5 MA	56	10
15 MA	.14 V	13.55 to 14.55 MA	56	10
5 MA	.04 V	3.85 to 4.15 MA	56	10
1.5 MA	.014 V	1.35 to 1.45 MA	56	10
.5 MA	.004 V	0.385 to 0.415 MA	56	10
150 μA	1.38 V	133.5 to 142.5 μA	56 K	10 K
50 μA	0.46 V	44.5 to 47.5 μA	56 K	10 K
15 μA	0.138 V	13.35 to 14.25 μA	56 K	10 K
5 μA	0.046 V	4.45 to 4.75 μA	56 K	10 K
1.5 μA	0.014 V	1.36 to 1.45 μA	56 K	10 K

b. Connect DC Voltmeter (-hp- Model 3466A) to DC AMPLIFIER OUTPUT on rear panel of Model 410C. Set DC Voltmeter RANGE to 10 V.

c. Set Model 410C FUNCTION SELECTOR to +DCV; RANGE to .015 V.

d. Adjust the DC Standard for +.015 VDC output.

e. The voltmeter should indicate from 1.467 V to 1.533 V. This will verify a gain of 100, where the gain equals $E_{DC\ out}/E_{DC\ in}$.

f. If the dc voltmeter does not indicate within the limits of step e, refer to Paragraph 5-26 for proper adjustment procedure.

5-17. Output Level Test.

a. A DC Standard and a DC Voltmeter (-hp- Model 3466A) will be required for this test.

b. Connect dc voltmeter to dc amplifier OUTPUT on Model 410C rear panel. Place ground lead between Model 410C circuit ground and earth ground terminals. Set dc voltmeter RANGE to 10 V.

c. Set Model 410C FUNCTION SELECTOR to +DCV; RANGE to 1.5 V.

d. Adjust the DC Standard to provide +1.5 V.

e. Model 410C and dc voltmeter should indicate from 1.467 V to 1.533 V.

f. If dc voltmeter does not indicate within the limits of step e, refer to Paragraph 5-26 for proper adjustment procedure.

5-18. Amplifier Output Impedance Test.

a. Connect an external DC Voltmeter (-hp- Model 3466A) to Model 410C DC AMPLIFIER OUTPUT terminals on rear panel.

b. Set Model 410C FUNCTION SELECTOR to OHMS position; RANGE to RX10K.

c. Record voltage indicated on external dc voltmeter for use as a reference.

d. Connect a 1.5 kΩ ± 1% resistor (-hp- Part Number 0730-0017) across 410C DC AMPLIFIER OUTPUT terminals. DC voltage recorded in step c above should not change more than 3 mV, indicating that dc amplifier output impedance is within the 3 Ω specification at dc.

5-19. Amplifier Noise Test.

a. Connect an AC Voltmeter (-hp- Model 3466A) to the DC AMPLIFIER OUTPUT of Model 410C.

b. Set the Model 410C FUNCTION SELECTOR to +DCV; RANGE to 1500 V.

c. Short the Model 410C DCV and COM cables. External ac voltmeter reading should be less than 2.65 mV rms (7.5 mVp-p).

d. Reset Model 410C RANGE to 1.5 V. AC Voltmeter should read less than 2.65 mV rms.

5-20. Overload Recovery Test.

a. Connect the DC Standard output to Model 410C DCV and COM cables.

b. Set Model 410C FUNCTION SELECTOR to +DCV; RANGE to .15 V.

c. Adjust the DC Standard for +0.15 VDC: note reading on Model 410C.

d. Readjust the DC Standard for +15 VDC output; wait 5 seconds for complete saturation; then switch voltmeter calibrator back to +.15 VDC output. Note time required for meter to return to original position.

e. Recovery time should be less than 3 seconds.

f. Repeat this same Overload Recovery Test with the 410C set for −DCV and the DC Standard set for −DCV.

5-21. AC Rejection Test.

a. An AC Calibrator (-hp- Model 745A) and an RMS Voltmeter (-hp- Model 3466A) are required for this test.

b. Set 410C FUNCTION SELECTOR to -DCV; RANGE to .015 V.

c. Connect the AC Calibrator output to Model 410C DCV and COM cables and input of rms voltmeter. Set rms voltmeter to read 10 V.

d. Adjust the AC Calibrator to provide 3.18 V (4.5 V peak) reading on rms voltmeter at 50 Hz.

e. Model 410C should not read more than 2.25 mV verifying 66 dB ac rejection at 50 Hz.

f. Increase frequency to check ac rejection about 60 Hz.

g. Switch Model 410C FUNCTION SWITCH to +DCV and repeat steps e and f.

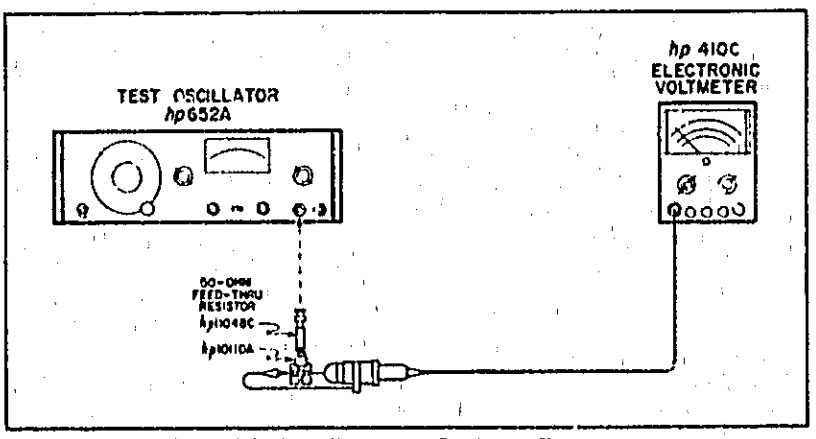


Figure 5-2. Low Frequency Response Test.

5-22. AC Voltmeter Operation.

CAUTION

When measuring ac voltages, do not permit ac ground jumper of Model 410C AC Probe to contact ungrounded side of ac source or serious damage to 410C will result.

WARNING

Hazardous voltages used in some of the following tests.

5-23. AC Voltmeter Accuracy Test.

a. Set Model 410C RANGE to 0.5 V. Short the input of the AC Probe. Adjust ZERO vernier for zero pointer deflection.

b. Connect ACV probe to the AC Calibrator (-hp- Model 745A).

c. Adjust the AC Calibrator for 400 Hz output.

d. Set Model 410C FUNCTION SELECTOR to ACV; RANGE to 500 V.

e. Adjust the AC Calibrator to settings listed in Table 5-5. Model 410C should indicate readings within limits specified. If not, refer to Paragraph 5-36 for corrective action. Record Model 410C reading with 0.3 V input.

NOTE

The frequency response tests are performed using reference voltage obtained with 0.3 V input.

Table 5-5. AC Accuracy Test.

410C Range	Voltmeter Calibrator 400 Hz Voltage Selection	Model 410C Readings
500 V	300	285 to 315 V
150 V	150	145.5 to 154.5 V
50 V	50	48.5 to 51.5 V
15 V	15	14.55 to 15.45 V
5 V	5	4.85 to 5.15 V
1.5 V	1.5	1.455 to 1.545 V
.5 V	0.5	0.485 to .515 V
.5 V	0.3	0.285 to .315 V

5-24. AC Voltmeter Low Frequency Response Test.

a. A Test Oscillator (-hp- Model 652A), a BNC-to-Binding Post Adaptor (-hp- Part Number 10110A) and a 50 Ω Feed-thru Termination (-hp- Part Number 11048C) are required for this test.

b. Connect Model 410C as shown in Figure 5-2.

c. Set Model 410C FUNCTION SELECTOR to ACV; RANGE to 0.5 V.

d. Set Test Oscillator frequency to 400 Hz, and adjust amplitude to give same 410C reading as recorded in Paragraph 5-23, step e, with 0.3 V input.

e. Set Test Oscillator REF SET to convenient level.

f. Adjust frequency of Test Oscillator to various cardinal points between 20 Hz and 10 MHz, resetting amplitude to reference level set in step d for each frequency. Model 410C readings should be the same as the reading set at 400 Hz in step d ± 10% from 20 Hz to 100 Hz and ± 2% from 100 Hz to 10 MHz.

5-25. AC Voltmeter High Frequency Response Test.

a. A VHF Signal Generator (-hp- Model 608E), a UHF Signal Generator (-hp- Model 612A), a Probe-T-Connector (-hp- Model 11042A), a Micropotentiometer (Ballantine Model 440), and a DC Voltmeter (-hp- Model 3466A) are required for this test. Figure 5-3 describes test arrangement to be used.

NOTE

The micropotentiometer must have the proper radial resistance and current rating to deliver 0.30 V at its output.

b. Set VHF oscillator output to provide output to Model 410C reading recorded in Paragraph 5-24, step f, with .3 V input; frequency to 10 MHz. Record dc voltmeter reading for reference.

c. Vary VHF oscillator frequency from 10 MHz to 480 MHz maintaining reference dc voltmeter reading by readjusting VHF oscillator output. Model 410C reading should be the same as the reading set at 400 Hz in Paragraph 5-24, step d, ± 2% at frequencies to 50 MHz, 0 to -4% from 50 MHz to 100 MHz and ± 1.5 dB at all higher specified frequencies.

d. Replace VHF oscillator with UHF oscillator in Figure 5-3. Repeat steps b and c for UHF oscillator output frequencies from 480 MHz to 700 MHz.

WARNING

Calibration described herein is performed with power supplied to the instrument, and protective covers removed. Such maintenance should be performed only by service trained personnel who are aware of the hazards involved (for example, fire and electrical shock).

Socket for A3 board has dangerous voltages (+270 V, +175 V, and +140 V). See Schematic 5-8.

5-26. ADJUSTMENT AND CALIBRATION PROCEDURE.

5-27. The following is a complete calibration procedure for the Model 410C. These operations should only be performed if it has been determined by the Performance Tests, Paragraph 5-5, that the Model 410C is out of adjustment. If the procedures outlined do not resolve any discrepancies that may exist, refer to Paragraph 5-40, Troubleshooting, for a possible cause and recommended corrective action.

