## Errata

**Title & Document Type:** **8614A Signal Generator Operating and Service Manual**

**Manual Part Number:** **08614-90001**

**Revision Date:** **March 1979**

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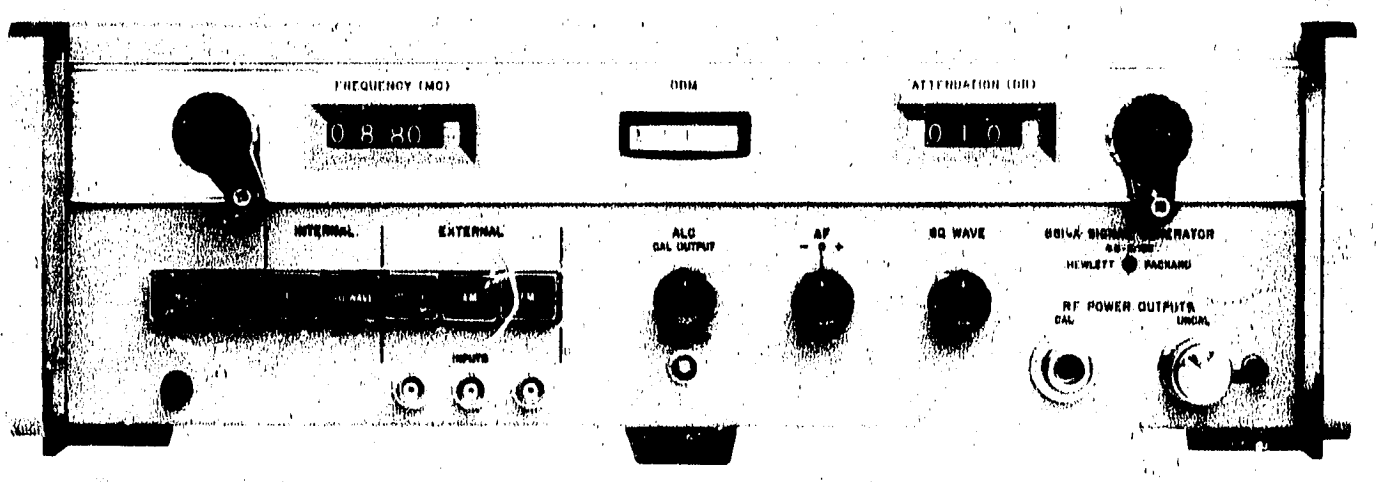
HP 8614A

OPERATING AND SERVICE MANUAL

# 8614A
# SIGNAL GENERATOR

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OPERATING AND SERVICE MANUAL

# 8614A
# SIGNAL GENERATOR

**SERIALS PREFIXED: 815- above 02201**

This Operating and Service Manual applies to HP 8614A instruments with serial number prefix 815- above 02201.

**SERIAL PREFIXES NOT LISTED**

For instruments with serial number prefixes 815- below 02201, a "Backdating" Appendix is supplied in the back of this manual.


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MANUAL PART NUMBER 08614-90001
Microfiche Part Number 08614-90007

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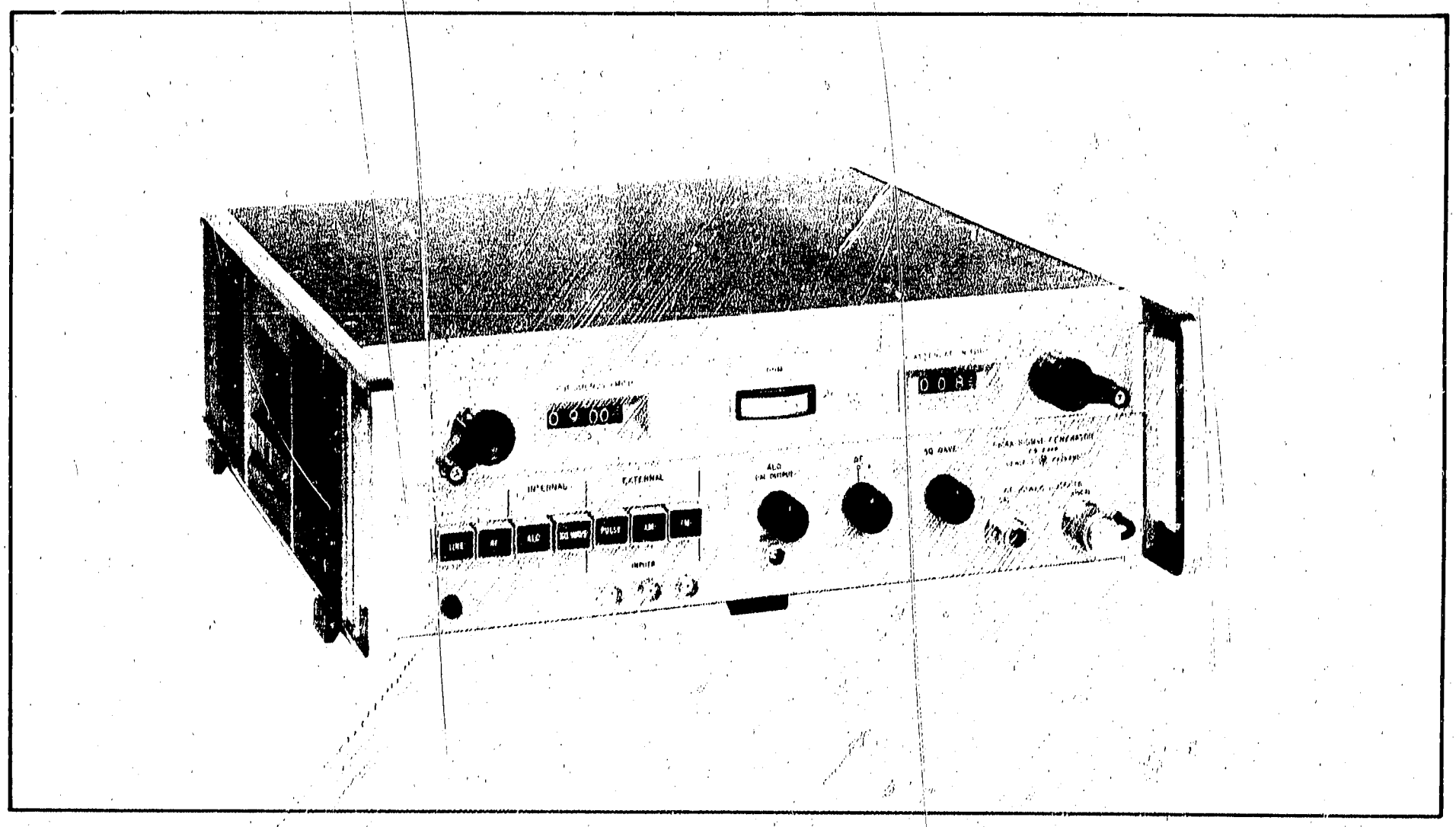



**Figure 1-1. Model 8614A Signal Generator**

# SECTION I
# GENERAL INFORMATION

## 1-1. INTRODUCTION

1-2. The Model 8614A Signal Generator provides RF power in the 800 to 2400 MHz ranges and produces an RF power output of at least 10 milliwatts. Output frequency and attenuation are read directly on digital dials, and fine frequency changes can be made by means of the front-panel ΔF control. Complete specifications are given in Table 1-1. The 8614A is shown in Figure 1-1.

1-3. The instrument has two power output connectors which supply RF power simultaneously. One output provides at least 10 milliwatts of power and may be leveled. When in the leveled output mode of operation and the output is 0 dBm or less, the RF output is held quite constant across the band without resetting the attenuator or power monitor. The other output connector provides an uncalibrated output of at least 0.5 milliwatt. A waveguide-beyond-cutoff attenuator, which is referenced to the RF output, accurately attenuates the calibrated RF power output from 0 to −127 dBm.

1-4. RF power output can be internally square-wave modulated. In addition, the RF power can be externally AM, FM, or pulse modulated. An external ALC (automatic level control) input which can be used for remote leveling loop control and an external decoupled FM input which can be used for external AFC is also provided.

1-5. PIN diode attenutors are used for leveling, square wave, pulse, and amplitude modulation. The PIN attenuator is an absorption device that can be electrically controlled to attenuate RF power. A sampling loop which includes a PIN diode attenuator compensates for changes in RF power output to hold the RF power output nearly constant.

## 1-6. SUPPLEMENTARY INSTRUMENTS

1-7. The HP 8403A (Option 002), an external pulse and amplitude modulator, extends the Signal Generator's modulation capabilities.

1-8. The Model 2650A (obsolete) oscillator synchronizer may be used directly to stabilize all internal cavity reflex klystron signal generators. Short-term stability is one part in $10^8$ /sec, and long-term stability is one part in $10^6$ /week over 0 to 50 degrees centigrade.

## 1-9. INSTRUMENT OPTIONS

1-10. In addition to the standard instrument, the Option 01 is available. The Option 01 instrument has its input connectors located on both the front and rear panel and its output connectors located on the rear panel; in all other respects it is the same as the regular signal generator.

## 1-11. INSTRUMENTS COVERED BY MANUAL

1-12. This instrument has a two-part serial number. The first four digits and the letter constitute the serial number prefix. The last five digits form the sequential suffix that is unique to each instrument. The contents of this manual apply directly to instruments having the same serial number prefix as listed under SERIAL NUMBERS on the title page. If the serial prefix on your instrument does not appear on the title page of this manual, there are differences between the manual and your instrument which are described in the Appendix or in a Manual Change Sheet included with the manual. If the change sheet is missing, the information can be supplied by your local sales office.

## 1-13. KLYSTRON WARRANTY CLAIM SHEET

1-14. The klystron supplied and replacement klystrons purchased from the Hewlett-Packard Company are guaranteed by the manufacturer against electrical failure for a specified period of time (time from date of purchase or hours of operation); warranty conditions vary with the type of tube used. Thus, for the actual warranty period of the klystron in your instrument, contact your local sales office. A sheet for your use is included in the appendix of this manual; follow the instructions on the sheet explicitly.

**Table 1-1. Specifications**

## FREQUENCY CHARACTERISTICS

**Range:** 800 to 2400 MHz; single, linearly calibrated control; direct reading within 2 MHz.

**Vernier:** $\Delta$ F control has a minimum range of 1.0 MHz for fine tuning.

**Frequency Calibration Accuracy (0 dBm and below):** ±5 MHz.

**Frequency Stability:**

**Line Voltage:** < 30 ppm for ±10% change from nominal voltage.

**Temperature:** approximately 50 ppm/°C change in ambient temperature.

**Residual FM:** <2500 Hz peak in a 10 kHz bandwidth.

## OUTPUT CHARACTERISTICS

**Range:**

**CAL Output:** 0 dBm (0.223V) to −127 dBm (0.1 $\mu$V), continuously variable. Above 0 dBm output is not calibrated, max level +10 dBm (0.707V).

**UNCAL Output:** −3 dBm (0.16V) nominal.

**Flatness:** <±0.75 dB.

**Level Accuracy:** ±0.75 dB + attenuator accuracy (0 to −127 dBm).

**Attenuator Accuracy:** +0, −3 dB from 0 to −10 dBm; ±0.2 dB ±0.06 dB/10 dB from −10 to −127 dBm; direct reading linear dial, 0.2 dB increments.

**Impedance:** 50 ohms; SWR < 2.0.

## MODULATION CHARACTERISTICS

**Internal Square-Wave:** 950 to 1050 Hz. Other frequencies available on special order. On/off ratio at least 20 dB.

**Square-Wave Sync:** Square-wave can be synchronized with a +1 to +10-volt signal applied to the pulse input.

**External Pulse:** 50 Hz to 50 kHz, 2.0 $\mu$s rise time. +20 to +100 V peak input. On/off ratio at least 20 dB.

**External AM:** dc to 1 MHz.

**External FM:** Mode width between 3 dB points varies from a minimum of approximately 4 MHz at a frequency of 800 MHz to a maximum of approximately 15 MHz at a frequency of 2000 MHz. Sensitivity is approximately 100 kHz/volt between 800 and 1600 MHz and 200 kHz/volt between 1600 and 2400 MHz.

(a) Front-panel connector capacitively coupled to the repeller of the klystron. Input impedance, 220 kΩ shunted by approximately 300 pF.

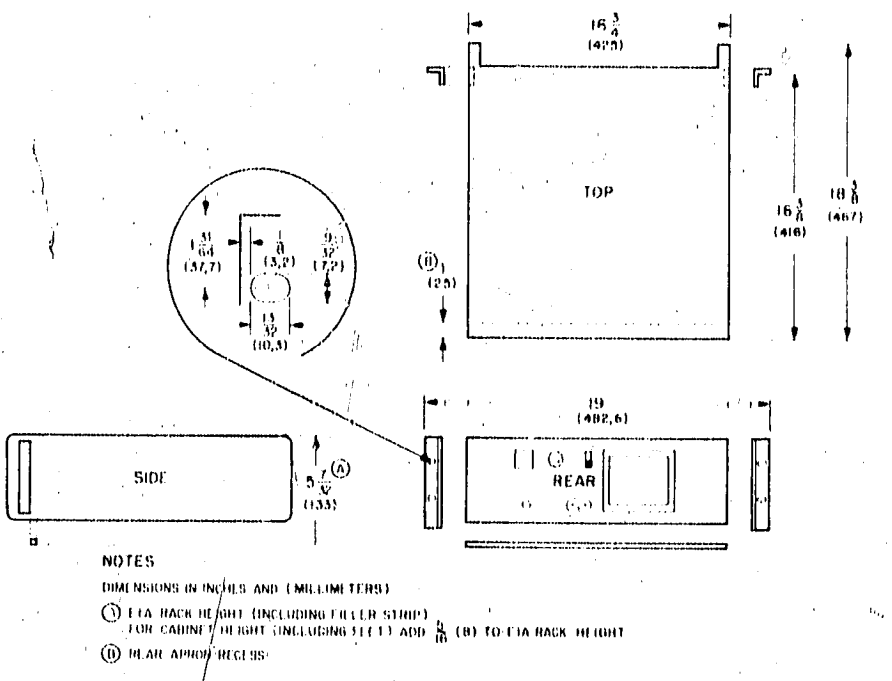
(b) Rear-panel connector is dc-coupled to the repeller of the klystron.

## GENERAL

**RFI:** Conducted and radiated leakage limits are below those specified in MIL-I-6181D.

**Power Source:** 115 or 230 volts ±10%, 50 to 60 Hz, approximately 130 watts.

**Dimensions:**




**Weight:** Net, 19.5 kg(43 lb).

**Option 001:** Ext. modulation input connectors on rear panel in parallel with front panel connectors, RF connectors on rear panel only.

NOTE: Specifications apply with the $\Delta$F control centered.

# SECTION II
# INSTALLATION

## 2-1. INCOMING INSPECTION

**WARNING**

*To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, meters).*

2-2. Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. Procedures for checking electrical performance are outlined in paragraph 5-8. If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the electrical performance test, notify the nearest Hewlett-Packard office. If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping materials for the carrier's inspection.

## 2-3. INSTALLATION

2-4. The Model 8614A is delivered as a cabinet mount instrument. A kit is supplied with the instrument for conversion from cabinet to rack mount.

**NOTE**

*This instrument is electrostatically shielded but not magnetically shielded. Hence, a magnetic field near the top or bottom covers can cause excessive incidental FM in the output signal. To eliminate this problem, a metal shield, such as a sheet of silicon steel, must be placed between the 8614A and any magnetic field.*

2-5. Whether the instrument is cabinet or rack mounted, provision should be made for adequate circulation of air around the instrument. The instrument cooling fan is located at the rear of the instrument and louvers are located on instrument side panels. Proper air circulation is most important at the sides and rear of the instrument.

**CAUTION**

*IF FAN IS NOT OPERATING, THE INSTRUMENT SHOULD NOT BE OPERATED.*

## 2-6. CONVERSION TO RACK MOUNT

a. Remove trim strip on sides of instrument (refer to Figure 2-1).

b. Remove tilt stand by pressing two sides of stand toward center of instrument and lifting it out.

c. Remove five feet at bottom of instrument. Press button in center of each foot, slide them toward center of instrument, and lift out.

d. Place rack mounting flanges (two) where trim strips were and secure with screws provided.

e. Add filler strip to bottom of instrument.

f. Rack mounting under *severe* vibration conditions must be supplemented with additional support at rear.

## 2-7. Air Filter Inspection

2-8. The Model 8614A uses forced-air cooling to maintain tolerable temperature within the instrument. Incoming air is filtered through a special filter at the rear of the instrument. The air filter should be checked periodically and if dirty, cleaned. Refer to paragraph 5-4 for air filter maintenance.

## 2-9. POWER REQUIREMENT

2-10. The Model 8614A can be operated from a 115- or 230-volt, 50- to 60-Hz source. A two-position slide switch (LINE VOLTAGE) at the rear of the instrument selects ac operation mode. The line voltage at which the instrument is set to

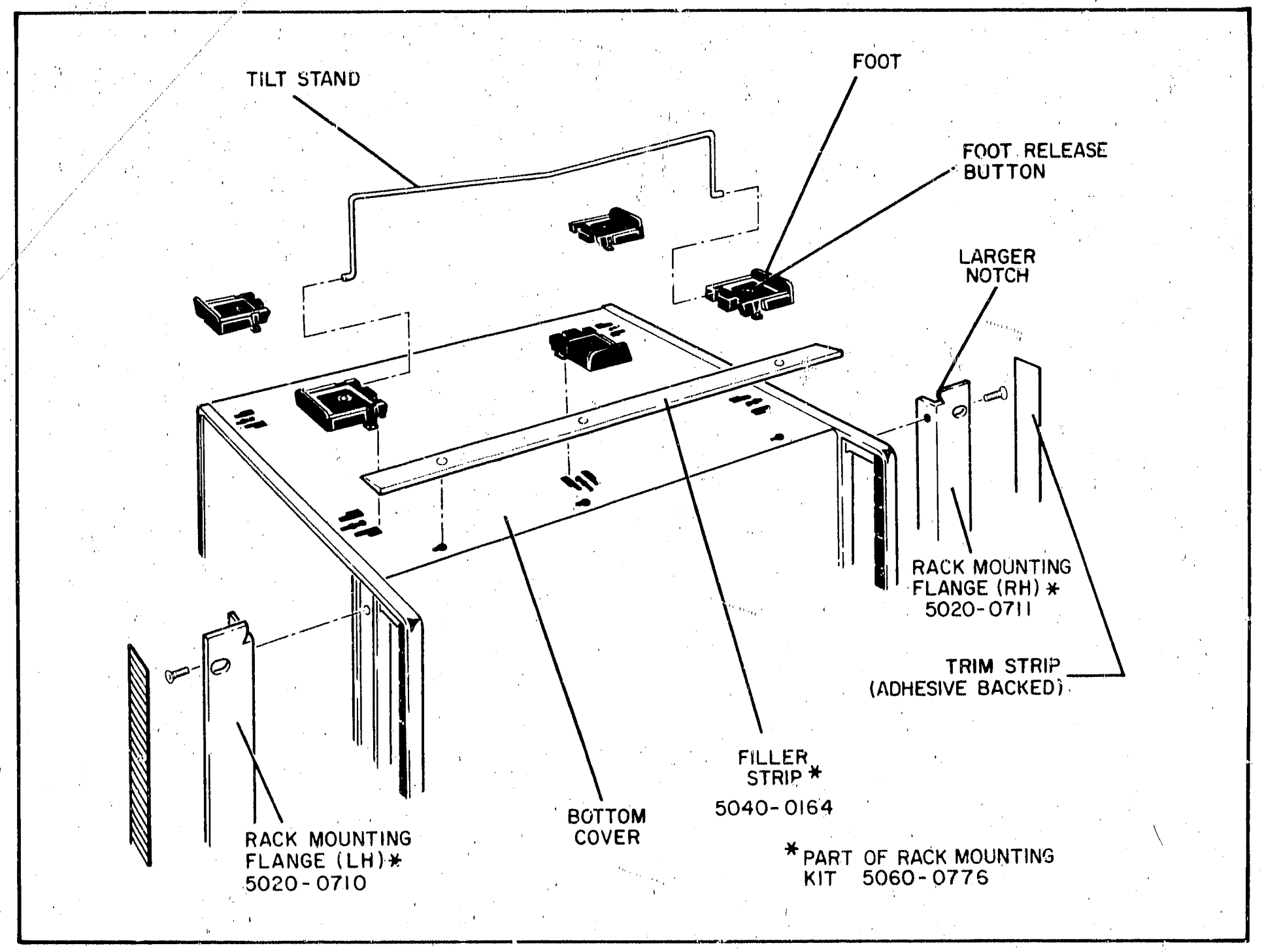
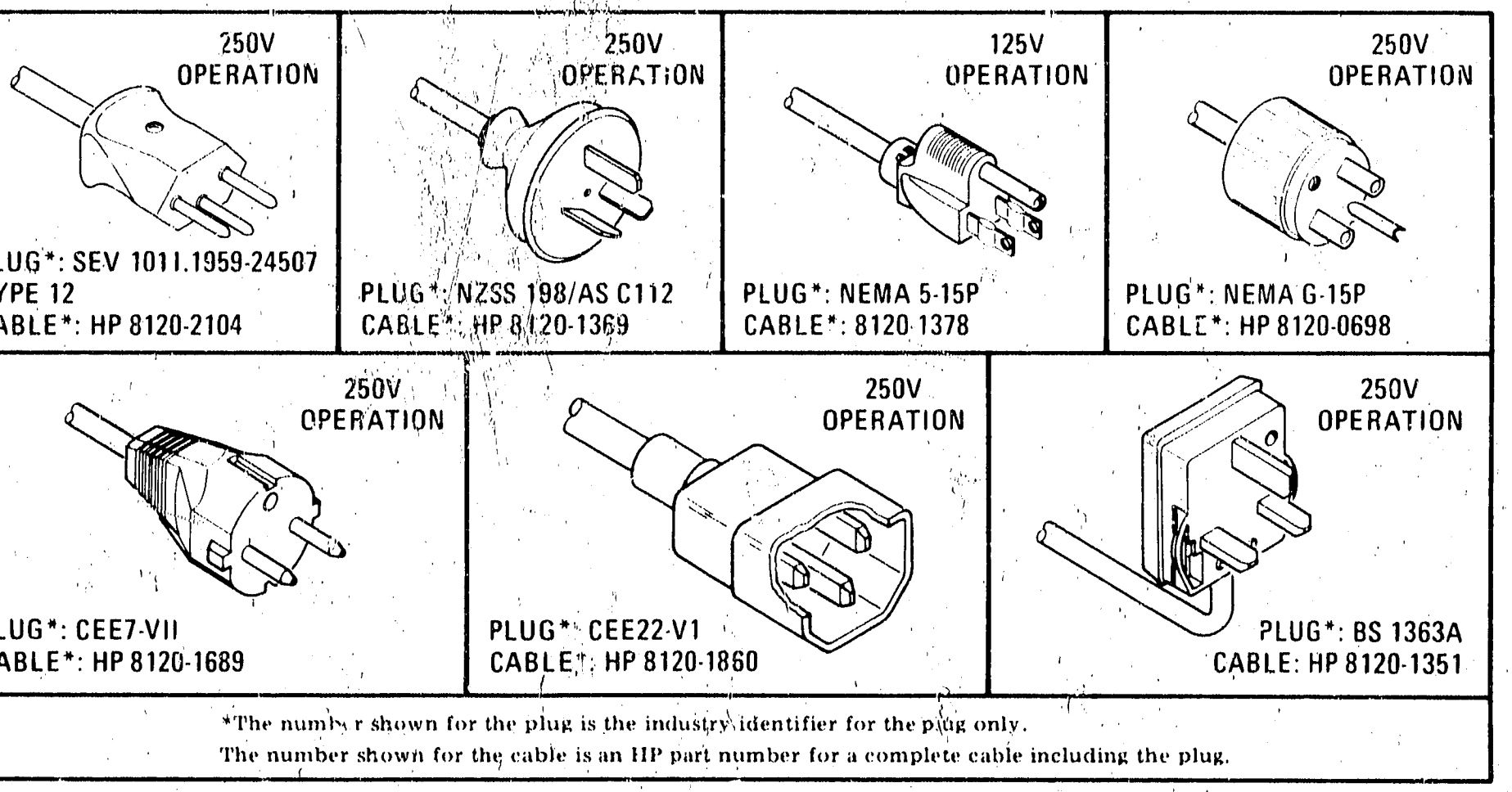



**Figure 2-1. Conversion to Rack Mount**




*The number shown for the plug is the industry identifier for the plug only.
The number shown for the cable is an HP part number for a complete cable including the plug.

**Figure 2-2. Power Cable and Mains Plug Part Numbers**

## POWER REQUIREMENT (Cont'd)

operate appears on the slider of the switch. A 1½ ampere standard fuse is used for 115V operation; a ¾ ampere standard fuse is used for 230V operation.

## 2-11. THREE-CONDUCTOR POWER CABLE

**WARNING**

*BEFORE CONNECTING THIS INSTRUMENT, the protective earth terminals of this instrument must be connected to the protective conductor of the (Mains) power cord. The Mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective conductor (grounding).*

2-12. This instrument is equipped with a three-wire power cable. When connected to an appropriate ac power receptacle, this cable grounds the instrument cabinet. The type of power cable plug shipped with each instrument depends on the country of destination. Refer to Figure 2-2 for the part numbers of available cables.

## 2-13. REPACKAGING FOR SHIPMENT

2-14. The following list is a general guide for repackaging an instrument for shipment. However, if you have any questions, contact your local sales and service office (see lists at rear of manual).

a. If possible, use the original container designed for the instrument. If a carton and packing materials are desired, they can be ordered from your local sales and service office.

b. The instrument is supported by four polyethylene supports fitted to the instrument height; one support located at each corner.

