TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL INCLUDING REPAIR PARTS AND SPECIAL TOOLS LISTS

FOR

TELEPHONE TEST OSCILLATOR TS-3329/U (NSN 6625-00-251-5211) (HEWLETT-PACKARD MODEL 236A)

H E A D Q U A R T E R S , D E P A R T M E N T O F T H E A R M Y

8 FEBRUARY 1980

WARNING

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

TECHNICAL MANUAL No. 11-6625-2903-14&P } HEADQUARTERS, DEPARTMENT OF THE ARMY WASHINGTON, DC *8 February 1980*

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL INCLUDING REPAIR PARTS AND SPECIAL TOOLS LISTS FOR TELEPHONE TEST OSCILLATOR TS-3329/U (NSN 6625-00-251-5211) (HEWLETT-PACKARD MODEL 236A)

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in back of the manual direct to: Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-ME-MQ, Fort Monmouth NJ 07703.

In either case a reply will be furnished direct to you.

This manual is an authentication of the manufacturer's commercial literature which, through usage, has been found to cover the data required to operate and maintain this equipment. Since the manual was not prepared in accordance with military specifications and AR 310-3, the format has not been structured to consider levels of maintenance.

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SECTION 0
INTRODUCTION

0-1. Scope

This manual applies to HP Model 236A, telephone test oscillator, Serial Numbers: 1107A6774 and greater. See Appendix A to adapt manual to earlier serial numbers. The equipment will be referred to as the Oscillator throughout the manual.

0-2. Indexes of Publications

a. DA Pam 310-4. Refer to the latest issue of DA Pam 3i0-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

b. DA Pam 310-7. Refer to DA Pam 310-7 to determine whether there are modification work orders (MWO's) pertaining to the equipment.

0-3. Maintenance Forms, Records and Reports

a. Report of Maintenance and Unsatisfactory Equipment. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by TM 38-750, the Army Maintenance Management System.

b. Report of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Packaging Improvement Report) as prescribed in AR 700-58/NAVSUPINST/4030.29/AFR 71-12/MCO P4030.29A, and DLAR4145.8.

c. Discrepancy in Shipment Report (DISREP) (SF361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/NAVSUPINST 4610.33B/AFR 75-18/MCOP4610.19C and DLAR 4500.15.

0-4. Reporting Equipment Improvement Recommendations (EIR)

If your TS-3329/U needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design. Tell us why a procedure is hard to perform. Put it on an SF 368 (Quality Deficiency Report). Mail it to us at Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-ME-MQ, Fort Monmouth, NJ 07703. A reply will be furnished to you

0-5. Administrative Storage

Administrative storage of equipment issued to and used by Army activities shall be in accordance with TM 740-90-1.

0-6. Destruction of Army Electronics Materiel

Destruction of Army Electronics materiel to prevent enemy use shall be in accordance with TM 750-244-2.

SECTION I
GENERAL INFORMATION

1-1. INSTRUMENT DESCRIPTION.

1-2. The -hp- Model 236A Oscillator generates sine wave signals from 50 Hz to 560 kHz at an output level adjustable from + 10 dBm to - 31 dBm in steps of 10, 1, and 0.1 dBm. The frequency is controlled by the position of the FREQUENCY dial, multiplied by the setting of the FREQ RANGE switch Specifications for this Oscillator are given in Table 1-1

1-3. The FUNCTION switch selects a balanced output with impedance of 600 or 900 ohms from 50 Hz to 20 kHz and 135 ohms from 5 kHz to 560 kHz The first position of the FUNCTION switch, designated DIAL/DC, connects the DC TEST meter to the power supply for checking the battery or the ac power supply in this position of the FUNCTION switch, the DIAL terminals are connected to the OUTPUT terminals for dial through operation The FUNCTION switch also provides a HOLD position for 600 and 900 ohm OUTPUT impedance's to simulate an OFF-HOOK condition The added path furnishes a shunt for dc but offers high impedance to the oscillator signal.

1-4. The impedance's designated on the positions of the FUNCTION switch are held constant with variations the OUTPUT LEVEL control

1-5. INSTRUMENT IDENTIFICATION.

1-6. Hewlett-Packard uses a two-section serial number The first section (prefix) identifies a sense of instruments. The last section (suffix) identifies a particular instrument within the series if a letter is included with the serial number, it identifies the country in which the instrument was manufactured if the serial number of your instrument is lower than the one on the title page of this manual, refer to Appendix A for backdating information that will adapt this manual to your instrument. All correspondence with Hewlett-Packard should include the complete serial number

1-7. APPLICATIONS.

1-8. This Oscillator is specifically designed to be used by telephone and communication companies. The OUTPUT impedance's, OUTPUT connectors, DIAL connectors and the frequency range of the Oscillator make it applicable for telephone system testing and troubleshooting.

Table 1-1. Specifications.

Frequency Range: 50 Hz to 560 kHz in 4 ranges. Frequency Dial Accuracy: ± 3% Frequency Response 135 Ω 5 kHz to 560 kHz ± 5 dB 600 Ω and 900Ω*: 50 Hz to 20 kHz ± 3 dB *With Hold on accuracy only specified from 100 Hz to20 kHz Output Power: + 10 to - 31 dBm in 0.1 dBm steps Output Level Accuracy: Absolute Accuracy ± 0.2 dB. (1 kHz reference) Attenuator Relative Accuracy Each attenuator ±0.5dB.	Distortion: At least 40 dB below fundamental output Noise: At least 65 dB below total output, or below - 90 dBm, whichever noise is greater Output Balance: 135 ohms: >50 dB at5 kHz >30 dB at 560 kHz 600 and 900 ohms: >70 dB at 100 Hz > 55dB at 3 kHz Output Impedance: 135 ohms ± 10%, 5 kHz to 560 kHz 600 and 900 ohms ± 5%, 50 Hz to 20 kHz

Table 1-2. General Information.

Hold Circuit 600 and 900 ohms only Applied loop currents of over 60 mA will degrade accuracy specifications Hold coil used, ≈ 10 Henry, dc resistance 700 Ω ± 10% Output Circuit Balanced and Floating Metallic (Tip to Ring) 150 V peak Longitudinal (Tip or Ring to ground) ± 200 V dc plus 200 V rms Output Connectors Jacks to accept Western Electric 241, 309, and 310 plugs. Binding posts accept Banana Plugs, Spade Lugs, Phone Tips, or Bare Wires	Dial/AC Monitor Jacks Will accept Western Electric 309 and 310 Plugs Accepts WE 1011 B Linemans Handset or Type 52 Headsets Power Requirements Internal Battery Single NEDA 202 45 V "B" Battery furnished. Expected battery life is 180 hours at 3 hours per day discharge cycle at 70° F (21° C) AC: 115V or 230V ± 10%, 48-440 Hz, 10vA Dimensions 7-3/4" wide x 10-1/2" high x 8-1/16": deep (196,9 x 266,7 x 204,8 MM) Weight: Net: 13.5 lbs (6,2 KG) Shipping 18.5 lbs (8,3 KG).

SECTION II
INSTALLATION

2-1. INSPECTION.

2-2. The instrument was carefully inspected both mechanically and electrically before shipment it should be physically free of mars or scratches and in perfect electrical condition on receipt. To confirm this, the instrument should be inspected for physical damage in transit, for supplied accessories and for electrical performance. Paragraph 5-7 outlines the electrical performance checks using test equipment listed in Table 5-1. If there is damage or deficiency, see the warranty on the inside front cover of this manual

2-3. POWER REQUIREMENTS.

2-4. This Oscillator is designed to operate from a 45 volt internal battery or an ac power source (115 V ac or 230 V ac, 48 to 440 Hz). The power source is selected by a slide switch on the left side of the Oscillator case. Normally, the power transformer will be connected for 115 V ac unless otherwise specified If a change to a 230 V ac power supply voltage is desired, the dual primary of the power transformer is changed from a parallel configuration to a sense configuration. These connections are shown in the schematic diagram located in Section V.

2-5. THREE-CONDUCTOR POWER CABLE.

2-6. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. All Hewlett-Packard instruments are equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The power cable is detachable from the instrument and is stored inside the front cover. To remove this cover from the instrument, release the two spring latches on either side of the instrument, then lift the cover. When replacing the cover, first check the latches for released position, then place cover in position for latching.

CAUTION

Do not force cover into place. There is a protection on the cover which turns the power switch to the off position to preserve battery life. If this is not binding, the cover fits easily into place. The cover may be installed in either position.

2-7. BATTERY.

2-8. This instrument is operated from a single 45 v battery when the power selection switch, on the left side of the case, is in the BAT position and a suitable battery is installed. (See Table 2-1 for batteries suitable for use in this Oscillator.)

Table 2-1. Suitable Batteries

Manufacturer	Mfr. Part No
Hewlett-Packard	1420-0026
Western Electric	KS-14370
NEDA	202
Eveready	482
Burgess	M-30
RCA	VS013
Bright Star	3033-158, 30-33
Mallory	M-202
Ray-O-Vac	202, P7830
Sears	6461
Wards	42
Wizard	386241
Zenith	2783
General	W30B
Marathon	4202
National Carbon	482
Military	BA-59

2-9. INSTALLATION AND REMOVAL OF BATTERY.

2-10. To install or replace a battery, turn the four 1/4 turn fasteners on the battery cover counterclockwise to remove the cover. Lift the battery out of its recess and unplug the three-prong connector.

2-11. Reverse the above procedure when installing a new battery

2-12. REPACKAGING FOR SHIPMENT.

NOTE

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

2-13. The following is a general guide for repackaging an instrument for shipment.

a. Place instrument in original container if available.

If original container is not used,

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

c. Use plenty of packing material around all sides of instrument.

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

e. Mark shipping container with "Delicate Instrument" or "Fragile".

SECTION III

OPERATION

3-1. INTRODUCTION.

3-2. The Oscillator generates a stable sine wave output at frequencies from 50 Hz to 560;kHz-with an output amplitude of +10 dBm to -31 dBm. The output is balanced to chassis and case ground and is available from the front panel with standard binding posts and telephone jacks. The Oscillator is portable and battery powered for field operation. Provisions are made for talking and dialing with hookswitch control.

3-3. DESCRIPTION OF FRONT PANEL CONTROLS.

3-4. The designation and description of the front panel and left side, controls are given in Figure 3-1.

3-5. CALIBRATION.

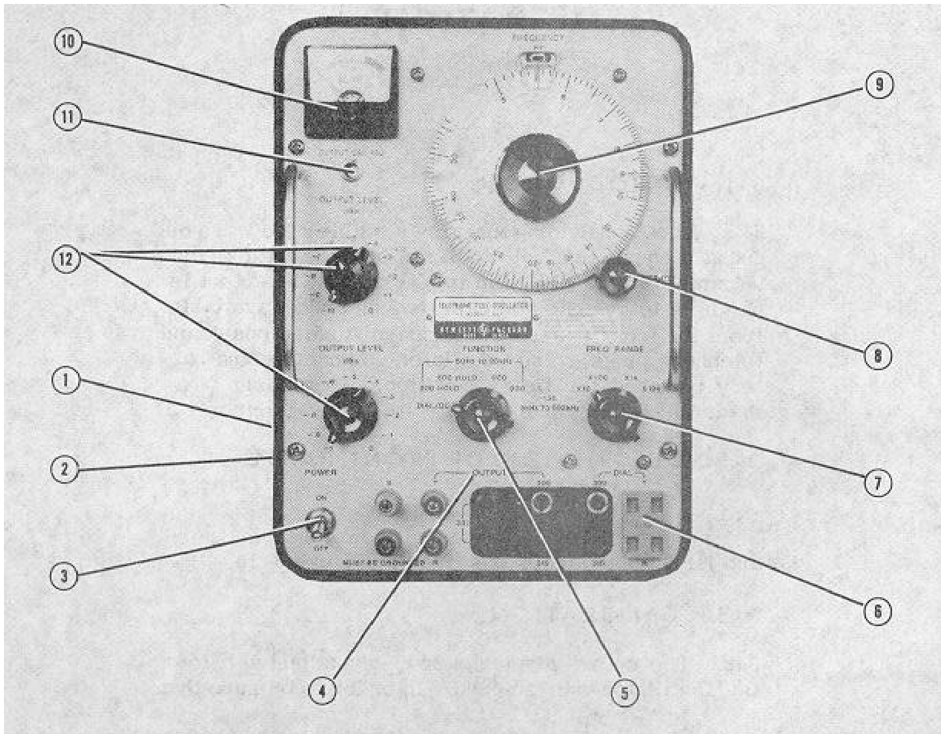
3-6. The output level was properly adjusted before the Oscillator was shipped. In order to be sure that this adjustment has not been disturbed or whenever the maximum accuracy as stated under specifications (Table 1-1) is required, the output power should be calibrated according to the instructions on the inside of the Oscillator cover.

3-7. OPERATING PROCEDURE

3-8. Operating instructions for this Oscillator are given in Figure 3-2. Instructions are keyed to the illustration for front panel and left side controls.

3-9. APPLICATIONS.

3-10. This instrument is specifically designed for use in telephone and communication systems. The Oscillator frequency range, output level, balanced output impedances with the HOLD position of the FUNCTION switch, OUTPUT and DIAL connectors make this instrument specifically adaptable to telephone transmission line checking and troubleshooting.



(1) AC-BAT power source slide switch (left side of instrument case) connects either the battery or the power transformer to the input of power supply board A2.

(2) POWER INPUT: this three-prong connector (left side of instrument case) is used to connect primary power to the Oscillator through the detachable power cord furnished with the instrument.

(3) POWER ON, OFF switch turns instrument power off or on.

(4) OUTPUT connectors

T - Tip R - Ring S - Sleeve G - Chassis and case	Binding posts on 3/4 inch centers to accept standard banana plugs, phone tips, ground spade lugs or bare wires.

241 - Western Electric type 223A lacks on 5/8 inch centers to accept Western Electric type 241 plug.
309 - Western Electric type 246A lack to accept Western Electric type 309 plug.
310 - Western Electric type 238A lack to accept Western Electric type 310 plug.

(5) FUNCTION switch selects output impedance and function. It has six positions: DIAL/DC, 600 HOLD, 900 HOLD, 600, 900 and 135. The 600 and 900 positions are for low frequency outputs (50 Hz to 20 kHz). The 135 position is for high frequency outputs (5 kHz to 560 kHz).

(6) DIAL Connectors

T - Tip R - Ring	Clip connectors to accept Western Electric type 1011B lineman's handset.

309 - Western Electric type 246A lack to accept Western Electric type 309 plug.
310 - Western Electric type 238A lack to accept Western Electric type 310 plug.

(7) FREQ RANGE switch: selects one of four output frequency range multipliers (X10, X100, X1K, X10K).

(8) VERNIER: provides fine frequency adjustment for the frequency dial.