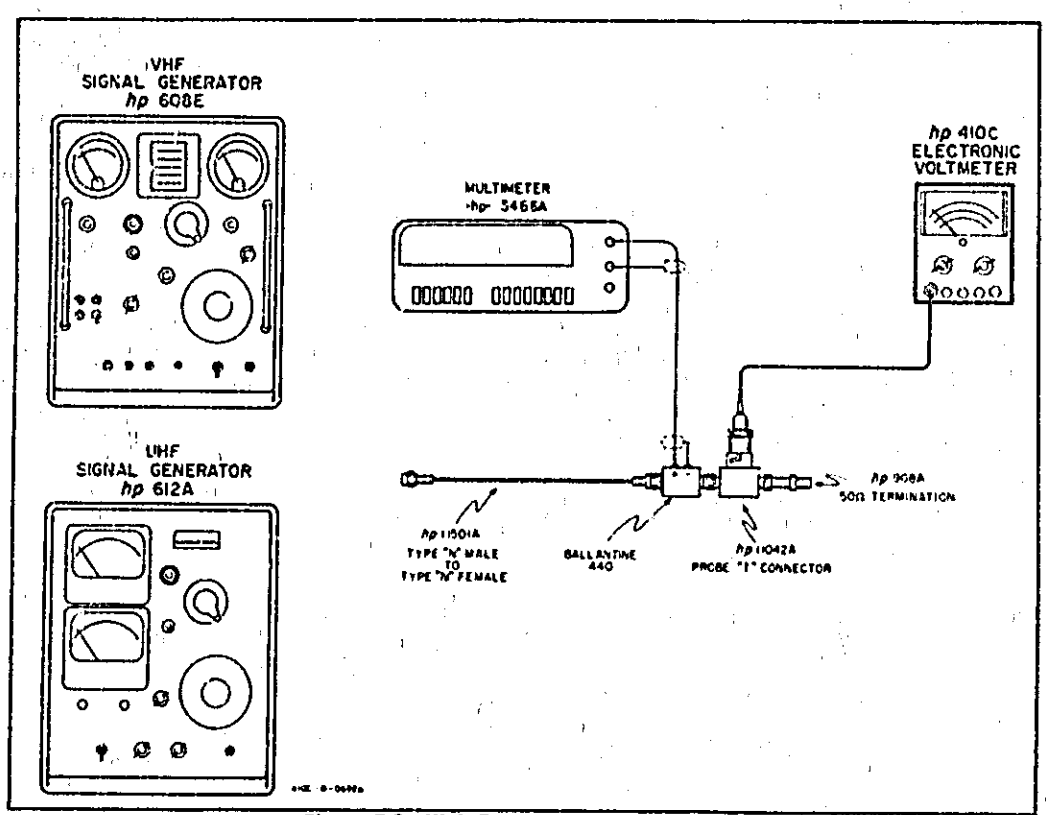


Figure 5-3. High Frequency Response Test.

5-28. Disconnect the ac power from the Model 410C. Remove the top and bottom covers and the two side panels from the instrument. Refer to Figure 5-4 and 5-5 throughout this procedure for adjustment locations.

5-29. Power Supply Test.

a. Apply power to 410C.

b. Refer to Table 5-6 and Figure 5-7 for Power Supply test points and typical voltage values. Measure dc voltages between COM lead and designated location on A7.

Tabel 5-6. Power Supply Test.

Voltage	Location on A7 (Figure 5-8)	Tolerance
+ 38 V	Junction of CR6 and R4	± 8..0 V
+ 6 V	926	± 0.6V
− 9 V	Junction CR7 and R7	± 1.8 V

5-30. Amplifier Current Adjustment.

a. Connect a 3466A voltmeter or equivalent voltmeter with an input impedance of 10 M ohms or greater across A3R7.

b. Adjust A3R12 for the voltmeter to read 9.476 V dc; 400 μA will be flowing through R7 with this 9.476 V reading.

5-31. DC VOLTMETER CALIBRATION.

5-32. DC Zero Adjustment.

a. Set Model 410C FUNCTION SELECTOR to +DCV and RANGE switch to 0.5 V.

b. Short the DCV probe to the COM lead.

c. Set the DC ZERO adj. control at the back of the instrument its center position.

d. Adjust the Zero Adj. pot A3R6 on the A3 amplifier board till there is no meter movement when the FUNCTION SELECTOR is switched from −DCV to +DCV.

5-33. DC Full Scale Adjust.

a. Connect the Model 410C DCV and COM cables to the DC Standard output terminals.

b. Set the Model 410C FUNCTION switch to the +DCV position and the RANGE switch to the .015 V position.

c. Set the DC Standard for an output voltage of .015 VDC.

d. Adjust A6R18 to provide a full scale reading.

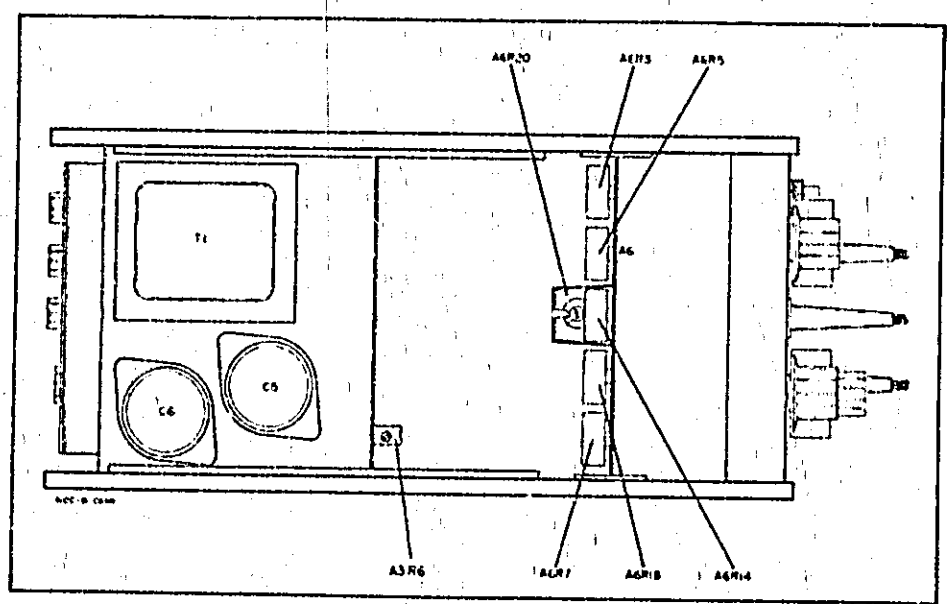


Figure 5-4. Adjustment Locations.

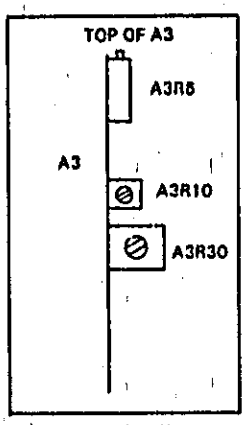


Figure 5-5. A3 Board Adjustment Locations.

e. Using Table 5-7 as a guide, adjust A6R18 to a setting which will provide the best overall full scale readings on the 0.015 V, 0.05 V, 0.15 V ranges. Adjust A3R30 for the best overall full scale readings on all ranges above 0.15 V.

NOTE

A6R18 must be adjusted before A3R30 because A6R18 affects all ranges, and A3R30 only affects ranges above the 0.15 V range.

Table 5-7. DCV Calibration Procedure.

Model 410C Range Settings	DC Standard Voltage	Model 410C Meter Readings	Adjustment
.015 V	.015	.0147 to .0153 V	A6R18
.05 V	.05	.049 to .051 V	A6R18
.15 V	.15	.147 to .153 V	A6R18
.5 V	.5	.49 to .51 V	A3R30
1.5 V	1.5	1.47 to 1.53 V	A3R30
5 V	5	4.9 to 5.1 V	A3R30
15 V	15	14.7 to 15.3 V	A3R30
50 V	50	49 to 51 V	A3R30
150 V	150	147 to 153 V	A3R30
500 V	300	290 to 310 V	A3R30
1500 V	300	270to 330 V	A3R30

5-34. Ohmmeter Calibration.

a. Set the Model 410C FUNCTION SELECTOR switch to OHMS and the RANGE to RX10M.

b. Short the OHMS and COM leads together. The Model 410C should read zero. If it does not, recheck the DC ZERO ADJ (see 4-32). Check for a zero reading on all ranges. The RX10 range should read about 0.1 ohms which is the resistance of the leads.

c. Disconnect the OHMS and COM leads. Adjust the OHMS ADJ (410C rear panel) for a reading of infinity.

d. The meter should indicate infinity when the range switch is changed to other ranges.

5-35. Amplifier Output Calibration.

a. Set the Model 410C FUNCTION SELECTOR switch to the + DCV position and the RANGE switch to 5.0 V.

b. Connect the 410C DCV and COM leads to the DC Standard. Set the DC Standard for a voltage output of 5.0 V.

c. Connect the 3466A voltmeter to the DC AMPLIFIER OUTPUT terminals on the back of 410C.

d. Adjust A6R20 to give a 1.5 V dc reading on the voltmeter.

NOTE

The amplifier output will give a negative voltage for all negative dc and ac inputs.

5-36. AC VOLTMETER CALIBRATION.

5-37. An AC Calibrator (-hp- Model 745 and 746 or equivalent) is required for the AC Voltmeter calibration.

5-38. AC Zero Adjust.

a. Insert the telephone plug from the 11036A AC Probe into the AC Probe receptical on the Model 410C. Set the FUNCTION SELECTOR switch to the ACV position and the RANGE switch to 0.5 V. Allow 5 minutes for the diode in the AC Probe to stabilize.

b. Set the AC Zero vernier, which is concentric with the FUNCTION SELECTOR switch, to the center of its rotation.

c. Short the Model 11036A AC Probe tip to the AC Probe common.

d. Adjust A3R31 for a Model 410C meter reading of zero.

e. If necessary, use the AC ZERO vernier as a fine adjust to obtain the Model 410C meter indication of zero.

5-39. AC Full Scale Adjust.

CAUTION

When measuring ac voltages, do not allow the ac ground lead of the 11036A AC Probe to contact the ungrounded side of the ac source or serious damage to the Model 410C will result.

a. Connect the Model 410C AC PROBE (11036A) to the output terminals of the AC CALIBRATOR.

b. Set the Model 410C RANGE switch and the AC CALIBRATOR to the settings outlined in Table 5-8. Set the calibrator frequency to 400 Hz. Adjust the appropriate control for the required Model 410C reading. This completes the calibration procedure.

Table 5-8. AC Full Scale Adjust.

Model 410C Range	Voltmeter Calibrator AC Voltage Settings	Model 410C Reading ± 3%	Adjustment
.5 V	.50	.5 V	A6R3
1.5 V	1.5	1.5 V	A6R5
5 V	5	5 V	A6R7
*15 V	15	15 V	A6R14
*50 V	50	50 V	A6R14
*150 V	150	150 V	A6R14
*500 V	300	300 V	A6R14

*A6R14 is proper adjustment of Model 410C for RANGE settings from 15 V ac to 500 V ac. Select proper A6R14 setting which will provide best overall results for these ranges.

WARNING

Maintenance described herein is performed with power supplied to the instrument, and protective covers removed. Such maintenance should be performed only by service trained personnel who are aware of the hazards involved (for example, fire and electrical shock). Where maintenance can be performed without power applied, the power should be removed.

Before any repair is completed, ensure that all safety features are intact and functioning, and that all necessary parts are connected to their protective grounding means.

Note that the socket for the A3 board has dangerous voltages (+270V, +175V and +140V). See Figure 5-8, Amplifier Schematic.

5-40. Troubleshooting.

5-41. Preliminary Troubleshooting. Before you disassemble the instrument for troubleshooting, check the Model 410C on several functions and ranges. This can frequently lead or point to the source of trouble. For example, if the Model 410C fails on all ACV ranges but works correctly on all DCV ranges, the failure may lie in the 11036A AC probe or perhaps in the input switching network. If the problem exists only in the OHMS measurement mode, you should check the OHMS current source (i.e. A2R1, R2, R34; A7R10; R3 (rear panel) and the +6 volt supply).