**NOTE**

*If the instrument is to be shipped to the Hewlett-Packard Company for service or repair, attach to the instrument a tag identifying the instrument by owner, model, and full serial number, and indicating the service or repair to be accomplished. In any correspondence, refer to the instrument by model number and complete serial number including the prefix.*

# OPERATION

# SECTION III
# OPERATION

## 3-1. INTRODUCTION

3-2. The Model 8614A can provide 1.0 milliwatt of leveled power across its frequency range (RF outputs leveled to within ±0.5 dB can be obtained across the band for attenuator setting of 0 dB or less). Output power can be attenuated to −127 dB. When operating unleveled, attenuation reference is the klystron power output; when operating leveled, attenuation reference is output reference setting. Internal square-wave modulation is available from 950 to 1050 Hz. External FM, AM, and pulse modulation voltages also can be used. Two or three modulation modes of operation can be applied to the instrument simultaneously; push-button controls select the mode of operation. External modulation signal inputs are located directly below the modulation button to which they apply.

**CAUTION**

*RF power in excess of approximately 125 mW should never be applied to RF power output connectors as internal damage could result.*

## 3-3. CONTROLS AND INDICATORS

3-4. Front and rear panel controls and connectors are shown in Figure 3-1. Each control and connector is identified with a numbered callout, and an explanation of the function, given in the accompanying text, is keyed to the callout number.

## 3-5. OPERATING PROCEDURES

3-6. The operating procedures (Figures 3-2 through 3-8) give step-by-step procedures for the various modes of operation. Instructions are given for obtaining the following leveled and unleveled outputs: CW, square-wave modulated (modulating voltage supplied internally), and FM, AM, and pulse-modulated (modulating voltage supplied externally). Steps of each procedure are numbered according to the sequence in which they are to be performed, and any control or connector which is identified with the number of the step in which it is used.

**NOTE**

*A magnetic field near the 8614A can cause excessive incidental FM in the output signal. A strong field can cut off the RF output. To eliminate the problem, place a sheet of high permeability metal, such as silicon steel, between the 8614A and radiation source.*

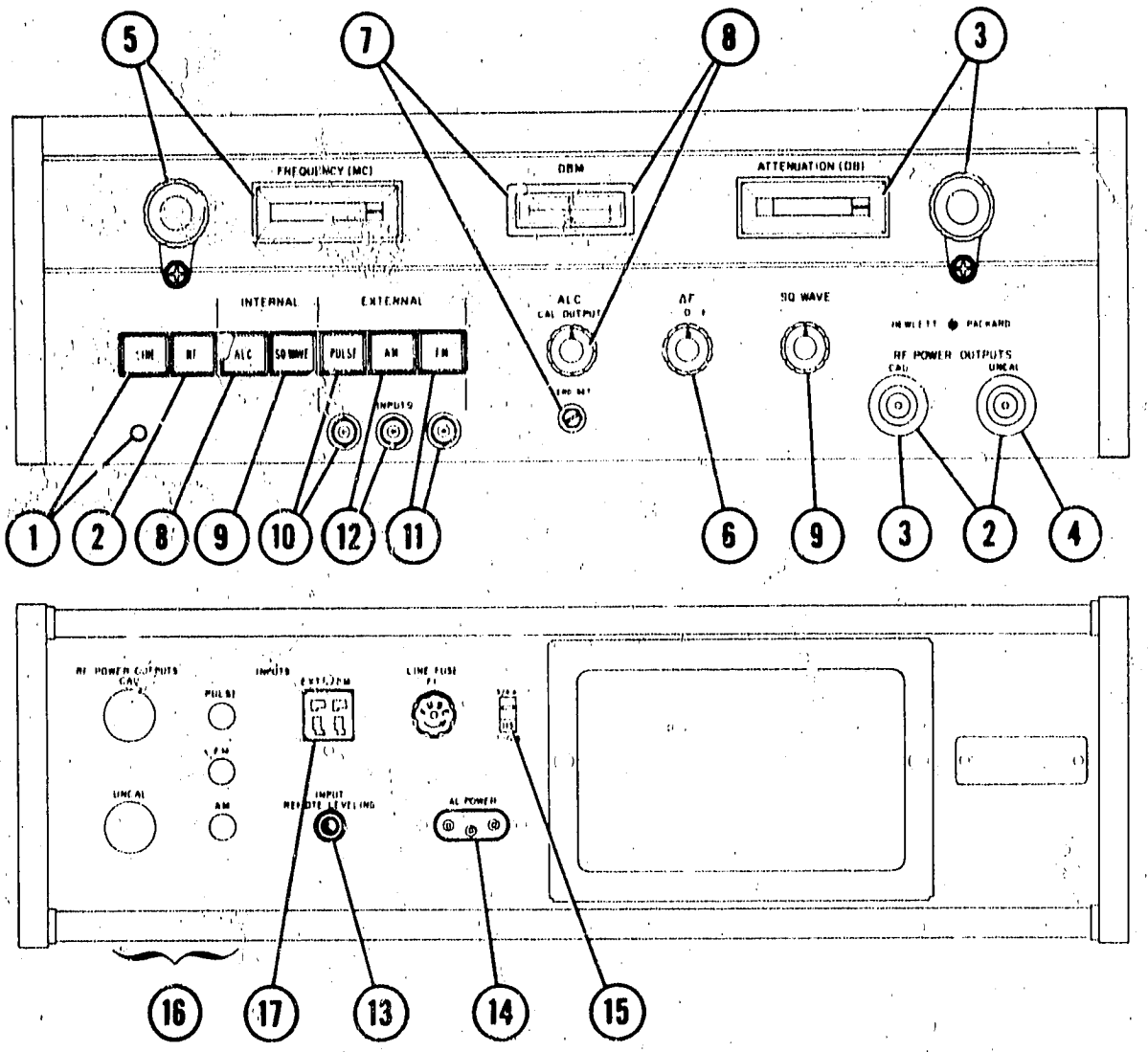
## 3-7. STABILIZED SOURCE

3-8. To use the 2650A Oscillator Synchronizer (obsolete) with the signal generator, proceed as follows:

a. The rear panel connector EXT FM (J201) is a Cinch-Jones type S304AB. Connection between this jack and J5 of the 2650A must be made as follows:

Pin 3, J201, to Pin E, J5 — 2650A
Pin 4, J201, to Pin F, J5 — 2650A
Pin 1, J201, to Pin G, J5 — 2650A
Pin 2, J201, no connection.

b. Connect RF output from UNCAL OUTPUT connector on Model 8614A to OSCILLATOR INPUT connector on Model 2650A. Depress EXTERNAL FM button on the Model 8614A and proceed as explained in the instruction manual for the Model 2650A.




1. **LINE.** Connects primary power to instrument; lamp glows.

2. **RF.** Applies power to RF POWER OUTPUTS.

3. **ATTENUATION (DB).** Sets RF power level at the CAL RF POWER OUTPUT.

4. **UNCAL RF POWER OUTPUT.** Provides approximately 0.5 mW unleveled and unattenuated RF power.

5. **FREQUENCY (MC).** Sets RF frequency.

6. **ΔF.** Permits small deviations from FREQUENCY (MC) setting (±1.5 MHz minimum).

7. **ZERO SET.** Adjust for zero indication on DBM meter (with RF turned off).

8. **ALC.** Levels calibrated RF output; used to set a reference on DBM meter.

9. **INTERNAL SQ WAVE.** Modulates CAL RF OUTPUT. SQ WAVE control adjusts modulation frequency.

10. **EXTERNAL PULSE.** Positive pulses to external pulse input will provide modulation voltages required to pulse modulate CAL RF OUTPUT. Positive pulses turn RF "ON".

11. **EXTERNAL FM.** AC voltages applied to external FM input will provide frequency modulation of both CAL and UNCAL outputs.

12. **EXTERNAL AM.** Signals applied to external AM input will provide modulation voltages required to AM-modulate CAL RF OUTPUT.

13. **INPUT REMOTE LEVELING.** Input jack for external leveling loop voltage applied to level generator CAL RF POWER OUTPUT.

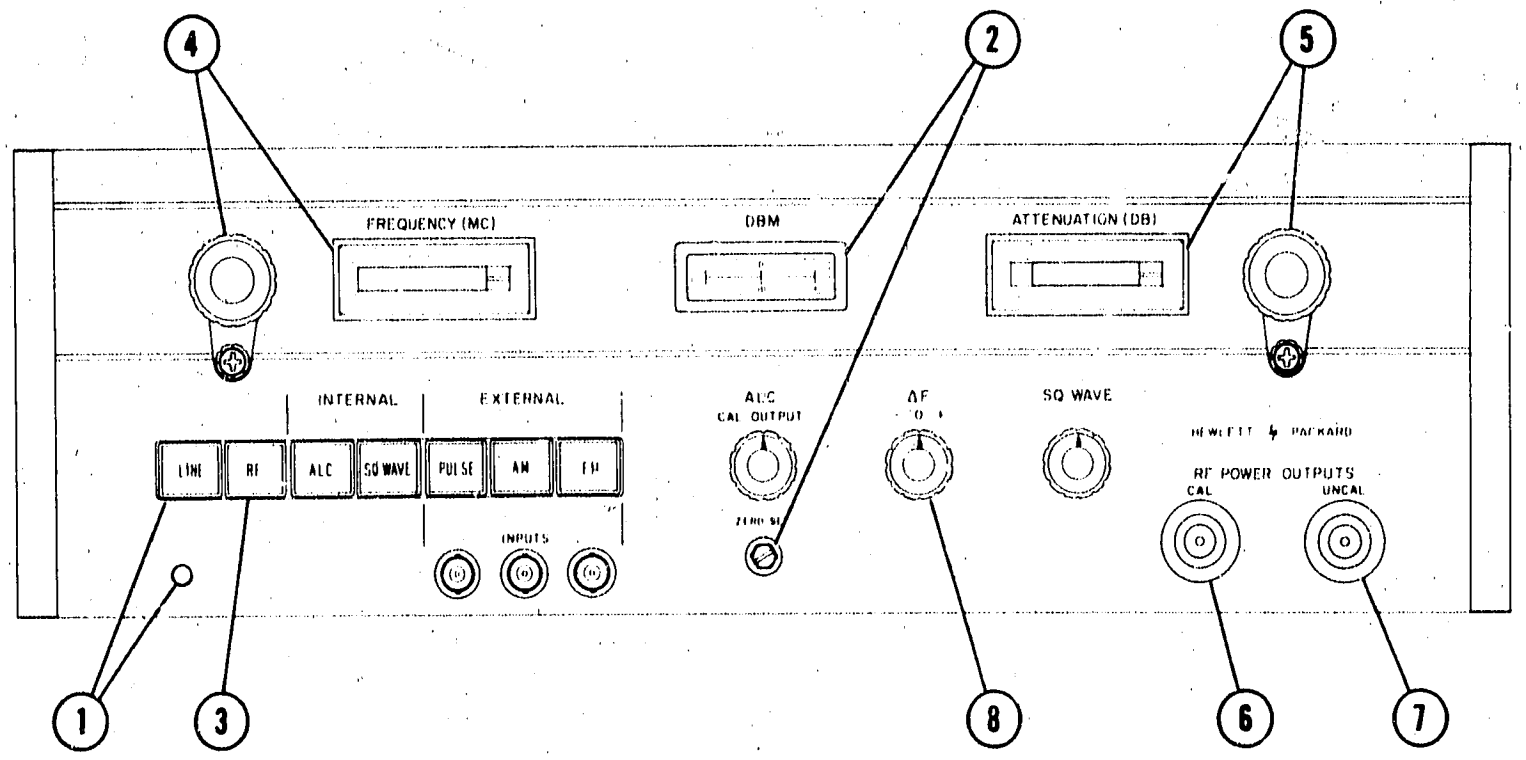
14. **POWER.** Male receptacle which connects to the power cord.

15. **LINE VOLTAGE.** Arranges input power transformer to accept either 115- or 230-volt, 50- to 60-Hz primary power input.

16. **OPTION 01.** Input and output connectors located on rear panel (input connectors also located on front panel).

17. **EXT FM.** Two terminal connector dc-coupled to klystron for stabilization of output frequency.

**Figure 3-1. Front and Rear Panel Controls and Indicators**




1. Depress LINE.

2. Note meter pointer on DBM meter.

3. Depress RF; there should be some deflection of DBM meter pointer.

**NOTE**

*When RF button is depressed, meter pointer will fluctuate from approximately +1 dBm at low frequency to +4 dBm or more at high frequency.*

4. Set FREQUENCY (MC) to desired frequency.

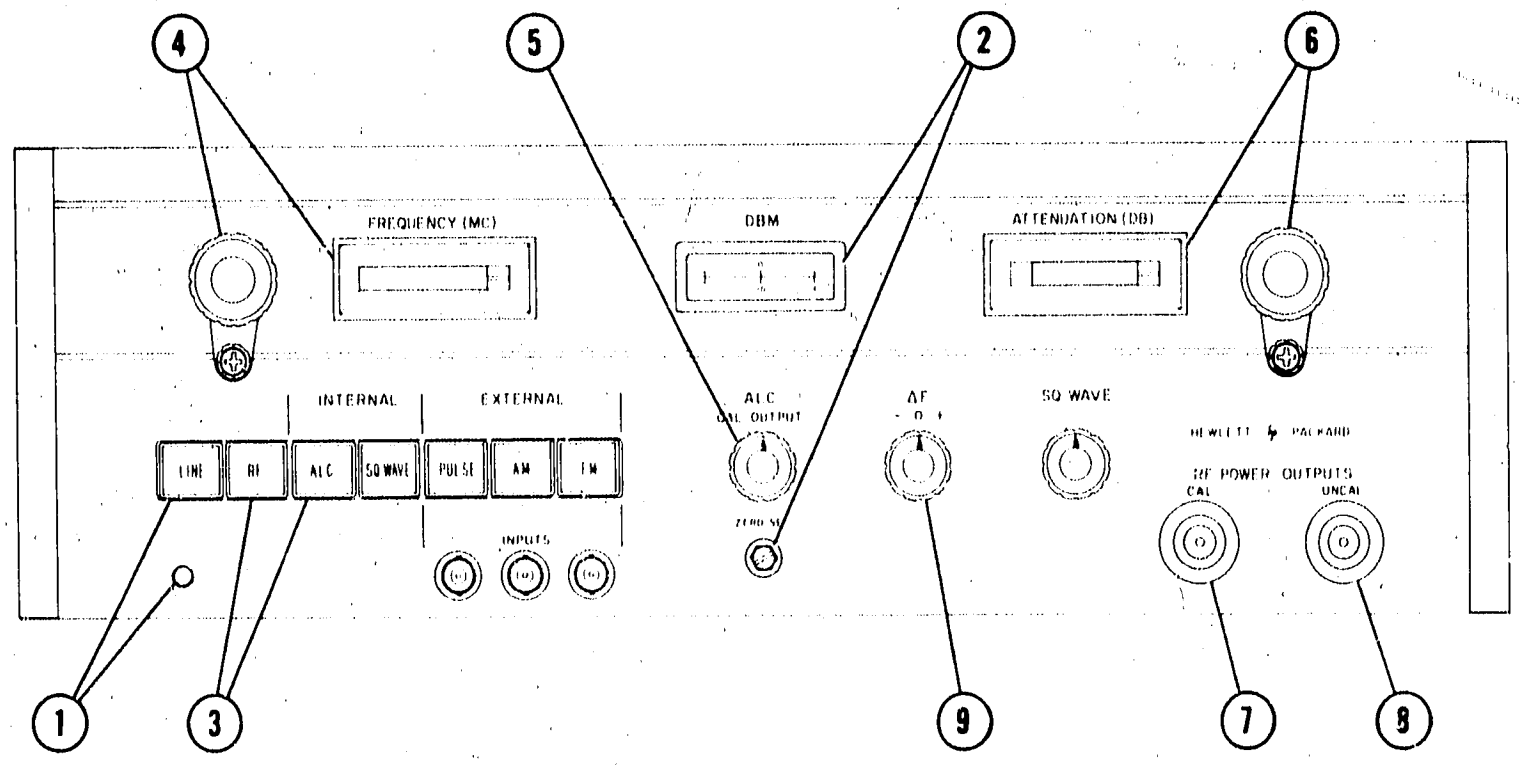
5. The ATTENUATION (DB) knob will attenuate RF power at CAL RF POWER OUTPUT. Counterclockwise rotation will increase output power, although fully counterclockwise rotation will cause output power to decrease.

6. Take unleveled but attenuable RF power at CAL RF POWER OUTPUT.

7. Take unleveled and unattenuable RF power at UNCAL RF POWER OUTPUT.

8. For maximum output at the CAL RF POWER OUTPUT, adjust ATTENUATION (DB) and ΔF controls together and monitor output with a power meter. Note: changing ΔF setting will also change frequency.

**Figure 3-2. Unleveled RF Power Output**



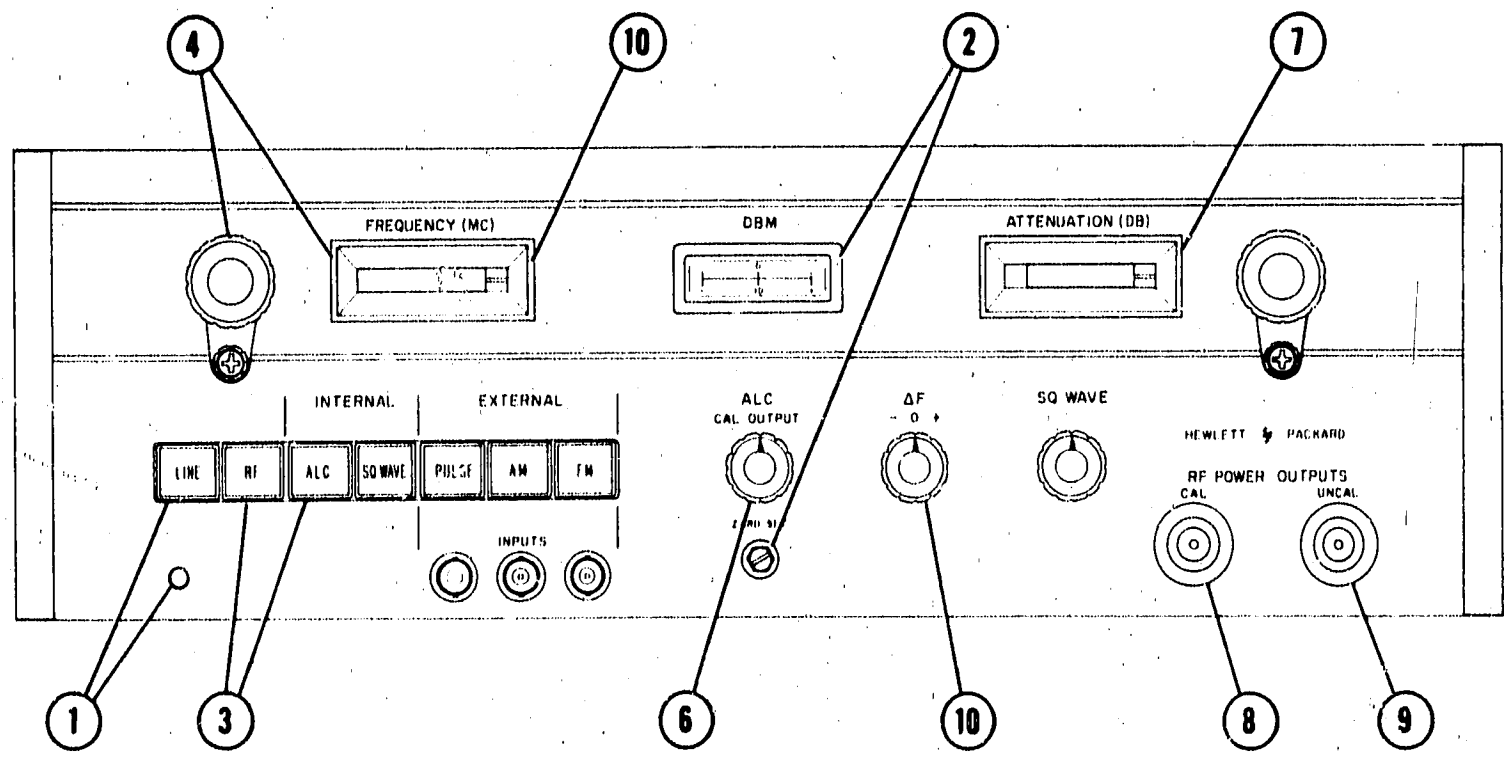

1. Depress LINE.
2. Check that meter pointer on DBM meter is on ZERO SET mark; if not, adjust accordingly.
3. Depress RF and INTERNAL ALC; there should be some deflection of DBM meter pointer.
4. Set FREQUENCY (MC) for 800 MHz.
5. Adjust ALC CAL OUTPUT for desired dBm reference on DBM meter. The ALC system holds RF output power across the band to within ±0.75 dB for levels of 0 dBm or less. The most common DBM meter reference is 0 so that the attenuated RF output power can be read directly from attenuator readout. Note: the ATTENUATION (DB) will not accurately calibrate above −15 dB.

**NOTE**

*Power may be leveled above 0 dBm over that portion of the band where the desired power is available.*

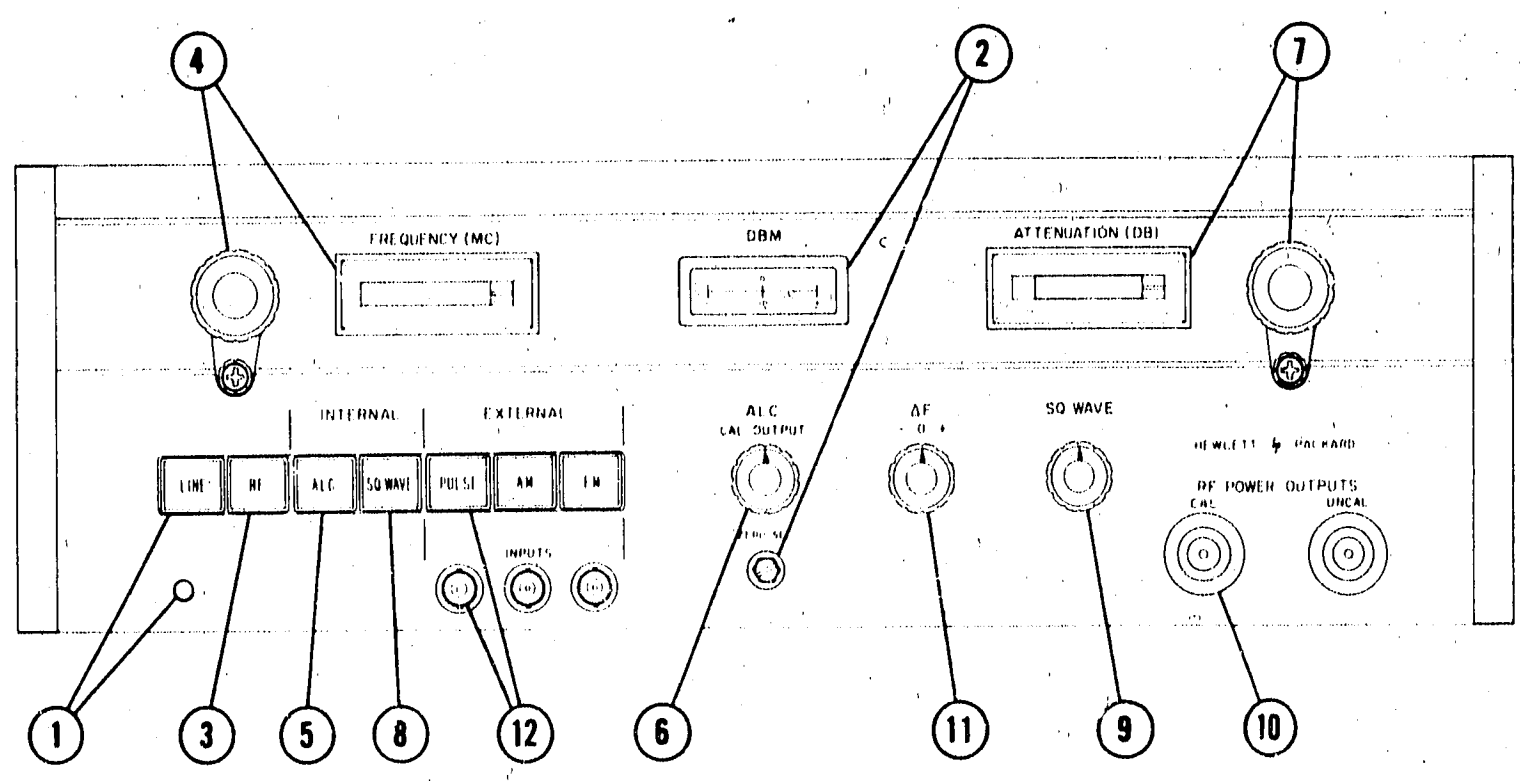
6. Set ATTENUATION (DB) to desired attenuation. The RF power level at CAL RF POWER OUTPUT is the algebraic sum of the DBM meter setting and of the ATTENUATION (DB) setting.
7. Take leveled and attenuable RF power available at CAL RF POWER OUTPUT.
8. Take unleveled and unattenuable RF power at UNCAL RF POWER OUTPUT.
9. ΔF control should be centered.

**Figure 3-3. Internally Leveled RF Output**




1. Depress LINE.
2. Check that meter pointer on DBM meter is on ZERO SET mark.
3. Depress RF and INTERNAL ALC.
4. Set FREQUENCY (MC) for 800 MHz.
5. With a directional coupler connected between CAL output and the load, and as close to the load as possible, sample and detect incident power and apply the detected signal to INPUT REMOVE LEVELING phone jack connection (rear panel). Adjust ATTENUATION (DB) control for detected 40 to 240 mV signal. Note: ATTENUATION (DB) control cannot be adjusted fully counterclockwise or loading effects will appear at higher frequencies.
6. Adjust ALC CAL OUTPUT for desired reference on DBM meter. This reference point may vary from that used with internal leveling due to different detector sensitivities.
7. Do not change ATTENUATION (DB) setting once leveling loop is set up. Adjusting attenuator position may degrade leveling loop operation.
8. Take leveled and attenuable RF power available at CAL RF POWER OUTPUT.
9. Take unleveled and unattenuable RF power at UNCAL RF POWER OUTPUT.
10. ΔF control should be centered when not in use.