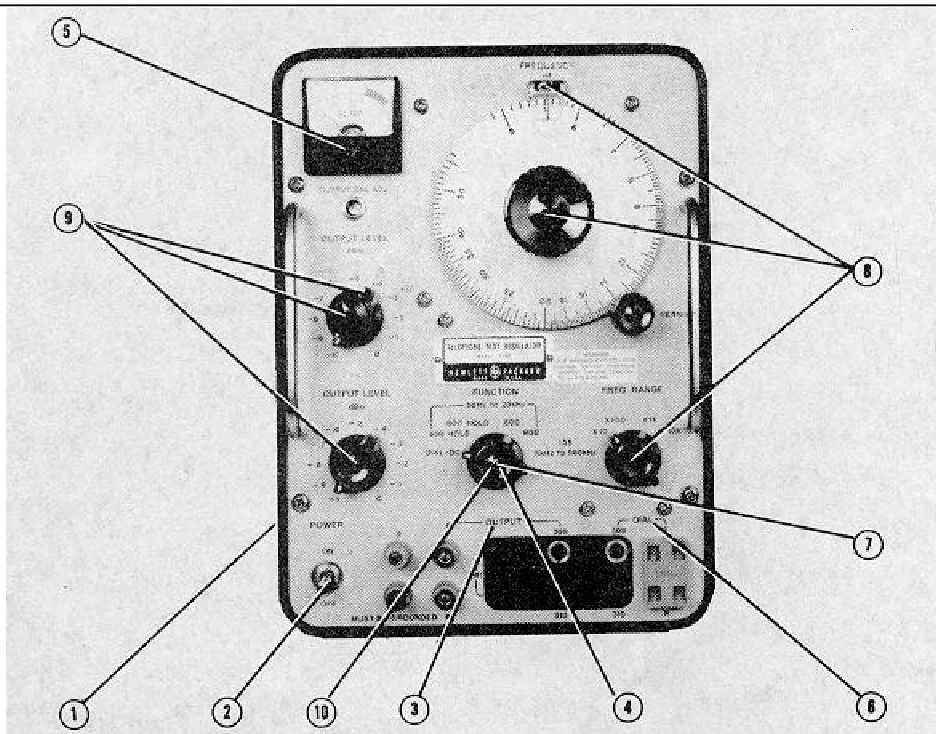
(9) FREQUENCY, HZ: varies the output frequency within the range selected by the FREQ RANGE switch. The dial reading multiplied by the FREQ RANGE setting is the Oscillator output frequency.

(10) DC TEST meter: monitors the unregulated power supply or battery voltage.

(11) OUTPUT CAL ADJ: provides proper output level calibration. The calibration procedure is located on the inside of the Oscillator cover.

(12) OUTPUT LEVEL, DBM: selects output level in steps of 10 dBm, 1 dBm and 0.1 dBm. The output level is the algebraic sum of all output level settings.

Figure 3-1. Front Panel and Left Side Control Description



(1) Set the slide switch located on the left side of the instrument case to the desired power source (BAT or AC).

(2) Turn the power switch to the ON position.

(3) Connect the OUTPUT terminals to the circuit being tested Tip, Ring and Sleeve connections are available at all three types of OUTPUT connectors. The sleeves of all connectors are normally connected to the instrument case and chassis ground through a jumper wire (exposed part insulated) which must be installed by the user on the front panel connectors provided. When using the Oscillator where the sleeve terminal is used for supervision, the jumper wire may be removed to isolate the sleeve from ground. The OUTPUT lacks accept standard telephone plugs as indicated on the front panel. Test frequencies at the impedances and levels indicated on the front panel controls are available from these lacks.

CAUTION

No attempt should be made to use more than one OUTPUT jack at a time

Normal application of ringdown signaling and central office battery voltages will not damage the Oscillator, however, ringing voltage should not be applied continuously. When using patch cords to connect the Oscillator to a circuit, the cord should be plugged into the Oscillator first.

(4) Rotate the FUNCTION switch to the DIAL/DC position.

(5) Monitor the battery or power supply voltage on the DC TEST meter. The Oscillator will operate normally at any meter reading within the GOOD area. A reading at the left hand end of the GOOD area indicates the end of useful battery life on BAT operation or a low power line voltage on ac operation.

(6) The DIAL lacks and clip posts will accept a lineman's handset such as the Western Electric 1011 B or a dial with the impulse springs connected to the tip and ring of a 309 or 310 plug in the DIAL/DC position of the FUNCTION switch, the DIAL jacks are connected to the OUTPUT jacks. The circuit under test must supply the talk battery.

(7) After connection is established, rotate the FUNCTION switch to either 600 HOLD or 900 HOLD. This will provide an off-hook condition to hold the dialed line. The Oscillator output will be connected to the OUTPUT jacks. To release the line, rotate the FUNCTION switch to the 600 or 900 position which provides an on-hook condition or remove the line connection from the OUTPUT jacks.

OSCILLATOR OPERATION

(8) The output frequency is established by a combination of settings of the FREQUENCY dial and the FREQ RANGE switch. The FREQUENCY dial setting, read under the dial cursor, multiplied by the FREQ RANGE switch setting determines the output frequency.
Example: FREQ dial 7 5, RANGE switch X100 = frequency of 750 Hz.

(9) The output amplitude is determined by the setting of the OUTPUT LEVEL controls. The absolute level is the algebraic sum of the three settings.
Example A: OUTPUT LEVEL settings; 10 dBm switch at + 10, 1 dBm switch at - 4, 0 1 dBm switch at -0.7 = 5.3 dBm output
Example b: OUTPUT LEVEL settings; 10 dBm switch at - 10, 1 dBm switch at - 2, 0.1 dBm switch at - 0.5 = - 12.5 dBm output

(10) The FUNCTION switch determines the output impedance and acts as a hookswitch control by virtue of the HOLD position. The 600 HOLD and 900 HOLD positions are for use on subscriber loops and PBX systems. The 600 and 900 positions are for use when the hold feature is not desired or tests are performed on dry trunks. The frequency range for these settings is 50 Hz to 20 kHz.

The 135 position is used in carrier system testing and the holding feature is not available. The frequency range for this setting is 5 kHz to 560 kHz.

Figure 3-2. Operation.

SECTION IV
FUNCTIONING OF EQUIPMENT

4-1. INTRODUCTION

4-2. This instrument consists of an oscillator-amplifier, attenuator, power supply, meter circuit and a selective output circuit. A block diagram of the instrument is shown in Figure 4-2. The Oscillator uses a modified Wien bridge network to generate a stable, low distortion sine wave signal. The peak detector circuit provides a degenerative feedback voltage to the Oscillator circuit to stabilize the output amplitude. There is a three-stage step attenuator which is connected to the output transformers through one section of the FUNCTION switch. The output from the low frequency transformer (50 Hz to 20 kHz) can be selected by the FUNCTION switch for a balanced output of 600 ohms impedance, 600 ohms hold, 900 ohms and 900 ohms hold. In the hold positions, L1 completes the path for dc on the line but offers a high impedance to the ac Oscillator output. The output from the high frequency transformer (5 kHz to 560 kHz) has a balanced 135 ohm impedance. In the DIAL/DC position of the FUNCTION switch, the power supply voltage is monitored and the OUTPUT terminals are disconnected from the Oscillator and connected to the DIAL terminals. The power source can either be a 45 volt dry cell or 115/230 V ac. The regulated output of the supply is plus and minus 13 volts dc.

4-3. CIRCUIT DESCRIPTION.

4-4. <u>OSCILLATOR.</u>

4-5. The Oscillator circuit generates a sinusoidal signal at the frequency selected by the FREQ RANGE switch and FREQUENCY dial located on the front panel. The RC bridge network is a modified Wien bridge circuit consisting of an RC frequency selective network and a resistive voltage divider network. The Wien bridge in this Oscillator differs from the conventional Wien bridge circuit in the design of the resistive voltage divider network. This difference is illustrated in the block diagram, Figure 4-2. The lamp bulb in the conventional Wien bridge is replaced with impedance Z_1.

4-6. Oscillation at the selected frequency is made possible by the use of both regenerative feedback (+ feedback) and degenerative feedback (- feedback) as shown in Figure 4-2. Positive feedback is provided through a frequency sensitive RC network to the gate of A1Q1; negative feedback is provided to the emitter of A1Q2 through a network insensitive to frequency. Only at the selected frequency will the positive feedback exceed the negative feedback voltage to sustain oscillation.

4-7. The FREQ RANGE switch selects combinations of resistors S1R1 through R4 and S1R5 through R8 to establish the frequency sensitive RC network for four ranges. The FREQUENCY dial varies the main tuning elements C1 and C2. The RC components maintain the proper phase relationship of the positive feedback voltage. When Xc = R, the positive feedback voltage is in phase with the Oscillator output voltage (refer to Figure 4-1) and exceeds the negative feedback voltage. At frequencies other than where Xc = R, the positive feedback voltage is neither of the right phase nor of sufficient amplitude to maintain oscillations.

4-8. <u>IMPEDANCE CONVERTER.</u>

4-9. In order to prevent loading of the high impedance bridge circuit, an impedance converter is added (field effect transistor A1Q1) which offers a high impedance to the bridge circuit and a low impedance to the transistor amplifier.

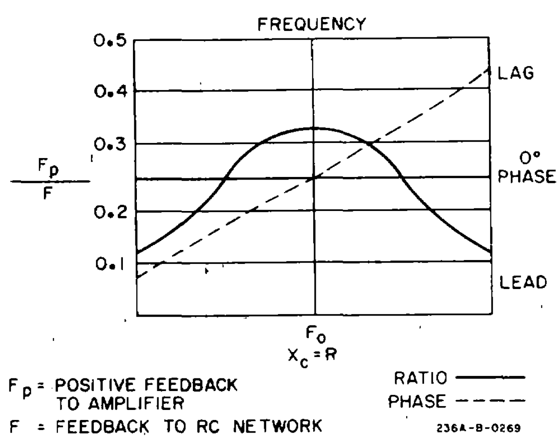


Figure 4-1. RC Network Characteristics

4-10. AMPLIFIER.

4-11. The output of A1Q1 is ac coupled to the three-stage negative feedback amplifier A1Q2 through A1Q5. A1Q2 amplifies the difference between the amplifier-input signal from the frequency selective RC network and the negative feedback signal. This signal is amplified again by A1Q3, which in turn drives A1Q4 and A1Q5, a complimentary symmetry emitter follower pair, for power amplification. This type of power amplifier provides a low output impedance and a wide dynamic range. The complimentary symmetry transistors are forward-biased by diodes A1CR2 and A1CR3 and, under a no signal condition, are conducting slightly to reduce crossover distortion. (Maximum output level is + 10 dbm).

4-12. The output voltage of the amplifier is held constant by the action of the peak detector.

4-13. PEAK DETECTOR.

4-14. The peak detector circuit provides a bias voltage proportional to the Oscillator output voltage, to control the dynamic resistance of diodes A1CR4 and A1CR6 (refer to Figure 5-8). The peak detector A1Q6 conducts only on the positive peaks of the Oscillator output signal. When these positive peaks exceed a set level, the reference diode (A1CR5) breaks down causing a reduction in the forward bias of A1CR4 and A1CR6. The decrease in forward bias cause the diodes to conduct less, increasing their dynamic resistance, and thus increasing the impedance Z_1 (Figure 4-2). The increase in impedance Z_1 increases the negative feedback voltage to A1Q2, which results in a reduction of the Oscillator, output signal. The reduction in signal compensates for the initial increase in the Oscillator output.

4-15. OUTPUT ATTENUATOR.

4-16. The output attenuator provides a means of attenuating the output signal level. The attenuator, designated OUTPUT LEVEL on the front panel, is between the amplifier and the output transformers. The output level may be varied without changing the output impedance. Three attenuators S2, S3 and S7, connected in series, make attenuation possible in 10 dBm, 1 dBm, and 0.1 dBm steps. (See Figure 5-9, Attenuator Schematic Diagram.)

4-17. POWER SOURCE.

4-18. BATTERY.

4-19. This Oscillator uses a 45-volt dry cell battery as a power source. These dry cells are of the carbon-zinc type with their attendant limitations due to temperature. The service obtained from carbon-zinc cells depends on factors such as current drain, discharged temperature, discharge time and storage prior to use.

4-20. These cells are designed to provide in excess of 180 hrs of operation of the Oscillator on a 3 hr/day duty cycle at 77°F (25°C). At other temperatures this time will change. For example, at temperatures above 131°F(55°C), the batteries

4-21. High storage temperature is damaging to dry cells and tends to reduce their shelf life. Low storage temperature is beneficial to battery life although the batteries should be warmed to room temperature before use. Turning off the instrument when not in actual use and consideration of the above factors will maximize battery life.

4-22. AC POWER SOURCE.

4-23. In addition to the battery power source, this instrument may use 115V/230V ac as its primary source. The instrument is normally connected to use 115 v ac; however, if 230-volt operation is desired, the dual winding primary of the power transformer (A2T1) can be changed from a parallel to a series configuration. (See Figure 5-8), Schematic Diagram.) To transfer the Oscillator from battery source to ac source or vice-versa, a slide switch, S6, is provided on the left side of the instrument case.

4-24. METER CIRCUIT.

4-25. In the DIAL/DC position of the FUNCTION switch, the meter is used to monitor the power source voltage. In the BAT position of S6, the meter reads the battery voltage. The green area, labeled GOOD, designates a voltage from approximately +30 to +45 volts. The Oscillator will operate properly within these voltage limits. If the meter reading drops below the GOOD area, the battery should be replaced. In the ac position of S6, the meter monitors the rectified ac.

4-26. REGULATED POWER SUPPLY.

4-27. The regulated power supply provides a plus and minus 13 volts dc with respect to circuit ground. These regulated voltages are used throughout the Oscillator circuits. The unregulated supply is either rectified ac or the 45 v battery. A zener diode A2CR2 regulates the –13 volts and serves as a reference for the +13 volt regulator circuit.

4-28. The +13 volt supply is a conventional series regulator type with A2Q2 as the control amplifier, A2Q1 as the series regulator and A2Q3 as a load current limiter. If the load current becomes excessive, the current limiter conducts causing the series regulator A2Q1 to reduce the output voltage until the load causing the excessive current is removed. The variable resistor A2R6 furnishes an adjustment for the +13 volt regulated output.

4-29. OUTPUT CIRCUITRY.

4-30. The output transformers T1 and T2 have separate outputs, each balanced to chassis ground. If a load of any value other than those designated on the FUNCTION switch is used or if more than one OUTPUT connector is used at the same time, the output power specifications will be degraded.

4-31. For a detailed description of the output terminals and their use, see Figure 3-2, Operation.

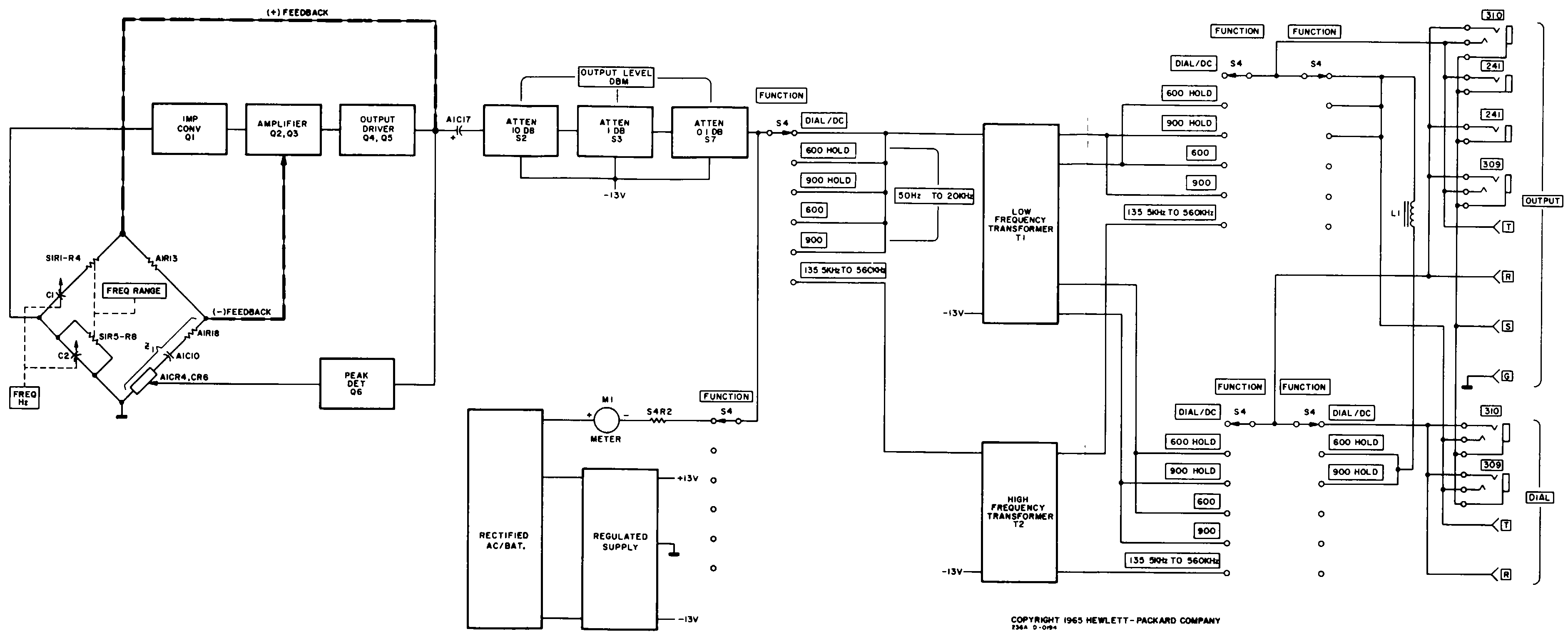


Figure 4-2. Model 236A Block Diagram.