5-42. Remove the power cord and top, bottom and side covers from the 410C and conduct a thorough visual inspection of the instrument. Look for overheated or loose components, loose connections, or any other obvious conditions which might indicate the source of trouble. You may wish to pull out the A3 board for a closer inspection. The A3 board edge connector contacts may be cleaned by rubbing them with a common pencil eraser.

5-43. Power Supply Troubleshooting.

5-44. A chart showing some of the more pertinent voltage and resistance values for the A7 Power Supply circuit board is given in Figure 5-6. This chart and the power supply schematic (Figure 5-7) may be used to troubleshoot and diagnose the power supply.

5-45. Amplifier Troubleshooting.

5-46. When analyzing amplifier problems, refer to the Block Diagram in Figure 4-1 and the Amplifier Schematic in Figure 5-8. Check all of the eleven DCV ranges to see if the input attenuator/switching, the A3 Amplifier Assembly, and the feedback/switching are functioning correctly. Perform these checks in the following manner.

a. Set the 410C Function Selector Switch to the +DCV position.

b. Connect a dc voltage source (Systron Donner Model M107 or equivalent) to the DCV and Com leads of the 410C.

c. Connect a dc voltmeter (-hp- Model 3466A or equivalent) to the DC Amplifier Output terminals on the 410C's back panel.

d. The DC Amplifier Output should read 1.5 V dc for each range with a full scale input. If the readings are not correct for all of the ranges, check the input attenuator/switching and feedback circuit paths for the defective range(s). (The Systron-Donner Model M107 has a maximum output of 300 V dc so readings for the 500 V and 1500 V ranges will be less than 1.5 V dc unless a higher dc voltage source is used).

e. If all of the ranges read incorrect, check for +15 mV dc on pin 1 of the A3 board. If this reading is wrong, check the input attenuator/switching.

f. If the reading at pin 1 is correct, short pin 11 to pin 7 on the A3 board. If the voltage on pin 7 reads +15 mV (amplifier gain of 1; normal gain of amplifier is 100), the feedback circuit is defective. If pin 7 does not read +15 mV, op amp U1 is most likely bad.

5-47. Schematic Diagrams.

5-48. The schematic diagrams (Figures 5-7 through 5-16) are divided into two groups: The Detailed schematics and the Simplified schematics that show the signal flow for the four measurement modes of operation (DCV, DCA, Ohms, and ACV). A pictorial wiring of the Function and Range switches is also given.

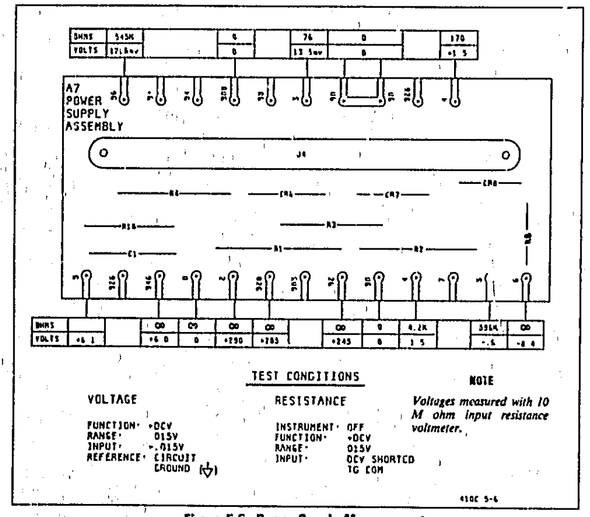


Figure 5-6. Power Supply Measurements.

GENERAL SCHEMATIC NOTES

1. SWITCHES ARE SHOWN IN FULL CCW POSITIONS.
2. P/O = PART OF.
3. CAPACITANCE IN MICROFARADS AND RESISTANCE IN OHMS, UNLESS OTHERWISE SPECIFIED.
4. ⏚ = EARTH GROUND, ⏚ = CHASSIS GROUND. ▽ = CIRCUIT COMMON (FLOATING GROUND).
5. ——— – – – ——— INDICATES AN ASSEMBLY. ALL COMPONENTS LOCATED ON AN ASSEMBLY ARE PREFIXED BY THE ASSEMBLY DESIGNATION (e.g., R3 ON ASSEMBLY A7 BECOMES A7R3).
6. – – – – – – – INDICATES SUBASSEMBLY.
7. — — — — — INDICATES DC FEEDBACK.
8. ◯ INDICATES PANEL ADJUST: ⊘ INDICATES SCREWDRIVER ADJUST.
9. 937 INDICATES WIRE COLOR USING STANDARD COLOR CODE. (e.g., 0 = WHITE, 3 = ORANGE, 7 = VIOLET.)
10. * OPTIMUM VALUE SELECTED AT FACTORY. AVERAGE VALUE SHOWN.
11. ▭ INDICATES FRONT PANEL LOCATION. ▭ INDICATES REAR PANEL LOCATION.

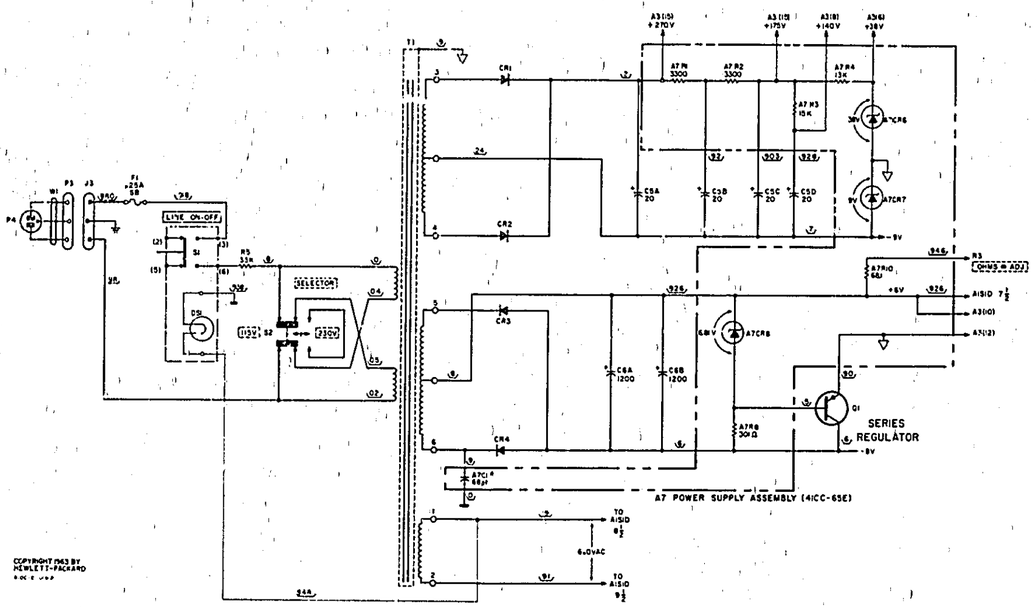
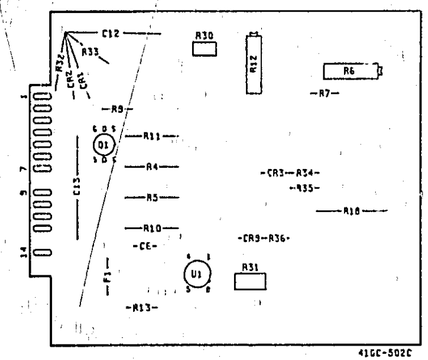
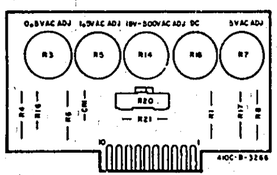


Figure 5-7. Power Supply Schematic.
5-11/5-12



A3
hp Part No. 00410-66502



A6
hp Part No. 410C-65B

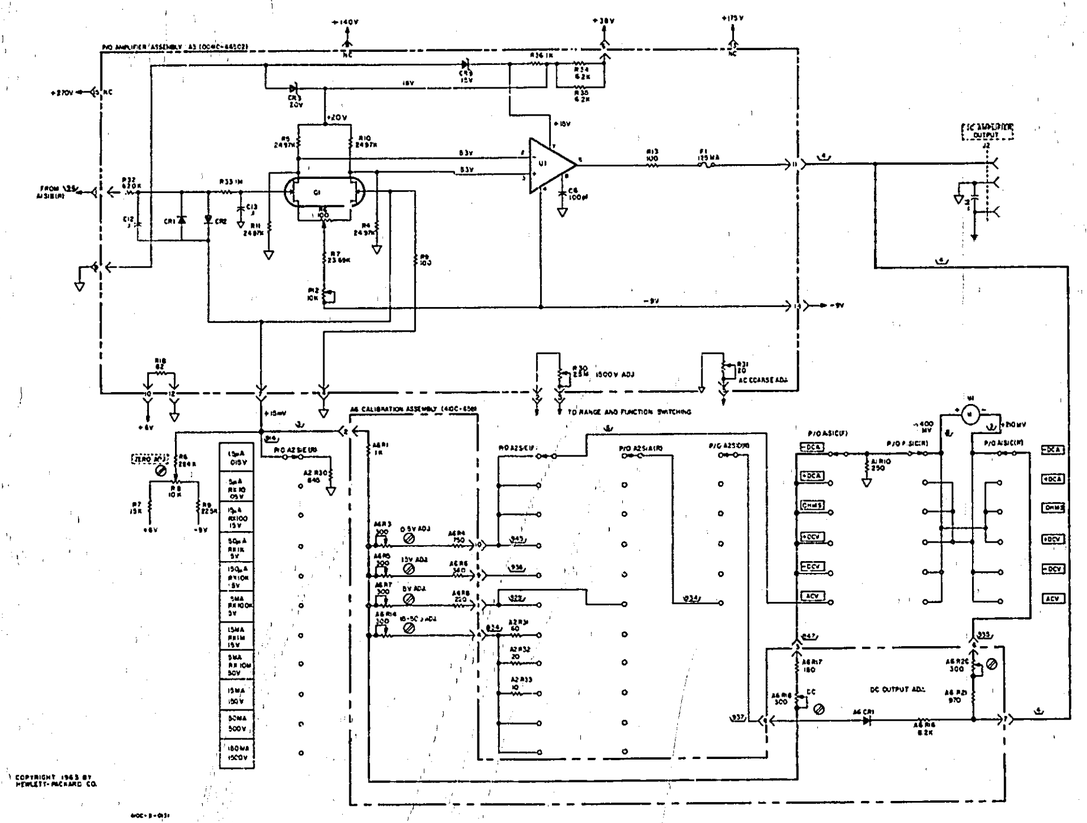


Figure 5-8. Amplifier Schematic.