**Figure 3-4. Externally Leveled RF Power**




1. Depress LINE.

**NOTE**

*When unleveled power is to be modulated, omit steps 2, 5, and 6.*

2. Check that meter pointer on DBM meter is on ZERO SET mark.

3. Depress RF.

4. Set FREQUENCY (MC).

5. Depress INTERNAL ALC.

6. Adjust ALC CAL OUTPUT for 0 dBm reference on DBM meter.

7. Set ATTENUATION (DB).

8. Depress SQ WAVE.

9. Adjust SQ WAVE for desired modulation frequency.

10. Take leveled and attenuable RF power output at CAL RF POWER OUTPUT.

11. The ΔF control may be adjusted for small changes in RF frequency and to peak maximum output power. However, adjusting too far from centered position will cause RF power to decrease and, if in leveled operation, poor leveling.

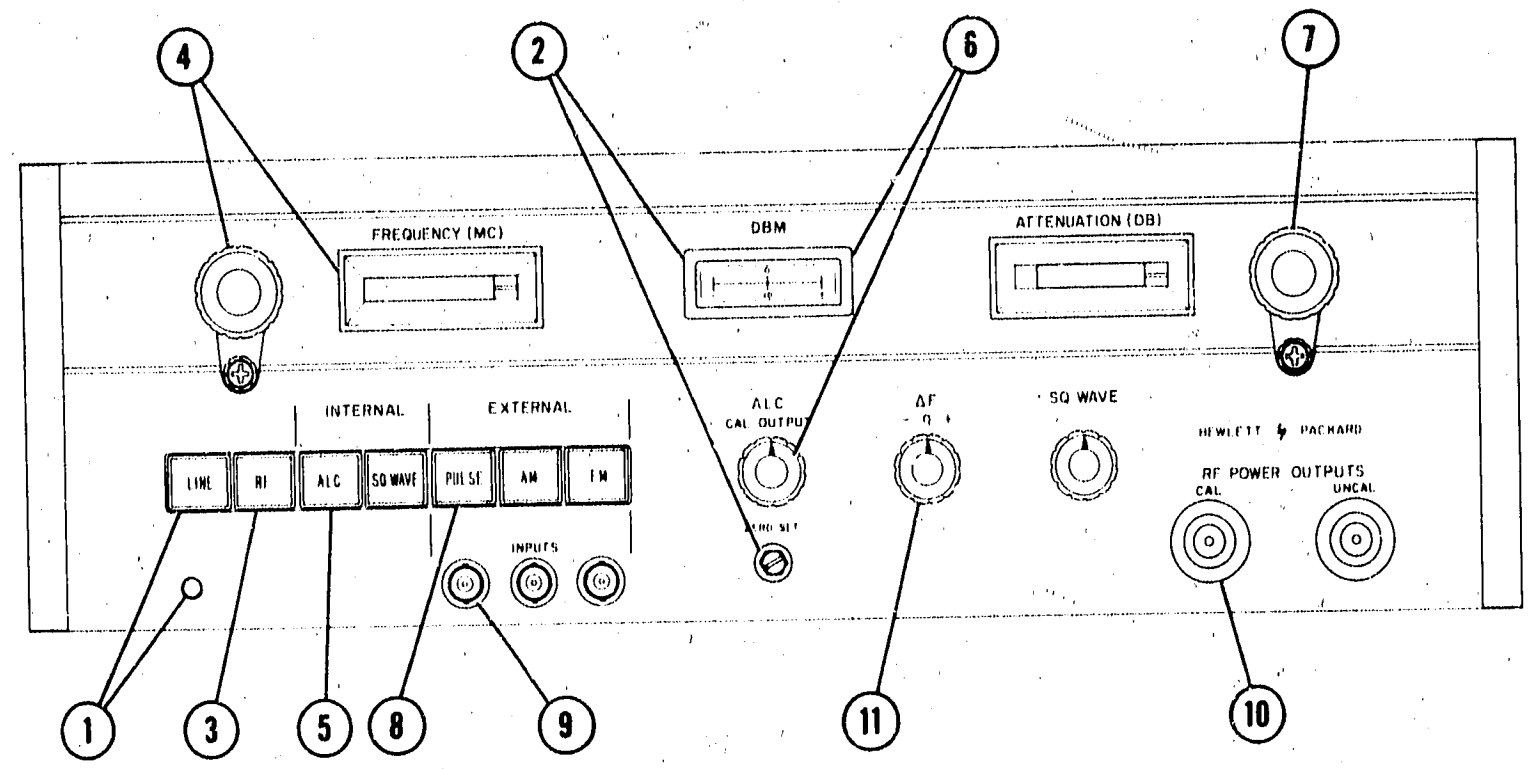
12. EXTERNAL SYNCHRONIZATION.

    a. Depress PULSE and apply +1 to +10V pulse.

    b. Pulse repetition rate must be equal to desired square wave frequency (950—1050 Hz).

    c. Decrease SQ WAVE frequency to a rate slightly slower than the pulse repetition rate.

**Figure 3-5. Internal Square-Wave Modulation and External Sync**



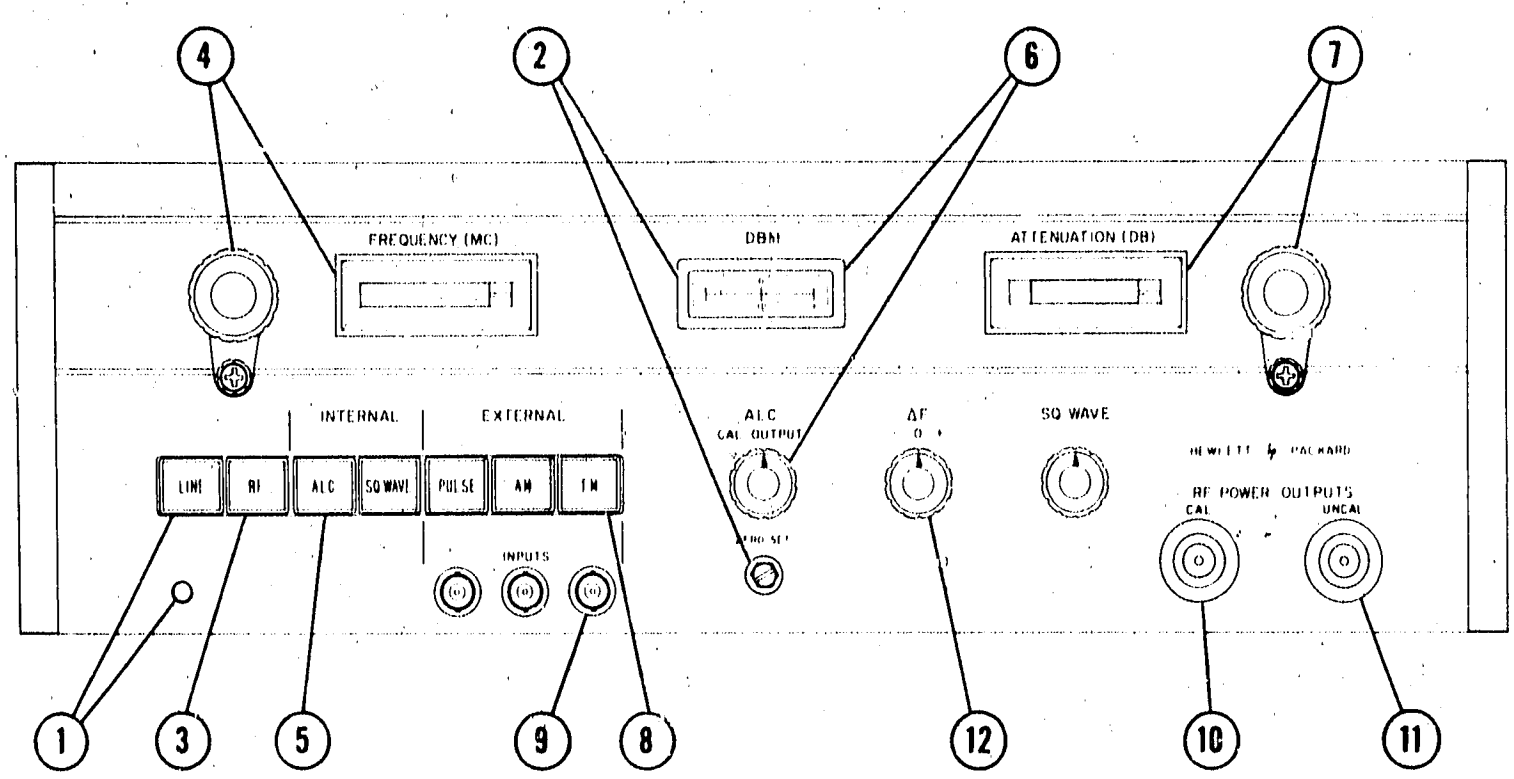

1. Depress LINE.

**NOTE**

*If external pulse modulation of unleveled power is desired, omit steps 2, 5, and 6.*

2. Check that meter pointer on DBM meter is on ZERO SET mark.
3. Depress RF.
4. Set FREQUENCY (MC).
5. Depress INTERNAL ALC.
6. Adjust ALC CAL OUTPUT for 0 dBm reference on DBM meter.
7. Set ATTENUATION (DB) as desired.
8. Depress EXTERNAL PULSE.
9. Apply 20- to 100-volt 50-Hz to 50-kHz positive pulse modulating signal to EXTERNAL PULSE INPUT.
10. Take leveled and attenuable pulse modulated RF power output at CAL RF POWER OUTPUT.
11. The ΔF control may be adjusted for small changes in RF frequency and to peak maximum output power. However, adjusting too far from centered position will cause RF power to decrease and, if in leveled operation, poor leveling.

**Figure 3-6. External Pulse Modulation**




1. Depress LINE.

**NOTE**

*If external FM modulation of unleveled power is desired, omit steps 2, 5, and 6.*

2. Check that meter pointer on DBM meter is on ZERO SET mark.

3. Depress RF.

4. Set FREQUENCY (MC).

5. Depress INTERNAL (ALC).

6. Adjust ALC CAL OUTPUT for 0 DBM meter reference. A 0 DBM reference allows a direct readout of ATTENUATION (DB) dial. The ALC system will level RF power with FM frequencies of 1 kHz or less and typically (depending upon individual klystron sensitivity) with FM voltage amplitutes of 40 volts or less between 800 and 1600 MHz and 60 to 75V between 1600 and 2400 MHz.

**NOTE**

*Power may be leveled above 0 dBm over that portion of the band where the desired power is available.*

7. Set ATTENUATION (DB).

8. Depress EXTERNAL FM.

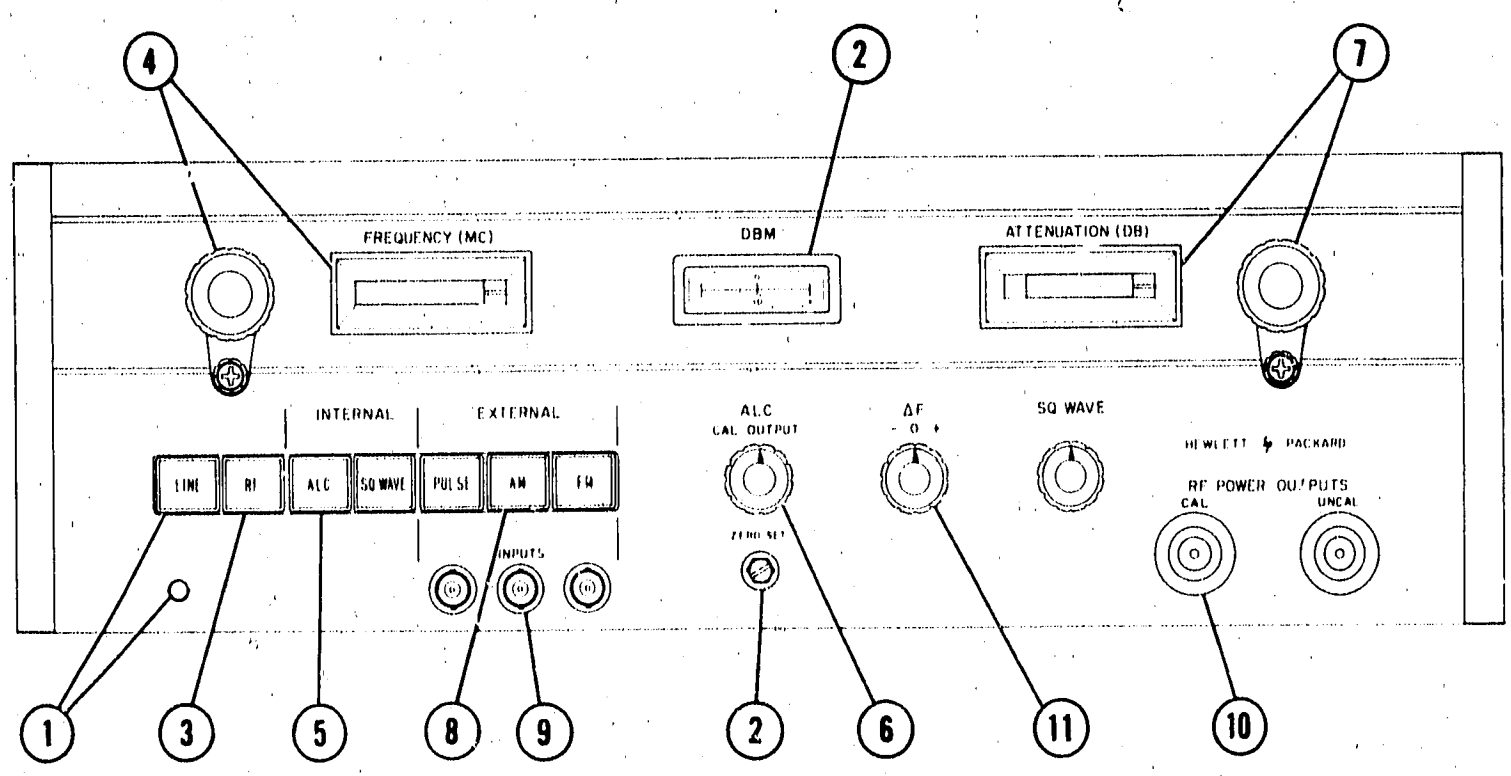
9. Apply modulating signal to EXTERNAL FM INPUT (front or rear panel).

10. Take leveled and attenuable frequency modulated RF power output at CAL RF POWER OUTPUT.

11. Take unleveled FM-modulated RF power at UNCAL RF POWER OUTPUT.

12. ΔF control should be centered so that the klystron will operate in the center of the mode.

**Figure 3-7. External FM Modulation**




1. Depress LINE.

2. Check that meter pointer on DBM meter is on ZERO SET mark.

3. Depress RF.

4. Set FREQUENCY (MC).

**NOTE**

*The modulator used is an absorption-type. If leveling mode of operation is not used, the positive portions of AM modulating signal will be clipped.*

5. Depress INTERNAL ALC.

6. Adjust ALC CAL OUTPUT control for a −3 dBm reference on DBM meter. A −3 dBm reference on the DBM meter is the most common used because this allows the AM signal to modulate the RF up to 3 dB above the output level.

7. Set ATTENUATION (DB) to 000 or less; recheck DBM meter.

8. Depress AM button.

9. Apply AM modulating signal to external AM INPUT (5 to 6 volts peak).

10. Modulated signal available at CAL RF OUTPUT only.

11. The ΔF control may be adjusted for small changes in RF frequency and to peak maximum output power. However, adjusting too far from centered position will cause RF power to decrease and, if in leveled operation, poor leveling.

**Figure 3-8. External AM Modulation**

# THEORY

# SECTION IV
# PRINCIPLES OF OPERATION

## 4-1. INTRODUCTION

4-2. Basically, the instrument includes an RF Oscillator, PIN Diode Modulator, Automatic Leveling Circuit, Modulation Circuits, and Power Supply as shown in Figure 4-1. The RF Oscillator is a reflex klystron which always operates CW. The PIN diode modulator is a current-controlled device that attenuates RF power up to 20 dB or more. The control circuits provide the modulation currents required by the PIN modulator. The power supply provides the regulated dc voltages required to operate the circuits in the instrument.

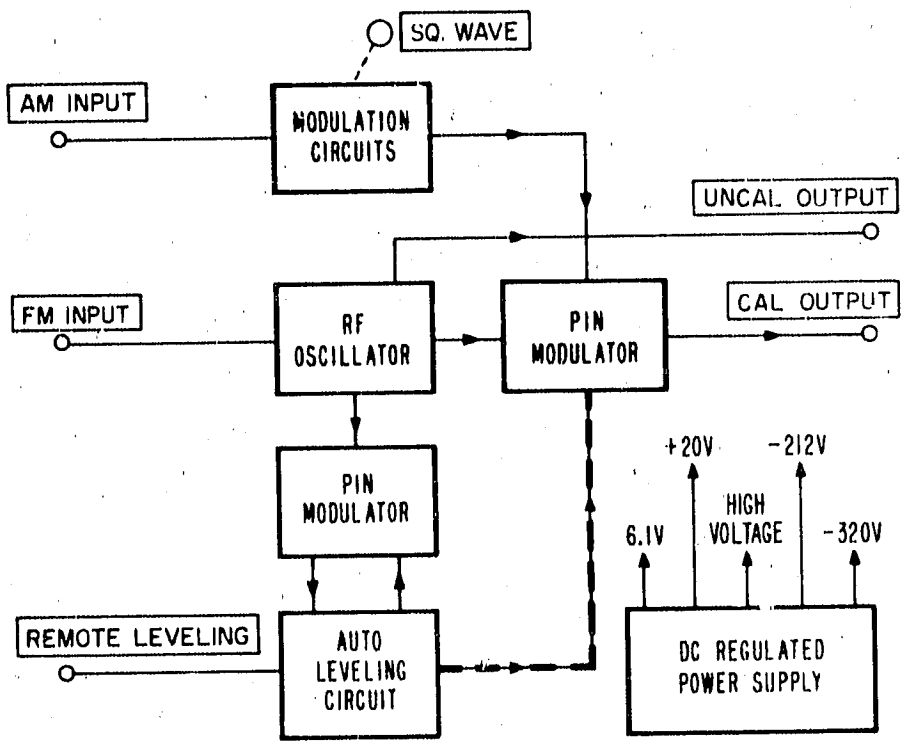



**Figure 4-1. Circuit Block Diagram**

## 4-3. RF OSCILLATOR

4-4. The RF Oscillator, providing the RF power, consists of a velocity-modulated tube operating in an external resonant cavity. The tube is a reflex klystron operating in the 1¾ and 2¾ repeller modes.

4-5. The RF power output from the oscillator, which may be CW or CW with FM, is obtained from the resonant cavity by means of pickup probes located in small sections of waveguide which open into the resonant cavity. One of these probes delivers RF power directly to the UNCALIBRATED RF OUTPUT connector, the other two deliver RF power to the PIN modulator.

## 4-6. PIN DIODE MODULATOR

4-7. The PIN modulator, which is two nearly identical units in one, is a high-speed, current, controlled absorption-type attenuator. The Modulator is shown in Figure 5-11. A simplified illustration of the modulator is shown in Figure 4-2. Each PIN diode unit includes a transmission line, PIN diodes, low-pass filter, and two high-pass filters.

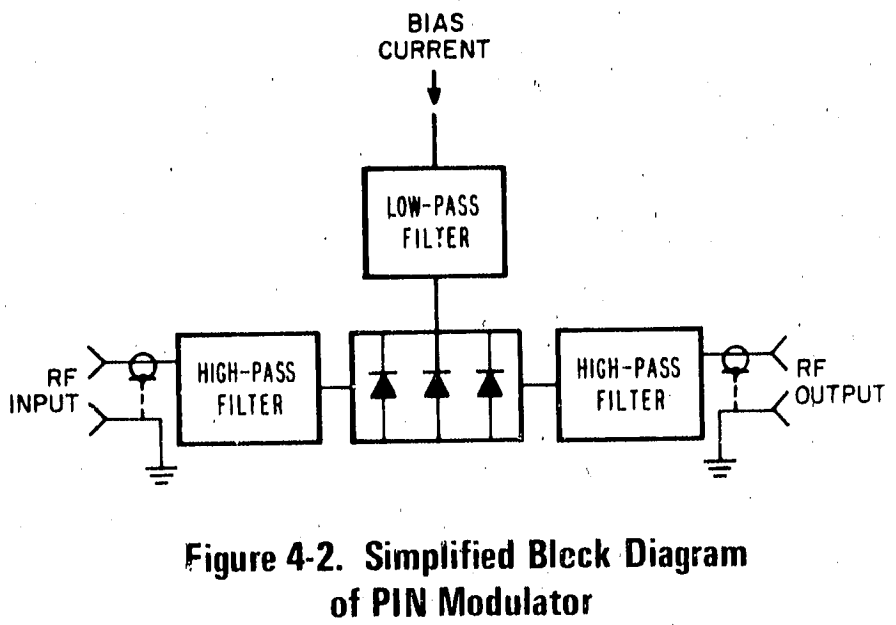



**Figure 4-2. Simplified Block Diagram of PIN Modulator**

4-8. The PIN diode is a slice of nearly pure silicon wafer in which the P and N traces are nearly equal. P-type impurities are diffused from one side into the wafer, and N-type impurities are diffused from the other side, leaving a layer of intrinsic semiconductor (silicon) through the middle; thus the name PIN diode. At frequencies below 100 MHz the PIN diode rectifies the same as any other good junction diode. However, at frequencies above 100 MHz, rectification efficiency drops rapidly because of carrier storage in the intrinsic (I) layer.

4-9. When forward-bias current flows through the PIN diode, holes and electrons are stored in the I layer. The more the bias current, the larger the amount of stored charge-carriers. When reverse bias is applied, reverse current flows until the stored carriers are depleted. During this period, the diode impedance remains low. Currents above several hundred megacycles do not flow in the reverse direction for a long enough time to remove those charge carriers. Therefore, the microwave currents *do not* significantly change the instantaneous amount of charge carriers stored, and there is negligible rectification.

## PIN DIODE MODULATOR (Cont'd)

4-10. There is, however, a resistance to microwave current flow. This resistance is inversely proportional to the number of charge carriers stored in the I layer, and the number of charge carriers, in turn, is proportional to the forward bias current. By varying the bias on a diode from back bias (no stored charge) to about ½ mA forward bias, the resistance to microwave currents varies from approximately 5000 ohms to 30 ohms.

**4-11. Pin Diodes Mounted in a Transmission Line.** To understand how a PIN modulator works, consider a PIN diode mounted across a transmission line that has a characteristic impedance of 50 ohms. When the diode is back-biased to about 5000 ohms, the microwave signal on the transmission line is unattenuated because 5000 ohms compared to 50-ohm line impedance has little effect. However, when the diode is forward-biased to about 30 ohms, most of the microwave current will flow through the 30-ohm diode instead of propagating down the 50-ohm transmission line. This current through the 30-ohm diode represents microwave energy dissipated as heat. Consequently, the diode actually absorbs microwave energy.

4-12. Figures 4-3 and 4-4 show the schematic of the PIN diode modulator used in the Model 8614A. The PIN modulator contains seven PIN diodes which are placed at approximately 1/4 wavelength along each strip transmission line. The 1/4 wavelength at midband spacing results in the lowest average SWR because reflection from one diode will tend to be absorbed and cancelled by the adjacent diode. The resistance in series with the diodes reduces voltage to the diodes and thereby protects the circuit.

4-13. Modulation input in the form of diode bias is used to change attenuation of the PIN diodes.