CAUTION

THIS INSTRUMENT CONTAINS EXTREMELY HIGH IMPEDANCE CIRCUITS TO ENHANCE ITS PERFORMANCE. GREAT CARE HAS BEEN TAKEN IN ITS MANUFACTURE TO AVOID LEAKAGE PATHS THROUGH CONTAMINATION.

THE FOLLOWING PRECAUTIONS MUST BE OBSERVED TO AVOID CONTAMINATION AND TO PRESERVE ACCURACY AND PERFORMANCE.

1. **WHEN WORKING ON PRINTED CIRCUIT BOARDS AND OTHER SENSITIVE AREAS, AVOID TOUCHING COMPONENTS AND CONDUCTIVE SURFACES WITH BARE FINGERS. BODY OILS AND ACIDS ARE VERY CONTAMINATING. CLEAN COTTON OR RUBBER GLOVES SHOULD BE WORN.**

2. **USE ONLY 1-2% FLUX, SMALL DIAMETER ROSIN CORE SOLDER FOR REPAIRS ALPHA-C SOLDER, MANUFACTURED BY ALPHA METALS CO., JERSEY CITY, N.J., IS RECOMMENDED. *DO NOT USE ACID CORE SOLDERS OR ACID FLUX***

3. **USE A LOW-HEAT (35-45 WATTS) SMALL-TIP SOLDERING, IRON FOR REPAIRS.**

4. **AFTER REPAIR, CLEAN ASSEMBLY WITH A WEAK SOLUTION OF WARM WATER AND MILD DISH WASHING DETERGENT (SUCH AS "FISH"). RINSE THOROUGHLY WITH CLEAN WATER.**

5. **DO NOT USE CARBON TETRACHLORIDE OR ANY COMMERCIAL TELEVISION AND RADIO SWITCH CLEANERS IN THIS INSTRUMENT. THESE AGENTS ARE EXTREMELY CONTAMINATING AND WILL CAUSE LEAKAGE PATHS AND SUBSEQUENT DETERIORATION OF THE PERFORMANCE OF YOUR INSTRUMENT.**

6. **DO NOT REMOVE CABINET UNLESS NECESSARY FOR MAINTENANCE. AN ACCUMULATION OF DUST, OR OTHER FOREIGN MATTER, CAN CAUSE CIRCUIT LEAKAGE**

DO NOT DISTURB THE LEAD DRESS OF THE GREEN AND WHITE WIRES FROM TUNER TO RANGE SWITCH OR FROM PRINTED CIRCUIT BOARD TO RANGE SWITCH THIS WILL AFFECT THE FREQUENCY

WARNING

These servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so.

Table 5-1. Test Equipment Required

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	USE	RECOMMENDED MODEL
Electronic Counter	Frequency Range: 50 Hz to 560 kHz Accuracy. ± 0.2%	Frequency Dial Ac curacy Calibration	-hp- Model 5532A
Distortion Analyzer	Distortion Range: -40 dB Frequency: 50 Hz to 560 kHz	Distortion Measure-ments	-hp- Model 331A
Oscilloscope	Vertical bandwidth: 50 Hz to 560 kHz Sweep Range: 2 μsec/cm to 0.2 msec/cm	Spurious Check Troubleshooting	-hp- Model 140A with 1402A and 1420A Plug-in
Power Supply	Output Voltage from 0 to 40 V dc	Meter Check	-hp- Model 723A
Attenuator Set	Range: 0-40 dB in 1 dB and 10 dB in-crements Accuracy: known within 0.01 dB at 1 kHz. Impedance: 600 ohms	Attenuator Accuracy Check	-hp- Model 3501 (with known accuracy)
Digital Volt-meter	Display: 4 digits Accuracy: ± 0.1% of reading ±1 digit Voltage Range 99.99 mV to 9.999 V Resistance Accuracy: ± 0.3% of read-ing Resistance Ranges: 1 K Ω to 10 M Ω ± 1 digit	Frequency Response Output Impedance Output Calibration Adjustment	-hp- Model 3480C with 3484A Plug-in Digital Voltmeter with Multifunctlon Unit.
Impedance Bridge	Resistance Range: 100 ohms to 1000 ohms Reactance Range: 0 to 100 K ohms Accuracy: ± 2% Frequency Range: 50 Hz to 560 kHz	Output Impedance Phase Angle	General Radio Type 1603 -A Z-Y Bridge (20 cps to 20 Kc) and 916-AL R-F Bridge
AC Vacuum Tube Volt-meter	Accuracy: known within ± 2% of fullscale Meter: linear expanded dB scale Calibration: 1 mW in 600 ohms	Attenuator Check Output Balance Check AC Voltage Measurements	-hp- Model 400L (with known tracking accuracy)
Noise Measuring Set	Voltage Range: -90 dBm	Output Hum and Noise Check	-hp- Model 3555B
Variable Line Transformer	Voltage: var, 103.5 to 126.5 V ac Power Capability: 500 mW	Line Regulation Checks	Superior Type UC1M
900 Ohm Re-sistor	Accuracy: ± 0.1% Type: metal film	Terminating Load	IRC Type CEA T-O
600 Ohm Re-sistor	Accuracy: ± 0.1% Type: metal film	Terminating Load	-hp- Part No. 0698-7408
135 Ohm Re-sistor	Accuracy: ± 0.1% Type: metal film	Terminating Load	-hp- Part No. 0698-7364

SECTION V

MAINTENANCE

5-1. INTRODUCTION

5-2. This section contains maintenance and service information for the Oscillator. Included are Performance Checks, Adjustment, and Calibration Procedures and Troubleshooting Techniques.

5-3. TEST EQUIPMENT REQUIRED.

5-4. Test equipment required to maintain the Oscillator is given in Table 5-1, Test Equipment Required. This table lists the type of equipment to be used, the critical specifications required for testing, and recommended commercially available test equipment.

5-5. CABINET REMOVAL.

5-6. To remove and replace the Oscillator cabinet:

a. Disconnect power cord and turn POWER switch OFF.

b. Place the Oscillator on its back.

c. Remove four #8 socket head screws from the front panel

d. Grasp front panel handles and pull the Oscillator straight up and, out of its cabinet.

e. If desired, disconnect the interconnecting cable by unplugging it from the Power Supply circuit board.

f. Reverse the above procedure to replace cabinet.

CAUTION

WHEN REPLACING CABINET, FOLD INTERCONNECTING CABLE NEATLY UNDER OUTPUT JACKS BEING CAREFUL THAT CABLE DOES NOT BECOME PINCHED BETWEEN CABINET AND PANEL.

5-7. ERFORMANCE CHECKS

5-8. he Performance Checks are in-cabinet procedures that can be used to verify the Oscillator's performance. These procedures can be used for periodic maintenance, checking specifications after a repair or incoming quality control checks.

Table 5-1. Test Equipment Required (Cont'd)

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	USE	RECOMMENDED# MODEL
1000 Ohm Resistor	Accuracy: ± 10% Type: composition	Feedback Adjustment	hp- Part No. 0687-1021
150 Ohm Resistor	Accuracy: ± 5% Power: 1/2 watt Type: composition	Balance Check	-hp- Part No. 0686-1505
300 Ohm Resistors (matched pair)	Matched Within: ± 0.02% Absolute Accuracy: ± 5% Type: metal film	Balance Check	Selected
450 Ohm Resistors (matched pair)	Matched Within: ± 0.02% Absolute Accuracy: ± 5% Type: carbon film	Balance Check	Selected
67.5 Ohm Resistors (matched pair)	Matched Within: ± 0.02% Absolute Accuracy: ± 5% Type: carbon film	Balance Check	Selected
Adapter	BNC to dual banana plug	Adapting Terminating Loads	-hp- Model 10110A
Test Leads (2)	Length: 12 inches Connectors: alligator clips	Interconnecting Test Setups	NSN
Test Lead	Length: 44 inches- Connectors: dual banana plugs, shielded cable	Interconnecting Test Setups	-hp- Model 11000A

Other test equipment with the required characteristics may be substituted.

5-9. The Performance Checks are performed with the ac power cord connected to 115 volts, 60 Hz unless otherwise specified.

5-10. FREQUENCY DIAL ACCURACY CHECK.

a. An Electronic Frequency Counter (-hp- Model 5532A), a 600 ohm load, a 135 ohm load, a BNC to dual-banana plug adapter (-hp- Model 10110A) and a pair of test leads 12 inches long with alligator clips will be required for this test. Figure 5-1 shows the recommended test setup.

b. Connect a 135 ohm load across the electronic counter input as shown in Figure 5-1. Set Oscillator FUNCTION switch to 135.

c. Check dial accuracy at the 56, 40, 25, 10 and 5 dial calibration points on the X10K and X1K frequency ranges.

d. The above dial readings should agree with the reading on the electronic counter within ± 3%.

e. Remove the 135 ohm load and replace with a 600 ohm load Set FUNCTION selector to 600 position.

f. Check dial accuracy at the 56, 40, 25, 10 and 5 dial calibration points on the X100 and X10 frequency ranges.

g. The above dial readings should agree with the reading on the electronic counter within ±3%.

5-11. FREQUENCY RESPONSE CHECK.

a. A 900 ohm load, a 600 ohm load, a 135 ohm load and a pair of test leads 12 inches long with alligator clips will be required. A 4-digit Digital Voltmeter (-hp- Model 3480C with a 3484A Multi-Function Unit) and a dual banana to dual banana test lead 44 inches long will be required. The Oscillator should be operated from its internal battery and the power cord removed. No case ground should be provided. Figure 5-2 shows the recommended test setup.

b. Connect a 600 ohm load across the AC to DC Converter input as shown in Figure 5-2. Set Oscillator FUNCTION switch to 600 position

c. Set frequency to kHz (10 x 100). Set OUTPUT LEVEL for +10 dBm output.

d. Set OUTPUT CAL ADJ for a reading of 2.450 V on the Digital Voltmeter.

e. Sweep slowly through the frequency range from 50 Hz to 20 kHz, changing the FREQ RANGE as necessary. Note deviation from 1 kHz reference setting (step d).

f. The output amplitude should remain within +0. 2 dB (2. 393 V to 2. 505 V) of the above reference from 50 Hz to 20 kHz.

g. Remove 60C ohm load and replace with 900 ohm load. Set FUNCTION switch to 900.

h. Sweep slowly through the frequency range from 50 Hz to 20 kHz, changing the FREQ RANGE as necessary. Note the voltage range.

j. The output amplitude should be within the range of 2.931 to 3.069 from 50 Hz to 20 kHz.

k. Remove the 900 ohm load and replace with a 135 ohm load. Set FUNCTION switch to 135.

m. Sweep slowly through the frequency range from 5 kHz to 560 kHz, changing the FREQ RANGE as necessary. Note the voltage range.

n. The output amplitude should be within the range of 1. 135 to 1.189 V from 5 kHz to 560 kHz.

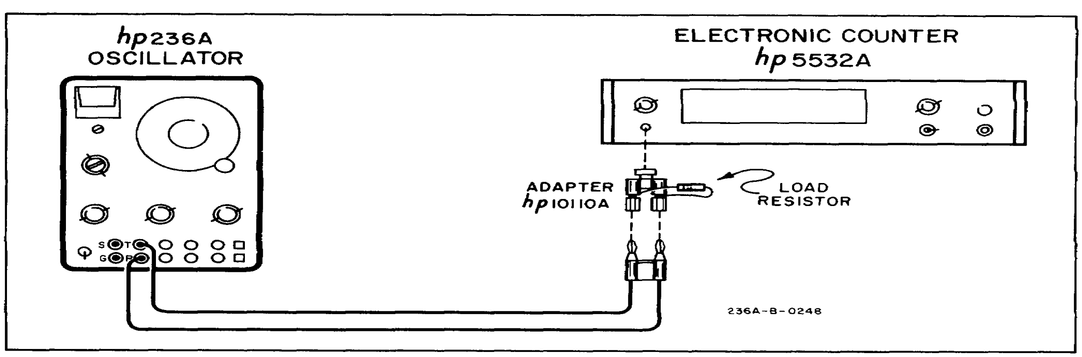


Figure 5-1. Frequency Dial Accuracy Check

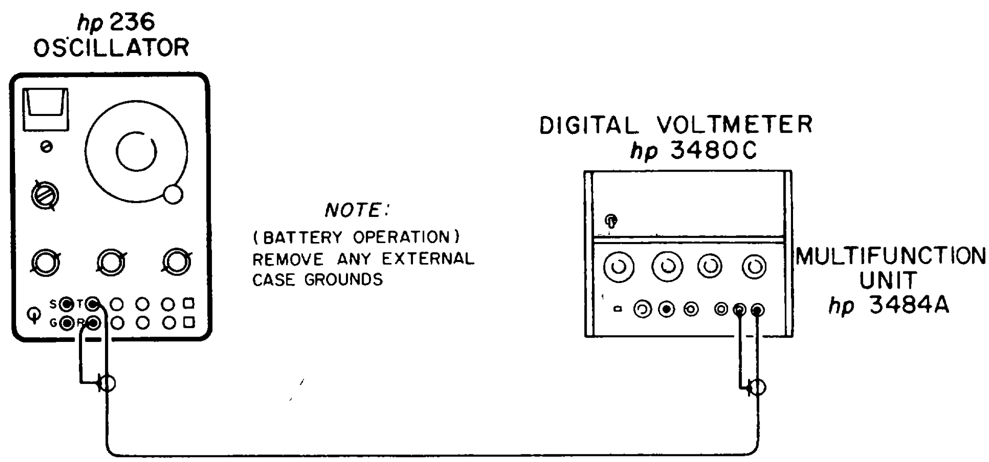


Figure 5-2. Frequency Response Check

5-12. DISTORTION CHECK.

a. A Distortion Analyzer (-hp- Model 331A), a 600 ohm load, a 135ohm load and a test cable 44 inches long with dual banana plugs will be required for this test.
b. Connect the Oscillator OUTPUT to the distortion analyzer input. Connect the 600 ohm load across the distortion analyzer input terminals and set the Oscillator FUNCTION to 600. Set OUTPUT LEVEL to +10 dBm.
c. Measure output distortion at 50 Hz and 1 kHz, using the procedures outlined in the Distortion Analyzer Operating and Service Manual.
d. Remove the 600 ohm load and replace with a 135 ohm load. Set FUNCTION to 135.
e. Measure output distortion at 560 kHz.
f. Distortion measured n steps (c) and (e) should be more than 40 dB below the fundamental.