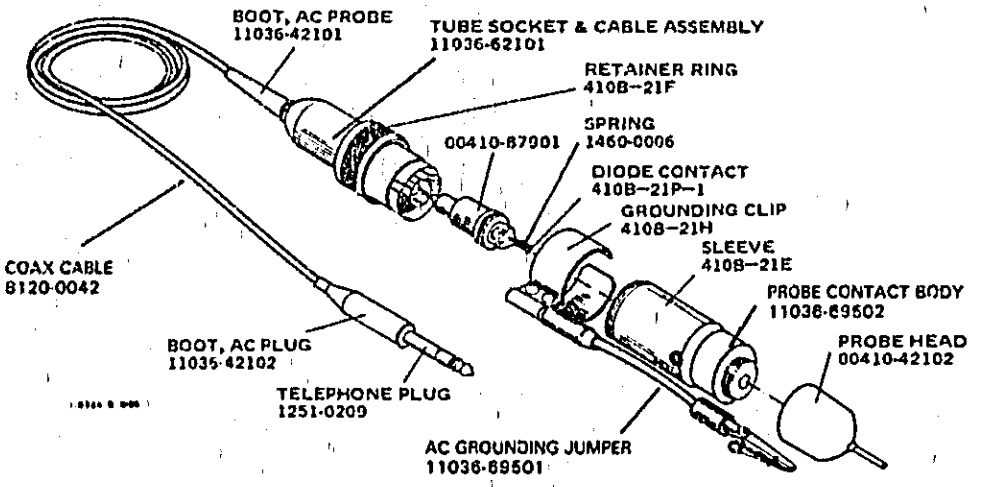
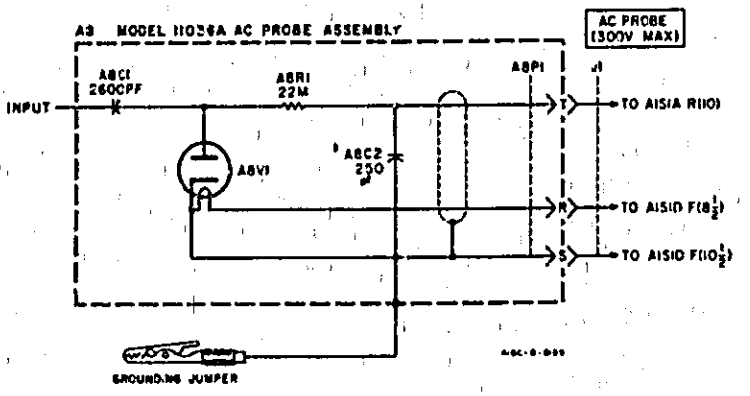


Figure 5-9. Model 11036A AC Probe (Exploded View).



NOTES

1. Unless otherwise specified, resistance in ohms. Capacitance in microfarads.
2. † value of A8C2 includes probe lead capacity.
3. – – – – indicates an assembly. All components located on any assembly are prefixed by the assembly designation (e.g., R1 on assembly A8 becomes A8R1).

Figure 5-10. Model 11036A AC Probe Schematic.

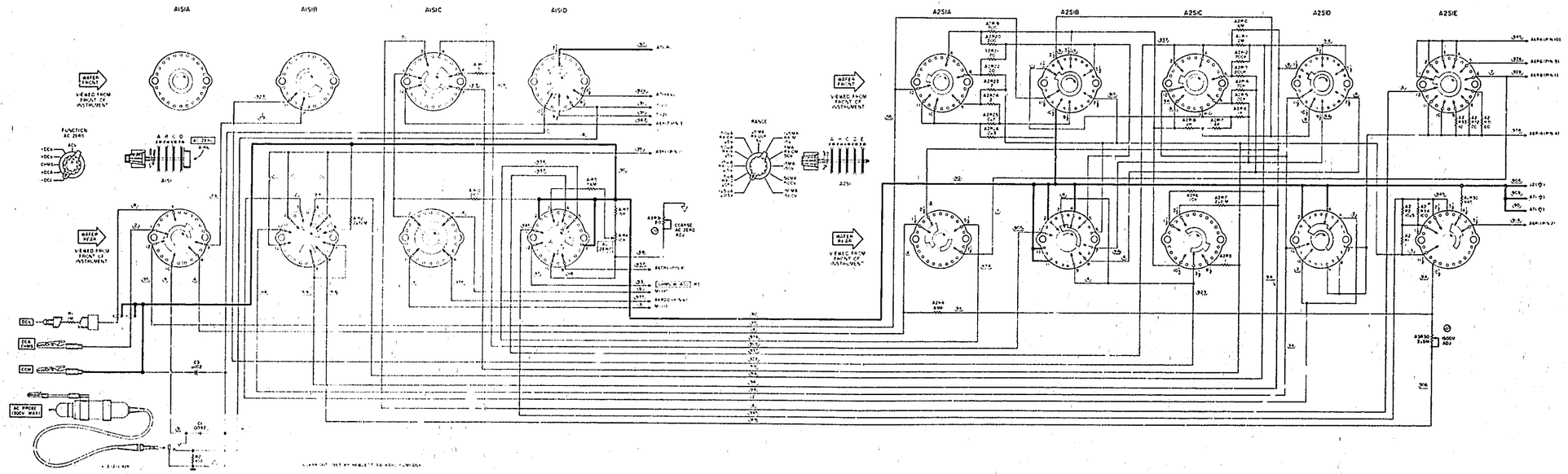


Figure 5-11. Range and Function Switching (Pictorial).

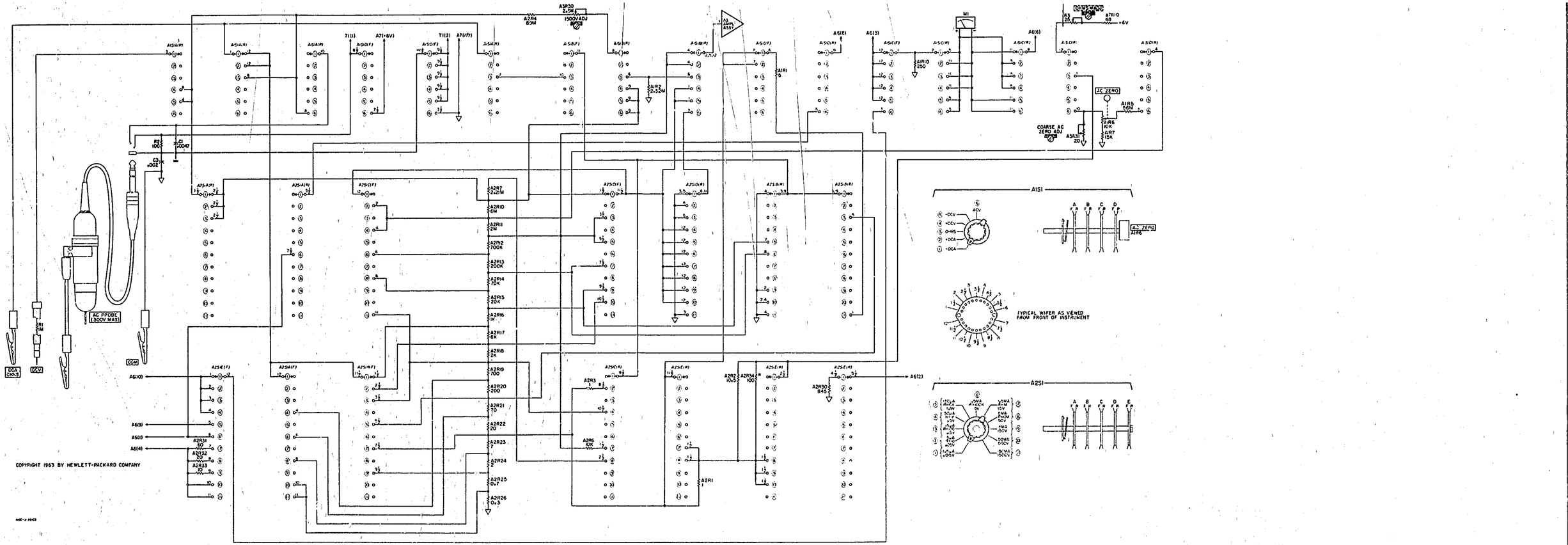


Figure 5-12. Input Range and Function Switching Schematic.

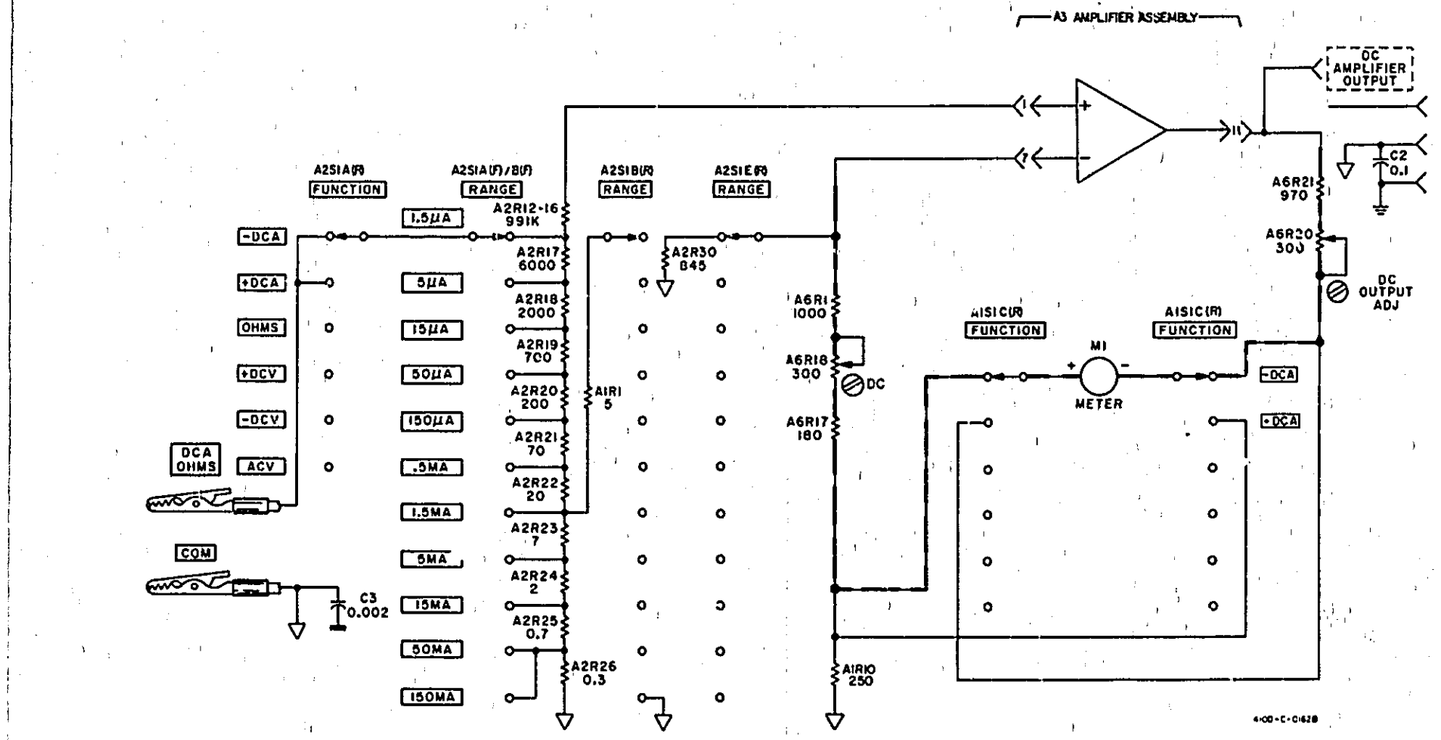


Figure 5-13. Simplified Schematic, DC Current Measurement.