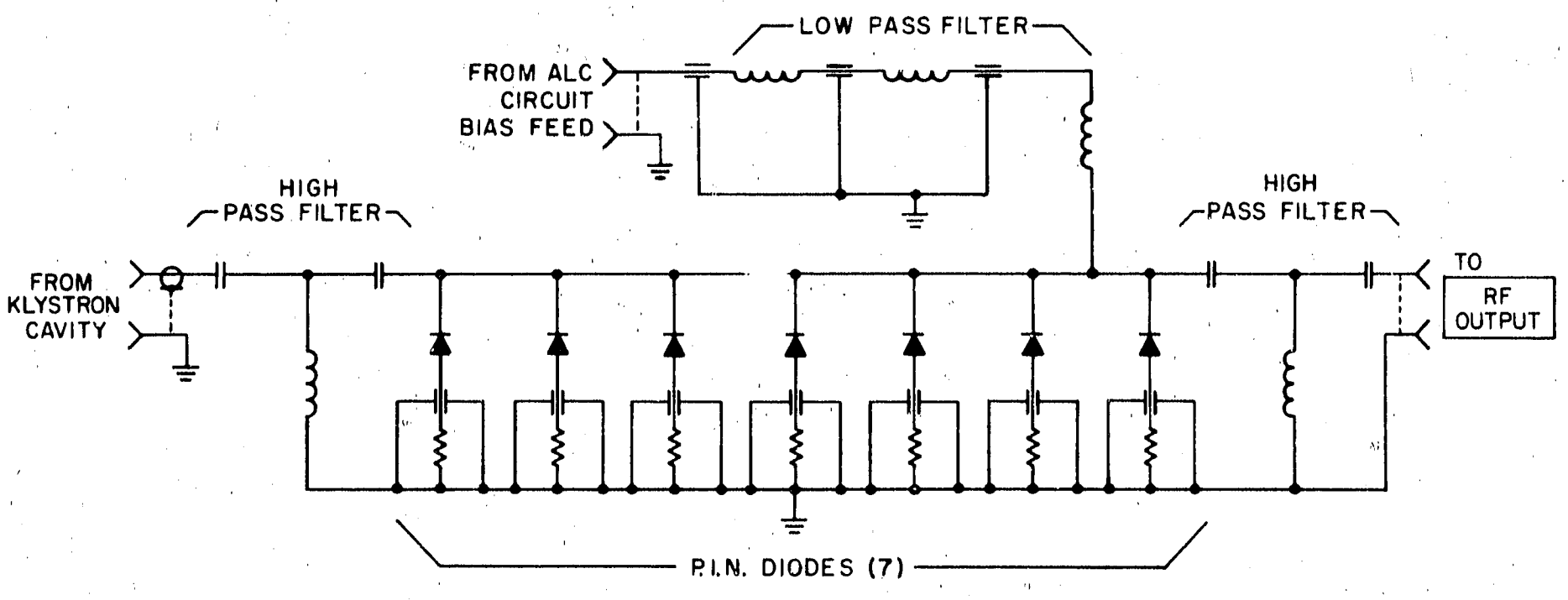



**Figure 4-3. Controlled RF Attenuator Unit**

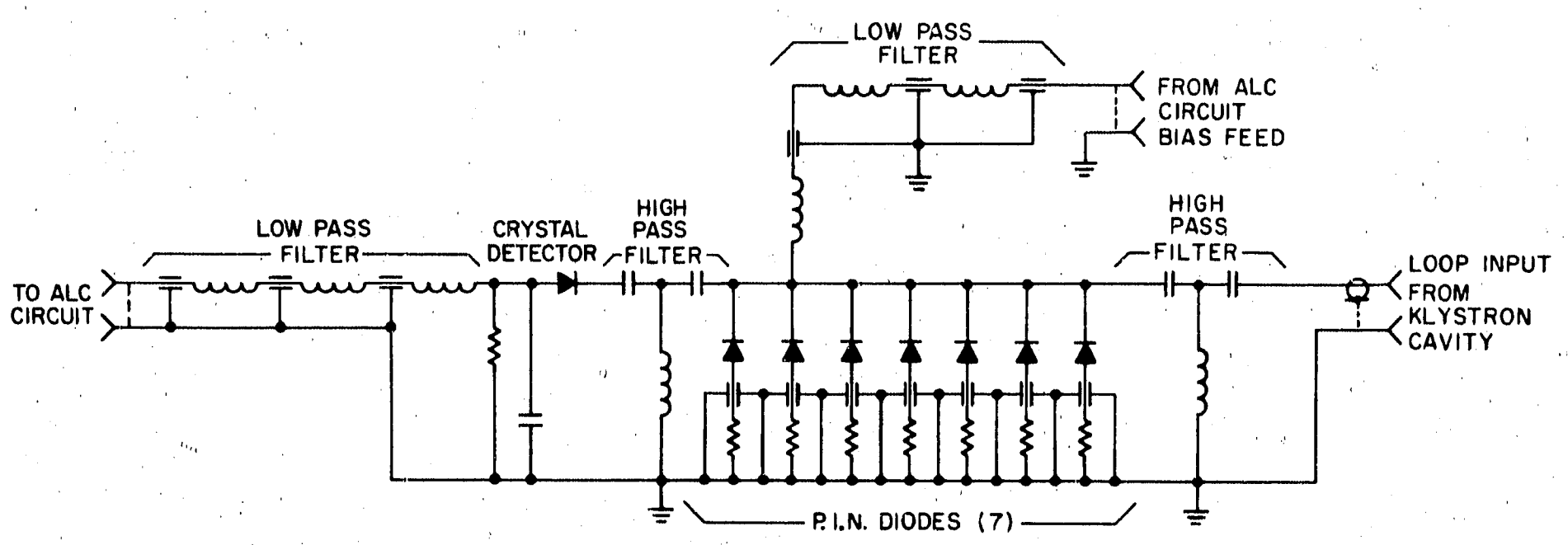



**Figure 4-4. Control ALC Attenuator Unit**

**PIN DIODE MODULATOR (Cont'd)**
Changes in diode bias produce changes in RF output level.

4-14. Modulation circuits external to the PIN modulator are protected by a low-pass filter (Figures 4-3 and 4-4) which prevents RF leakage. Leakage, if present, could cause erratic action in the circuits driving the PIN modulator and could also cause RF interference.

4-15. The high-pass filters (Figures 4-3 and 4-4) permit RF energy to enter and leave the diode strip line while keeping the low frequency modulating signals from entering the RF circuits preceding or following the PIN modulator.

## 4-16. MODULATION CIRCUITS

4-17. The basic function of the modulating circuit is to provide the forward- or reverse-bias to the RF PIN attenuator unit. The arrangement of the modulation circuit depends upon the mode of operation. The mode of operation is selected by depressing the appropriate front-panel button.

### 4-18. External Pulse

4-19. A simplified diagram of the circuits used in the external pulse mode of operation is shown in Figure 4-5. When the pulse button is depressed, V401A is cut off, and V401B is conducting. The conducting of V401B draws current through the PIN diodes in the RF attenuator unit; hence, conduction of V401B forward-biases the PIN diodes causing the RF output to decrease by more than 20 dB. A positive pulse applied to the external pulse input turns V401A on, turns V401B off, and allows RF power to pass through the PIN diode attenuator with the RF output level clamped to a set level by CR403. The amount of bias applied to the PIN diodes is limited by R420. Resistor R422 prevents the +20 volt supply from shorting to ground through CR403 when resistance of R420 is minimum.

### 4-20. Internal Square Wave

4-21. A simplified diagram of the circuits used in the internal square wave mode of operation is shown in Figure 4-6. When V401B is conducting, capacitor C402 is discharging toward approximately −200 volts while holding V401A cut off. When C402 discharges sufficiently, V401A begins to conduct and biases V401B off through the common cathode resistor R408. This results in C402 charging toward approximately −225 volts as long as V401 conducts. When C402 charges sufficiently, however, the current in V401A becomes limited and V401B again conducts causing V401A to cut off. The RC time constant of C402 is varied by R413, allowing frequency to be changed from 950 to 1050 Hz. When

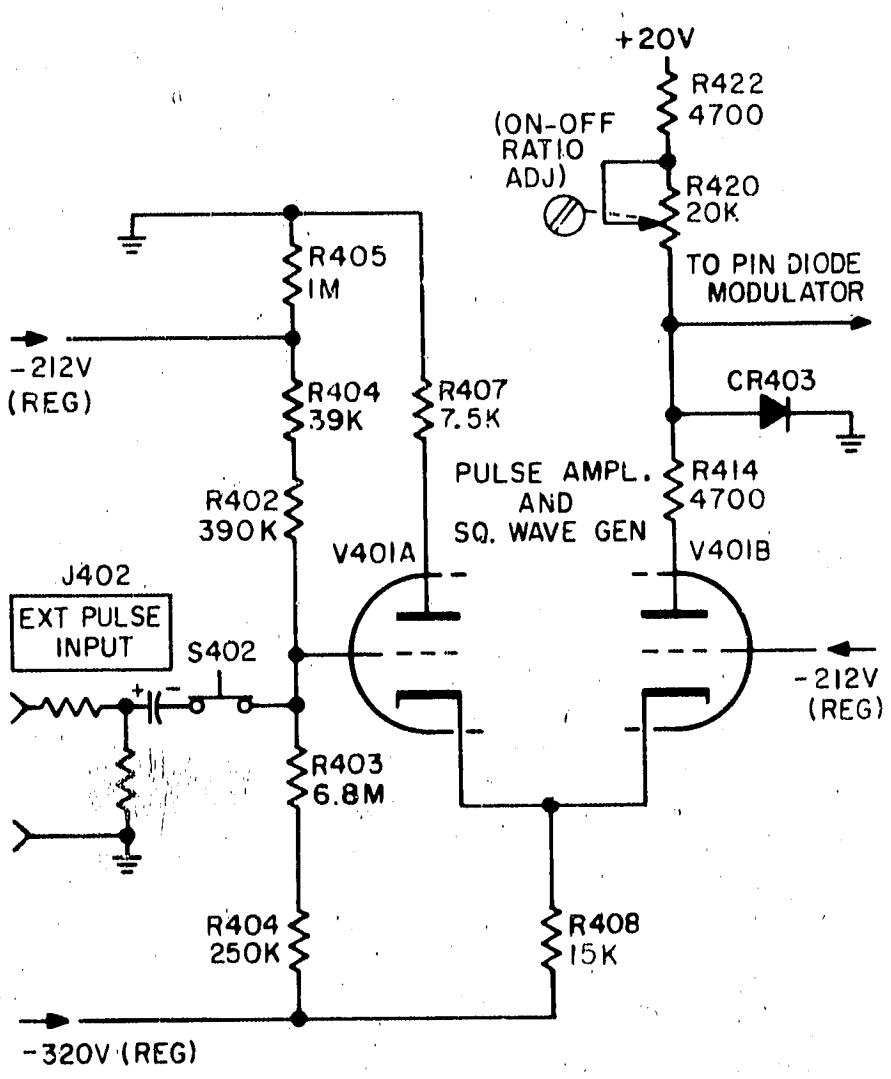



**Figure 4-5. Pulse Modulation Circuit**

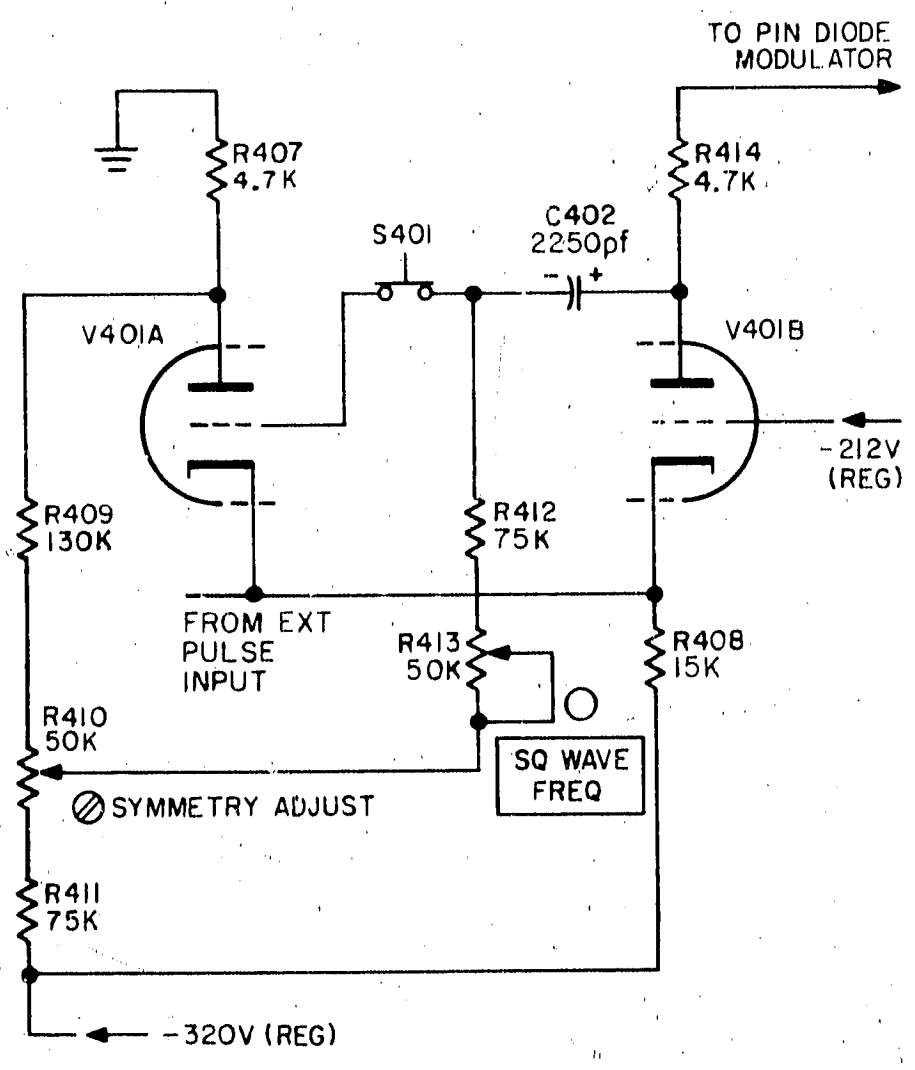



**Figure 4-6. Square-Wave Modulation Circuit**

**Internal Square Wave (Cont'd)**

401B is conducting the RF output is cut off by the PIN diodes. The symmetry of the square wave is adjusted by R410. R410 varies the voltage difference across C402; by varying R410, the time for C402 to charge or discharge to a given potential is controlled.

## 4-22. Synchronized Square Wave

4-23. With SQ WAVE and PULSE depressed and no signal applied to the pulse input, operation is as described in paragraph 4-21. When a positive pulse of at least 1 volt is applied to the cathode of V401A, tube current decreases. With limited current, V401B begins to conduct, causing the RF output to cut off. Any input signal applied while V401B is conducting will not affect normal square wave circuit operation. Square-wave frequency may be synchronized to any pulse repetition rate between about 955 to 1050 Hz providing internal square-wave frequency is set to a slightly slower rate.

## 4-24. External AM

4-25. A simplified diagram of the circuit used in the external AM mode is shown in Figure 4-7. With the AM button depressed, diode CR403 conducts clamping the voltage at the junction of R420 and R419 to about +0.6 volts. This back-biases CR404 which causes current to flow through R419 and R418. When an applied signal goes positive, it reduces the bias current, through R419 and R418, to the controlled RF PIN modulator. Reduced bias current increases the back bias on the PIN diodes which allows more RF power to pass though the PIN modulator. A negative signal increases the bias current which increases the forward bias which causes increased attenuation of RF power through the PIN modulator (up to about 20 dB maximum attenuation depending on the amplitude of the negative half cycle of the AM signal).

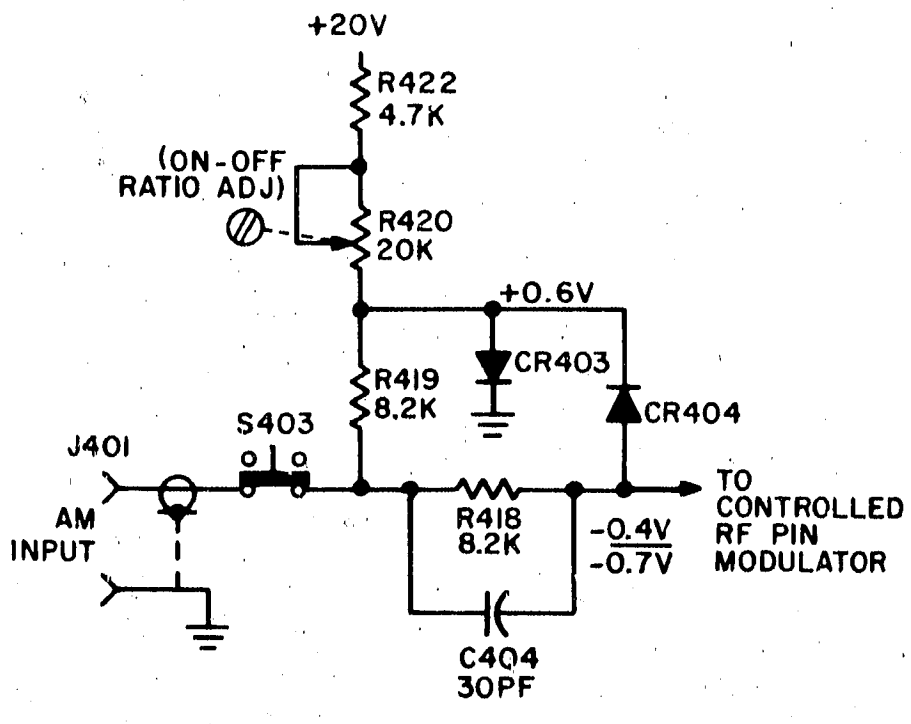



**Figure 4-7. External AM Circuit**

4-26. Since the PIN modulator is an absorption-type attenuator, it is necessary to lower the unmodulated RF output power level by an amount equal to the peak level of the AM signal so that the positive peaks will not be clipped. To do this, the instrument must be operated in the leveled mode of operation so that the ALC CAL CONTROL can be used to set the RF carrier power level.

4-27. For most purposes a signal level reduction of up to 20 dB should be sufficient since it approximates 100% modulation. The amount of distortion is dependent upon the percentage of modulation: at 30% modulation the amount of distortion is almost unnoticeable; at 100% modulation the distortion may be 5 to 20%.

## 4-28. Internal Meter and Automatic Level Control (ALC)

4-29. A simplified diagram of the ALC circuit is shown in Figure 4-8. The meter amplifier is a dual function circuit, performing both a leveling and/or a power output monitoring function. RF power is taken from the klystron cavity through the ALC attenuator assembly (part of the PIN diode modulator) and delivered to the ALC circuit. The meter amplifier monitors the power level and in leveled operation with the ALC amplifier, maintains a constant RF output.

4-30. Actual operation is as follows: RF power from the klystron is coupled from a fixed probe in the klystron cavity to the ALC attenuator (part of the PIN diode modulator). The RF power is delivered through a high-pass filter to the ALC diode attenuator, then through another high-pass filter to a crystal detector. The detected signal from CR701 is then delivered to a low-pass filter and to the ALC circuit.

4-31. The crystal detector CR701 is arranged so that the detected signal is negative in polarity. An increase in RF level as the klystron is tuned across the band will cause a more negative output. A decrease in RF power from the klystron causes a less negative output. The detected RF output level from CR701 is then delivered to the base of Q501A.

4-32. Consider the circuit operation when the RF level from the klystron increases. An increase in klystron output level causes a more negative signal

**Internal Meter and Automatic Level Control (ALC) (Cont'd)**

on the base of Q501A. The conduction of Q501A decreases, causing the collector of Q501A to go in a positive direction. The positive signal goes through the cathode follower, V401, and is applied to the base of Q502, decreasing the conduction of Q502. The collector of Q502 goes more negative.

4-33. A portion of the negative-going signal from the collector of Q502 is applied to the base of Q501B as negative feedback. The feedback factor is determined by the ratio of R513 to R514. The open loop gain of the meter amplifier (Q501A/B, Q502, and Q503) is sufficiently high so that the closed loop gain is essentially a function of the feedback factor and is, therefore, less dependent upon the normal aging effects on the tubes and transistors in the circuit.

4-34. The negative-going signal from Q502 is also applied to the meter M501 for output indication. The meter is protected against overload by the breakdown diode CR501. If the internal ALC switch, S601, is on, the negative-going output is applied to the base of the differential amplifier, Q601, causing a decrease in conduction. The collector of Q601 will go more positive, causing an increase in conduction of the emitter followers, Q603 and Q604. This causes the emitter of Q604 to also become more positive. The positive-going signal is applied to the bases of Q605 and Q605, increasing their conduction and causing both collectors to become more negative.

4-35. The collectors of Q605 and Q606 appear as constant current sources, so the decrease in collector potential causes current to be drawn from the PIN diodes. This increased bias current (increased forward bias) reduces the RF power output to its original level. The negative-going output from Q605 is delivered to the RF PIN diode attenuator allowing less RF to pass through it also. The net result is that an increase in klystron output causes an increase of forward bias on the PIN diodes which decreases the RF output.

**4-36. Leveling Accuracy.** For accurate leveling, the ALC and RF PIN diode attenuators must track together as far as attenuation and frequency are concerned. The adjustment of R614, R615, R620, and R621 provide for matching the attenuator characteristics.

**4-37. ALC CAL Output.** The RF OUTPUT can be controlled by adjusting the front panel ALC CAL OUTPUT control which varies the bias on the base of the differential amplifier, Q602, which in turn changes the bias on the PIN diode attenuator.

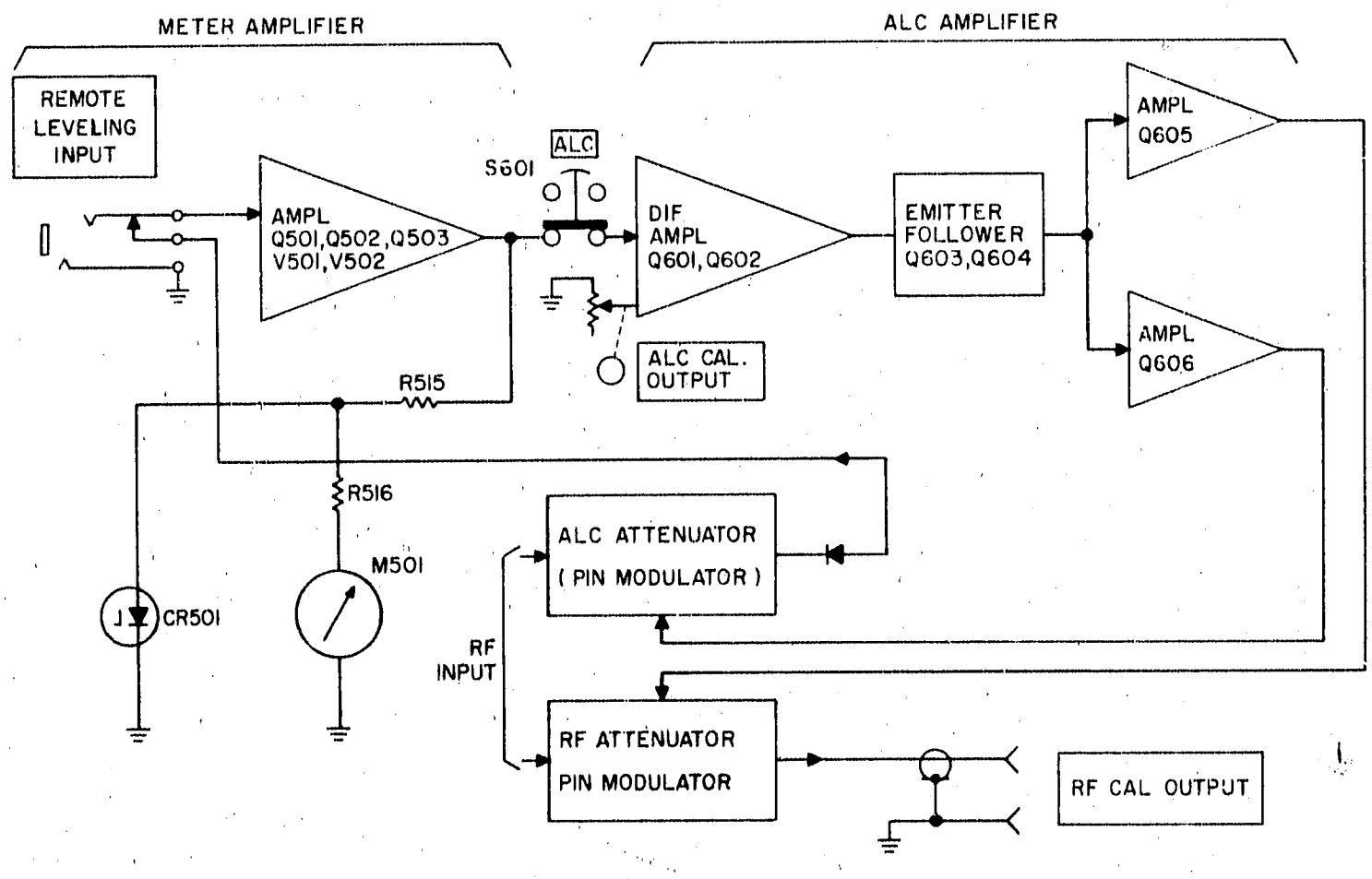



**Figure 4-8. ALC and Meter Circuit**

## 4-38. External Leveling

4-39. A simplified diagram of the ALC circuit is shown in Figure 4-8. Operation of the external leveling is the same as that described for internal leveling except that the ALC Attenuator and Q606 are no longer a part of the circuit. Also, the meter M501 does not accurately indicate RF output. If the RF output is to be changed, an external attenuator must be used once leveling is set up.

## 4-40. Regulated Power Supply

4-41. There are three regulated power supplies: high voltage, +20 volt, and filament. All three supplies are series-regulated types. The series regulator is connected in series with the main load. The output voltage is monitored and compared to a reference voltage. The voltage differential is applied through a control amplifier to the series regulator. This differential voltage changes the effective resistance of the series regulator which in turn holds the output voltage constant (see Figure 4-9).

4-42. The high-voltage supply consists of two supplies which have been combined to obtain required voltages. They are a −320 volt supply on which a −350 volt supply has been stacked to provide a total of −670 volts. Both supplies use voltage doublers to drive series regulator circuits. Since this is a combined circuit arrangement, the −320 volt and −350 volt supplies are interdependent. There is also a gas regulator tube, V105, connected to the −320 volt supply to provide a −212 volt regulated source.

4-43. There are two low-voltage supplies. One provides +20 volts sc for the ALC circuit, the other 6.1 volts dc for filament operation. The +20 volt supply uses a voltage doubler and series regulator, while the filament supply uses a half-wave rectifier and a series regulator.

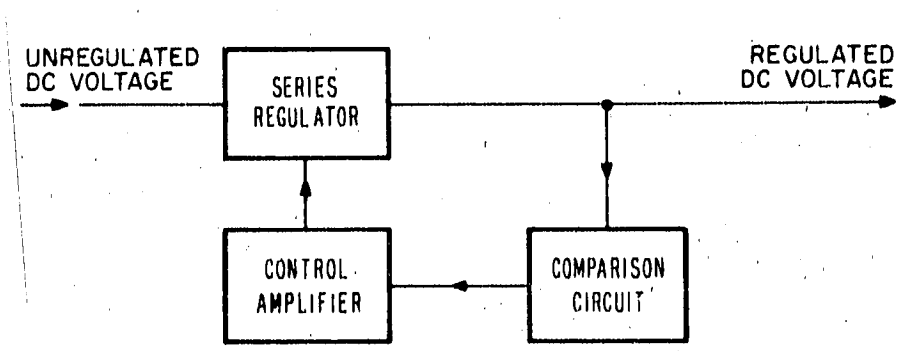



**Figure 4-9. Series-Regulated Power Supply**

# MAINTENANCE

# SECTION V
# MAINTENANCE

## 5-1. INTRODUCTION

5-2. This section provides instructions for performance testing, calibrating, troubleshooting, and repairing the signal generator. If the serial prefix (the first three numbers of the serial number) of your instrument is different than that listed on the title page of this manual, differences exist between your instrument and the instrument described in this section (refer to the Appendix for difference information).