5-13. SPURIOUS OSCILLATIONS CHECK.

a. An Oscilloscope (-hp- Model 140A with 1402A and 1420A Plug-ins) and a BNC to Dual Banana Plug Adapter and a test lead 44 inches long with dual banana plugs will be required for this test.
b. Connect the Oscillator OUTPUT to the oscilloscope vertical input. Do not connect a load.
c. Set the Oscillator controls as follows:

FUNCTION 600
OUTPUT LEVEL...................... +10 dBm

d. Sweep slowly through the frequency range from 50 Hz to 20 kHz, changing the FREQ RANGE as necessary.
e. There should be no spurious oscillations or amplitude modulation on the waveform.
f. Set FUNCTION to 135.
g. Sweep slowly through the frequency range from 5 Kc to 560 Kc, changing the FREQ RANGE as necessary.
h. There should be no spurious oscillations or amplitude modulation on the waveform.

5-14. OUTPUT IMPEDANCE CHECK.

a. A 900 ohm ± 0.1% load, a 600 ohm ± 0.1% load and a pair of test leads 12 inches long with alligator clips will be required. A 4-digit Digital Voltmeter (-hp- Model 3480C with a 3484A Multi-Function Unit Plug-in) and a dual banana plug to dual banana plug test lead 44 inches

Figure 5-2 shows the recommended test setup.

b. Set frequency to 1 kHz (10 X 100). Set output level to +10 dbm and FUNCTION selector to the 600 position. Place the 600 ohm load across the output of the Oscillator.

c. Set the OUTPUT CAL ADJ for a convenient reference level near half of full scale on the Digital Voltmeter.

d. Remove the 600 ohm load.

e. The output voltage should read twice the reference level ± 5%.

f. Repeat the above procedure for the 900 and 135 ohm outputs using the appropriate load resistor and reference level settings. For the 135 ohm output, set the frequency to 5 kHz (5 X 1000). The output voltage tolerance is 10%.

5-15. HOLDING COIL RESISTANCE CHECK.

a. An Ohmmeter (-hp- Model 3480C with a 3484A plug-in) will be required for this test.

b. Turn Oscillator POWER OFF. Set FUNCTION to 600 HOLD.

c. Connect Ohmmeter across OUTPUT terminals.

d. The resistance should read 700 ohms ±10%.

e. Set FUNCTION selector to 900 HOLD.

f. The resistance should read 700 ohms ±10%.

5-16. METER CHECK.

a. A Power Supply (-hp- Model 723A), a Digital Voltmeter (-hp- Model 3480C with a 3484A plug-in), and a pair of test leads 12 inches long, with alligator clips will be required for this test. Set FUNCTION to DIAL/DC.

b. Disconnect battery and connect power supply to battery cable, referring to Figure 5-3 for proper polarity connections.

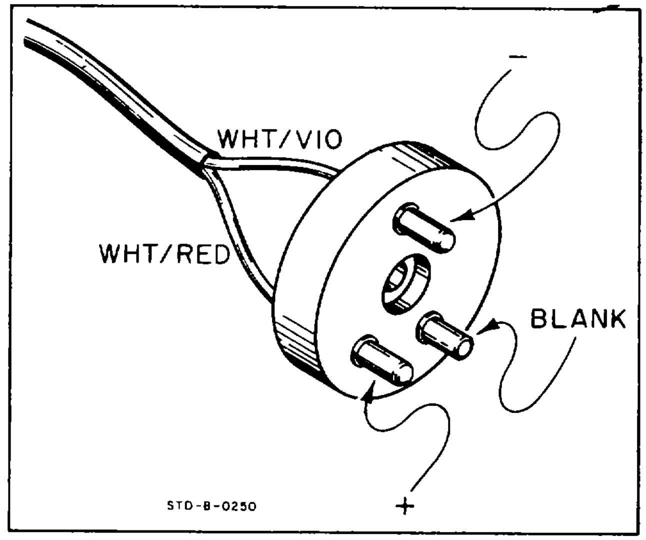


Figure 5-3. Battery Cable Connections

c. Monitor power supply with voltmeter and adjust voltage until Oscillator meter reads on left margin of GOOD area

d. The output voltage should be 30.0 to 32.5 volts dc. The size of S4R2 may be changed to adjust this voltage

5-17. ATTENUATOR ACCURACY CHECK.

a. An AC Voltmeter (-hp- Model 400L), a 600 Ohm Attenuator Set with known accuracy (-hp-Model 350D), a 600 ohm 1% load and a pair of test leads 12 inches long with alligator clips and a test lead 44 inches long with dual banana plugs will be required for this test. Figure 5-4 shows the recommended test setup for steps b through h.

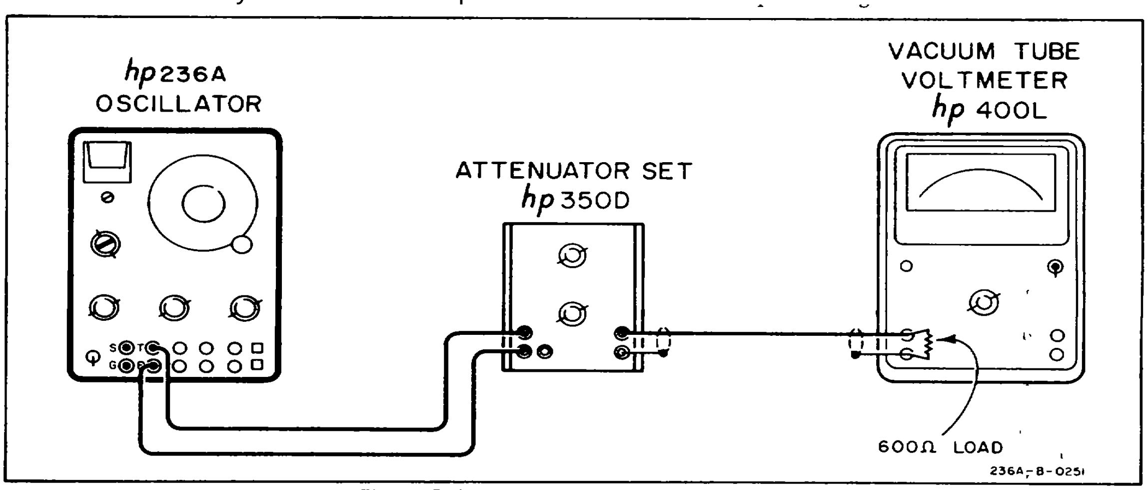


Figure 5-4. Attenuator Accuracy Check

b. Set the Oscillator controls as follows:
FREQ RANGE.......................... X100
FREQUENCY dial 10
FUNCTION 600
OUTPUT LEVEL...................... +10 dBm

c. Set the Attenuator Set controls for 40 dB attenuation.

d. If necessary, set OUTPUT CAL ADJ for a reference reading on the voltmeter.

e. Check the accuracy of the 10 dB OUTPUT LEVEL attenuator by simultaneously increasing attenuation with the OUTPUT LEVEL selector (red knob) and decreasing attenuation of Attenuator Set in 10)dB steps.

f. The voltmeter should return to the reference level set in step d ± 0.1 dB ± the error of the Attenuator Set.

g. Check the accuracy of the 1dB OUTPUT LEVEL attenuator by simultaneously increasing attenuation with the OUTPUT LEVEL selector (black knob) and decreasing attenuation of Attenuator Set in 1dB steps.

h. The voltmeter should return to the reference level set in step d ± 0.1 dB ± the error of the attenuator set.

j. Disconnect the Attenuator Set from the test setup and connect the voltmeter directly across the Oscillator OUTPUT terminated with 600 ohms.

k. Verify that the 0.1 dB OUTPUT LEVEL attenuator attenuates the output signal in 0.1 dB increments by changing the setting of the OUTPUT LEVEL and observing the readings on the voltmeter. The tracking error of the voltmeter should be taken into account.

5-18. OUTPUT IMPEDANCE PHASE ANGLE CHECK.

a. An impedance bridge covering the frequency range from 50 Hz to 560 kHz (General Radio 1603-A Z-Y Bridge and 916-AL Radio-Frequency Bridge with appropriate accessories), and a pair of test leads 12 inches long with alligator clips will be required for this test. The instrument should be operated from its internal battery and any external case ground connection should be removed.

b. Disable the Oscillator by grounding the frame of the tuning capacitor.

c. Measure the resistive and reactive components of the 600 and 900 ohm outputs at 50 Hz and 20 kHz using the procedures outlined in the bridge instructions manual.

d. Measure the resistive and reactive components of the 135 ohm output at 5 kHz and 560 kHz using the procedures outlined in the bridge instructions manual.

e. Calculate the phase angle using one of the following formulas depending on whether the reactive component is capacitive or inductive:

$$\phi = \text{ARC TAN } \frac{X_L}{R} \quad (X_L = 2\pi fc)$$

$$\phi = \text{ARC TAN } \frac{X_C}{R} \quad (X_C = \frac{1}{2\pi fc})$$

f. The phase angle should not exceed 10 degrees from 50 Hz to 100 Hz and 5 degrees from 100 Hz to 560 kHz.

5-19. OUTPUT BALANCE CHECK.

a. An AC Voltmeter (-hp- Model 400L), a 150 ohm ± 5% resistor, a pair of 300 ohm resistors matched within ± 0.02%, a pair of 450 ohm resistors matched within ± 0.02%, a pair of 67.5 ohm resistors matched within ± 0.02%, and a pair of test leads 12 inches long with alligator clips will be required for this test.

b. Connect the 300 ohm matched resistors R1 and R2 as shown in Figure 5-5. Do not connect 150 ohm resistor across voltmeter inputs at this time.

c. Set the Oscillator controls as follows:
FUNCTION 600
OUTPUT LEVEL...................... +10 DBM
FREQUENCY X10
FREQUENCY dial 10

d. Connect test lead A to point (a) and test lead B to point (b).

e. Connect 150 ohm resistor across voltmeter input. Connect test lead A to point (c) and test lead B to point (d).

f. Decrease voltmeter RANGE setting as necessary and read difference between final reading and reading recorder in step d.

g. Repeat steps b through f at 3 kHz (100 x 30).

h. The difference between the reference and final readings should be more than 70 dB at 100 Hz and more than 55 dB at 3 kHz.

j. Repeat steps b through h at 900 ohms output impedance with the matched pair of 450 ohm resistors.

k. Remove the 450 ohm resistors and replace with 67.5 ohm matched resistors. Set FUNCTION to 135 .

m. Repeat steps d through f at 5 kHz and 560 kHz.

n. The difference between the reference and final readings should be more than 50 dB at 5 kHz and more than 30 dB at 560 kHz.

5-20. OUTPUT HUM AND NOISE CHECK.

a. A Noise Measuring Set (Northeast Electronics Corp. Model TTS-37B) and a shielded test lead 44 inches long with dual banana plugs will be required for this test.

b. Connect the Oscillator OUTPUT to the noise measuring set input with the patch cable.

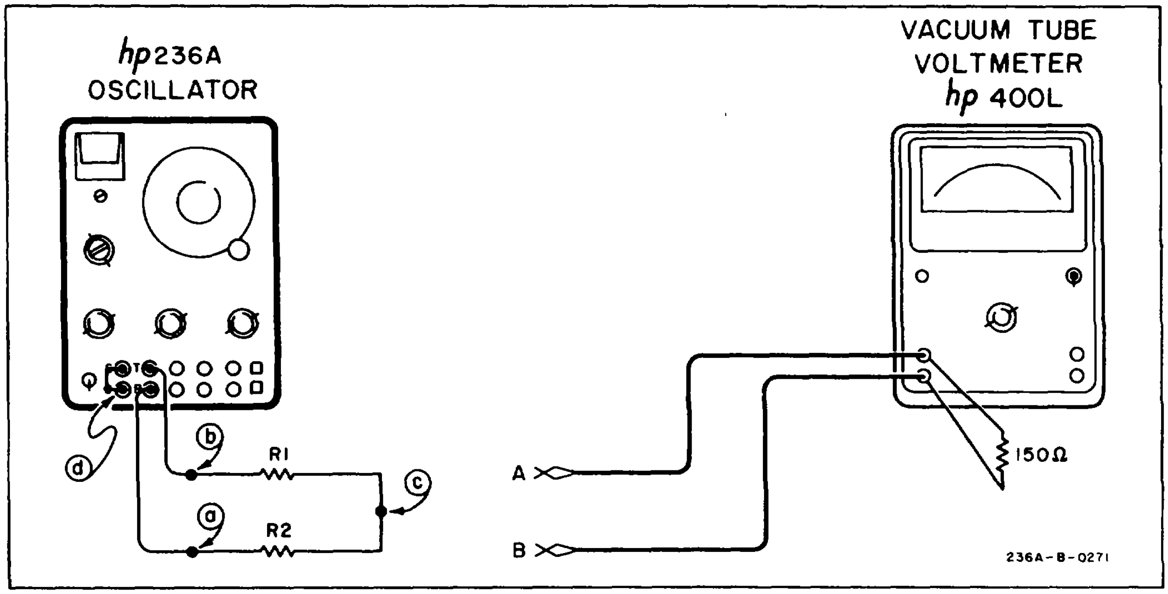


Figure 5-5. Output Balance Check

c. Set the Oscillator controls as follows:
FUNCTION .... 600 HOLD
FREQ RANGE.......................... X10K
FREQUENCY dial 56
OUTPUT LEVEL....................... +10 DBM

d. Disable Oscillator by grounding frame of tuning capacitors.

e. Set the noise measuring set controls as follows:
INPUT selector .... TERM 600 Ω
FILTER selector........................ 3 kHz FLAT
SENS controls .... -80 DBM
HOLD switch .... OFF

f. Check output hum and noise of the Oscillator at OUTPUT LEVEL settings shown in Table 5-2. Hum and noise should be below the level shown in the LIMITS column.

Table 5-2. Output Hum and Noise Check

Output Level	Limits
+10 dBm	-55 dBm
0 dBm	-65 dBm
-10 dBm	-75 dBm
-20 dBm	-85 dBm
-25 dBm	-90 dBm
-30 dBm	-90 dBm

5-21. ADJUSTMENT AND CALIBRATION PROCEDURES.

5-22. The following is a complete adjustment and calibration procedure for the Oscillator. Before proceeding with these adjustments, the Performance Checks should be performed to determine whether adjustments are necessary. If your instrument does not meet the test limits specified in the following steps, refer to Troubleshooting Procedure for possible cause and corrective action.

5-23. The Adjustment and Calibration Procedure is performed with the ac power cord connected to 115 volts, 60 Hz, unless otherwise specified.

5-24. METER MECHANICAL ZERO SET.

5-25. The meter is properly zero-set when the pointer rests over the zero calibration mark on the meter scale when the instrument is 1) at normal operating temperature, 2) in its normal operating position, and 3) turned off. Adjust zero set, if necessary as follows:

a. Rotate mechanical zero-adjustment screw clockwise until meter pointer is to the left of zero and moving upscale toward zero.

b. Continue to rotate adjustment screw clockwise; stop when pointer is exactly at zero. If the pointer overshoots zero, repeat step a.

c. When pointer is exactly on zero, rotate adjustment screw slightly counterclockwise. This is enough to free the zero adjustment screw from the meter suspension. If the pointer moves during this step, repeat steps a through c.

5-26. POWER SUPPLY ADJUSTMENT.

5-27. A Digital Voltmeter (-hp- Model 3480C with a 3484A plug-in), an AC Vacuum Tube Voltmeter (-hp- Model 400L), and a pair of clip leads 12 inches long will be required for this test.

5-28. -13 VOLT SUPPLY.

a. Connect dc digital voltmeter to negative side of A2C4. Connect common lead to chassis.

b. The digital voltmeter should read -13.0 ± 1.0 volts.

5-29. +13 VOLT SUPPLY.

a. Set AC/BAT switch on the left side of the case to AC.

b. Connect dc digital voltmeter to positive side of A2C3. Connect common lead to chassis.

c. Adjust A2R6 for +13.0 volts.

5-30. LINE VOLTAGE REGULATION.

a. Connect dc digital voltmeter as specified in 5-29b.

b. Vary line voltage between 103.5 volts and 126. 5 volts.

c. There should be no perceptible change in the +13 v voltage. (A2R8* is selected for <0.05 dB output change over the green area of meter.)