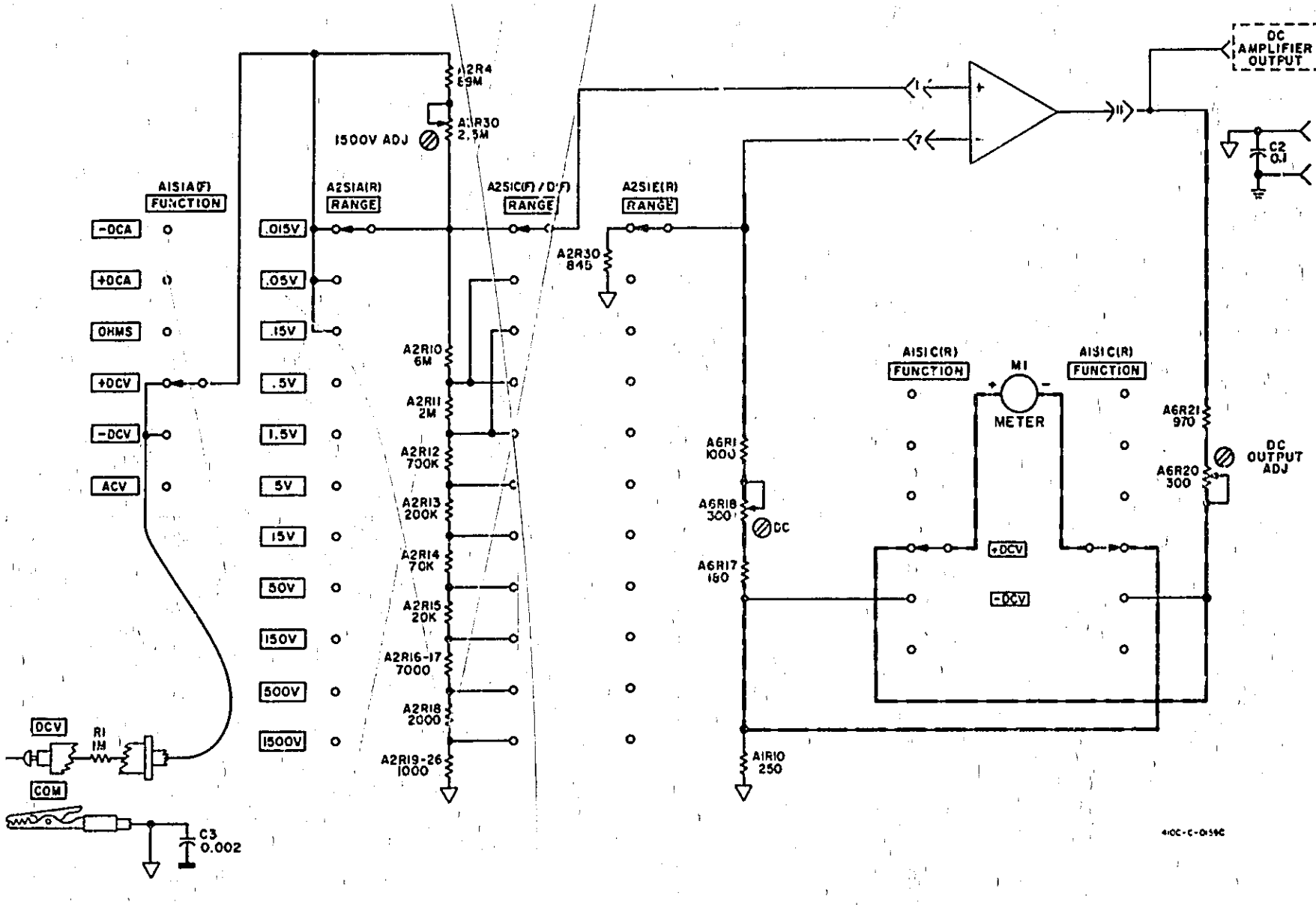


Figure 5-14. Simplified Schematic, DC Voltage Measurements.

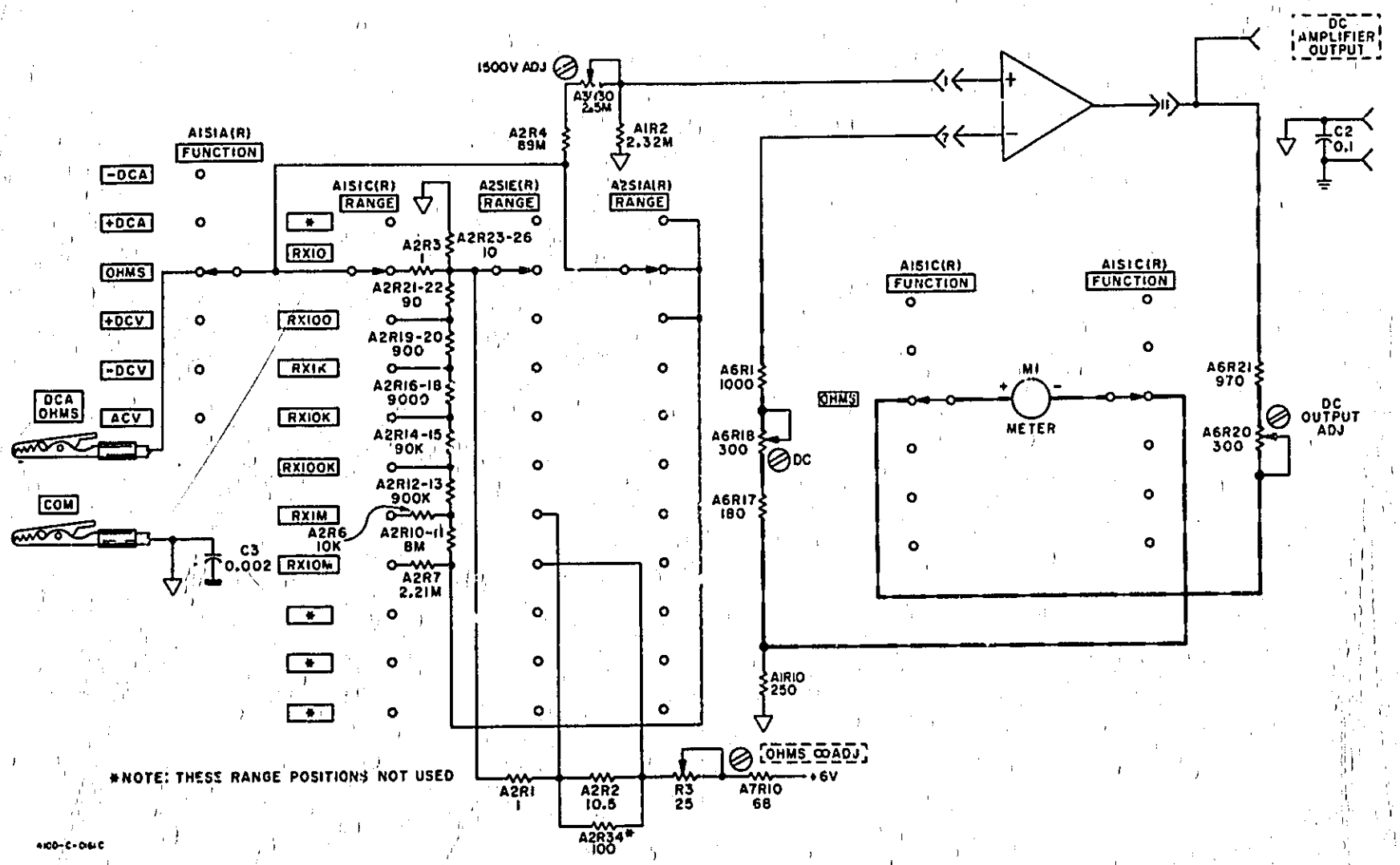


Figure 5-15. Simplified Schematic, Resistance Measurement.
5-21/5-22

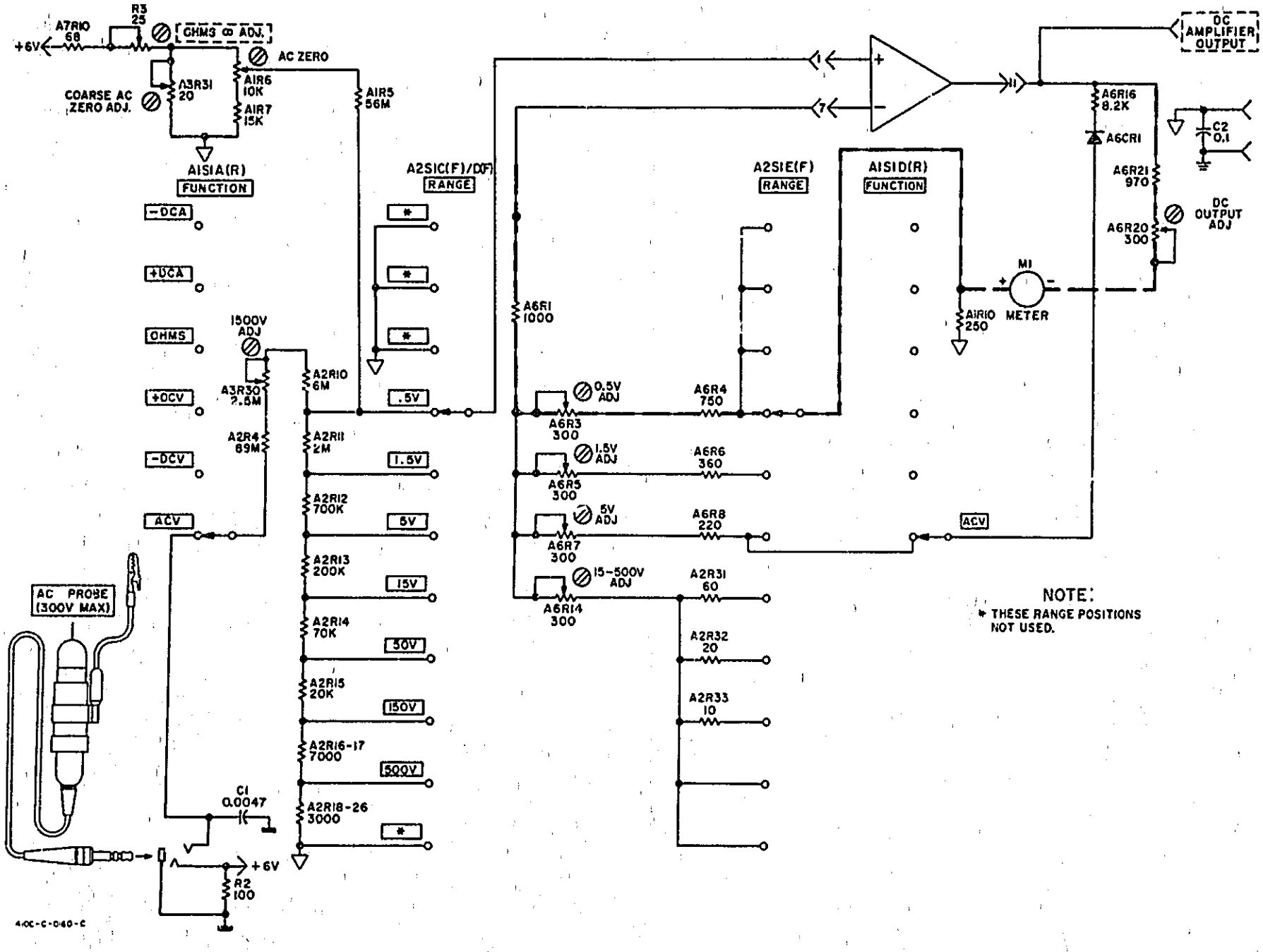


Figure 5-16. Simplified Schematic, AC Voltage Measurement.