## 5-3. PERIODIC MAINTENANCE

### 5-4. Cleaning Air Filter

5-5. Inspect the air filter regularly and, if necessary, remove and wash in detergent and water. Dry filter and replace: no oiling or coating of filter is necessary. Unrestricted air flow gives longest component life. Keep the filter clean.

### 5-6. Lubrication

5-7. No routine lubrication is needed. Lubricate mechanical parts (e.g., dial drive, klystron cavity carriage assemblies) only when necessary using light machine oil on shafts and light grease on gears.

## 5-8. PERFORMANCE CHECKS

**5-9. Purpose.** The procedures of paragraphs 5-10 through 5-17 check signal generator performance for incoming inspection, periodic evaluation, calibration, and troubleshooting. The tests can be performed without access to the signal generator interior. The specifications of Table 1-1 are the performance standards.

**5-10. Test Equipment Required.** The test instruments required to make the performance checks are listed in Table 5-1. Test instruments other than the ones listed may be used provided their performance equals or exceeds the Critical Specifications.

### 5-11. Frequency and Power Check

a. Connect equipment as shown in Figure 5-1.

b. Set up Signal Source as follows:

| | |
|---|---|
| LINE | depressed |
| RF | depressed |
| ΔF | centered |
| FREQUENCY (MC) | 800 |

c. Set Power Meter for a mid-scale reading.

d. Using calibrated frequency meter, measure actual signal frequency. Specification: accuracy must be ±5 MHz. Note: frequency meter must be calibrated to an accuracy of approximately ±0.03%.

e. Repeat above procedure every 200 MHz and at all points of particular interest to a frequency dial indication of 2400 MHz.

f. If dial accuracy is not within specification, refer to paragraph 5-59 for adjustment procedure.

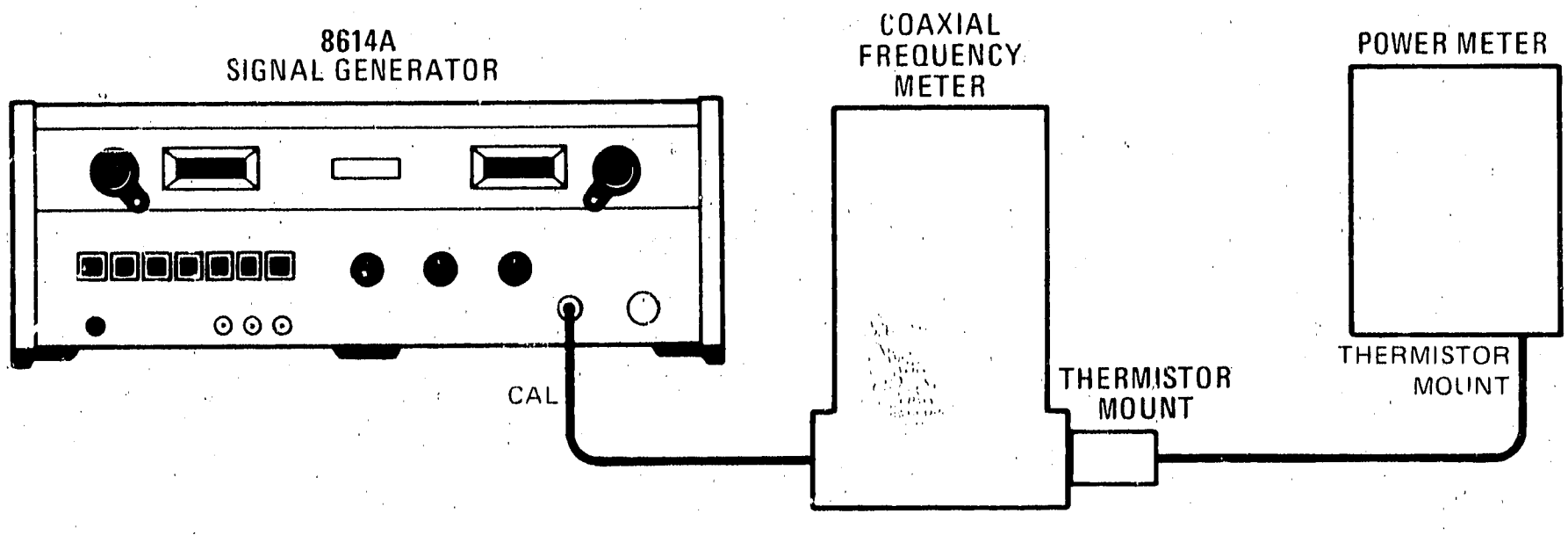



**Figure 5-1. Frequency and Power Measurement**

**Table 5-1. Test Equipment Required**

| Instrument Type | Check | Critical Specifications | Recommended Instrument |
|---|---|---|---|
| Oscilloscope | Calibration<br>Troubleshooting<br>Performance | Frequency Response: > 1 MHz<br>Range: 30 to 0.5 μs/cm<br>Sensitivity: 0.005 to 1.0 V/cm<br>Accuracy: ±3% | HP Model 180C with HP 1801A and HP 1821A |
| Crystal Detector | Calibration<br>Troubleshooting<br>Performance | Frequency Range: 800 to 2400 MHz<br>Sensitivity: 100 mV/0.35 mW<br>Frequency Response: ±0.5 dB | HP Model 423A |
| Power Meter | Calibration<br>Performance | Power Range: 0.1 to 10 mW<br>Frequency Range: 800 tc 2400 MHz<br>Accuracy: ±3% | HP Model 432A Power Meter with HP Model 478A Thermistor Mount |
| DC Voltmeter | Calibration<br>Troubleshooting | Range: 1 to 685V<br>Accuracy: ±0.2% of reading<br>Floating Input: may operate within ±470 Vdc of chassis ground | HP Model 3435A Digital Voltmeter |
| AC Voltmeter | Calibration<br>Troubleshooting | Range: 0 to 20 mV<br>Accuracy: ±2% of reading<br>Floating Input: may operate within ±470 Vdc of chassis ground | HP Model 3435A Digital Voltmeter |
| Clip-On Milliammeter | Calibration<br>Troubleshooting | Range: 0 to 35 mA<br>Accuracy: 3% ±0.1 mA | HP Model 428B |
| Frequency Counter | Calibration<br>Performance | Range: 800 to 2400 MHz | HP Model 5342A |
| Pulse Generator | Calibration<br>Performance | Pulse Width: 3 μs<br>Pulse Rep Rate: 50 Hz to 50 kHz<br>Output: 27V peak | HP Model 214B |
| FM Modulator | Calibration | Outputs: 300V peak-to-peak and 6.3 Vac<br>Input: 115 Vac, 60 Hz<br>Phase Adjustable: Approx 80° | Power Transformer (1) (9100-0045)<br>Capacitor (1) (0160-0904)<br>Potentiometers (2) (2100-0047)<br>Fuseholder, extractor post type (1) (1400-0084)<br>Power Cord (1) (8120-0050)<br>Fuse (1) Amp, 115V, Slo Blow (2110-0007)<br>(see Figure 5-14) |
| DC Power Supply | Troubleshooting | Output: 315 to 353 Vdc<br>Ripple: Less than 3 mV | HP Model 711A |
| Test Oscillator | Calibration<br>Check | Frequency Range: 10 kHz<br>Output: 5 to 6V peak<br>Output Impedance: 50 ohms | HP Model 651B |
| Electronic Counter | Calibration<br>Check | Compatible with Transfer Oscillator | HP Model 5245L |
| Transfer Oscillator | Calibration<br>Check | Frequency Range: 90 MHz<br>Harmonic: 20 | HP Model 5257A |
| Modulation Analyzer | Calibration<br>Check | Carrier Frequency: 500 kHz<br>Audio Filtering: 15 kHz Low Pass | HP Model 8901A |
| Ohmmeter | Troubleshooting | Range: .02 to 500 megohms<br>Accuracy: ±3% of full scale | HP Model 410C |
| 10 dB Attenuator | Calibration<br>Performance | Frequency Range: DC to 12.4 GHz | HP Model 8491A |

**Frequency and Power Check (Cont'd)**

g. To check power output: remove frequency meter from test setup and measure maximum power output at both CAL and UNCAL RF OUTPUT connectors. Specification: The sum of attenuation of 10-dB attenuator plus power meter reading must be at least +10 dBm at CAL RF OUTPUT. The attenuator attenuation and meter reading must equal at least −3.0 dBm at UNCAL RF OUTPUT. If either output is not satisfactory, refer to paragraphs 5-58 and 5-60.

## 5-12. Leveled Output Check

a. Connect instruments as shown in Figure 5-1, omitting the frequency meter.

b. Set up Model 8614A as follows:

| | |
|---|---|
| LINE | depressed |
| RF | depressed |
| FREQUENCY (MC) | 800 MC |
| ALC | depressed |
| ALC CAL OUTPUT | counterclockwise |
| ΔF | centered |

**NOTE**

*Before ALC button is depressed, DBM meter should indicate approximately +1 dBm; depressing ALC button should cause DBM meter indication to decrease. ALC CAL OUTPUT: 0 dBm (DBM meter indication); ATTENUATOR (DB): −0 dB or less.*

c. Set power meter for mid-scale reading.

d. Noting power meter variation from setting (step c), tune Model 8614A across frequency band. The variation should not exceed ±0.75 dB.

e. If ALC operation is not satisfactory, refer to paragraph 5-64.

## 5-13. On-Off Ratio Check

a. Connect instruments as shown in Figure 5-1, omitting the frequency meter and attenuator.

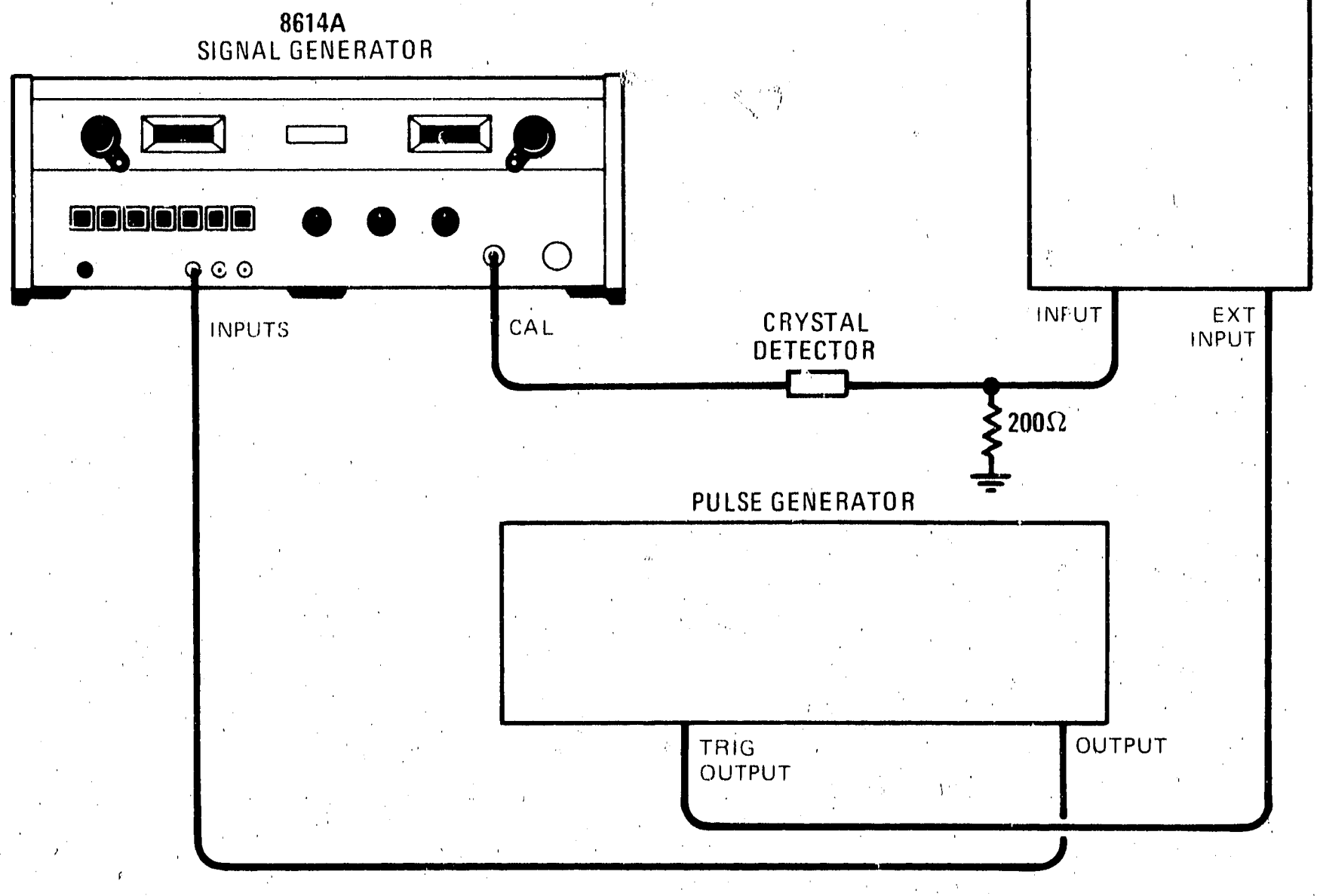



**Figure 5-2. External Pulse Check**

**On-Off Ratio Check (Cont'd)**

b. Set up Model 8614A as follows:

| | |
|---|---|
| LINE | depressed |
| RF | depressed |
| FREQUENCY (MC) | 2400 |
| EXTERNAL PULSE | not depressed |
| ATTENUATION (DB) | 000 |
| ALC | depressed |
| ΔF | centered |

c. Set power meter on 0 DBM scale and adjust Model 8614A for convenient reference.

d. Depress EXTERNAL PULSE on Model 8614A.

e. Reference on the power meter should change to the −20 DBM scale. Specification: On-off ratio must be at least 20 dB.

f. If on-off ratio is not at least 20 dB, refer to paragraph 5-68.

## 5-14. Pulse Modulation Check

a. Connect instruments as shown in Figure 5-2.

**NOTE**

*Oscilloscope vertical input should be shunted with 200-ohm resistor.*

b. Set up Model 8614A as follows:

| | |
|---|---|
| LINE | depressed |
| RF | depressed |
| EXT PULSE | depressed |
| ΔF | centered |

c. Set up pulse generator for a +20 volt, 50-prf signal with a pulse width of 4 μs.

d. A pulse presentation should be seen on the oscilloscope. Specification: Rise Time, 2 μs.

e. Set up pulse generator for a +20 volt 5000-prf signal with a pulse width of 4 μs.

f. A pulse presentation should be seen on the oscilloscope. Specification: Rise Time, 2 μs.

g. If pulse operation is not satisfactory, refer to paragraph 5-69.

## 5-15. Square-Wave and Sync Check

a. Connect instruments as shown in Figure 5-3 (see Note, paragraph 5-14, step a).

b. Set up Model 8614A as follows:

| | |
|---|---|
| LINE | depressed |
| RF | depressed |
| SQ WAVE | depressed |
| ATTENUATION (DB) | 0 DB |
| SQ WAVE FREQ | full counterclockwise |
| ΔF | centered |

c. Set oscilloscope sweep time to .1 MHz/CM.

d. Readjust rate control to display one complete square wave on oscilloscope. Square wave symmetry should be better than 45/55%. Range should be at least 950 to 1050 Hz. If square wave operation is not satisfactory, refer to paragraph 5-70.

e. To check external synchronization, connect equipment as shown in Figure 5-2.

f. With Model 8614A set up as detailed in step b above, set pulse generator as follows:

| | |
|---|---|
| AMPLITUDE | 2.0 |
| LENGTH (μSEC) | 1 |
| SYNC SELECTOR | X10 |
| PULSE RATE | 100 |
| POLARITY | (+) |

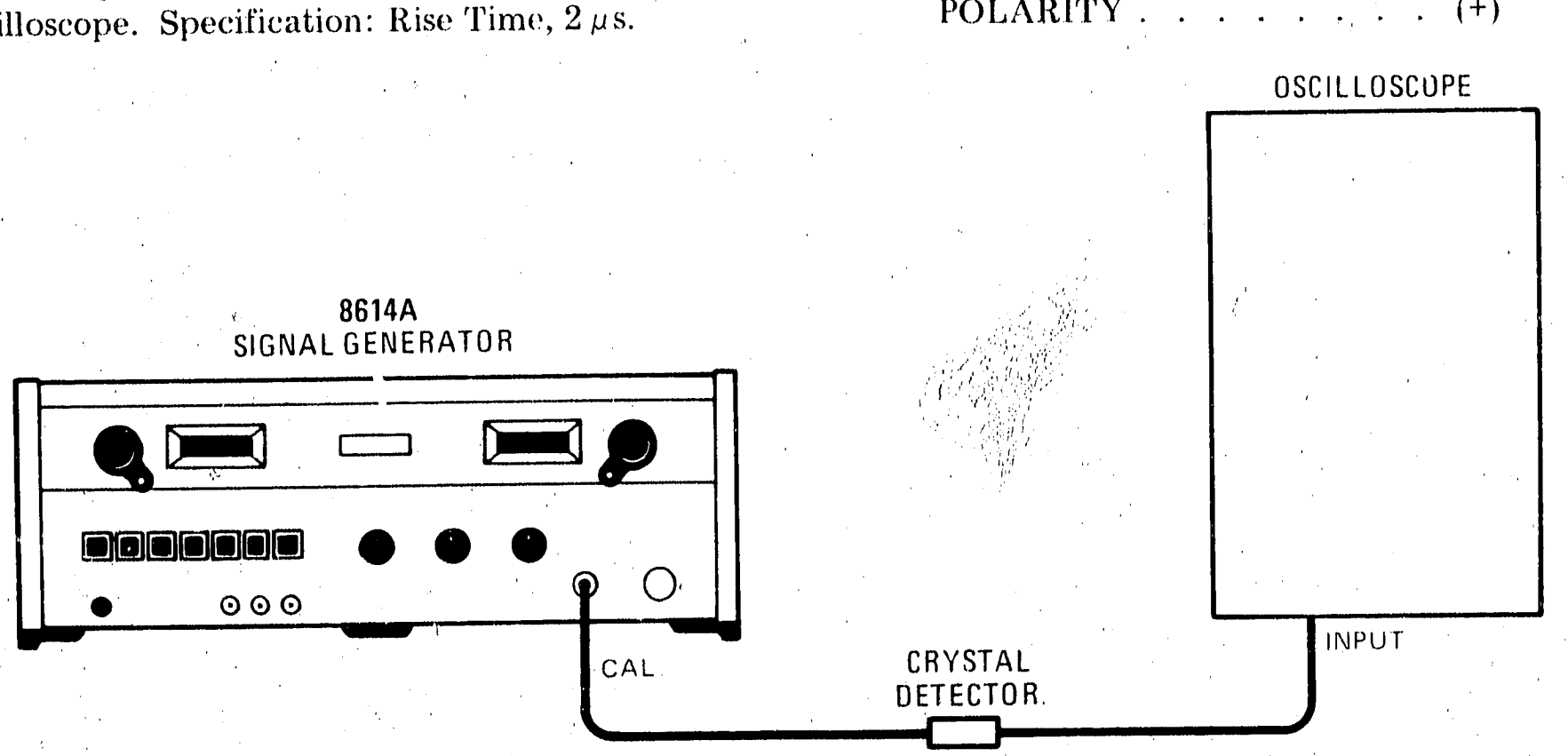



**Figure 5-3. Internal Square-Wave Check**

**Square-Wave and Sync Check (Cont'd)**

g. Set oscilloscope to INT TRIGGER SOURCE and adjust SQ WAVE FREQ for a period of 1 ±0.02 ms.

h. Set oscilloscope to EXT AC TRIGGER INPUT and depress PULSE button. Slowly increase PULSE RATE of pulse generator until square wave presentation on oscilloscope becomes stationary. If synchronization operation is not satisfactory, refer to paragraph 4-22.

## 5-16. External AM Check

a. Connect instruments as shown in Figure 5-4 (see Note, paragraph 5-14, step a).

b. Set up Model 8614A as follows:

| | |
|---|---|
| LINE | depressed |
| RF | depressed |
| AM | depressed |
| ALC | depressed |
| ALC CAL OUTPUT | −3 DBM (DBM Meter) |
| FREQUENCY (MC) | 800 |
| ATTENUATION (DB) | 000 or less |
| ΔF | centered |

c. Apply 5 to 6 volt peak sine wave to front panel BNC input.

d. Using ALC CAL OUTPUT, vary dc level of detected sinusoid so there is no peak clipping (vary input amplitude if necessary).

e. Adjust vertical sensitivity of oscilloscope to give 6-cm display of 1-kHz signal and then increase signal frequency to 1 MHz. The display should be greater than 3 cm.

f. If AM operation is unsatisfactory, refer to paragraph 4-24.

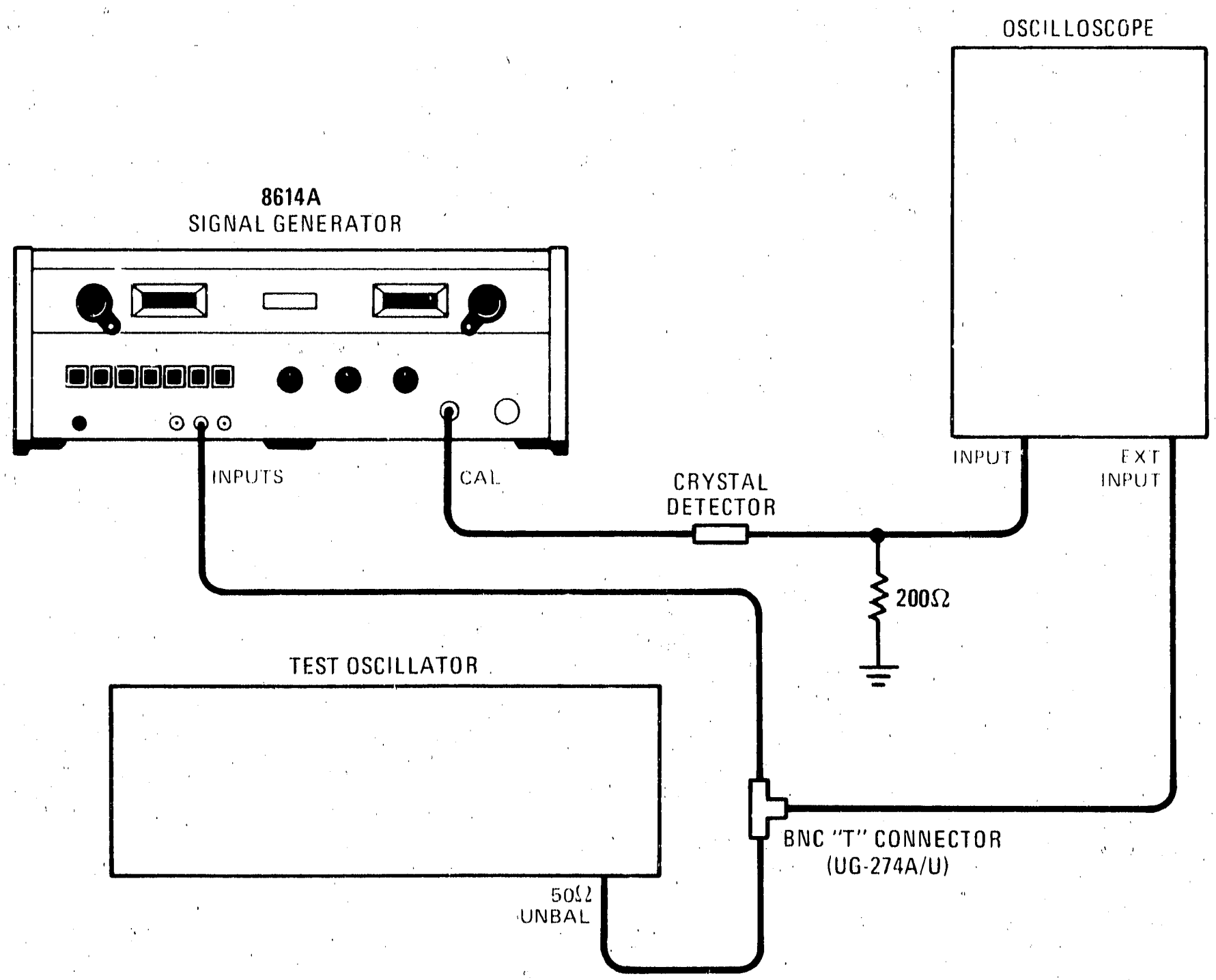



**Figure 5-4. External AM Check**

### 5-17. Measurement of Residual FM

a. Connect equipment as shown in Figure 5-5.

b. Set up 8616A to 1.8 GHz with LINE and RF pushbuttons pressed. Set RF output power to approximately −10 dBm.

c. Adjust transfer oscillator for 90 MHz and harmonic of 20.

d. Press AUTOMATIC and FREQ buttons on 8901A and tune 8616A frequency to obtain roughly 500 kHz to 1 MHz on 8901A display.

e. Press FM, 15 KHZ LOW PASS, and AVG buttons. Also make sure FM De-emphasis is off.

f. Read residual FM on display. It should be less than 5000 Hz.