5-31. POWER SUPPLY RIPPLE.

a. Connect ac vacuum tube voltmeter to positive side of A2C3. Connect common lead to chassis.

b. Disable oscillator by connecting a short clip lead between tuning capacitor frame and chassis ground.

c. Adjust line voltage to 103.5 volts.

d. Power supply ripple should be less than 5.0 millivolts rms.

5-32. FREQUENCY CALIBRATION.

a. An Electronic Counter (-hp- Model 5532A), a DC Digital Voltmeter (-hp- Model 3480C with a 3484A plug-in), a BNC to dual-banana plug adapter (-hp- Model 10110A), a 600 ohm load and a 135 ohm load and a pair of test leads 12 inches long with alligator clips will be required for this test.

NOTE

The Oscillator must be in its cabinet during this calibration

b. Connect the Oscillator OUTPUT to the electronic counter input. Connect a 600 ohm load across the electronic counter input as shown in Figure 5-1.

c. Connect a dc digital voltmeter to TP2 (accessible from battery compartment).

d. Set the Oscillator controls as follows:

FUNCTION 600
OUTPUT LEVEL....................... +10 DBM
FREQ RANGE.......................... X100
FREQUENCY Dial.................... full CCW

e. Adjust A1C18 and A1C19 (accessible from battery compartment) alternately until frequency counter reads 5.70 kHz and digital volt-meter reads approximately -0.4 volts.

f. Set frequency dial to full CW position.

g. Frequency should read 485 to 490 Hz. If incorrect, remove dial and loosen two set screws on hub behind-dial. Slip dial shaft until frequency counter reads 485 to 490 Hz when the long set-screw is against the dial stop. Tighten-set screws and replace dial.

h. Repeat steps e through g until electronic counter and digital voltmeter read as specified.

j. Adjust frequency dial until electronic counter reads 500 Hz. Loosen dial and slip until dial reads 5. Tighten dial.

k. Set dial to 56 (5.6 kHz) Adjust A1C18 and A1C19 (accessible from battery compartment) until frequency counter reads 5.60 kHz, and the voltage at TP2 is equal at the low and high ends of the dial. Record this voltage for future reference.

m. Remove 600 ohm load and replace with a 135 ohm load. Set FUNCTION to 135.

n. Set FREQ RANGE to X10K. Set FREQUENCY Dial to 56 (560 kHz).

p. Adjust A1C14 (accessible from battery compartment) until frequency counter reads 560 kHz. Note voltage reading at TP2. This voltage should be the same as recorded from step k, +0 or -0.06 volts.

NOTE

If the voltage at TP2 is not within the limits specified in step p, remove capacitor C3 from the FREQ RANGE switch and repeat - Paragraph 5-32. C4 on the X100 range and C5 on the 1K range affect these ranges in the same manner. (See note in Table 5-3 for resistor effects.)

q. Check dial tracking accuracy per Paragraph 5-10.

5-33. MINIMUM DISTORTION ADJUSTMENT.

a. A Distortion Analyzer (-hp- Model 331A), a 600 ohm load and a test lead 44 inches long with dual banana plugs will be required for this test.

NOTE

The Oscillator must be in its cabinet during this adjustment.

b. Connect the Oscillator OUTPUT to the distortion analyzer input. Connect a 600 ohm load across the distortion analyzer input terminals.

c. Set the Oscillator controls as follows:

FUNCTION 600
OUTPUT LEVEL .... +10 DBM
FREQ RANGE.......................... X100
FREQUENCY Dial 10

d. Measure output distortion using the procedures outlined in the Distortion Analyzer Operating and Service Manual.
e. Adjust A1R21 (accessible from battery compartment) for minimum distortion.
f. Distortion should be greater than 40 dB down from the fundamental. If this limit cannot be adjusted with A1R21, proceed to Paragraph 5-34 and then repeat Paragraph 5-33.

5-34. FEEDBACK ADJUSTMENT.

a. An AC Vacuum Tube Voltmeter (-hp-Model 400L), a 1000 ohm ±10% resistor and a pair of clip leads 12 inches long with alligator clips will be required for this test.

NOTE

The Oscillator must be in its cabinet during this test.

b. Connect the AC Vacuum Tube Voltmeter with a 1000 ohm resistor m series with the input to TP1 (accessible from battery compartment).
c. Signal level at this test point should measure 110 ±10 millivolts. If voltage is out of tolerance, change value of A1R19. Increasing value of R will decrease voltage.
d. If A1R19 is changed, it will be necessary to repeat Paragraph 5-33.

5-35. OUTPUT CALIBRATION ADJUSTMENT.

a. A 600 ohm ±0.1% load and a pair of test leads 12 inches long with alligator clips will be required. A 4-digit Digital Voltmeter (-hp-Model 3480C with a 3484A Multi-Purpose Unit and a dual banana to dual banana test lead 44 inches long will be required. Figure 5-2 shows the recommended test setup.
b. Set Oscillator FUNCTION to 600.
c. Set frequency to 1 kHz (10 X 100). Set OUTPUT LEVEL for 0 dBm output.
d. Set OUTPUT CAL ADJ for a reading of 0.7746 V.

NOTE

Output power relationship at 135 ohms and 600/900 ohms is controlled by S4R2. S4R2 is selected so that voltage at 1 kHz is 1% below voltage at 50 kHz (X1OK range).

5-36. TROUBLESHOOTING TECHNIQUES.

5-37. This section contains procedures designed to assist in the isolation of malfunctions. These operations should be taken only after it has been established that the difficulty cannot be eliminated by the Adjustment and Calibration Procedures. An investigation should be conducted to insure that the trouble is not a result of conditions external to the Oscillator. A visual check should be made for possible burned or loose components, loose connections, or any other obvious condition which might suggest a source of trouble.

CAUTION

THE OSCILLATOR CONTAINS VERY HIGH IMPEDANCE CIRCUITS ON THE AMPLIFIER CIRCUIT BOARD, RANGE SWITCH AND TUNING CAPACITOR. OBSERVE CAUTION WHEN TROUBLESHOOTING THIS SECTION NOT TO TOUCH THE CIRCUIT BOARD OR COMPONENTS WITH BARE FINGERS, ESPECIALLY IN THE AREA OF A1Q1. WEAR CLEAN COTTON OR RUBBER GLOVES IF HANDLING IS NECESSARY. SKIN OILS CAN CAUSE CONTAMINATION AND SUBSEQUENT LEAKAGE PATHS. OBSERVE THE PROCEDURE FOR "SERVICING ETCHED CIRCUIT BOARDS" IN PARAGRAPH 5-40.

5-38. Table 5-3 contains a summary of front-panel symptoms that may be encountered it should be used in initial efforts to select a starting point for trouble shooting operations. See Figures 5-6 and 5-7 for component location of the A1 and A2 etched circuit boards.

5-39. Table 5-4 contains procedures which may also be used as a guide in isolating malfunctions. The voltage values and waveforms described are based upon the following conditions, unless otherwise specified:

OUTPUT LEVEL .... +10 DBM
FREQ RANGE.......................... X100
FREQUENCY Dial 10
FUNCTION 600
Output Termination................... 600 ohms

The checks outlined in this table are not designed to measure all circuit parameters, rather only to localize the problem. Therefore, it is quite possible that additional measurements will be required to completely isolate the trouble. Amplifier gain may also vary slightly between instruments; therefore, it should not be necessary to precisely duplicate voltage values or waveforms described.

5-40. SERVICING ETCHED CIRCUIT BOARD.

5-41. The Oscillator has two etched circuit boards Use caution when removing them to avoid damaging mounted components. The-to-part number is on the interior of the circuit board to identify it. Refer to Section VI for parts replacement and -hp- part number information.

5-42. 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.

Table 5-3. Troubleshooting from Front Panel Symptoms

Front Panel Symptom	Possible Cause
Oscillator works on all frequency RANGES except: X10.......... X100.......... X1K.......... X10K..........	Check for open or shorted resistors. R1, R1A, R5, R5A R2, R2A, R6, R6A R3, R3A, R7, R7A R4, R4A, R8, R8A **NOTE** **Each combination of two resistors (such as R1 + R1A must be within 1/4% of designated value. The two pairs of the same value must be matched with-in 1/4% of each other. Due to this accuracy, it is recommended that a faulty switch be replaced by new switch assembly.**
Output frequency not correct: all ranges, one range.	Check C1 and C2 for all ranges. Check trimmers and resistors for that specific range (e.g. R2, R2A, R6, R6A, C4)
Meter reads low on battery operation.	Replace battery; check A2CR1.
Meter reads low on ac line operation.	Check A2T1 and A2CR1.
Instrument operates properly with FUNCTION set to 135 only.	Check low frequency transformer T1.
Instrument operates properly with FUNCTION set to 600 HOLD, 900 HOLD, 600 or 900 only.	Check high frequency transformer T2
Instrument functions using BAT, but not AC power source.	Check fuse F1; transformer A2T1.
10 dB OUTPUT LEVEL switch does not provide a 10 dB variation in output voltage.	Check 10 dB attenuator.
1 dB attenuator switch does not provide a 1 dB variation at Oscillator output when switched from one setting to next consecutive setting.	Check 1 dB attenuator.
0.1 dB attenuator switch does not provide a 0.1 dB variation at Oscillator output when switched from one setting to next consecutive setting.	Check 0.1 dB attenuator.
OUTPUT CAL ADJ has little or no effect on Oscillator output voltage.	Check R1 (OUTPUT CAL ADJ), S4R1, A1R24, A1CR7-9, A1Q6, A1CR5.
Oscillator output level low regardless of OUTPUT LEVEL setting.	Check amplifier circuit A1Q1-Q5. Refer to Figure 5-8 for typical dc voltage.

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.

Table 5-4. Isolating Malfunctions

CHECK	RESULTS AND RECOMMENDED ACTIONS
(1) Measure the dc voltage at the negative side of A2C4 and the positive side of C3. Voltages should be -13 V and +13 V respectively.	If +13 V is incorrect, check A2R6 adjustment. If -13 V is incorrect, check A2CR2. If both voltages are incorrect, check A2Q1, Q2, Q3 and A2CR1. If BAT mode is being used, check battery BT1. If ac mode is used, check transformer T1. If voltages are correct, proceed to (2).
(2) Observe ac waveform at the low side of S7R12 (red/white/yellow wire from S7 to S4).	Figure 5-8 describes the waveform which should be obtained If waveform appears correct, proceed to (3); if not, go directly to (4).
(3) Check transformer T1. Reset FUNCTION to 135, and check transformer T2.	If transformers check OK, malfunction is in output switches or connectors.
(4) Observe ac waveform at amplifier output (high side of S3R1).	Figure 5-8 describes the waveform which should be obtained. If correct, proceed to (5); if amplitude is incorrect, proceed to (6); if frequency is incorrect, proceed to (7).
(5) Check 10 dB, 1 dB and 0.1 dB attenuators using the procedure outlined in Paragraph 5-18.	This check should isolate the malfunction to one of the attenuators. Analysis of the defective range should further isolate the problem area.
(6) Check amplifier assembly A1Q1-Q6. Check adjustment of R1.	Refer to Figure 5-9 for typical dc voltage levels. See Adjustment and Calibration Procedure for OUTPUT CAL ADJ.
(7) Check adjustment of A1C14, A1C18, A1C19; and check A1C1, A1C2 and A3R1 through A3R8A.	Refer to Adjustment and Calibration Procedure Frequency Calibration.

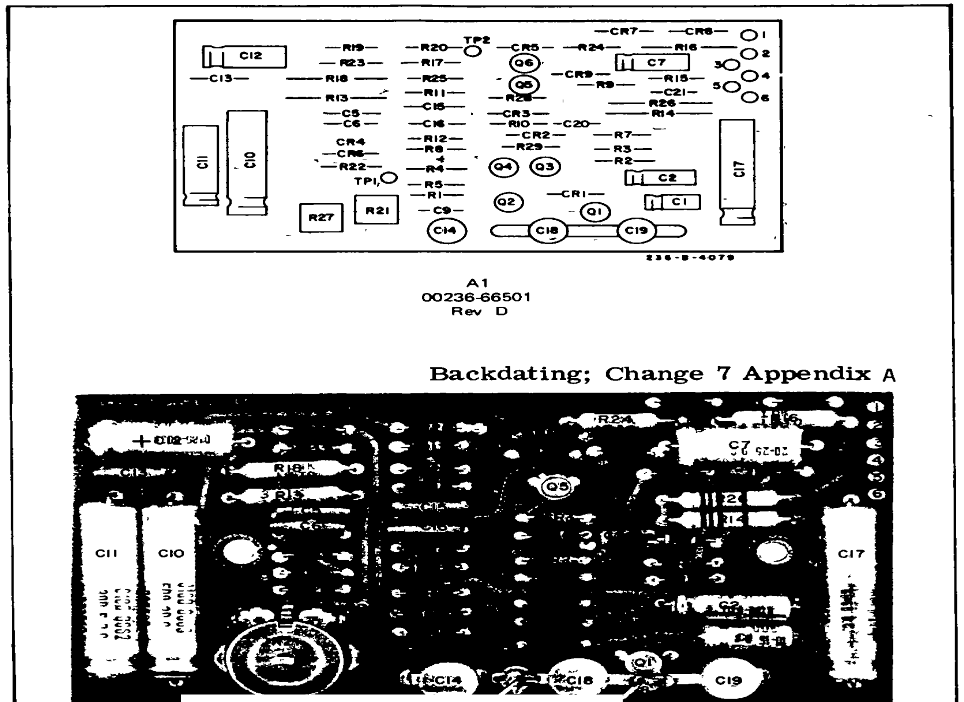
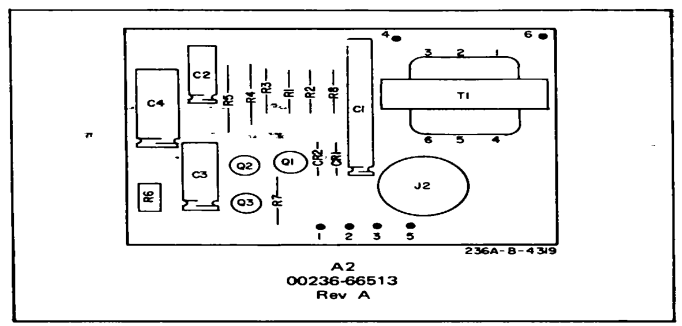


Figure 5-6. A1 Component Location



NOTE 1

For Serial Numbers 1107A06376 to 1107A06773 see Backdating (Appendix) Change No. 9.