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-3 lists parts in alphameric order of their reference designators and indicates the description, -hp- Part Number of each part, together with any applicable notes, and provides the following:

a. Total quantity used in the instrument (Qty column). The total quantity of a part is given the first time the part number appears.

b. Description of the part. (See list of abbreviations in Table 6-1.)

c. Typical manufacturer of the part in a five-digit code. (See Table 6-2 for list of manufacturers.)

d. Manufacturers part number.

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

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (Field Office Locations are listed at the back of the Manual.) Identify parts by their Hewlett-Packard Part Numbers. Include instrument model and serial 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.

Table 6-1. List of Abbreviations.

ABBREVIATIONS

Ag	silver	Hz	hertz (cycle(s) per second)	NPO	negative positive zero (zero temperature coefficient)	sl	slide
Al	aluminum	ID	inside diameter	ns	nanosecond(s) = 10 -9 seconds	SPDT	single pole double throw
A	ampere(s)	impg	impregnated	nsr	not separately replaceable	SPST	single pole single throw
Au	gold	incd	incandescent	Ω	ohm(s)	Ta	tantalum
C	capacitor	ins	insulation(ed)	obd	order by description	TC	temperature coefficient
cer	ceramic	kΩ	kilohm(s) = 10 +3 ohms	OD	outside diameter	TiO_2	titanium dioxide
coef	coefficient	kHz	kilohertz = 10 +3 hertz	p	peak	tog	toggle
com	common	L	inductor	pA	picoampere(s)	tol	tolerance
comp	composition	lin	linear taper	pc	printed circuit	trim	trimmer
conn	connection	log	logarithmic taper	pF	picofarad(s) 10 -12 farads	TSTR	transistor
dep	deposited	mA	milliampere(s) = 10 -3 amperes	piv	peak inverse voltage	V	volt(s)
DPDT	double pole double throw	MHz	megahertz = 10 +6 hertz	p/o	part of	vacw	alternating current working voltage
DPST	double pole single throw	MΩ	megohm(s) = 10 +6 ohms	pos	position(s)	var	variable
elect	electrolytic	met flm	metal film	poly	polystyrene	vdcw	direct current working voltage
encap	encapsulated	mfr	manufacturer	pot	potentiometer	W	watt(s)
F	farad(s)	ms	millisecond	p-p	peak to peak	w/	with
FET	field effect transistor	mtg	mounting	ppm	parts per million	wiv	working inverse voltage
fxd	fixed	mV	millivolt(s) = 10 -3 volts	prec	precision (temperature coefficient, long term stability and/or tolerance)	w/o	without
GaAs	gallium arsenide	μF	microfarad(s)	R	resistor	ww	wirewound
GHz	gigahertz = 10 +9 hertz	μs	microsecond(s)	Rh	rhodium	*	optimum value selected at factory, average value shown (part may be omitted)
gd	guard(ed)	μV	microvolt(s) = 10 -6 volts	rms	root mean square	**	no standard type number assigned, selected or special type
Ge	germanium	my	Mylar ®	rot	rotary	®	Dupont de Nemours
gnd	ground(ed)	nA	nanoampere(s) = 10 -9 amperes	Se	selenium		
H	henry(ies)	NC	normally closed	sect	section(s)		
Hg	mercury	Ne	neon	Si	silicon		
		NO	normally open				

DESIGNATORS

A	assembly	FL	filter	Q	transistor	TS	terminal strip
B	motor	HR	heater	QCR	transistor diode	U	microcircuit
BT	battery	IC	integrated circuit	RP	resistor(pack)	V	vacuum tube, neon bulb, photocell, etc.
C	capacitor	J	jack	RT	thermistor	W	cable
CR	diode or thyristor	K	relay	S	switch	X	socket
DL	delay line	L	inductor	T	transformer	XDS	lampholder
DS	lamp	M	meter	TB	terminal board	XF	fuseholder
E	misc electronic part	MP	mechanical part	TC	thermocouple	Y	crystal
F	fuse	P	plug	TP	test point	Z	network

Table 6-2. Code List of Manufacturers.

Manufacturer No.	Manufacturer Name	Address
H9027	Schurter AGH	Luzern, SW
00853	Sangamo Elect Co.	Pickens, SC 29671
01121	Allen-Bradley Co.	Milwaukee, WI 53204
04713	Motorola Semiconductor Products	Phoenix, AZ 85062
07088	Kelvin Electric Co.	Van Nuys, CA 91401
07263	Fairchild Semiconductor Corp. Div.	Mountain View, CA 94042
08806	GE Co. Miniature Lamp Prod. Dept.	Cleveland, OH 44112
09023	Cornell-Dubilier Elek Div.	Sanford, NC 27330
09134	Texas Capacitor Co. Inc.	Houston, TX 77036
10582	CTS of Asheville Inc.	Skyland, NC 28776
11502	TRW Inc. Boone Div.	Boone, NC 28607
14936	General Instr. Semicon Prod.	Hicksville, NY 11802
16554	VLN Corp. Victoreen Inst. Div.	Cleveland, OH 44103
19701	Mepco/Electra Corp.	Mineral Wells, TX 19701
26365	Gries Reproducer Corp.	New Rochelle, NY 10802
26742	Methode Electronics Inc.	Chicago, IL 60656
27014	Natl Semiconductor Corp.	Santa Clara, CA 95051
28480	Hewlett-Packard Co. Corporate Hq.	Palo Alto, CA 94304
28520	Heyman Mfg. Co.	Kentworth, NJ 07033
30983	Mepco/Electra Corp.	San Diego, CA 92121
34263	CTS of Brownsville Inc.	Brownsville, TX 78520
56137	Spaulding Fiber Co. Inc.	Tonawanda, NY 14150
56289	Sprague Electric Co.	North Adams, MA 01247
70371	3-M Tech Ceramics Products Div.	Chattanooga, TN 37405
71400	Bussman Mfg. Div. of McGraw Edison Co.	St. Louis, MO 63107
71785	TRW Eleck Comp. Clinch Div.	Elk Grove Vlge, IL 60007
73138	Beckman Inst, Inc. Helipot Div.	Fullerton, CA 92634
73734	Federal Screw Products Co.	Chicago, IL 60618
75915	Littlefuse Inc.	Des Plaines, IL 60016
76854	Oak Ind. Inc. SW Div.	Crystal Lake, IL 60014
78189	Illinois Tool Works	Elgin, IL 60126
78553	Tinnerman Products	Cleveland, OH 44101
82389	Switchcraft Inc.	Chicago, Il 60630
83259	Parker Seal Co. Div. Parker Hannifin	Lexington, KY 90231
84411	TRW Capacitor Div.	Ogallala, NE 69153
91637	Dale Electronics Inc.	Columbus, NE 68601
91260	Conner Spring & Mfg. Co.	San Jose, CA 95112
97913	Industrial Electronic Hardware Corp.	New York, NY 10012

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
A1	410C-198		1	SWITCH ASSEMBLY: FUNCTION	28480	410C-198
R1	0727-0004	4	1	R:FXD C FLM 50 Ω ± 1% 1/2W	91637	DCS-1/2-15
R2	0727-0480	4	1	R:FXD C FLM 2.32 MΩ ± 1% 0.5W	91637	DCS-1/2-2324-F
R3, R4				NOT ASSIGNED		
R5	0687-5661	1	2	R:FXD COMP 56 KΩ ± 10% 1/2W	01121	EB5661
R6	2100-0389	4	1	R:VAR WW LIN 10 KΩ ± 10% 1W	02460	AW
R7	0687-1551	1	1	R:FXD COMP 15 KΩ ± 10% 1/2W	01121	EB1551
R8, R9				NOT ASSIGNED		
R10	0727-0479	4	1	R:FXD C FLM 250 Ω ± 1% 1/2W	91637	DCS1/2-251-F
S1	3100-0383	1	1	SWITCH: ROTARY 4-SECTION 6-POSITION (FUNCTION)	76854	5-44643-563
A2	410C-19A			SWITCH ASSEMBLY: RANGE	28480	410C-19A
R1	0728-0004	4	2	R:FXD C FLM 1 Ω ± 1% 1/2W	91637	DCS-1/2-15
R2	0727-0955	4	1	R:FXD C FLM 10.5 Ω ± 1% 1/2W	91637	DCS-1/2-15
R3	0728-0004	4		R:FXD C FLM 1 Ω ± 1% 1/2W	91637	DCS-1/2-15
R4	0753-0018	1	1	R:FXD C FLM 89 MΩ ± 1% 2W	15554	RX-5
R5				NOT ASSIGNED		
R6	0687-1031	1	1	R:FXD COMP 10 KΩ ± 10% 1/2W	01121	EB1031
R7	0727-0478	4	1	R:FXD C FLM 2.21 MΩ ± 1% 1/2W	91637	DCS1/2-2214-F
R8, R9				NOT ASSIGNED		
R10	0730-0176	4	1	R:FXD C FLM 6 MΩ ± 0.5% 1W	91637	DC1-6004-D
R11	0727-0459	1	1	R:FXD C FLM 2 MΩ ± 0.5% 1W	91637	DC1-2004-D
R12	0727-0458	4	1	R:FXD C FLM 700 KΩ ± 0.5% 1/2W	91637	DCS1/2-7003-D
R13	0727-0457	4	1	R:FXD C FLM 200 KΩ ± .5% 1/2 W	91637	DCS1/2-2003-D
R14	0727-0456	4	1	R:FXD C FLM 70 KΩ ± 0.5% 1/2W	91637	DCS1/2-7002-D
R15	0727-0455	4	1	R:FXD C FLM 20 KΩ ± 0.5% 1/2W	91637	DCS1/2-2002-D
R16	0727-0451	4	1	R:FXD C FLM 1000 Ω ± 0.5% 1/2W	91637	DCS1/2-1001-D
R17	0727-0454	4	1	R:FXD C FLM 6000 Ω ± 0.5% 1/2W	91637	DCS1/2-6001-D
R18	0727-0453	4	1	R:FXD C FLM 2000 Ω ± 0.5% 1/2W	91637	DCS1/2-2001-D
R19	0727-0452	4	1	R:FXD C FLM 700 Ω ± 0.5%1/2W	91637	DCS1/2-701-D
R20	0727-0450	4	1	R:FXD C FLM 200 Ω ± 0.5% 1/2W	91637	DCS1/2-201-D
R21	0727-0449	4	1	R:FXD C FLM 100 Ω ± 1% 1/2W	91637	DCS-1/2-15
R22	0727-0448	4	2	R:FXD C FLM 20 Ω ± 1% 1/2W	91637	DCS1/2-20R0-F
R23	0727-0446	4	1	R:FXD C FLM 7 Ω ± 1% 1/2W	91637	DCS-1/2-15
R24	0727-0445	4	1	R:FXD C FLM 2 Ω ± 1% 1/2W	91637	DCS-1/2-15
R25	410C-268		1	R:FXD 0.7 Ω	28480	410C-268
R26	410C-26A		1	R:FXD 0.3 Ω	28480	410C-26A
R27 THRU R29				NOT ASSIGNED		
R30	0727-0701	4	1	R:FXD C FLM 845 Ω ± 1% 1/2W	91637	DCS-1/2-845R-F
R31	0727-0031	4	1	R:FXD C FLM 60 Ω ± 1% 1/2W	91637	DCS-1/2-15
R32	0727-0448	4		R:FXD C FLM 20 Ω ± 1% 1/2W	91637	DCS-20R0-F
R33	0727-0948	4	1	R:FXD C FLM 10 Ω ± 1% 1/2W	91637	DCS1/2-10R0-F
R34*	0687-1011	1	1	R:FXD COMP 100 Ω ± 10% 1/2W	01121	EB1011
S1	3100-0382	1	1	SWITCH: ROTARY 5-SECTION 11-POSITION (RANGE)	76854	5-43633-561
A3	00410-66502		1	ASSEMBLY: AMPLIFIER	28480	00410-66502
C6	0160-2204	2	1	C:FXD 100 PF 300V	00853	RUM15F101J3C
C12	0160-4402	3	1	C:FXD .1UF .10 100V	84411	HEW446
C13	0160-4402	3	1	C:FXD .1UF .10 100V	84411	HEW446
CR1	1901-0040	6	2	DIODE: SI .05A 30V	07263	FDH1088
CR2	1901-0040	6		DIODE: SI .05A 30V	07263	FDH1088
CR7	1902-0556	0	1	DIODE: BREAKDOWN 20V 5%	04713	SZ11213-227
CR9	1902-0202	0	1	DIODE: BREAKDOWN 15V 5%	04713	MZ11213-191
F1	2110-0077	5	1	FUSE: 1/8 A	75915	276.125
Q1	1855-0246	6	1	TRANSISTOR: JFET DUAL N-CHAN	27014	SF83075
R4	0811-2845	2	4	R: FXD 24.97K .025% .25W	07088	KP130
R5	0811-2845	2		R: FXD 24.97K .025% .25W	07088	KP130
R6	2100-3122	2	1	R: TRMR 100 10% 17 TURN	73138	89PR100
R7	0698-7670	9	1	R: FXD 23.69K .1% .125W	19701	MF4C 1/8-T2-25691-B
R9	0698-6325	4	1	R: FXD 100 .1% .125W	91637	CMF-55-1,T-9
R10	0811-2845	2		R: FXD 24.97K .025% .25W	07088	KP130
R11	0811-2845	2		R: FXD 24.97K .025% .25W	07088	KP130
R12	2100-3103	2	1	R: TRMR 10K 10% 17 TURN	73138	89PR10K
R13	0757-0401	9	1	R: FXD 100 1% .125W	19701	MF4C-1
R18	0698-3618	2	1	R: FXD 82 5% 2W	11502	GS-5
R30	2100-3854	7	1	R: TRMR 2.5M 20% 1-TRN	30983	8017SMW2.5M
R31	2100-3426	2	1	R: TRMR 20 10% 1-TRN	73138	72XR20
R32	0683-6245	1	1	R: FXD 620K 5% .25W	01121	CB6245
R33	0683-1055	1	1	R: FXD 1M 5% .25W	01121	CB1055
R34	0683-6225	1	2	R: FXD 6.2K 5% .25W	01121	CB6225
R35	0683-6225	1		R: FXD 6.2K 5% .25W	01121	CB6225
R36	0683-1025	1	1	R: FXD 1K 5% .25W FC TC=400/+500	01121	CB1025
U1	1826-0035	6	1	IC OP AMP	27014	LM308AH