## 5-18. TROUBLESHOOTING

### 5-19. Locating Trouble

5-20. Always start locating trouble with a thorough visual inspection for burned-out or loose components, loose connections, or any condition which suggests a source of trouble. Check tubes for open filaments by touching tubes and replace all that are cold (except V105 and V202 which are cold cathode tubes). Replacing a cold tube, in some cases, will restore the generator to normal operation. Check the fuse to see that it is not open.

5-21. If trouble cannot be isolated to a bad component by visual inspection or a cold tube, the trouble should then be isolated to a circuit section. Isolation to a circuit section can best be accomplished by reference to the block diagram (Figure 5-20), the troubleshooting charts (Tables 5-2 and 5-3), and isolation of all trouble symptoms using the performance check procedure (paragraph 5-8).

5-22. When testing the signal generator, it is recommended that line voltage be applied through a variable transformer and that the transformer be adjusted to deliver line voltage at the low end of the rated range (103 Vac for 115-volt operation and 207 Vac for 230-volt operation). An instrument in good condition should operate satisfactorily from any voltage within rated range, but where there is marginal operation (from weak tubes, etc), weaknesses become easier to trace at low line voltages.

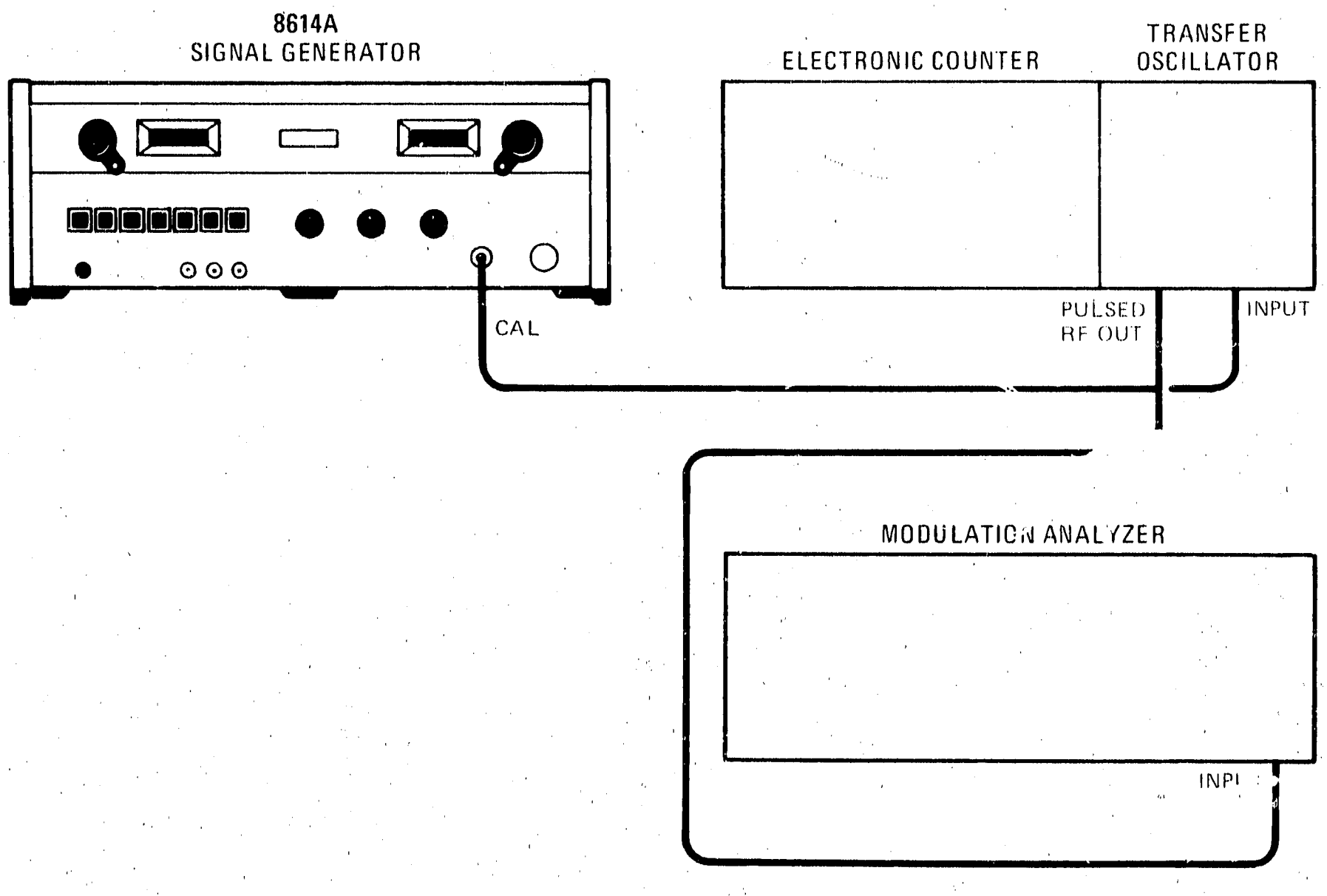



**Figure 5-5. Residual FM Check**

**Table 5-2. Power Supply Troubleshooting**

| Symptom | Conclusion | Remedy |
|---|---|---|
| **–350 VOLT SUPPLY** | | |
| Connect voltmeter common to test point 1 and voltage lead to test point 2 (see Figure 5-7). | | |
| –350 ±2 Vdc; 4 mV ac | Supply OK | |
| Small deviation | Out of adjustment | Adjust R212 (see Figure 5-6) |
| Large or erratic deviation | –350V or –320V supply bad<br>**NOTE**<br>*See Figure 5-21 for component location.* | Remove V101 and V102 and connect a –320 Vdc power supply between test point 1 and chassis ground. Recheck supply. If deviation still exists, check C201, C202, CR201, or CR202 voltages at test point 14 (see Figure 5-21). If OK, check V201, V202, V203, and V204. |
| **–320 VOLT SUPPLY** | | |
| Connect voltmeter common to chassis ground and voltage lead to test point 1 (see Figure 5-7). | | |
| +320 ±5 Vdc; 7 mV ac | Supply OK | |
| Small deviation | –350V supply out of adjustment | Check and adjust –350V supply |
| | –320V or –35V supply bad<br>**NOTE**<br>*See Figure 5-21 for component location* | Remove V201 and connect a –350 Vdc power supply between test points 1 and 2. Recheck supply. If deviation still exists check C101, C102, CR101, or CR102 voltages at test point 13 (see Figure 5-21). If OK check V101, V102, V103, and V104. |
| **–212 VOLT SUPPLY** | | |
| Connect voltmeter common to chassis ground and voltage lead to test point 5 (see Figure 5-7). | | |
| –212 ±5 Vdc | Supply OK | |
| Voltage unstable | Defective V105 | Check V105 |
| | Defective –320V regulation | Check –320V supply |
| **FILAMENT SUPPLY** | | |
| Connect voltmeter between test points 3 and 4 (see Figure 5-24) | | |
| –6.15 ±0.1 Vdc; 25 mV ac | Supply OK | |
| Small deviation | Out of adjustment | Adjust R5 (see Figure 5-6) |
| Large or erratic deviation | –320V reference or filament regulation defective | Check –320V supply<br>Check Q1, Q2, [illegible] or CR4 (see paragraph 5-27) |
| **+20 VOLT SUPPLY** | | |
| Connect voltmeter common to chassis ground and voltage lead to test point 6 (see Figure 5-23). | | |
| +20 ±0.1V; 4 mV ac | Supply OK | |
| Small deviation | Out of Adjustment | Adjust R53 (see Figure 5-23) |
| Large or erratic deviation | –212V reference or 20V regulation | Check –212V supply<br>Check Q50,Q51, Q52, Q53 (see para. 5-27) |

**Table 5-3. General Trouble Location**

| Symptom (outputs) | Trouble Location | Check |
|---|---|---|
| NO RF | High-voltage power supply | Measure supply voltages (see Table 5-2) |
| | Filament supply | Measure supply voltages (see Table 5-2) |
| | RF probes | Measure resistance of RF probes (see paragraph 5-61) |
| | Broken ground connection | Check chassis ground connections on both circuit boards |
| | PIN diodes | Check RF PIN diodes (see paragraph 5-68) |
| | Klystron | V1 |
| No Square Wave or Pulse | Modulation circuit | V401A/B |
| No ALC | Regulated +20V supply | Measure supply voltages (see Table 5-2) |
| | ALC circuit | V501-502, Q501-503, Q601-606 |
| | ALC probe | Measure resistance (see paragraph 5-61) |
| | PIN diodes | ALC PIN diodes and CR701 (see paragraph 5-61 and 5-68) |

## 5-23. Power Supply Trouble

5-24. Correct operation of the power supply is vital to proper operation of the signal generator. Noise or variation in the regulated voltages causes other circuits to operate in a random or erratic manner. It is advisable to make a voltage check of the power supply whenever the instrument is suspected of marginal operation. This eliminates factors such as low voltages or poor regulation which cause unsatisfactory performance in other sections of the instrument.

5-25. The power supply consists of two interdependent series-regulated high voltage supplies furnishing −320 and −670 volts as measured from chassis ground and two series regulated low voltage supplies furnishing −6.15 and +20 volts.

a. The −320 volt supply furnishes voltage to the klystron cathode and modulation circuit. It also furnishes a regulated −212 volts for the modulation, ALC, and +20 volt supply circuits. This

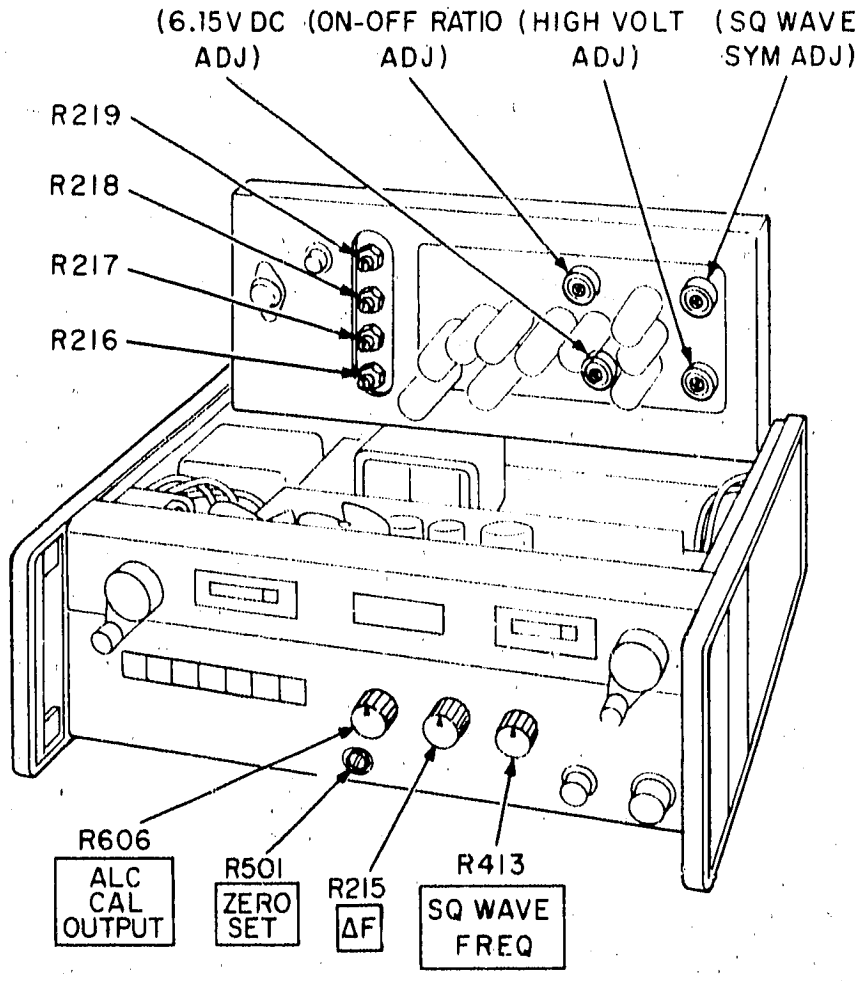



**Figure 5-6. Electrical Adjustment Location**

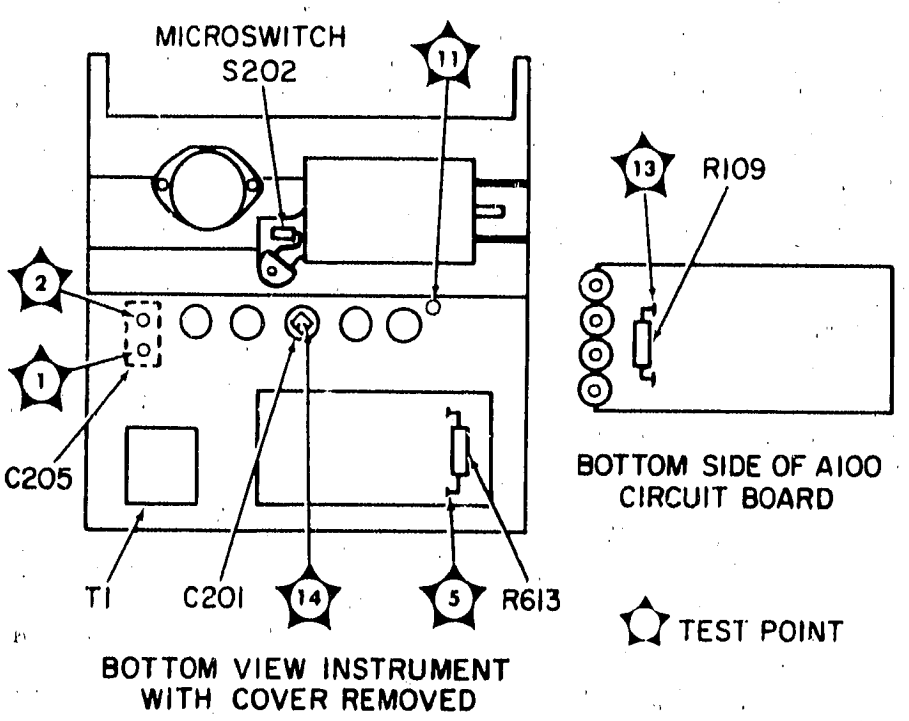
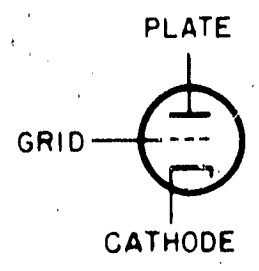
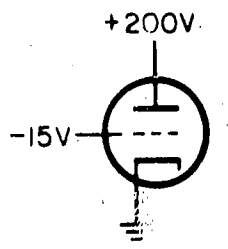
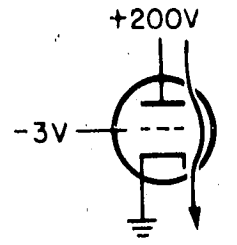
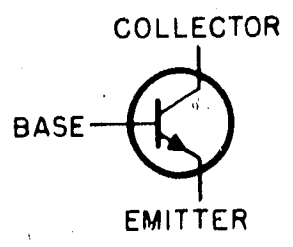
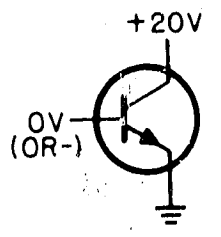
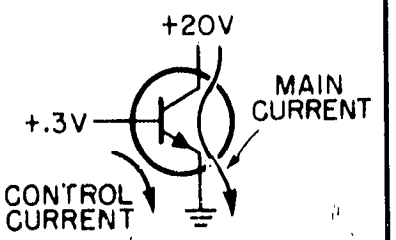
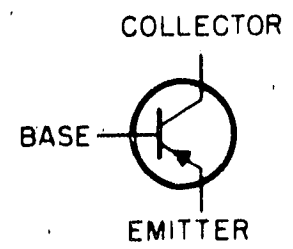
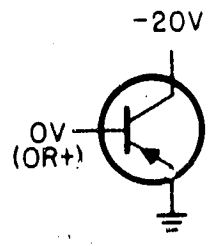
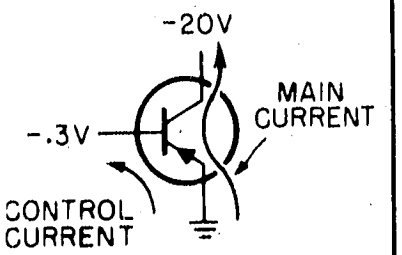



**Figure 5-7. High-Voltage Test Point Location**

## A. TRANSISTOR BIASING

| DEVICE | SYMBOL | CUTOFF | CONDUCTING |
|---|---|---|---|
| VACUUM TUBE |  |  |  |
| NPN TRANSISTOR |  |  |  |
| PNP TRANSISTOR |  |  |  |

## B. AMPLIFIER CHARACTERISTICS

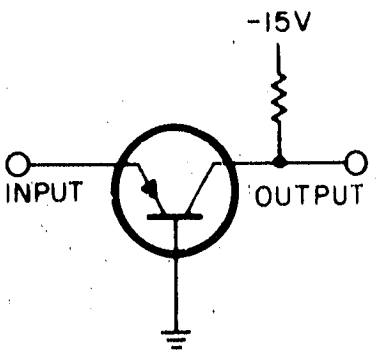
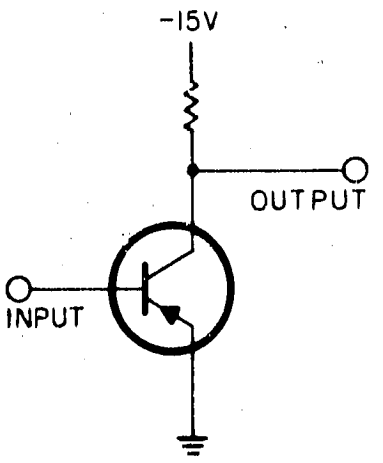
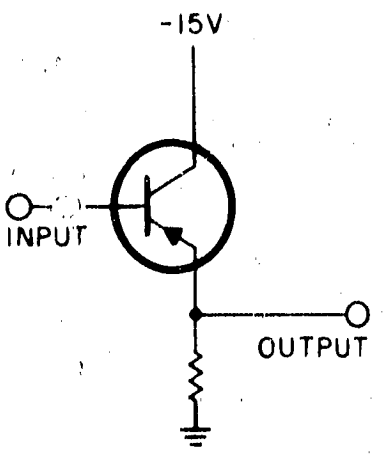
| CHARACTERISTIC | COMMON BASE | COMMON EMITTER | COMMON COLLECTOR |
|---|---|---|---|
| INPUT Z | 30-50 Ω | 500-1500 Ω | 20-500K Ω |
| OUTPUT Z | 300-500K Ω | 30-50K Ω | 50-1000 Ω |
| VOLTAGE GAIN | 500-1500 | 300-1000 | <1 |
| CURRENT GAIN | <1 | 25-50 | 25-50 |
| POWER GAIN | 20-30 dB | 25-40 dB | 10-20 dB |
| |  |  |  |

**Figure 5-8. Transistor Biasing and Operating Characteristics**

**Power Supply Trouble (Cont'd)**

−212 volts is taken from a voltage regulator tube, V105, included between the −320 volt supply and chassis ground.

b. The −670 volt supply consists of a −350 volt regulated supply stacked with the −320 volt supply. The −670 volt supply furnishes the klystron and modulation circuit.

c. The two low voltage supplies provide filament voltages (−6.15 volt supply) and operating voltages (+20 volt supply) to the ALC circuit. Both low voltage supplies are completely dependent upon proper operation of the high voltage supplies for their individual operation.

d. The two high voltage supplies are stacked and each supply provides reference voltages to the other. To troubleshoot either supply, always remove series regulator from one supply (V201 for the −350 volt supply) and replace with an external dc supply in order to check the other supply (see Table 5-2).

e. If trouble is isolated to either the −6.15 volt or +20 volt regulated supply refer to paragraph 5-27 for suggested troubleshooting techniques for transistor circuits (both "in-circuit" and "out-of-circuit" techniques).

5-26. To measure and adjust power supply voltages, remove top and bottom covers from instrument. Remove two screws that secure hinged power-supply board and place instrument on its side.

a. Set rear panel 115/230 switch as appropriate and check that proper fuse is installed in instrument.

b. Depress LINE button. Connect dc voltmeter and ac voltmeter in parallel and measure power supply voltages as instructed in Table 5-2.

**WARNING**

*When using a metal case VTVM with common lead connected to chassis ground (the metal case), the metal case will be at common lead potential.*

## 5-27. TRANSISTOR TROUBLESHOOTING

5-28. The following procedures and data are given to aid in determining whether a transistor is operational. Tests are given for both in-circuit and out-of-circuit transistors.

## 5-29. In-Circuit Testing

5-30. The common causes of transistor failures are internal short- and open-circuits. In transistor circuit testing the most important consideration is the transistor base-emitter junction. Like the control grid of a vacuum tube, this is the operational control point in the transistor. This junction is essentially a solid-state diode. For the transistor to conduct, the diode must conduct; that is, the diode must be forward biased. As with simple diodes, the forward-bias polarity is determined by the materials forming the junction. Use the transistor symbol on the schematic diagram to determine the bias polarity required to forward-bias the base-emitter junction. The A part of Figure 5-8 shows transistor symbols with terminals labelled. Notice that the emitter arrow points toward the type N material. The other two columns of the illustration compare the biasing required to cause conduction and cut-off in transistors and vacuum tubes. If the transistor base-emitter diode (junction) is forward-biased the transistor conducts. If the diode is heavily forward-biased, the transistor saturates. However, if the base-emitter diode is reverse-biased, the transistor is cut off (open). The voltage drop across a forward-biased emitter-base diode varies with transistor collector current. For example, a germanium transistor has a typical forward-bias, base-emitter voltage of 0.2−0.3 volts when collector current is 1−10 mA, and 0.4−0.5 volts when collector current is 10−100 mA. In contrast, forward-bias voltage for silicon transistors is about twice that for germanium types: about 0.5−0.6 volts when collector current is low, and about 0.8−0.9 volts when collector current is high.

5-31. Figure 5-8, part B, shows simplified versions of the three basic transistor circuits and gives the operating characteristics of each. When examining a transistor stage, first determine if the emitter-base diode is biased for conduction (forward-biased) by measuring the voltage difference between emitter and base. When using an electronic voltmeter, do not measure directly between emitter and base: there may be sufficient loop current between the voltmeter leads to damage the transistor. Instead, measure each voltage separately with respect to a voltage common point (e.g., chassis). If the emitter-base diode is forward-biased, check for amplifier action by short-circuiting base to emitter while observing collector voltage. The short circuit eliminates base-emitter bias and should cause the transistor to stop conducting (cut off). Collector voltage should then shift to near the supply voltage. Any difference is due to leakage current through the transistor and, in general, the smaller this current, the better the

### In-Circuit Testing (Cont'd)

transistor. If collector voltage does not change the transistor has either an emitter-collector short circuit or emitter-base open circuit.

## 5-32. Out-of-Circuit Testing

5-33. The two common causes of transistor failure are internal short- and open-circuits. Remove the transistor from the circuit and use an ohmmeter to measure internal resistance. See Table 5-4 for measurement data.

**CAUTION**

*Most ohmmeters can supply enough current or voltage to damage a transistor. Before using an ohmmeter to measure transistor forward or reverse resistance, check its open-circuit voltage and short-circuit current output ON THE RANGE TO BE USED. Open-circuit voltage must not exceed 1.5 volts and short-circuit current must be less than 3 mA. See Table 5-5 for safe resistance ranges for some common ohmmeters.*

**Table 5-4. Out-of-Circuit Transistor Resistance Measurements**

| Transistor Type | | Connect Ohmmeter | | Measure Resistance (Ohms) |
|---|---|---|---|---|
| | | Pos. lead to | Neg. lead to | |
| PNP Germanium | Small Signal | emitter | base* | 200—250 |
| | | emitter | collector | 10K—100K |
| | Power | emitter | base* | 30—50 |
| | | emitter | collector | several hundred |
| NPN Silicon | Small Signal | base | emitter | 1K—3K |
| | | collector | emitter | very high (might read open) |
| | Power | base | emitter | 200—1000 |
| | | collector | emitter | high, often greater than 1M |

*To test for transistor action, add collector-base short. Measured resistance should decrease.