Figure 5-7. A2 Component Location

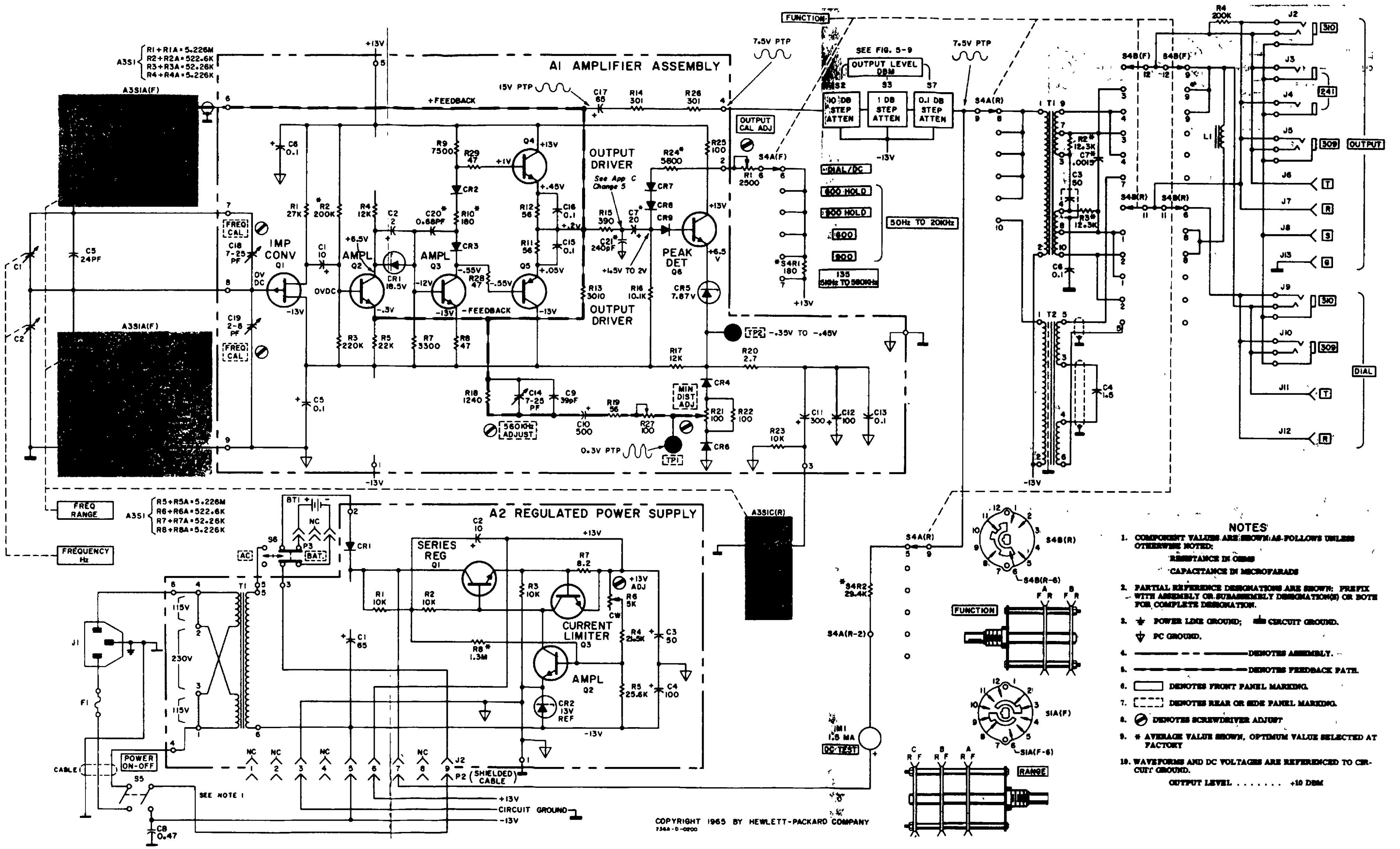


Figure 5-8. Model 236A Schematic Deiagram

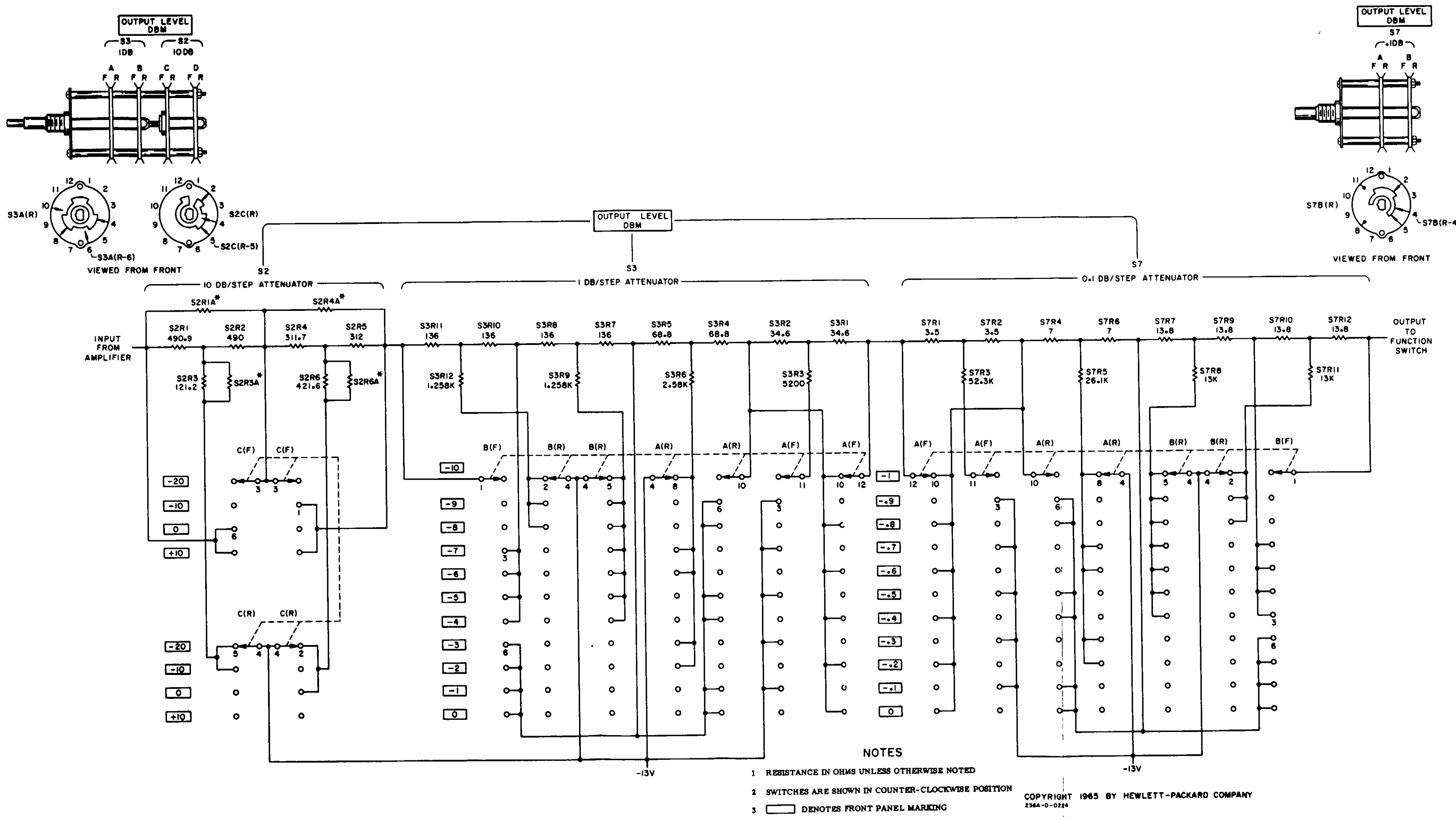


Figure 5-9. Model 236A Attenuator Schematic

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. Thus section contains information for ordering replacement parts. Table 6-1 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 is provided the first time an -hp- part number is listed (TQ column).

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

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

d. Manufacturer's part number

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

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. Identify parts by their Hewlett-Packard part numbers.

6-6. NON-LISTED PARTS.

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

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

ABBREVIATIONS

Ag	silver
Al	aluminum
A	ampere(s)
Au	gold
C	capacitor
cer	ceramic
coef	coefficient
com	common
comp	composition
conn	connection
dep	deposited
DPDT	double-pole double-throw
DPST	double-pole single-throw
elect	electrolytic
encap	encapsulated
F	farad(s)
FET	field effect transistor
fxd	fixed
GaAs	gallium arsenide
GHz	gigahertz = 10^{+9} hertz
gd	guard(ed)
Ge	germanium
gnd	ground(ed)
H	henry(ies)
Hg	mercury
Hz	hertz (cycle(s) per second)
ID	inside diameter
impg	impregnated
incd	incandescent
ins	insulation(ed)
kΩ	kilohm(s) = 10^{+3} ohms
kHz	kilohertz = 10^{+3} hertz
L	inductor
lin	linear taper
log	logarithmic taper
mA	milliampere(s) = 10^{-3} amperes
MHz	megahertz = 10^{+6} hertz
MΩ	megohm(s) - 10^{+6} ohms
met flm	metal film
mfr	manufacturer
ms	millisecond
mtg	mounting
mV	millivolt(s) = 10^{-3} volts
µF	microfarad(s)
µs	microsecond(s)
µV	microvolt(s) = 10^{-6} volts
my	Mylar®
nA	nanoampere(s) = 10^{-9} amperes
NC	normally closed
Ne	neon
NO	normally open
NPO	negative positive zero (zero temperature coefficient)
ns	nanosecond(s) = 10^{-9} seconds
nsr	not separately replaceable
Ω	ohm(s)
obd	order by description
OD	outside diameter
p	peak
pA	picoampere(s)
pc	printed circuit
pF	picofarad(s) 10^{-12} farads
piv	peak inverse voltage
p/o	part of
pos	position(s)
poly	polystyrene
pot	potentiometer
p-p	peak-to-peak
ppm	parts per million
prec	precision (temperature coeffient, long term stability and/or tolerance)
R	resistor
Rh	rhodium
rms	root-mean-square
rot	rotary
Se	selenium
sect	section(s)
Si	silicon
sl	slide
SPDT	single-pole double-throw
SPST	single-pole single-throw
Ta	tantalum
TC	temperature coefficient
TiO_2	titanium dioxide
tog	toggle
tol	tolerance
trim	trimmer
TSTR	transistor
V	volt(s)
vacw	alternating current working voltage
var	variable
vdcw	direct current working voltage
W	watt(s)
w/	with
wiv	working inverse voltage
w/o	without
ww	wirewound
*	optimum value selected at factory, average value shown (part may be omitted)
**	no standard type number assigned selected or special type
®	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}
deka	da	10	femto	f	10^{-15}
deci	d	10^{-1}	atto	a	10^{-18}

STD-B-2734

DESIGNATORS

A	assembly
B	motor
BT	battery
C	capacitor
CR	diode
DL	delay line
DS	lamp
E	misc electronic part
F	fuse
FL	filter
HR	heater
IC	integrated circuit
J	jack
K	relay
L	inductor
M	meter
MP	mechanical part
P	plug
Q	transistor
QCR	transistor-diode
R	resistor
RT	thermistor
S	switch
T	transformer
TB	terminal board
TC	thermocouple
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

Table 6-1. Replaceable Parts

REF DESIG.	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A1	00236-66501		1	Assembly: pc amplifier includes C1 thru C20 Q1 thru Q6 CR1 thru CR9 R1 thru R26	28480	00236-66501
A1C1	0180-0224		1	C: fxd A1 elect 10 µf +75% -10% 15 vdcw	56289	30D106G 015BA4
A1C2	0180-0111		1	C: fxd A1 elect 2 µf 25 vdcw	56289	40D173A2
A1C3, A1C4				Not assigned		
A1C5, A1C6	0150-0121		5	C: fxd cer 0 1 µf +80% -20% 50 vdcw	56289	5C50A obd
A1C7	0180-0045		1	C: fxd A1 elect 20 µf +75% -10% 25 vdcw	56289	30D206-G0-25DB-6M1
A1C8				Not assigned		
A1C9	0140-0145		1	C: fxd mica 22 pf ±5%	04062	RDM15C220J5C
A1C10	0180-0063		1	C: fxd elect 500 µf +100% -10% 3 vdcw	56289	D32530 obd
A1C11	0180-0062		1	C: fxd elect 300 µf +100% -10% 6 vdcw	56289	30D137G006DH4
A1C12	0180-0039		1	C: fxd elect 100 µf 12 vdcw	56289	D32697 obd
A1C13	0150-0121			C: fxd cer 0.1 µf +80% -20% 50 vdcw	56289	5C50A obd
A1C14	0121-0037		1	C: var cer 7-25 pf	72982	538-002 B2P0-93R
A1C15, A1C16	0150-0121			C: fxd cer 0.1 µf +80% -20% 50 vdcw	56289	5C50A obd
A1C17	0180-0149		2	C: fxd A1 elect 65 µf +100% -10% 60 vdcw	56289	Type 30D obd
A1C18	0121-0132		1	C: var cer 7-25 pf	72982	538-000, 7-25 pf, N300
A1C19	0121-0063		1	C: var cer 2-8 pf	72982	538-000-NP0-2-8 pf-(89R)
A1C20*	0150-0046		1	C: fxd TiO_2 0 68 pf ±5% .500 vdcw	78488	Type GA obd
A1C21*	0140-0147			C: fxd 180 pf ± 5% 500 wvdc mica	72136	DM15F181J0500WV1CR
A1CR1	1902-0766		1	Diode: breakdown 18.2 v ±5% 400 mw	28480	1902-0766
A1CR2, A1CR3	1901-0025			Diode: Si 100 ma at +1 v 100 piv 12 pf	93332	D3072 obd
A1CR4	1910-0016		2	Diode: Ge	93332	D2361 obd
A1CR5	1902-0072		1	Diode: breakdown 7 87 v ±2% 400 mw	04713	SZ10939-153
A1CR6	1910-0016			Diode: Ge	93332	D2361 obd
A1CR7 thru A1CR8	1901-0025			Diode: Si 100 ma at +1 v 100 piv 12 pf	93332	D3072 obd
A1CR9	1901-0537			Diode: Gen PRP 1000 200 mA	28480	1901-0537
A1Q1	1855-0004		1	TSTR: FET **	28480	1855-0004
A1Q2 thru A1Q4	1854-0071		3	TSTR: Si NPN **	28480	1854-0071
A105	1853-0009		1	TSTR: Si PNP **	28480	1853-0009
A1Q6	1854-0071		1	TSTR: Si NPN 2N3393	01002	1854-0071
A1R1	0684-2731		1	R: fxd comp 27 K ±10% 1/4 w	01121	CB2731
A1R2*	0683-2045		1	R: fxd comp 200 K ±5% 1/4 w	01121	CB2045
A1R3	0683-2245		1	R: fxd comp 220 K ±5% 1/4 w	01121	CB2245
A1R4	0684-1231		2	R: fxd comp 12 K ±10% 1/4 w	01121	CB1231
A1R5	0684-2231		1	R: fxd comp 22 K ±10% 1/4 w	01121	CB2231
A1R6				Not assigned		
A1R7	0684-3321		1	R: fxd comp 3300 ohms ±10% 1/4 w	01121	CB3321
A1R8	0684-4701		2	R: fxd comp 47 ohms ±10% 1/4 w	01121	CB4701
A1R9	0683-7525		1	R: fxd comp 7500 ohms ±5% 1/4 w	01121	CB7525
A1R10*	0684-1811		1	R: fxd comp 180 ohms ±10% 1/4 w	01121	CB1811
A1R11, A1R12	0684-5601		2	R: fxd comp 56 ohms ±10%. 1/4 w	01121	CB5601
A1R13	0757-0828		1	R: fxd met flm 3010 ohms ±1% 1/2 w	19701	MF7C T-0 obd
A1R14	0757-0808		2	R: fxd met flm 301 ohms ±1% 1/2 w	19701	MF7C T-0 obd
A1R15	0683-3915			R: 390 ohm 5%.25 w cc Tubular	01121	CB3915
A1R16	0757-0040		1	R: fxd met flm 10.1 K ± 1% 1/2w	19701	MF7C T-0 obd