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4, A5				NOT ASSIGNED		
A6	4110C-658			ASSEMBLY: CALIBRATION	28480	4110C-658
CR1	1901-0025	6	1	DIODE: SI 50 MA	07263	FDH536
R1	0737-0751	4	1	R:FXD C FLM 1000 Ω ± 1% 1/2W	91637	DCS-1/2-15
R2				NOT ASSIGNED		
R3	2100-0159	4	5	R:VAR WW LIN 300 Ω ± 20% 1W	10582	SERIES 110
R4	0727-0747	4	2	R:FXD C FLM 750 Ω ± 1% 1/2W	91637	DCS1/2-751-F
R5	2100-0394	4		R:VAR WW LIN 500 Ω ± 20% 1W	10582	SERIES 110
R6	0728-0011	4	1	R:FXD C FLM 360 Ω ± 1% 1/2W	91637	DCS1/2-361-F
R7	2100-0394	4		R:VAR WW LIN 500 Ω ± 20% 1W	10582	SERIES 110
R8	0728-0010	4	1	R:FXD C FLM 220 Ω ± 1% 1/2W	91637	DCS-1/2-15
R9 THRU R13				NOT ASSIGNED		
R14	2101-0394	4		R:VAR WW LIN 500 Ω ± 20% 1W	10582	SERIES 110
R15				NOT ASSIGNED		
R16	0698-5845	4	1	R:FXD 8.25K 1% .25W	91637	CMF-60-1,T-9
R17	0727-0865	4	1	R:FXD C FLM 180 Ω ± 1% 1/2W	91637	DCS1/2-180-F
R18	2100-0394	4		R:VAR WW LIN 500 Ω ± 20% 1W	10582	SERIES 110
R19				NOT ASSIGNED		
R20			1	R:VAR COMP LIN 500 Ω ± 20% 1/4W		
R21	0727-0973	4	1	R:FXD C 970 Ω ± 0.5% 1/2W	91637	DC6-1/2-15
A7	4110C-65C			ASSEMBLY: POWER SUPPLY	28480	4110C-65E
C1*	0140-0025	7	1	C: FXD MICA 6PF ±10% 500 VDC	00853	RCM15E680K
CR1 THRU CR5				NOT ASSIGNED		
CR6	1902-0026	0	1	DIODE: BREAKDOWN 36.5V ±10% 0.4W	04713	SZ30016-343
CR7	1902-3149	2	1	DIODE: BREAKDOWN 9.09V 5% DO-7	04713	SZ30016-170
CR8	1902-0048	0	1	DIODE: BREAKDOWN 6.81V 5% DO-7	04713	SZ30016-134
J4	1251-0213	4	1	CONNECTOR: 15 PIN PC	26742	91-6915-1700-00
R1,R2	0764-0003	1	2	R: FXD MET FLM 3300 ±5% 2W	11502	G5-3
R3	0757-0757	9	1	R: FXD 15K 1% .25W	19701	MF52C-1
R4	0764-0026	2	1	R: FXD MET FLM 13K ±5% 2W	11502	G5-5
R5,R6				NOT ASSIGNED		
R8	0757-0334	9	1	R: FXD 301 1% .25W	19701	MF52C-1
R9				NOT ASSIGNED		
R10	0757-0799	9	1	R: FXD MET FLM 68.1 1% .25W	19701	MF52C-1
A8	11036A			ASSEMBLY: AC PROBE (HP MODEL 11036A, COMPLETE)	28480	11036A
C1				NOT SEPARATELY REPLACEABLE, PART OF AC PROBE (11036A)		
C2				NOT SEPARATELY REPLACEABLE, PART OF AC PROBE (11036A)		
P1	1251-3709	5	1	PLUG: TELEPHONE 3 CONDUCTOR	82389	2P-1297
R1				NOT SEPARATELY REPLACEABLE, PART OF AC PROBE (11036A)		
V1	00910-87901			TUBE: ELECTRON DIODE	28480	00910-87901
C1	0170-0021	3	1	C:FXD MY 4700 PF ± 10% 400 VDCW	84411	663UW4700
C2	0170-0022	6	1	C:FXD MY 0.1 µF ± 10% 600 VDCW	09134	TYPE 2A
C3	0150-0023	2	1	C:FXD CER 2000 PF ± 20% 1000 VDCW	56289	20C295A2-CDM
C4				NOT ASSIGNED		
C5	0180-0025	2	1	C:FXD AL ELECT 4X20 µF +50% -10% 450 VDCW	56289	D32452DFP
C6	0180-0155	7	2	C:FXD AL ELECT 2X1200 µF +100% -10% 20 VDCW	56289	D37303DFP
CR1, CR2	1901-0036	6	1	DIODE:HV RECT 1KV 600MA	14936	MP496
CR3, CR4	1901-0049	0	1	DIODE:PWR RECT 50V 750MA	04713	SR1358-6
DS1	2140-0458	0	1	LAMP-INCAND 6.3 VDC 40MA	08806	388
F1	2110-0201	0		FUSE: 0.25A 250V	71400	MDL-1/4
J1	1251-0260	5	1	JACK: TELEPHONE 3 CONDUCTOR	82389	3J-1291A
J2				ASSEMBLY: DC AMPLIFIER OUTPUT (SEE MISCELLANEOUS FOR PART NOS.		
J3	1251-2357	5	1	CONNECTOR: POWER CORD RECEPTACLE	82389	EAC-301
M1	1120-0317		1	METER: 0-1 MA	28480	1120-0317
Q1	1853-0063	0	1	TSTR: SI PNP	04713	SJE407

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3 (CONT'D)						
R1	0727-0274	4	1	R:FXD C FLM 1 MΩ ± 1% 1/2W	91637	DC1/2-1004-F
R2	0757-0401	9	1	R:FXD 100 1% .125W	19701	MF4/-1
R3	2100-0415	4	1	R:VAR WW LIN 25 Ω ± 10% 2W	10582	117
R4,R5				NOT ASSIGNED		
R6	0727-0231	4	1	R:FXD-244K ± 0.5% 1/2W	91637	DC5-1/2-15
R7	0727-0166	4	1	R:FXD 15K-2-1% 1/2W	91637	DC5-1/2-15
R8	2100-1567	4	1	R:TRMR 10K 10%	10582	117
R9	0727-0380	4	1	R:FXD 25.5K	91637	DC5-1/2-15
S1	3101-1248	1	1	SWITCH: SPST PUSHBUTTON (LINE)	76854	53-55480-121-A1H
S2	3101-1234	5	1	SWITCH: DPDT SLIDE (SLECTOR)	82389	11A-12V2A
T1	9100-0179	2		TRANSFORMER: POWER 115/230V	28480	9100-0179
W1	8120-1348	2	1	CABLE: POWER 3 CONDUCTOR 7-1/2 FT. LONG	28480	8120-1348
XQ1	1200-0044	3	1	SOCKET: TRANSISTOR TO-3	97913	LSF1502-3