## 5-34. ETCHED CIRCUITS

5-35. The etched circuit boards in the Signal Generator are of the plated-through type consisting of metallic conductors bonded to both sides of insulating material. The metallic conductors are extended through the component mounting holes by a plating process. Soldering can be done from either side of the board with equally good results. Table 5-6 lists required tools and materials. Following are recommendations and precautions pertinent to etched circuit repair work.

a. Avoid unnecessary component substitution: it can result in damage to the circuit board and/or adjacent components.

b. Do not use a high-power soldering iron on etched circuit boards. Excessive heat may lift a conductor or damage the board.

c. Use a suction device (Table 5-6) or wooden toothpick to remove solder from component mounting holes. DO NOT USE A SHARP METAL OBJECT SUCH AS AN AWL OR TWIST DRILL FOR THIS PURPOSE. SHARP OBJECTS MAY DAMAGE THE PLATED-THROUGH CONDUCTOR.

d. After soldering, remove excess flux from the soldered areas and apply a protective coating to

**Table 5-5. Ohmmmeter Ranges for Transistor Resistance Measurements**

| Ohmmeter | Safe Range(s) | Open Ckt Voltage | Open Ckt Current | Lead | |
|---|---|---|---|---|---|
| | | | | Color | Polarity |
| HP 412A | R x 1K<br>R x 10K<br>Rx 100K<br>R x 1M<br>R x 10M | 1.0V<br>1.0V<br>1.0V<br>1.0V<br>1.0V | 1 mA<br>100 μA<br>10 μA<br>1 μA<br>0.1 μA | Red<br>Black | +<br>— |
| HP 410C | R x 1K<br>R x 10K<br>Rx 100K<br>R x 1M<br>R x 10M | 1.3V<br>1.3V<br>1.3V<br>1.3V<br>1.3V | 0.57mA<br>57 μA<br>5.7 μA<br>0.5μA<br>0.05μA | Red<br>Black | +<br>— |
| HP 410B | R x 100<br>R x 1K<br>R x 10K<br>Rx100K<br>R x 1M | 1.1V<br>1.1V<br>1.1V<br>1.1V<br>1.1V | 1.1 mA<br>110μA<br>11 μA<br>1.1 μA<br>0.11μA | Black<br>Red | +<br>— |
| Simpson 260 | R x 100 | 1.5V | 1 mA | Red<br>Black | +<br>— |
| Simpson 269 | R x 1K | 1.5V | 0.82 mA | Black<br>Red | +<br>— |
| Triplett 630 | R x 100<br>R x 1K | 1.5V<br>1.5V | 32 mA<br>3.25 mA | Varies with Serial Number | |
| Triplett 310 | R x 10<br>Rx 100 | 1.5V<br>1.5V | 750μA<br>75 μA | | |

**Table 5-6. Etched Circuit Soldering Equipment**

| Item | Use | Specifications | Item Recommended |
|---|---|---|---|
| Soldering Tool | Soldering<br>Unsoldering | Wattage rating: 37.5<br>Tip Temp: 750—800°F<br>Tip size: 1/8 inch OD | Ungar #776 Handle with Ungar #1237 Heating Unit |
| Soldering Tip, general purpose | Soldering<br>Unsoldering | Shape: chisel<br>Size: 1/8" | Ungar #PL113 |
| De-soldering aid | Unsoldering multi-connection components (e.g., tube sockets) | Suction device to remove molten solder from connection | Soldapullt by the Edsyn Company, Arleta, CA |
| Resin (flax) solvent | Remove excess flux from soldered area before applications of protective coating | Must not dissolve etched circuit base board material or conductor bonding agent | Freon<br>Acetone<br>Lacquer thinner<br>Isopropyl Alcholol (100% dry) |
| Solder | Component replacement<br>Circuit board repair<br>Wiring | Resin (flux) core, high tin content (60/40 tin/lead), 18-gauge (SWG) preferred | |
| Protective coating | Contamination, corrosion protection after soldering | Good electrical insulation corrosion-prevention properties | Krylon |

**ETCHED CIRCUITS (Cont'd)**

prevent contamination and corrosion. See Table 5-6 for recommendations.

e. When removing a multiple-connection component held tightly in a socket, such as a vacuum tube, loosen it gradually using gentle side-to-side or rotary motion to avoid damage to the plated-through conductor.

### 5-36. Component Replacement

a. Remove defective component from circuit board.

b. Remove solder from mounting holes using a suction desoldering aid (Table 5-6) or wooden toothpick.

c. Shape leads of replacement component to match mounting hole spacing.

d. Insert component leads into mounting holes and position component as original was positioned. DO NOT FORCE LEADS OF REPLACEMENT COMPONENT INTO MOUNTING HOLES. Sharp lead ends may damage plated-through conductor.

**NOTE**

*Axial lead components, such as resistors and tubular capacitors, can be replaced without unsoldering. Clip leads near body of defective component, remove component and straighten leads left in board. Wrap leads of replacement component one turn around original leads. Solder wrapped connection, and clip off excess lead.*

**5-37. Tube Socket Replacement.** There are three ways to remove a tube socket from the etched circuit board:

1) Cut terminals attaching socket to circuit board, remove socket, and unsolder remaining terminal pieces individually.

2) Using long nose pliers, break insulating material of socket away from its metal connectors, then unsolder connectors from board individually.

3) Use a special soldering iron tip designed to heat all socket connections simultaneously

**ETCHED CIRCUITS (Cont'd)**

and remove socket as a unit; or use a suction device (Table 5-6) to desolder all connections and remove socket.

**5-38. Etched Conductor Repair.** A broken or burned section of conductor can be repaired by bridging the damaged section with a length of tinned copper wire. Allow adequate overlap and remove any varnish from etched conductor before soldering wire into place.

### 5-39. Transistor Replacement

a. Do not apply excessive heat. See Table 5-6 for soldering tool specifications.

b. Use a heat sink such as pliers or hemostat between transistor body and hot soldering iron.

c. When installing a replacement transistor, ensure sufficient lead length to dissipate heat of soldering by maintaining about the same length of exposed lead as used for original transistor.

## 5-40. KLYSTRON REPLACEMENT

### 5-41. Tube Removal

**WARNING**

*BEFORE ATTEMPTING KLYSTRON REMOVAL OR REPLACEMENT, BE CERTAIN THAT LINE POWER IS COMPLETELY REMOVED FROM INSTRUMENT.*

a. Remove panel cover on left (with respect to front panel) side of instrument.

b. Set klystron frequency drive at top end (2400 MHz frequency dial setting).

c. Using truarc pliers which are available in a repair kit, HP Part No. 08614-800, remove the outer truarc ring from the outer cover of the klystron cavity (see Figure 5-9).

d. Remove outer cover. Pull tube socket from klystron with a straight pull.

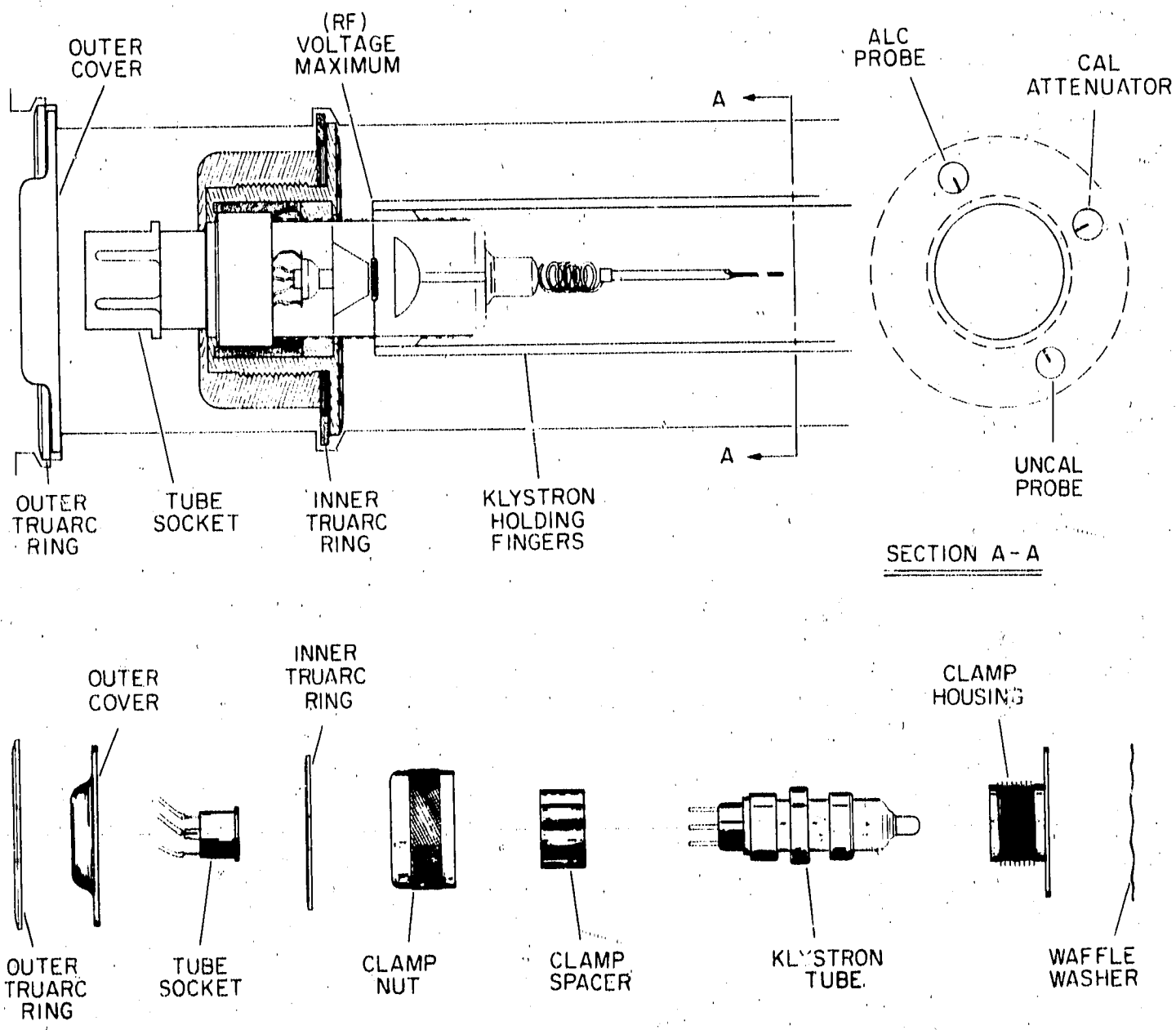



**Figure 5-9. Klystron Cavity Assembly, Cutaway View**

**Tube Removal (Cont'd)**

e. Remove inner truarc ring holding klystron clamp housing in klystron cavity. Grasp klystron tube and remove from cavity.

f. Unscrew clamp nut, lift out clamp saucer, and remove klystron (see Figure 5-9).

g. Remove waffle washer from cavity.

**NOTE**

*Refer to paragraph 1-14 for klystron warranty claim instructions.*

### 5-42. Tube Replacement

a. Reassemble new klystron, housing, spacer, and nut.

b. Set klystron frequency drive at top end (high frequency dial setting) for klystron centering.

c. Place waffle washer in klystron cavity.

d. Insert klystron into klystron cavity.

**CAUTION**

*Klystron should be inserted straight into cavity. Insertion of klystron should require no unnecessary force; the klystron should fit snugly but easily, into cavity.*

e. Replace inner truarc ring on clamp housing (if the klystron is properly in place the ring will fit properly). Allow tube to be centered by center conductor.

f. Install tube socket and outer cover.

g. Place edge of truarc ring on outer cover and rotate until ring lies flat on cover and is easily accessible with truarc pliers.

h. Refer to Adjustment Procedure (paragraph 5-55) and make necessary adjustments.

## 5-43. RF PROBE REPLACEMENT

### 5-44. Probe Removal

**WARNING**

*Before attempting removal or replacement of probe assembly, be certain that line power is completely removed from the instrument.*

a. Remove top cover from instrument.

b. Set FREQUENCY (MHz) drive to the highest frequency setting (2400 MHz).

c. Remove Attenuator Access Cover from Klystron Cavity Casting (see Figure 5-13).

d. Remove Right Side Frame Assembly.

e. Remove Cable Guide from Klystron Cavity Casting and disconnect cable assembly connectors from instrument.

f. Remove the cable assembly connector from the defective RF probe cable. Be careful not to lose any connector parts as they will be required for reassembly.

g. Remove the probe cable from the cable guide.

h. Remove the retaining screw holding the defective probe in the tuning carriage and remove the probe from the casting.

i. The defective probe assembly should be returned to your local Hewlett-Packard sales and service office for repair or replacement (see list at rear of manual).

### 5-45. Probe Replacement

**CAUTION**

*The probe is fragile and should be handled with care. The probe should be placed in a protective shield when handling or shipping.*

a. To install a new probe assembly, carefully insert the new probe into the klystron cavity casting and replace the probe retaining screw.

**CAUTION**

*Care must be taken not to damage the resistive element on the probe end or the spring wipers that make contact with the probe guide tube.*

b. Insert the probe assembly cable through the cable guide. Install the cable guide.

**Probe Replacement (Cont'd)**

c. Trim the insulation from the end of the probe assembly cable (for RF UNCAL probe, 5/16 inch; for RF CAL and ALC probes, 1/4 inch).

d. Place cable assembly connector parts on cable, with the exception of the clamping body, and fold the braid back upon the connector assembly (see Figure 5-10).

e. Place the clamping body on the cable and screw the clamp nut and clamping body together.

f. Trim the dielectric flush with the end of the clamping body so that the center conductor is bare.

g. Trim the center conductor protruding from the clamping body, then place the insulator washer on the center conductor.

**NOTE**

*After tinning center conductor the diameter may be too large, making it necessary to file the center conductor to the proper diameter.*

h. Before connecting connector assembly into the instrument, connect an ohmmeter between the probe center conductor and ground and measure the resistance across the range of the attenuator. The resistance should be approximately 50 ohms ±5 ohms. If the probe is open or shorted at any

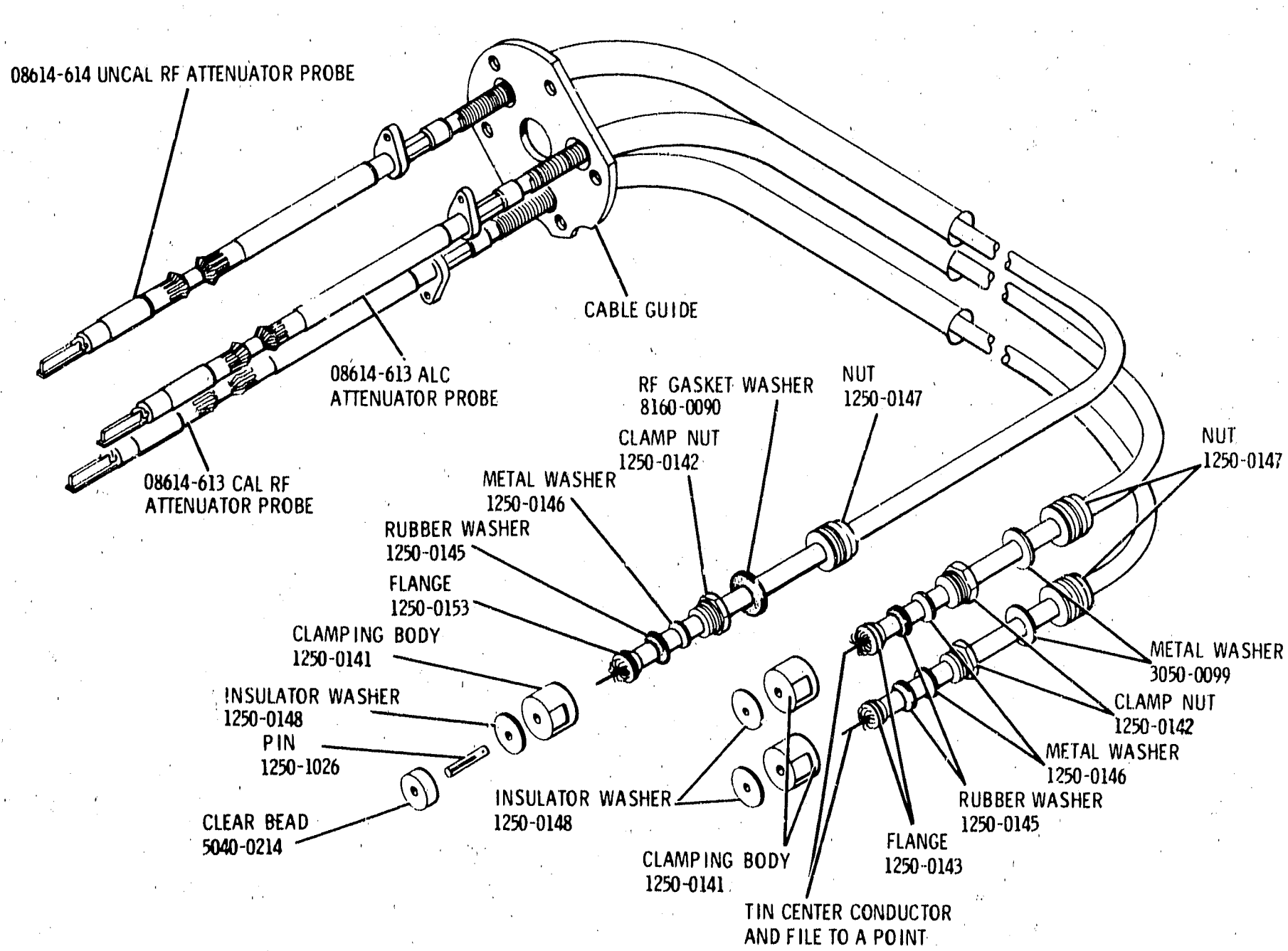



**Figure 5-10. RF Probe Assembly**

**Probe Replacement (Cont'd)**
point, the probe is defective and should be replaced.

i. Replace the connector assembly as it was before disassembly. Connect the probe connector to the instrument, making certain the center conductor makes good contact.

j. The probe installation is complete. Reassemble the instrument except for the front, right side panel, which is removed when performing the output power calibration adjustments.

## 5-46. PIN MODULATOR REPLACEMENT

### 5-47. Modulator Removal

5-48. The PIN modulator CANNOT be repaired in the field. If the PIN modulator is found to be faulty, it should be returned for repair. Remove the five screws holding the PIN modulator only. Removal of screws holding the PIN diodes in place can cause contamination of the PIN diodes, high SWR, etc.

a. Remove power line from instrument.

b. Remove top and bottom covers.

c. Place instrument on its side.

**CAUTION**

*DO NOT HANDLE CRYSTAL DIODE, CR701, NEEDLESSLY. A static charge which builds up on a body, especially on a cold, dry day, must NEVER be allowed to discharge through element. When installing or removing, touch casting first to ensure no difference in potential between hand and casting.*

d. Disconnect ground lug and wire from low pass filter.

e. Disconnect probe cable assembly connectors from the modulator (see Figure 5-10). Be careful not to lose any disassembled parts as they will be required for reassembly.

**CAUTION**

*Do not disconnect RF output from the modulator.*

f. Disconnect RF OUTPUT cable at RF CAL OUTPUT connector at front panel.

g. Disconnect ALC Bias Feed connections (1 and 2 on A500 board) from ALC circuit board.

h. Remove five screws holding PIN modulator to instrument chassis.

i. Remove PIN modulator from instrument.

j. Carefully pack PIN modulator in a container and return to your local Hewlett-Packard sales and service office for repair or replacement.

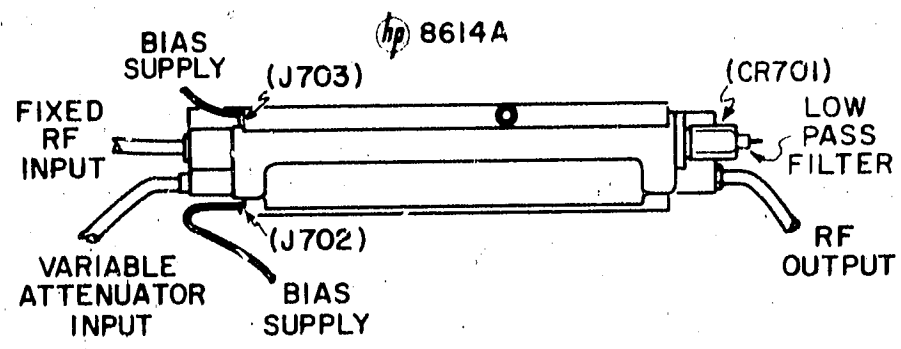



**Figure 5-11. PIN Modulator (External View)**

### 5-49. Modulator Replacement

a. Before installing PIN modulator, measure a resistance of PIN diodes with voltmeter, such as the HP 410B.

b. To measure PIN diode resistance, measure resistance between J703 and modulator ground and J702 and modulator ground. On the ohmmeter RX100 range with the common lead connected to ground, the resistance should measure approximately 1000 to 1500 ohms. On the ohmmeter RX1 Meg range with the ohms lead connected to ground, the resistance should measure approximately 100 megohms.

c. Replace five screws that hold PIN modulator in place.

d. Connect RF OUTPUT cable to front panel.

e. Connect ALC Bias Feed connections to ALC circuit board (A500).

f. Connect cable assembly connectors to PIN diode modulator (see CAUTION, paragraph 5-48).

## 5-50. CAM CABLE REPLACEMENT

### 5-51. Tools Required

a. Open-end wrench (3/8-inch).

b. Hex-socket wrench and 3/8-inch socket or equivalent tool.

c. Book of matches.

d. Roll of masking tape (1/2-inch or 1-inch width).

e. Rubber cement.

### 5-52. Procedure

5-53. If it is necessary to replace cam cable, order it by HP Part No. 08614-2[illegible] and description of usage. For easier access to the cams, remove the screws holding the High Voltage circuit board and swing the board out of the way. Use Figures 5-12 and 5-13 as guides and proceed as follows:

a. Remove power cord from instrument.

b. Remove instrument top cover and attenuator access cover.

c. Turn FREQUENCY (MC) to approximately the middle of the frequency band.

d. Orient Length Cam to Frequency Cam as shown in Figure 5-12.

e. Using a lead pencil, mark position of each cam and end of threaded portion of center conductor support rod on klystron cavity casing.

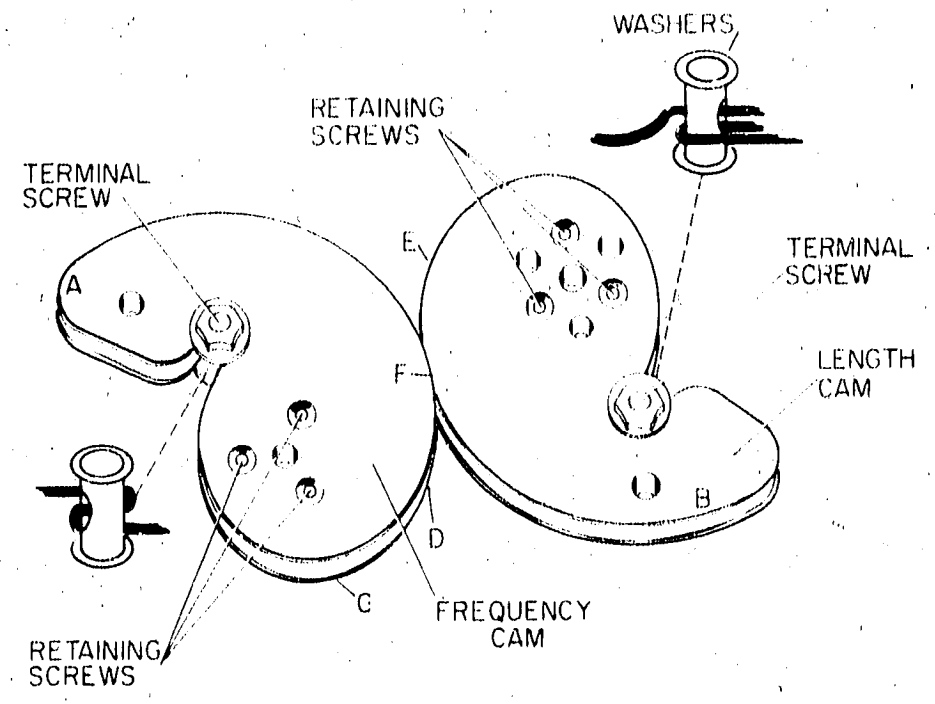



**Figure 5-12. Cam Assembly**

f. Using hex socket wrench and a 3/8-inch open-end wrench, remove both terminal screws, the four washers, and the two nuts (10-32 x 0.375 hex nuts).

g. Remove both terminal screws from cable.

h. On replacement cable, place a mark halfway between each end. Using matches, apply heat to an area approximately 1/2 to 3/4 inch on either side of mark to remove wire tension (heat to nearly white hotness).

i. Cut 10 or 11 strips of masking tape approximately one inch in length.

j. Remove three retaining screws from Frequency Cam and remove cam from instrument (Note: three retaining screws are 4-40 x 0.625 FH).

k. Slide cable through one terminal screw so that cable is oriented to terminal screw as shown in Figure 5-12 for the Frequency Cam, and install terminal screws on Frequency Cam.

**CAUTION**

*Be careful not to catch cable between lockwasher and cam.*

m. Slide cable onto cam just past point A and tape to cam (half of cable length should pass over points A and B; the other half should pass over points C, D, and E).

**NOTE**

*Each cam as shown in Figure 5-12 has two lips along which the cable should travel: one cable MUST travel along the upper lip of both cams and one cable must travel along the lower lip of both cams.*

n. Slide other half portion of cable onto cam just past point D and tape to cam.

p. Place Frequency Cam in original position in instrument and replace retaining screws.

q. Turn Length Cam so that cams are not touching at point F and place cable between cams: one cable along upper lip of cam and the other along lower lip of cam.

**Procedure (Cont'd)**

u. Install second terminal screw on Length Cam and tighten both terminal screws to remove all slack in cable.

v. Remove masking tape from cams and apply rubber cement to ends of cable to ensure that cable will not unravel.

w. Turn FREQUENCY (MC) knob to match Frequency Cam to pencil mark made in step e; the other marks made should match appropriately.

x. Perform Frequency Range Spread Adjustment, paragraph 5-59.

## 5-54. ADJUSTMENTS

### 5-55. Adjustment After Klystron Replacement

5-56. Following replacement of a klystorn, certain adjustments must be made before the instrument will operate properly. The general steps in the overall procedure are as follows:

a. Establish initial repeller tracking voltages.

b. Establish proper repeller mode operation.

c. Adjust frequency range spread.

d. Adjust power output.

e. Check internal leveling operation.

### 5-57. Initial Repeller-Voltage Adjust

a. Remove top and bottom covers and remove two screws that secure circuit board.

b. Check all power supply voltages as indicated in Table 5-2.

c. Connect voltmeter between klystron repeller (test point 11 and chassis ground, see Figure 5-7). Make sure ΔF control on front panel is set at zero (center position), and set voltages as indicated in Table 5-7 (see Figure 5-6).

**WARNING**

*Be careful not to ground test point 11 as power supply will be destroyed.*

### 5-58. Repeller Mode Adjust

a. At a dial frequency of 950 MHz, set attenuator dial for a calibrated output of about 0 dBm.

b. To observe repeller modes of the klystron, a FM Modulator, with adjustable phase and amplitude controls, is necessary. Such a device is shown in Figure 5-14; it consists of a small power transformer connected with the primary and secondary windings interchanged; two one-megohm potentiometers; a 0.05 μF capacitor; two BNC connectors; a fuseholder, and a power cord. Connected as shown, this modulator provides a power line frequency modulation voltage continuously variable in amplitude from 300 volts peak-to-peak, with phase variable over a range of approximately 95 degrees, plus a 6.3-volt ac output for oscilloscope sweep control (see Table 5-1).