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

REF DESIG.	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A1R17	0684-1231			R: fxd comp 12 K ±10% 1/4 w	01121	CB1231
A1R18	0757-0083		1	R: fxd met flm 1240 ohms ±1% 1/2 w	19701	MF7C T-0 obd
A1R19	0683-5605		1	R: fxd comp 56 ohms ±5% 1/4 w	01121	CB5605
A1R20	0684-0271		1	R: fxd comp 2.7 ohms ±10% 1/4 w	01121	CB27G1
A1R21	2100-0568		2	R: var TRMR 100 ohms 10% C Top Adj	73138	72PR100K
A1R22	0684-1011		2	R: fxd comp 100 ohms ±10% 1/4 w	01121	CB1011
A1R23	0684-1031		1	R: fxd comp 10K ±10% 1/4 w	01121	CB1031
A1R24	0757-0880		1	R: fxd met flm 6340 ohms ±1% 1/4 w	19701	MF6C T-0 obd
A1R25	0684-1011			R: fxd comp 100 ohms ±10%o 1/4 w	01101	CB1011
A1R26	0757-0808			R: fxd met flm 301 ohms ±1% 1/2 w	19701	MF7C T-0
A1R27	2100-0568			R: var 100 ohms 10% C Top Adj	73138	72PR100K
A1R28, 29	0683-4705			R: trmr 47 ohms 5%o 1/4 w cc Tubular	01121	CB4705
A2	00236-66503		1	Assembly pc power supply includes C1 thru C4 Q1 thru Q3 CR1, CR2 R1 thru R8 J1, J2 T1	28480	00236-66503
A2C1	0180-0149			C: fxd A1 elect 65 μf +100% -10% 60 vdcw	56289	Type 30D obd
A2C2	0180-0059		1	C: fxd elect 10 μf +100% -10% 25 vdcw	56289	30D106G025BB4
A2C3	0180-0105		1	C: fxd A1 elect 50 μf +100% -10% 25 vdcw	56289	D34114 obd
A2C4	0180-0094		1	C: fxd A1 elect 100 μf +100% -10% 25 vdcw	56289	30D107G025DH4
A2CR1	1901-0158		1	Diode: Pwr Rect 200V 750 mA	04713	SR1358-3
A2CR2	1902-3190		1	Diode: Si breakdown voltage 13.0 volts ± 5% 400 mw	07910	CD35739
A2J1				Not assigned		
A2J2	1200-0062		1	Socket: tube 9 pin miniature type	71785	121-51-11-060
A2Q1	1854-0263		1	TSTR: Si NPN 2N3019	04713	obd
A202, A2Q3	1854-0033		2	TSTR: Si NPN 2N3391	24446	2N3391
A2R1 thru A2R3	0687-1031		3	R: fxd comp 10 K ±10% 1/2 w	01121	EB1031
A2R4	0757-0451		1	R: fxd met flm 24.3 K ±1% 1/8 w F Tubular	24546	C4-1/8-To-2432-F
A2R5	0757-0043		1	R: fxd met flm 25.6 K ±1% 1/2 w	75042	CEC T-0 obd
A2R6	2100-0962		1	R: var comp lin 3000 ohms ±30% 1/4 w	76055	MTC-1 obd
A2R7	0699-0003		1	R: fxd comp 8.2 ohms ±10% 1/2 w	01121	EB82G1
A2R8*	0686-1355		1	R: fxd comp 1.3 meg ±5% 1/2 w	01121	EB1355
A2T1	9100-0172		1	Transformer: power	28480	9100-0172
A3S1	00236-61901		1	Assembly: switch frequency range (replaceable only as a complete assembly) Contains C3* thru C5* and R1 thru R8A* See Table 5-4	28480	00236-61901
A3S1R1	0698-3189		2	R: fxd met flm 4.99 meg ±1% 1 w	56289	421E obd
A3S1R2	0757-0052		2	R: fxd met flm 500 K ±1% 1/2 w	75042	CEC T-0 obd
A3S1R3	0757-0370		2	R: fxd met flm 49.9 K ±1% 1/2 w	75042	CEC T-2 obd
A3S1R4	0698-3188		2	R: fxd met flm 4990 ohms ±1% 1/2 w	75042	CEC T-0 obd
A3S1R5	0698-3189			R: fxd met flm 4.99 meg ±% 1 w	56289	421E obd
A3S1R6	0757-0052			R: fxd met flm 500 K ±1% 1/2 w	75042	CEC T-0 obd
A3S1R7	0757-0370			R: fxd met flm 49.9 K ±1% 1/2 w	75042	CEC T-2 obd
A3S1R8	0698-3188			R: fxd met flm 4990 ohms ±1% 1/2 w	75042	CEC T-0 obd
BT1	1420-0026		1	Battery: 45 v dry cell	28480 64959 06803# 83740 08358 86684 09823# 72665 77542#	1420-0026 KS-14370 202 482 M-30 VS013 3033-158, 30-33 M-202 202, P7830

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

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

REF DESIG.	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
BT1 (Cont'd)					53800#	6461
					41340#	42
					64912#	3B6241
					671770	2783
					24446	W30B
					74025#	4202
					42451#	482
					Armed Forces	BA-59
C1, C2	0121-0129		2	C: var air 2 sect 14.75 pf-617.75 pf	28480	0121-0129
C3	0180-0372		1	C: fxd non-polar A1 elect 50 µf +75% -10%	56289	Type 62D obd
C4	0160-2052		1	C: fxd metallized paper 1.5 µf ±10% 200 vdcw	56289	118P15592T13
C5	0160-0196		1	C: fxd mica 24 pf ±5%	04062	RDM15C240J3S
C6	0170-0022		1	C: fxd my 0.1 µf ±20% 600 vdcw 300 vacw	28480	0170-0022
C7*	0160-0012		1	C: fxd 0.0015 µf ±10% 600 vdcw	56289	160P15296
C8	0160-0174		1	C: fxd cer 0.47 µf +80% -20% 25 vdcw	56289	5C11A obd
F1	2110-0320		2	Fuse cartridge 0.15 amp 250 V	71400	MDL 15/100 obd
J1	1251-2357		1	Connector: ac power cord receptacle	28480	1251-2357
J2	1251-1143		2	Jack: telephone long frame switchboard type 2 circuit	82389	MT-332B obd
J3, J4	1251-0065		2	Jack: telephone long frame switchboard type 1 circuit	82389	MT-331 obd
J5	1251-1144		2	Jack: telephone long frame switchboard type 2 circuit	82389	MT-342B obd
J6, J7	1510-0010		2	Binding post: red insulator with solder turret	28480	1510-0010
J8	1510-0011		1	Binding post: black insulator with solder turret	28480	1510-0011
J9	1251-1143			Jack: telephone long frame switchboard type 2 circuit	82389	MT-332B obd
J10	1251-1144			Jack: telephone long frame switchboard type 2 circuit	82389	MT-342B obd
J11, J12	5020-8343		2	Post: clip	28480	5020-8343
J13	5060-0627		1	Assembly: binding post	28480	5060-0627
L1	9100-1311		1	Inductor: audio	28480	9100-1311
M1	1120-0901		1	Meter: 1.5 ma with special scale marked DC TEST	55026	1212C obd
P1				Not assigned		
P2	1480-0062		9	Pin: connector phosphor bronze	18076	obd
	5020-0427		1	Base: connector	28480	5020-0427
	5040-0007		1	Cap: connector	28480	5040-0007
P3	1251-1145		1	Plug battery 3-prong	72825	7364 obd
R1	2100-0190		1	R: var comp lin 2500 ohms ±20% 1/2 w	11237	45 obd
	1410-0052		1	Bushing pot	28480	1410-0052
	2950-0040		1	Nut hexagonal pot mounting	28480	2950-0040
R2*, R3*	0698-3217		2	R: fxd met flm 24.9 K ±1% 1/4 w	19701	MF6C T-0 obd
S1				See A3S1		
S2, S3	00236-61904		1	Assembly switch 1 and 10 db attenuation	28480	00236-61904
	3100-1708		1	Switch rotary 4-sect concentric 11-pos and 4-pos	28480	3100-1708
S2R1, S2R2	0698-5064		2	R: fxd met flm 490.9 ohms ±0.25% 1/2 w	28480	0698-5064
S2R3	0698-5489		1	R: fxd met flm 121.2 ohms ±0.25% 1/2 w	28480	0698-5489
S2R4, S2R5	0698-5062		2	R: fxd met flm 311.7 ohms +0.25% 1/2 w	28480	0698-5062
S2R6	0698-5063		1	R: fxd met flm 421.6 ohms ±0.25% 1/2 w	28480	0698-5063
S2R1A*, R3A*, R4A*, R6A*				R: fxd met flm 1/2 w	75042	CEC obd
S3R1, S3R2	0727-0489		2	R: fxd carbon flm 34.6 ohms ±1% 1/2 w	0000T	CD1/2PR obd
S3R3	0727-0364		1	R: fxd carbon flm 5200 ohms ±0 5% 1/2 w	19701	DC 1/2A obd
S3R4, S3R5	0727-0490		2	R: fxd carbon flm 68.8 ohms ±1% 1/2 w	94459	CVS obd

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

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

REF DESIG.	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
S3R6	0727-0495		1	R: fxd carbon flm 2580 ohms ±1% 1/2 w	0000T	CD1/2PR obd
S3R7 S3R8	0727-0492		4	R: fxd carbon flm 136 ohms ±1% 1/2 w	94459	CVS obd
S3R9	0727-0493		2	R: fxd carbon flm 1258 ohms ±1% 1/2 w	94459	CVS obd
S3R10, S3R11	0727-0492			R: fxd carbon flm 136 ohms ±1% 1/2 w	94459	CVS obd
S3R12	0727-0493			R: fxd carbon flm 1258 ohms ±1% 1/2 w	94459	CVS obd
S4	00236-61902		1	Assembly: switch function	28480	00236-61902
	3100-1706		1	Switch: rotary 2-sect 6-pos	28480	3100-1706
S4R1*	0683-1815		1	R: fxd comp 180 ohms ±5% 1/4 w	01121	CB1815
S4R2*	0698-4221		1	R: fxd met flm 29.4 K ±2% 1/2 w	19701	MF6C T-0 obd
S5	3101-0003		1	Switch: tog DPST	04009	81204-GB
S6	3101-0045		1	Switch: slide DPDT	42190	obd
S7	00236-61903		1	Assembly: switch 0.1 db attenuation	28480	00236-61903
	3100-1707		1	Switch: rotary 2-sect 11-pos	28480	3100-1707
S7R1 S7R2	0698-3182		2	R: fxd carbon flm 3.5 ohms ±1% 1/2 w	94459	CVS obd
S7R3	0727-0403		1	R: fxd carbon flm 52.3 K ±0.5% 1/2 w	94459	CVF obd
S7R4	0727-0446		2	R: fxd carbon flm 7 ohms ±1% 1/2 w	94459	CVS obd
S7R5	0727-0791		1	R: fxd carbon flm 26.1 K ±1% 1/2 w	94459	CVF obd
S7R6	0727-0446			R: fxd dep carbon flm 7 ohms ±1% 1/2 w	94459	CVS obd
S7R7	0698-3184		4	R: fxd carbon flm 13.8 ohms ±1% 1/2 w	94459	CVS obd
S7R8	0757-0165		2	R: fxd met flm 13 K ±2% 1/2 w	07115	C20 obd
S7R9, S7R10	0698-3184			R: fxd carbon flm 13.8 ohms ±1% 1/2 w	94459	CVS obd
S7R11	0757-0165			R: fxd met flm 13 K ±2% 1/2 w	07115	C20 obd
S7R12	0698-3184			R: fxd carbon flm 13.8 ohms ±1% 1/2 w	94459	CVS obd
T1	9100-1309		1	Transformer: audio 600 ohm/600 ohm/900 ohm matching	28480	9100-1309
T2	9100-1310		1	Transformer: audio 600 ohm/135 ohm matching	28480	9100-1310
W1	8120-0078		1	Assembly: cable power smooth black extra limp 7.5' long	70903	KH-4147 obd
				<u>MISCELLANEOUS</u>		
	00236-64511		1	Assembly: case	28480	00236-64511
	00236-64509		1	Assembly: cover	28480	00236-64509
	5040-0607		1	Assembly: disc vernier drive	28480	5040-0607
	5060-0020		1	Assembly: gear with coupling hub	28480	5060-0020
	5060-0021		1	Assembly: gear	28480	5060-0021
	00236-01201		1	Bracket: shield	28480	00236-01201
	00236-04105		1	Cover battery	28480	00236-04105
	00236-04001		1	Dial: frequency	28480	00236-04001
	0905-0427		3	Gasket: vinyl, 3 ft. long	28480	0905-0427
	2110-0359		2	Holder fuse extractor post type Bay Cap/ 15A	75915	342012
	00236-44102		1	Insulator: jack block for 6 connectors	28480	00236-44102
	0340-0099		4	Insulator: single binding post for J6 thru J8 and J13	28480	0340-0099
	0340-0109		2	Insulator: single binding post for J11 and J12	28480	0340-0100

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

REF DESIG.	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
				MISCELLANEOUS (Cont'd)		
	0370-0115		1	Knob: bar red 5/8" diameter	28480	0370-0115
	0370-0025		1	Knob: round 3/4" diameter	28480	0370-0025
	0370-0160		1	Knob: round 1-5/8" diameter black	28480	0370-0160
	0370-0112		3	Knob: skirted bar 3/4" diameter black	28480	0370-0112
	0370-0113		1	Knob: skirted bar 3/4" diameter black	28480	0370-0113
	00236-90004		1	Manual: operating and service	28480	00236-90004
	00236-00203		1	Panel: front	28480	00236-00203
	00236-24101		1	Plate: insulator (C1, C2)	28480	00236-24101
	00236-44101		1	Plate: mounting (C1,C2)	28480	00236-44101
	5000-0637		1	Spring: thrust	28480	5000-0637
	5040-0665		1	Window: dial	28480	5040-0665

Table 6-2. PART NUMBER – NATIONAL STOCK NUMBER
CROSS REFERENCE INDEX

PART NUMBER	FSCM	NATIONAL STOCK NUMBER	PART NUMBER	FSCM	NATIONAL STOCK NUMBER
CB1011	01121	5905-00-726-5340	0340-0100	28480	5970-00-837-0062
CB1031	01121	5905-00-755-2613	0370-0025	28480	5355-00-721-8924
CB1231	01121	5905-00-686-4529	0370-0112	28480	5355-00-919-9953
CB1815	01121	5905-00-097-9534	0370-0113	28480	5355-00-908-9402
CB2045	01121	5905-00-136-7103	0370-0160	28480	5355-00-059-9065
CB2231	01121	5905-00-498-6053	0683-3915	28480	5905-00-931-1062
CB2245	01121	5905-00-105-7765	0683-7525	28480	5905-00-056-0520
CB2731	01121	5905-00-076-9664	0684-1011	28480	5905-00-056-0527
CB3321	01121	5905-00-126-6683	0684-1031	28480	5905-00-931-1060
CB3915	01121	5905-00-907-4118	0684-2231	28480	5905-00-498-6053
CB4701	01121	5905-00-104-8368	0684-4701	28480	5905-00-056-0422
CB4705	01121	5905-00-909-3798	0687-1031	28480	5905-00-082-7476
CB5605	01121	5905-00-133-0440	0698-3182	28480	5905-00-400-4023
CB7525	01121	5905-00-91-3779	0727-0403	28480	5905-00-914-2122
D2361	93332	5961-00-954-9182	0727-0446	28480	5905-00-918-9221
D34114	56289	5910-00-809-3431	0757-0052	28480	5905-00-931-1408
EB1031	01121	5905-00-185-8518	0757-0083	28480	5905-00-422-4986
0121-0037	28480	5910-00-011-4521	0757-0199	28480	5905-00-981-7513
0140-0190	28480	5910-00-852-3004	0757-0370	28480	5905-00-920-5301
0140-0199	28480	5910-00-914-2604	0757-0808	28480	5905-00-998-1949
0150-0046	28480	5910-00-950-5603	1200-0062	28480	5935-00-808-9569
0150-0121	28480	5910-00-950-6822	121-51-11-060	71785	5935-00-808-9569
0160-0174	28480	5910-00-234-9817	1251-2357	28480	5935-00-233-6728
0160-0196	28480	5910-00-920-0475	1410-0052	28480	5895-00-061-2906
0170-0022	28480	5910-00-826-1162	1510-0084	28480	5940-01-035-6151
0180-0039	28480	5910-00-773-7702	1510-0087	28480	5940-01-035-6152
0180-0045	28480	5910-00-080-1890	1853-0009	28480	5961-00-955-7708
0180-0059	28480	5910-00-827-1218	1854-0033	28480	5961-00-931-0152
0180-0094	28480	5910-00-082-5119	1854-0071	28480	5961-00-137-4608
0180-0105	28480	5910-00-809-3431	1854-0263	28480	5961-00-914-6008
0180-0111	28480	5910-00-837-5903	1855-0004	28480	5961-00-931-7009
0180-0149	28480	5910-00-766-6271	1901-0025	28480	5961-00-978-7468

Table 6-2. PART NUMBER – NATIONAL STOCK NUMBER
CROSS REFERENCE INDEX -- CONTINUED

PART NUMBER	FSCM	NATIONAL STOCK NUMBER	PART NUMBER	FSCM	NATIONAL STOCK NUMBER
1901-0158	28480	5961-00-087-9496			
1902-0072	28480	5961-00-766-1447			
1902-0766	28480	5961-00-828-5639			
1902-3190	28480	5961-00-008-7042			
1910-0016	28480	5961-00-954-9182			
2N3391	24446	5961-00-931-0152			
2100-0190	28480	5905-00-088-0164			
30D106G025BB4	56289	5910-00-889-4854			
30D107G025DH4	56289	5910-00-827-1209			
3101-0003	28480	5930-00-817-9289			
3101-0045	28480	5930-00-402-6752			
342012	75915	5920-00-450-8063			
5C11A	56289	5910-00-883-0838			
5000-0637	28480	5360-00-763-0796			
5020-0427	28480	5935-00-877-6751			
5040-0607	28480	6625-00-911-6364			
5040-0665	28480	5355-00-471-3961			
5060-0020	28480	3020-00-289-9755			
5060-0021	28480	3020-00-677-4928			
7364	72825	5935-00-201-8514			
8120-0078	28480	5995-00-995-9822			
9100-0172	28480	5950-00-774-9410			

APPENDIX A
DIFFERENCE DATA SHEET

This Difference Data Sheet makes this manual applicable to earlier instruments. Instrument-component values that differ from those in the manual, and not listed in the Difference Data Sheet, should be replaced using the part number given in the manual.