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-3. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
				MISCELLANEOUS		
	1490-0028	0	1	CLIP: GROUND	71785	422-11-11-095
	1510-0084	2	2	BINDING POST	28480	1510-0084
	1510-0087	2	1	BINDING POST ASSEMBLY	28480	1510-0087
	0340-0732	2	5	INSULATOR BINDING POST	28480	0340-0732
	11036-42102	2	1	BOOT: AC PLUG (P/O 11036A)	28480	11036-42102
	11036-42101	2	1	BOOT: AC PROBE (P/O 11036A)	28480	11036-42101
	412A-83A	2	3	BOOT: CABLE	28480	412A-83A
	410C-12B	2	1	BRACKET: SWITCH (USED WITH A6 CONNECTOR)	28480	410C-12B
	00410-01202		2	BRACKET: COVER RETAINER	28480	00410-01202
	410C-12A	2	1	BRACKET: CONNECTOR (USED WITH A5 CONNECTOR)	28480	410C-12A
	1200-0081	3	2	BUSHING: INSULATOR (USED WITH Q1)	26365	574 SPECIAL
	1410-0091	1	2	BUSHING: PANEL (USED WITH A1S1 AND A2S2)	28520	SB-437-4
	0400-0019	2	3	BUSHING: STRAIN RELIEF	28480	0400-0019
	410C-1A	2	1	CHASSIS: TRANSFORMER	28480	410C-1A
	410B-21H	2	1	CLIP: GROUNDING (P/O 11036A)	28480	410B-21H
	410B-21P	2	1	CONTACT: DIODE (P/O 11036A)	28480	410B-21P
	3130-0038	1	1	COUPLER: SWITCH-ROTARY	76854	16591-M1
	5000-8565		1	COVER: SIDE	28480	5000-8565
	00410-64102		1	COVER: TOP (REQUIRES 2 BRACKETS 00410-01202)	28480	00410-64102
	5000-8571		1	COVER: BOTTOM	28480	5000-8571
	5060-0727		2	FOOT ASSEMBLY	28480	5060-0727
	5060-0703		2	FRAME: SIDE	28480	5060-0703
	5040-0700		2	HINGE (USED WITH TILT STAND)	28480	5040-0700
	1400-0089		1	INSULATOR: CLIP (P/O 11036A)	28480	1400-0089
	0340-0086		1	INSULATOR: BINDING POST DOUBLE	28480	0340-0086
	0340-0091		1	INSULATOR: BINDING POST TRIPLE	28480	0340-0091
	1520-0001	6	2	INSULATOR: CAPACITOR (USED WITH C1-C2)	56137	XP
	0340-0007	0	1	INSULATOR: CERAMIC STANDOFF	70371	
	0370-0112	2	1	KNOB: BLACK BAR CONCENTRIC	28480	0370-0112
	0370-0113	2	1	KNOB: BLACK BAR W/ARROW	28480	0370-0113
	0370-0114	2	1	KNOB: RED W/ARROW	28480	0370-0114
	0360-0016	3	1	LUG: SOLDER LOCK #4	78189	
	0360-0007	3	4	LUG: SOLDER, #10	78189	2501-10-00
	0360-0042	3	2	LUG: SOLDER 90°	78189	08D
	2260-0001		4	NUT: HEX 4-40 X 1/4 IN.	28480	2260-0001
	2420-0001	0	4	NUT: HEX 6-32 X 5/16 IN. W/LOCK	78555	
	2820-0001	5	3	NUT: HEX 10-32 X 3/8 IN.	73734	08D
	2950-0006	5	3	NUT: HEX 1/4-32 X 5/8 IN.	73734	9000
	2950-0001	5	3	NUT: HEX 3/8-32 X 1/2 IN.	73734	08D
	2950-0037	0	1	NUT: HEX 1/2-16 X 11/16 IN.	78555	C6800-632-24B
	2950-0038	5	1	NUT: HEX 1/2-24 X 11/16 IN.	75915	903-32
	0590-0039	0	4	NUT: SPEED 6-32	78555	C6800-632-1
	0590-0052	0	2	NUT: SPEED 6-32	78555	C8020-632-4
	410C-41A		1	PLATE: INSULATOR (USED WITH A1S1 AND A2S2)	28480	410C-41A
	0340-0580		1	INSULATOR-XSTR THRM-CNDCT	28480	0340-0580
	1251-0209	5	1	PLUG: TELEPHONE (P/O 11036A)	82389	2P-1297
	00410-42101		1	PROBE: CONTACT BODY (P/O 11036A)	28480	00410-42101
	00410-42102		1	PROBE HEAD (P/O 11036A)	28480	00410-42102
	410B-21F		1	RING: RETAINER (P/O 11036A)	28480	410B-21F
	2200-0006	5	2	SCREW: MACHINE 4-40 X 3/8 IN RH	73734	08D
	2200-0014	5	2	SCREW: MACHINE 4-40 X 9/16 IN RH	73734	08D
	2370-0001	5	20	SCREW: MACHINE 6-32 X 1/4 IN. RH	73734	08D
	2390-0007	5	4	SCREW: MACHINE 6-32 X 5/16 IN BH W/LOCK	73734	08D
	2370-0002	5	8	SCREW: MACHINE 6-32 X 3/8 IN FH	73734	08D
	2370-0003	5	2	SCREW: MACHINE 6-32 X 1/2 IN FH	73734	08D
	410B-21E		1	SLEEVE (P/O 11036A)	28480	410B-21E
	1460-0006	0	1	SPRING: DIODE CONTACT (P/O 11036A)	91260	08D
	1490-0031	0	1	STAND: TILT	91260	08D

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
	410C-66A		2	SUPPORT: CIRCUIT BOARD (USED WITH A3)	28480	410C-66A
	410C-21D		1	TEST LEAD ASSEMBLY: COM	28480	410C-21D
	410C-21C		1	TEST LEAD ASSEMBLY: DCA + OHMS	28480	410C-21C
	410C-21A		1	TEST LEAD ASSEMBLY: DCV (INCLUDES R1)	28480	410C-21A
	5020-5352		1	TRIM: METER	28480	5020-5452
	11036-62101		1	TUBE: SOCKET AND CABLE ASSEMBLY (P/O 11036A)	28480	11036-62101
	3050-0066	5	2	WASHER: FLAT #6	73734	OBD
	3050-0067	5	3	WASHER: FLAT 3/8 IN. ID	73734	OBD
	0900-0016	3	1	O-RING: FUSE HOLDER	61259	2-112-N674-70
	2190-0005	8	2	WASHER: LOCK #4 EXTERNAL	78189	OBD
	2190-0004	8	2	WASHER: LOCK #4 INTERNAL	78189	SF1904
	2190-0002	8	2	WASHER: LOCK #4 SPLIT	78189	OBD
	2190-0047	8	30	WASHER: LOCK #6 COUNTERSUNK	78189	OBD
	2190-0011	8	2	WASHER: LOCK #10 INTERNAL	78189	1910
	2190-0028	8	2	WASHER: LOCK #10 INT/EXT	78189	4010-18-00
	2190-0027	8	3	WASHER: LOCK 1/4 IN INTERNAL	78189	1914
	2190-0022	8	4	WASHER: LOCK 3/8 IN ID	78189	1920
	2190-0037	8	2	WASHER: LOCK 1/2 IN INTERNAL	78189	1224-08
	1400-0090	5	1	WASHER: NEOPRENE	75915	901-7
	2580-0004		1	NUT-HEX-W/LKWR 4-32-THD	00000	ORDER BY DESCRIPTION
	0360-0014		1	BARRIER BLOCK 2-TERM GAI PHEN	28480	0360-0014
	00410-00222		1	PANEL: REAR	28480	00410-00222
	00410-00221		1	PANEL: FRONT	28480	00410-00221
	00410-01213		1	BRACKET: CONNECTOR (USED WITH A3 CONNECTOR	28480	00410-01213
	8150-0022		1	WIRE: RED 5 IN	28480	8150-0022
	8150-0037		1	WIRE: WHITE/RED 5 IN	28480	8150-0037
	8150-0036		1	WIRE: WHITE/ORANGE 5 IN	28480	8150-0036
	8150-0040		1	WIRE: YELLOW/WHITE 5 IN	28480	8150-0040
	0370-1095		1	KNOB-BASE 1/2 OBP .25-IN-ID	28480	0370-1095
	2190-0022		1	WASHER: LK INTL T 3/8 IN	28480	2190-0022
	2950-0001		2	NUT-HEX-DBL-CHAM 3/8-32-THD	00000	ORDER BY DESCRIPTION
	2110-0564	9	1	FUSEHOLDER BODY 12A MAX FOR UL	06328	031.1651
	2110-0565		1	FUSEHOLDER CAP 12A MAX FOR UL	28480	2110-0565
	2110-0569		1	FUSEHOLDER NUT 12A MAX FOR UL	28480	2110-0569
	1400-0090		1	FUSEHOLDER COMPONENT FOR USE ON	28480	1400-0090

See introduction to this section for ordering information
*Indicates factory selected value

MANUAL CHANGES

MANUAL CHANGES

-hp- MODEL 410C

ELECTRONIC VOLTMETER

New or Revised Item

Manual Part Number 00410-90009

CHANGE NO. 1

Title Page. Change the instrument serial numbers to which this 00410-90009 manual applies from "Serial Numbers: 0982A22339 and Above" to read "Serial Numbers: 0982A22439 and Above". Change the NOTICE statement from "For those instruments with serial numbers 0982A22338 and below, refer to Manual Part No. 00410-90007." to read "For those instruments with serial numbers 0982A22438 and below, refer to Manual Part No. 00410-90007."

Page 5-13, Figure 5-8 and Page 6-4, Replaceable Parts. Change the A6 Calibration Assembly part number from 410C-65B to 00410-66505. In Figure 5-8, the change should be made on both the schematic and component locator.

Page 5-13, Figure 5-8. Change the value of A6R20 from 300 ohms to 500 ohms.

Page 6-4, Replaceable Parts. For A6R20, make the following additions and changes:

Reference Designation	-hp- Part Number	C D	Qty
R20	2100-3351	2	1

Description	Mfr. Code	Mfr. Part No.
R: TRMR 500Ω10%	73138	72XR500

CHANGE NUMBER 2.

For Serial Numbers 0982A22449 and above with solid state amplifier board (A3) P/N 00410-66502.

Page 5-7, Paragraph 5-30. Amplifier Current Adjustment. Change the paragraph to read:

a. Connect a 3466A voltmeter or equivalent voltmeter with an input impedance of 10 Mohms or greater across A3R7.

b. Adjust A3R12 so that the voltmeter reads 8.240 Vdc; 400 micro amps will flow through R7 with this reading.

Page 5-13, Figure 5-8. Amplifier Schematic. Change R7 in the biasing circuitry of the main amplifier to 20.605 Kohm, as shown in Figure CS1.

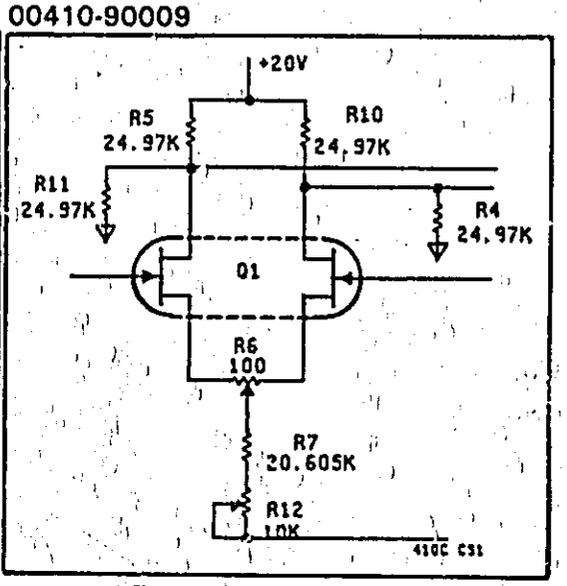


Figure CS1. Amplifier Schematic

Page 6-3, Table 6-3, Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description
DELETE: A3,R7	0698-7670	9	1	R: FXD 23.69K .1% .125W
ADD: A3,R7	0698-7371	9	1	R: RXD 20.605K .1% .125W