CHANGE No. 1 for serial Nos. 512-02285 and below.

The 236A Case Assembly (old -hp- Part No 00236-64503) was changed to incorporate new 1/4 turn fasteners on the battery cover (old -hp- Part No. 0023604102). This new case and battery cover makes it easier to replace the battery.

The new style Case and Battery Cover Assembly (-hp- Part No 00236-69501) is interchangeable with the old style case and battery cover but the battery covers alone are not interchangeable. The old style case and battery covers were used on units with serial numbers 512-02285 and below and are no longer available Model 236A with Serial Nos. 929-02311 and above had the new Case and Battery Cover Assembly installed at the factory.

After installation of the new Case and Battery Cover Assembly, change your Operating and Service Manual to reflect the change. The replacement part numbers for the new style case, battery cover, and fasteners are listed below:

Description	-hp- Part No.
Model 236A	
Case and Battery Cover Assembly	00236-69501
Case Assembly only	00236-64508
(includes captive spacer, body, latch, vinyl gasket, receptacle, leather handle, case, battery holder, feet, etc)	
Battery Cover Assembly	00236-69503
(includes Fasteners and Battery Cover)	
¼Turn Fastener	1390-0186
Snap Ring	1390-0137
Battery Cover	00236-04104

NOTE

For proper identification of your instrument, remove the serial number plate on the rear of the case to be replaced and attach it to the new Case and Battery Cover Assembly.

CHANGE NO. 2 for Serial Nos. 929-02595 and below.

Page 6-2. Change Part No. A1CR9 to 1901-0025.

CHANGE NO. 3 for Serial Nos. 929-02655 and below.

Page 6-4. Change Part No. of F1 to 2110-0017.

CHANGE NO. 4 for Serial Nos. 1107A3260 and below.

Page 6-5 and Page 6-6.

Panel: front	00236-00201
Cover: battery	00236-04104
Assembly: cover	00236-64504
Assembly: case	00236-64506

CHANGE NO. 5 for Serial Nos. 1107A4459 and below.

Page 5-11, Page 6-2. Delete C21, 180 pF, 0140-0147. Change R15 to 47 ohms 0684-4701 on the A1 Amplifier Ass'y.

CHANGE NO. 6 for Serial Nos. 1107A5185 and below.

Page 5-11, Table 6-1, Page 6-3. Add A2R4, 23.2K, -hp- Part No. 0757-0886.
Delete A2R4, 24.3 K, -hp- Part No. 0757-0451.

CHANGE NO. 7 for Serial Nos. 1107A5485 and below.

Page 5-11, Table 6-1, Pages 6-2 and Page 6-3.

Add:
- A1R19*, 110 Ω, -hp- Part No. 0683-1115.
- A1R24, 6.34 K, -hp- Part No. 0757-0880.
- A1Q2, Q3, Q4, -hp- Part No. 1854-0057.
- A1R21, 100Ω, -hp- Part No. 2100-0277.

Delete:
- A1R28 and R29 (in senses with the base of Q5, and Q4), 47 Ω, -hp- Part No. 0683-4705.
- A1R19, 56 Ω, -hp- Part No. 0683-5605.
- A1R24, 5.6 k Ω, -hp- Part No. 0683-5625.
- A1Q2, Q3, Q4, transistor, -hp- Part No. 1854-0071
- A1R21 and R27 (R27 is in series with R19 and Slider of R21), 100 Ω, -hp- Part No. 2100-0568.

CHANGE NO. 8 for Serial Nos. 1107A6035 and below.

Page 1-1, Table 1-1 under "output connectors," Add after last sentence "with removable shorting link between sleeve and ground terminals."

Page 3-2 under operation for Index No. (3) use shorting bar in pace of jumper wire for operational description.

Page 6-4 Change J6, J7 part number to 1510-0010 (Binding Post: Red).
Change J8 part number to 1501-0011 (Binding Black)
Change J13 part number to 5060-0627 (Assembly: Binding Post).

Page 6-6 Change Front Panel part number to 00236-00203.

CHANGE NO. 9 for Serial Nos 1107A6376 and below.

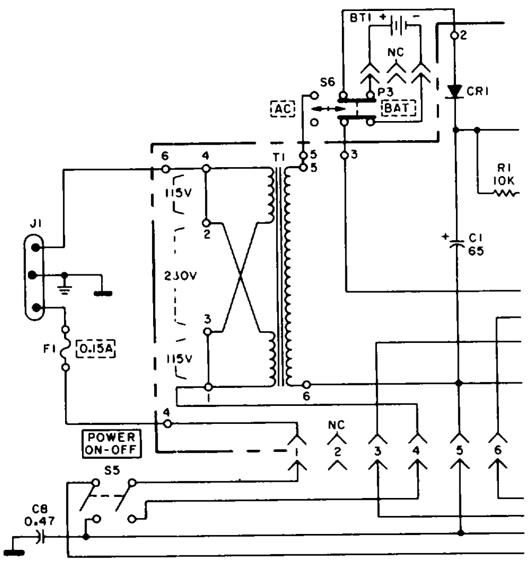
Page 2-1 below Paragraph 2-3 Power Requirements, and

Page 5-1 below Paragraph 5-5, Cabinet Removal, Delete warning.

Page 3-0 Change Index No. (3) Delete battery from sentence.

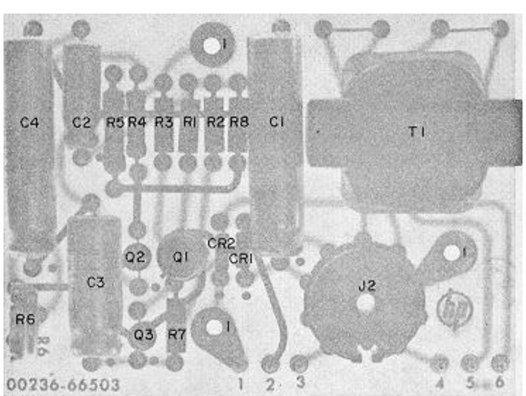
Page 3-2 Change Index No. (2) Procedure, Delete "If battery operation is desired "

Page 5-11 Revise schematic diagram as follows:



Page 6-3 Change A2 part number to 00236-66503.

Page 5-11 Delete component locator for 00236-66513 and Add 00236-66503 Component Locator.



236A-A -0227

CHANGE NO. 10 for Serial Nos. 1107A06376 to 1107A06773, Miswired Power Switch.

Instruments in the above group may have a miswired power switch. When the switch is miswired it has no affect on the instruments operation when it is powered from the ac line.
Instruments in the above group may be returned to the nearest -hp- Sales and Service Office for modification under warranty (WA) If necessary.

Performance Test.

1. Connect suitable measuring instrument (scope, counter, VTVM, etc) to the 236A output.
2. Operate the 236A from the ac power line and check operation of the 236A POWER switch. It should turn the output on and off. If it doesn't, perform the following modification.
3. Operate the 236A from its internal battery and check operation of the 236A POWER switch. It should turn the output on and off. If it doesn't, recheck the wiring of the POWER switch.

Modification.

Parts Needed For Modification.

Quantity	Description	-hp- Part No
1	Cable	00236-61618
1	Solder Lug	0360-1089

1. Remove the white/yellow wire from the POWER switch and trim it off, it will not be used.
2. Connect the white/brown/gray wire in the new replacement cable (on the cable end that doesn't have a crimped on connector) to the POWER switch in place of the wire removed in Step 1.
3. Remove the white/brown wire from the POWER switch and trim it off, it will not be used.
4. Connect the gray wire in the new replacement cable to the POWER switch in place of the wire removed in Step 3.
5. Remove the POWER switch from the front panel and install new solder lug under switch. Reinstall POWER switch.
6. Connect the green/yellow wire in the new replacement cable (in the cable end that doesn't have a crimped on connector) to the lug installed In Step 5.
7. Remove white/brown/gray wire from input fuse to Pin 4 of the A2 Power Supply Board and discard wire.

8. Connect green/yellow wire from unconnected end of new replacement cable to the solder lug on the A2 assembly near the ac input plug. This solder lug should already have one green/yellow wire connected to it and running to the ground terminal of the ac input plug.
9. Connect gray wire of new cable to Pm 4 of A2.
10. Connect white/brown/gray wire of new cable to input fuse In place of wire removed in Step 7.
11. Redo Performance Test given earlier in this note.

APPENDIX B

REFERENCES

The following publications contain information applicable to the operation and maintenance of Telephone Test Oscillator TS-3329/U.

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, supply Manuals (Types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.
DA Pam 310-7	US Army Index of Modification Work Orders.
TM 38-750	The Army Maintenance Management System (TAMMS).
TM 740-90-1	Administrative Storage of Equipment.
TM 750-244-1	Procedures for Destruction of Electronics Materiel to Prevent Enemy Use (Electronics Command).

APPENDIX C
MAINTENANCE ALLOCATION

Section I. INTRODUCTION

C-1. General
This appendix provides a summary of the maintenance operations for TS-3329/U. It authorizes categories of maintenance for specific maintenance functions on repairable items and components and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

C-2. Maintenance Function
Maintenance functions will be limited to and defined as follows:

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination.

b. Test. To verify serviceability and to detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition, i.e., to clean (decontaminate), to preserve, to drain, to paint, or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

d. Adjust. To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to the specified parameters.

e. Align. To adjust specified variable elements of an item to bring about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipment's used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Install. The act of emplacing, seating, or fixing into position an item, part, module (component or assembly) in a manner to allow the proper functioning of the equipment or system.

h. Replace. The act of substituting a serviceable like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

i. Repair. The application of maintenance services (inspect, test, service, adjust, align, calibrate, replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

j. Overhaul. That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e., DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours, miles, etc.) considered in classifying Army equipments/components.

C-3. Column Entries

a. Column 1, Group Number. Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

b. Column 2, Component/Assembly. Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Functions. Column 3 lists the functions to be performed on the item listed in column 2. When items are listed without maintenance functions, it is solely for purpose of having the group numbers in the MAC and RPSTL coincide.

d. Column 4, Maintenance Category. Column 4 specifies, by the listing of a "worktime" figure in the appropriate subcolumn(s), the lowest level of maintenance authorized to perform the function listed in column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate "worktime" figures will be shown for each category. The number of task-hours specified by the "worktime" figure represents the average time required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time, and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. Subcolumns of column 4 are as follows:

C - Operator/Crew
O - Organizational
F - Direct Support

H - General Support
D - Depot

e. Column 5, Tools and Equipment. Column 5 specifies by code, those common tool sets (not individual tools) and special tools, test, and support equipment required to perform the designated function.

f. Column 6, Remarks. Column 6 contains an alphabetic code which leads to the remark in section IV, Remarks, which is pertinent to the item opposite the particular code.

C-4. Tool and Test Equipment Requirements (Sect. III)

a. Tool or Test Equipment Reference Code. The numbers in this column coincide with the numbers used in the tools and equipment column of the MAC. The numbers indicate the applicable tool or test equipment for the maintenance functions.

b. Maintenance Category. The codes in this column indicate the maintenance category allocated the tool or test equipment.

c. Nomenclature. This column lists the noun name and nomenclature of the tools and test equipment required to perform the maintenance functions.

d. National/NA TO Stock Number. This column lists the National/NATO stock number of the specific tool or test equipment.

e. Tool Number. This column lists the manufacturer's part number of the tool followed by the Federal Supply Code for manufacturers (5-digit) in parentheses.

C-5. Remarks (Sect. IV)

a. Reference Code. This code refers to the appropriate item in section I, column 6.

b. Remarks. This column provides the required explanatory information necessary to clarify items appearing in section II.

(Next printed page is C-3)

SECTION II

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	 O	 F	 H	 D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
00	TEST SET, TELEPHONE TS-3329/U	INSPECT		0 1					A
		TEST		0 2					B
		TEST				0.4		1 thur 7	
		REPAIR		0.2				10	C
		REPAIR				1.0		8	
		OVERHAUL				2.0		1 thru 9	

SECTION III. TOOL AND TEST EQUIPMENT REQUIREMENTS FOR TEST SET, TELEPHONE TS-3329/U

(1) TOOL OR TEST EQUIPMENT REF CODE	(2) MAINTENANCE LEVEL	(3) NOMENCLATURE	(4) NATIONAL/NATO STOCK NUMBER	(5) TOOL NUMBER
1	H, D	ANALYZER, SPECTRUM TS723/U	6625-00-668-9418	
2	H, D	COUNTER, ELECTRONIC DIGITAL READOUT AN/USM-207	6625-00-044-3228	
3	H, D	MULTIMETER AN/USM-223	6625-00-999-7465	
4	H, D	OSCILLOSCOPE AN/USM-281C1	6625-00-106-9622	
5	H. D	VOLTMETER AN/GSM-64B	6625-00-022-7894	
6	H. D	VOLTMETER ME-30E/U	6625-00-643-1670	
7	H. D	TRANSFORMER, VARIABLE, POWER CN-16/U	5950-00-235-2085	
8	H, D	TOOL KIT, ELECTRONIC EQUIPMENT TK-100/G	5180-00-605-0079	
9	D	AUDIO SPECTRUM ANALYZER H P 3580A OR EQUAL		
10	0	TOOLS AND TEST EQUIPMENT AVAILABLE TO THE ORGANIZATIONAL TECHNICIAN BECAUSE OF HIS/HER ASSIGNED MISSION		

SECTION IV. REMARKS

REFERENCE CODE	REMARKS
A	VISUAL
B	OPERATIONAL CHECKS; CHECK BATTERIES,
C	REPLACE KNOBS AND BATTERIES

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USA Dep (1)
Sig Sec USA Dep (1)
Units org under fol TOE:
(1 copy each unit)
29-134
29-136
(2 copies each unit)
29-207
29-610

ARNG: None
USAR: None

For explanation of abbreviations used, see AR 310-50.

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

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