**Table 5-7. Klystron Repeller Voltages**

| Frequency Dial | Adjust | Voltage (between klystron repeller and ground) |
|---|---|---|
| 800 | R216 | −370 ±5V |
| Mid-frequency | | |
| below switch | R217 | −600 ±5V |
| above switch | R218 | −425 ±5V |
| 2400 | R219 | −580 ±5V |

R216 and R217 interact as do R218 and R219; therefore, repeat above measurements after any adjustments.

c. Apply external FM (60 cycles) and view mode patterns on oscilloscope. Adjust PHASE control of FM modulator and appropriate tracking pot for mode patterns shown.

**NOTE**

*DC repeller voltages at 950 MHz and 1600 MHz (above switch) are relatively small and will not appear correctly if FM signal is excessive.*

(1) Adjustments should allow about 2 MHz variations with ΔF control.

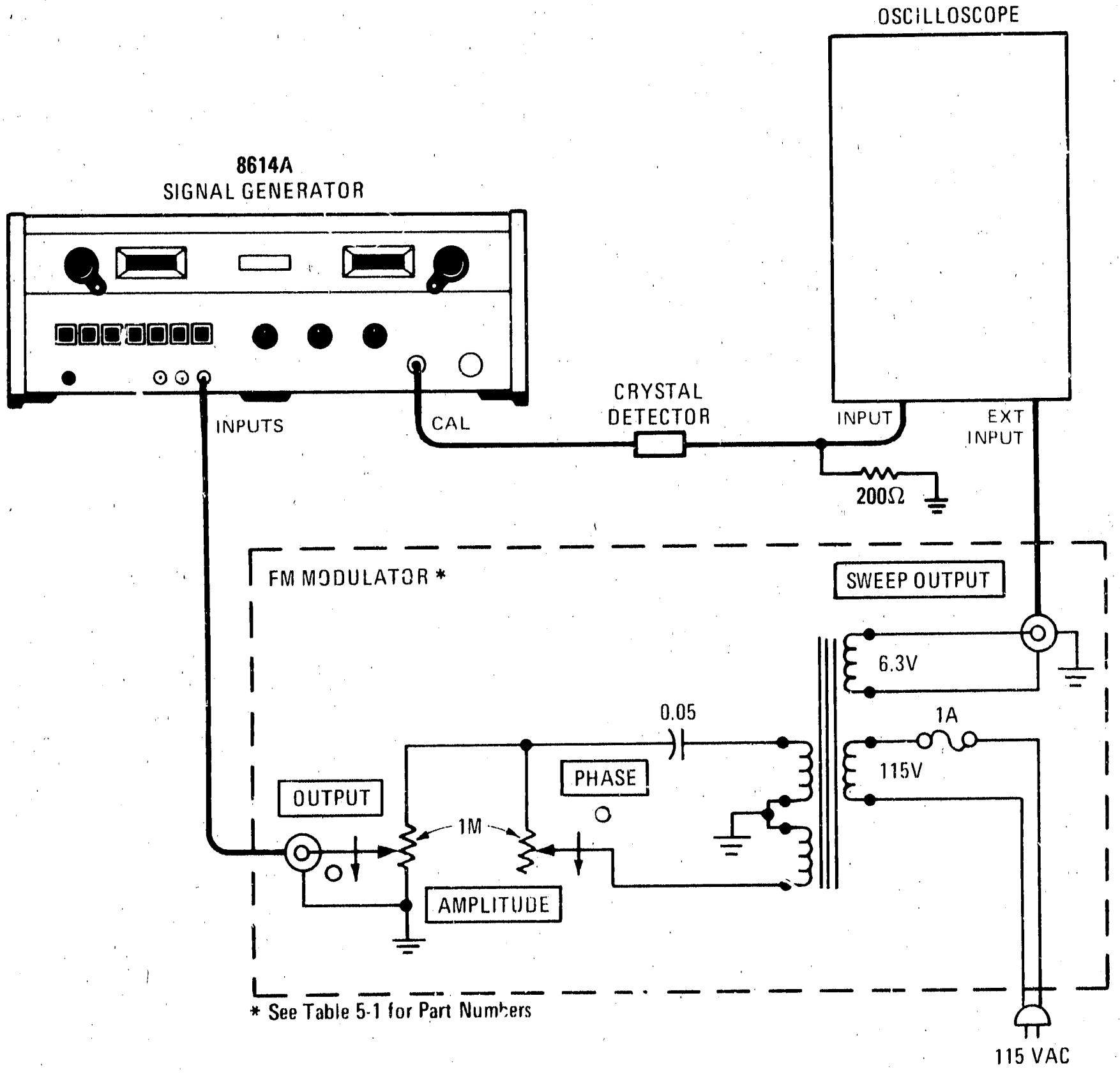
(2) The tracking pots interact making it necessary to repeat the adjustments a time or two in order to ensure proper tracking.

d. Connect a clip-on milliammeter to wire on center feedthrough capacitor, C4 (wht/orn/vio wire, see Figure 5-13). Current must not exceed 30 mA unless klystron is defective.

### 5-59. Frequency Range Spread Adjust

a. Using a calibrated frequency meter, measure actual frequency at dial settings of 1000 and 2400 MHz. To eliminate backlash error, always approach frequency dial settings from the same direction.

b. The difference in the frequency measurements of step a should be 1400 MHz. If frequency



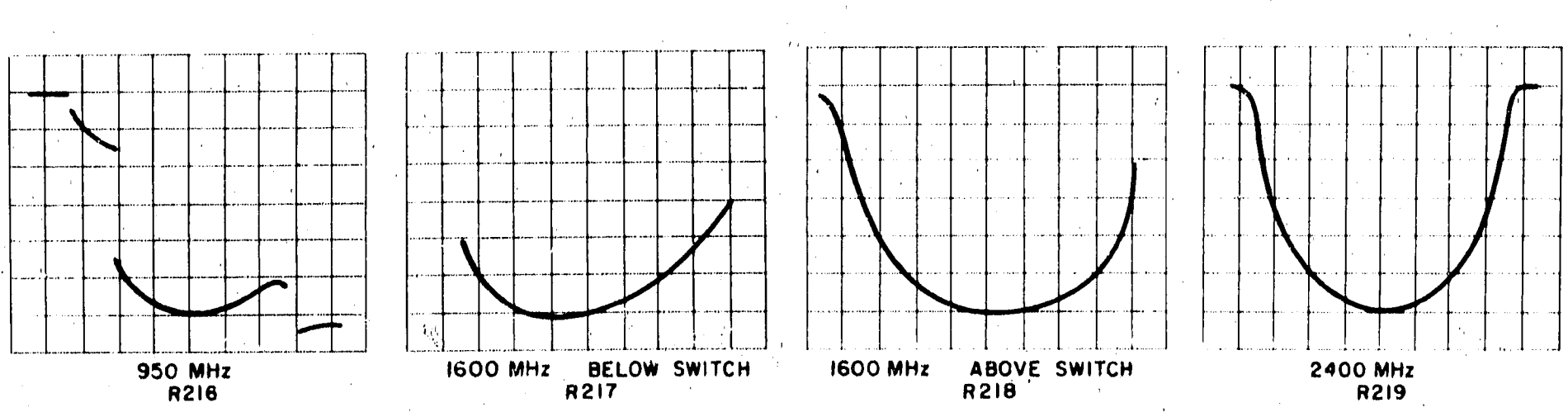




**Figure 5-14. Repeller Mode Adjust Setup**

**Frequency Range Spread Adjust (Cont'd)**

difference is other than specified, correction must be made (see step c).

c. Refer to graph, Figure 5-15. The horizontal axis represents the measured frequency change from step b, the vertical axis indicates the dial corrective setting. For example, if the difference between dial settings (step b) is 1354 MHz, the corrective setting for the dial as found on the graph is 990 MHz. To make correction, set frequency dial to 1000 MHz, loosen the two setscrews that clamp dial plunger to rack, hold dial plunger stationary, and set dial to 990 MHz. Tighten two setscrews (see Figure 5-16).

d. If any adjustment was necessary, repeat steps a, b, and c. Repeat this procedure until measured frequency difference corresponds to a change of 1400 MHz ±3 MHz.

e. Set actual frequency to 1000 MHz. Loosen spur gear on worm shaft and rotate gear until frequency dial reads 1000 MHz (see Figure 5-13).

f. Check FREQUENCY (MC) dial settings at both upper and lower ends of dial travel. The respective dial end points should be less than 800 MHz and greater than 2400 MHz. If dial travel is not satisfactory, loosen bevel gear on frequency drive shaft and reset dial.

g. Check microswitch action: microswitch should energize and de-energize at about 1590 to 1610 MHz. If microswitch does not switch at proper dial settings, microswitch cam (located on underside of cavity casting) should be repositioned (see Figure 5-7).

h. Being careful to approach all dial settings from the same (either clockwise or counterclockwise) direction, using the procedure given in paragraph 5-11, check accuracy of frequency dial by approaching all dial settings from a clockwise direction and then from a counterclockwise direction.

**NOTE**

*The frequency meter used must be calibrated to an accuracy of approximately ±0.03%.*

i. If frequency dial reading errors are greater than ±5 MHz, shifting the dial may bring all errors within specification. If shifting dial will not sufficiently correct errors, it may be necessary to shift position of center conductor support rod (see Figure 5-16). The center conductor is notched at end closest to right side of instrument and may be loosened and then adjusted "in" or "out" of klystron cavity. Notch or scratch center conductor rod so that original position may always be known. If overall frequency error was positive, adjust center conductor toward right side of instrument. If overall error was negative, adjust center conductor toward left side of instrument. When adjusting cen-

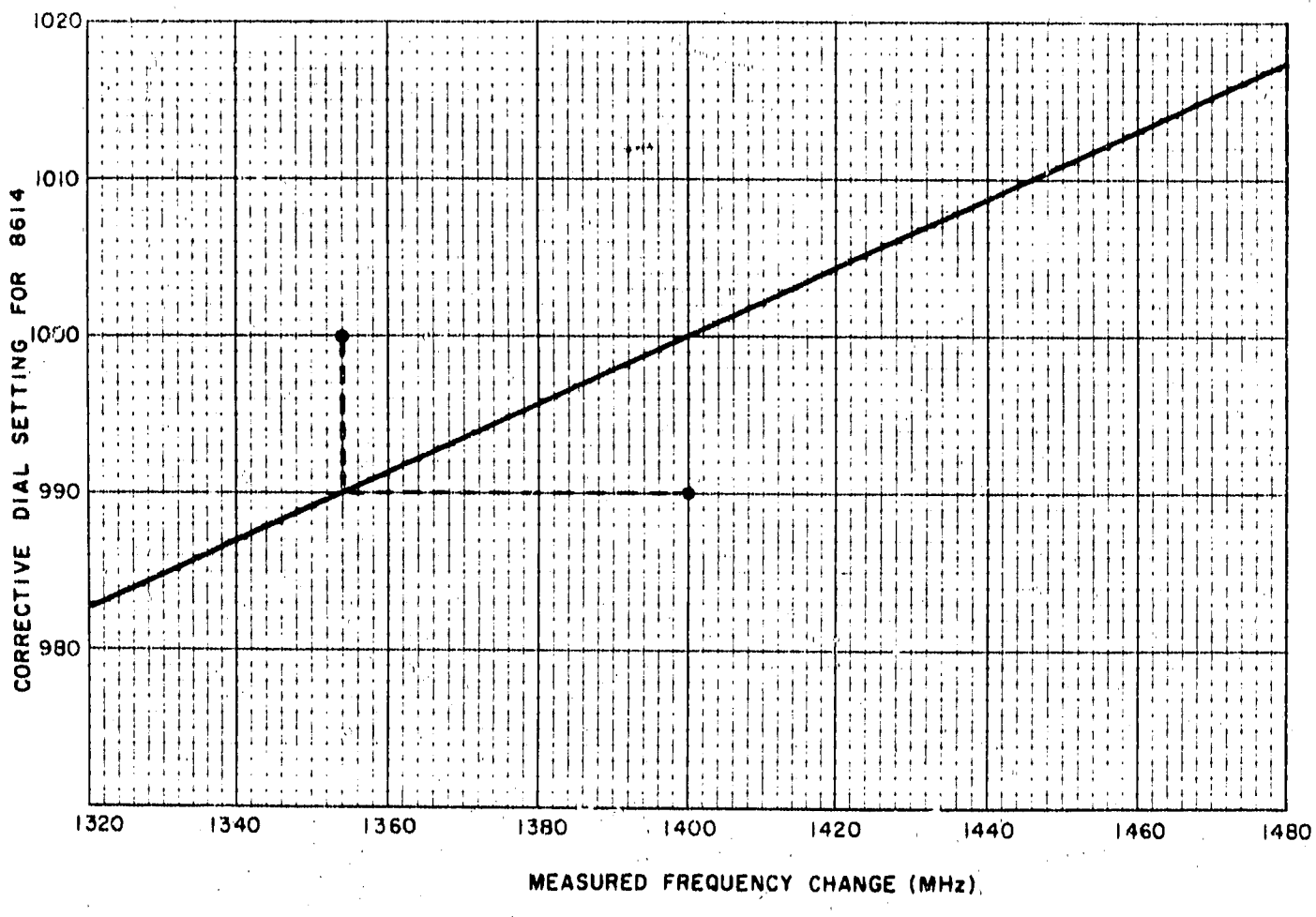



**Figure 5-15. Frequency Range Spread Correction Curve**

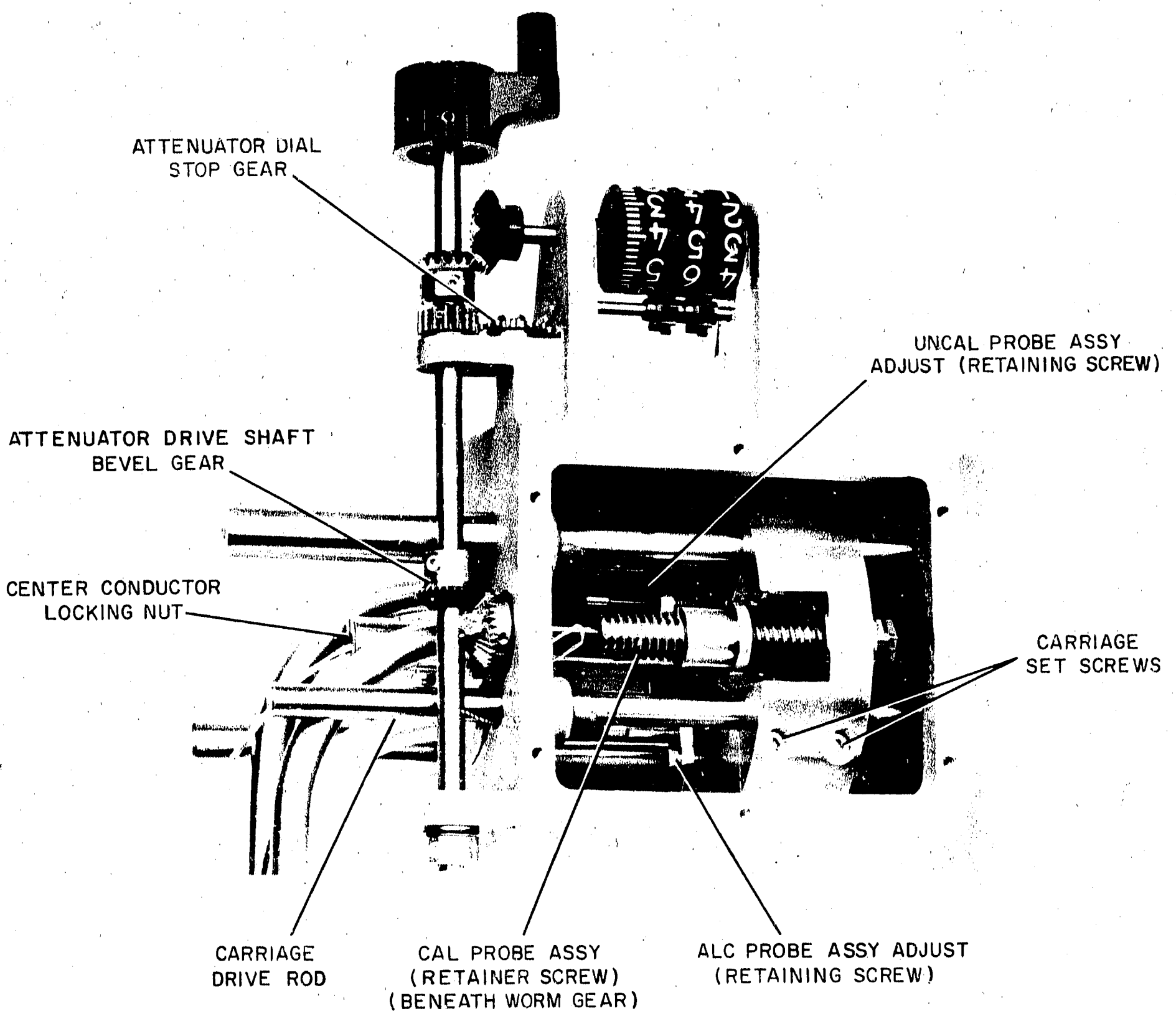



**Figure 5-16. Probe Assembly Adjust**

**Frequency Range Spread Adjust (Cont'd)**
ter conductor position, never change by more than about 20 thousandths of an inch at a time.

**NOTE**

*If any adjustment of instrument was necessary, repeat entire check and adjustment procedure until no adjustment is required.*

### 5-60. RF Power Output Adjustment

5-61. Front Panel Settings: Have ALC button released (OFF). Set ATTENUATION (dB) to 012 dB. Set FREQUENCY to 800 MHz.

a. CAL RF Adjustment: if measurements made agree with readings shown in Table 5-8, proceed to next paragraph.

1. With a power meter, measure the CAL RF output power. It should be −11 dBm ±0.1 dBm.
2. If it is not, loosen the two setscrews in the attenuator drive shaft bevel gear (see Figure 5-13). With the bevel gear loose, turn the attenutor gear with your fingers until the output power is −11 dBm. Without disturbing the −11 dBm power setting, turn the attenuator knob on the front panel until the attenuator counter reads 012 dB. Tighten the two setscrews in the bevel gear.

b. UNCAL RF Adjustment:

1. Measure the UNCAL RF power output. It should be −3 dBm ±0.3 dBm.

**RF Power Output Adjustment (Cont' )**

2. If it does not, the RF UNCAL probe requires adjustment. The front right side panel should be removed, exposing the probe assembly cable guide. Remove the screw in the cable guide that is in line with the UNCAL probe retaining screw (see Figure 5-13). Insert a long Allen wrench through the hole left by removing the cable guide screw into the UNCAL probe retaining screw. Turn the retaining screw to adjust the UNCAL probe penetration for −3 dBm ±0.3 dBm output.

c. ALC Adjustment:

1. With a dc voltmeter (HP 3435A) measure the dc voltage at the output of the CR701 crystal diode, or the base of Q501A.

**CAUTION**

*Do not use a digital voltmeter with Autoranging as it might damage the crystal diode.*

The dc voltage should be 120 mV ±2 mV.

2. If it is not, the ALC attenuator probe requires adjustment. The front right side panel should be removed, exposing the probe assembly cable guide. Remove the screw in the cable guide that is in line with the ALC probe retaining screw (see Figure 5-13). Insert a long Allen wrench through the hole left by removing the cable guide screw into the ALC probe retaining screw. Turn the retaining screw to adjust the ALC probe penetration for 120 mV ±2 mV at the ALC crystal output.

**Table 5-8. Klystron Probe Adjust**

| Probe for | Measuring Point | Instrument | Reading |
|---|---|---|---|
| ALC | CR701 or base of Q501A | HP 3435A | 120 ±2 mV |
| Cal Pwr | Front panel connector | HP 432A | −11 ±0.1 dBm |
| Uncal Pwr | Front panel connector | HP 432A | −3 ±0.3 dBm |

## 5-62. Internal Leveling Adjust

5-63. Replacement of the klystron should not affect internal leveling operation (ALC). However, the characteristics of the new klystrons can differ enough to require readjustment of the ALC Amplifier and the Meter Amplifier. Refer to paragraph 5-12 and check the leveled output; if adjustment is necessary refer to paragraph 5-64 for procedure.

## 5-64. Adjustments after PIN Modulator Replacement

5-65. Following replacement of a PIN modulator, certain adjustments must be made before the instrument will operate properly. The general steps in the overall procedure are as follows:

a. Adjust Meter Amplifier
b. Adjust ALC Amplifier
c. Adjust on-off ratio
d. Adjust Pulse Modulation
e. Adjust Square-Wave Modulation
f. Adjust AM Response.

## 5-66. Meter Amplifier Adjust

a. Release RF button. Zero front-panel meter with front-panel ZERO SET.

b. Depress RF button; set frequency dial to 800 MHz. Note: See paragraph 5-61 and adjust ALC probe.

c. Measure meter amplifier output voltage (wire with green and violet tracers on front panel ALC switch). This voltage must be −6.4 ±0.3 volts. This corresponds to a gain of 53 ±2 volts.

d. Front panel DBM meter should read +1.0 ±0.3 volts.

## 5-67. ALC Amplifier Adjust

a. Set FREQUENCY (MC) to 800 MHz and ATTENUATION (DB) to 012.

b. Depress ALC button and set front panel DBM meter to 0 DBM by means of ALC CAL OUTPUT knob.

c. Track ALC amplifier at CAL RF OUTPUT and adjust as indicated in Table 5-9; use a power meter and a thermistor mount or equivalent equipment.

## 5-68. On-Off Ratio Adjust

a. Set up Model 8614A as follows:
LINE . . . . . depressed

**On-Off Ratio Adjust (Cont'd)**

ZERO SET . . set DBM meter to ZERO SET
RF . . . . . depressed
ALC CAL OUTPUT . . . full ccw for 0 dBm meter reading
ALC . . . . . depressed
ΔF . . . . . centered
FREQUENCY (MC) . . . 1600
ATTENUATION (DB) . . . 000

b. Connect power meter to CAL RF OUTPUT and adjust signal generator for a full scale reading on the 0 DBM range of the power meter.

c. With no input applied to PULSE INPUT, depress PULSE button. The CAL RF OUTPUT should drop at least 20 dBm.

**Table 5-9. ALC Amplifier Adjust**

| Frequency | Adjust | Calibration Power Output |
|---|---|---|
| Low freq. | R614 | −12 ±0.2 dBm |
| Mid-freq. below switch | R621 | −12 ±0.2 dBm |
| Mid-freq. above switch | R615 | −12 ±0.2 dBm |
| High freq. | R620 | −12 ±0.2 dBm |

Note: R614 and R621 interact as do R615 and R620. To simplify the adjustment, overcorrect with pot for frequency indicated, then back off with interacting pot. For example, the reading at 1600 MHz (below microswitch) is −10 dBm. Adjust R621 for −13 dBm, then adjust R614 for −12 dBm at 1600 MHz.

d. If the on-off ratio is not 20 dB or greater, adjust R420 for proper on-off ratio. If on-off ratio will not adjust properly, PIN modulator may be defective. Check bias current through R414 and through R420: the current through R414 should be approximately 6 mA, and the current through R420 should be 3 mA. If these bias currents are correct and CR403 is not shorted, then the modulator may be defective. Check RF Probe resistance (refer to paragraph 5-61); if resistance is OK then modulator is defective (refer to paragraph 5-46).

### 5-69. Pulse Modulation Adjust

a. Depress PULSE button and apply an externally generated 20 volt 4 μs positive pulse to front panel pulse BNC input (refer to paragraph 5-14).

b. If pulse operation is not satisfactory, adjust R420.

**NOTE**

*Resistor R420 also adjusts the on-off ratio; if adjustment was necessary recheck on-off ratio (paragraph 5-68)*

### 5-70. Square-Wave Modulation Adjust

a. Depress SQ WAVE button and check square wave output on an oscilloscope (refer to paragraph 5-15).

b. Adjust R410 for best symmetry at 1000 ±50 Hz.

c. Rotate SQ WAVE control full counterclockwise: square wave frequency should be equal to or less than 950 Hz.

d. Rotate SQ WAVE control full clockwise: square wave frequency should be at least 1050 Hz.

e. The square-wave frequency range is determined by R413 (front panel SQ WAVE control) and C402. The value of C402 is selected for proper frequency range: it may be 2250 pF, 2676 pF, or 3000 pF. Increasing the capacity decreases the upper and lower limit of the range while decreasing the capacity will increase the upper and lower limit.

### 5-71. AM Response Adjust

a. Check AM operation at about 50 Hz (see paragraphs 5-16).

b. If AM waveform is not satisfactory, change value of C404 by about 10 pF and recheck operation. Note: typically, undistorted AM operation is achieved with either a 30- or 39-pF capacitor.

## 5-72. REPELLER POT (R220) REPLACEMENT

### 5-73. Tools Required

a. Small pair of wire cutters
b. No. 6 allen drive wrench (hex head drive)
c. Screwdriver with flat thin blade

### 5-74. Procedure

5-75. If it is necessary to replace the repeller pot (R220, a wirewound resistor), then both R220 (HP Part No. 2100-0399) and the insulator plate (HP Part No. 08614-254) must be replaced. Use Figure 5-7 as a location guide and Figures 5-17 and 5-18 as replacement guides and proceed as follows:

a. Remove power cord from instrument.

b. Remove instrument bottom cover and repeller pot access cover.

c. Loosen the two allen screws retaining the tracking pot rotor and remove rotor.

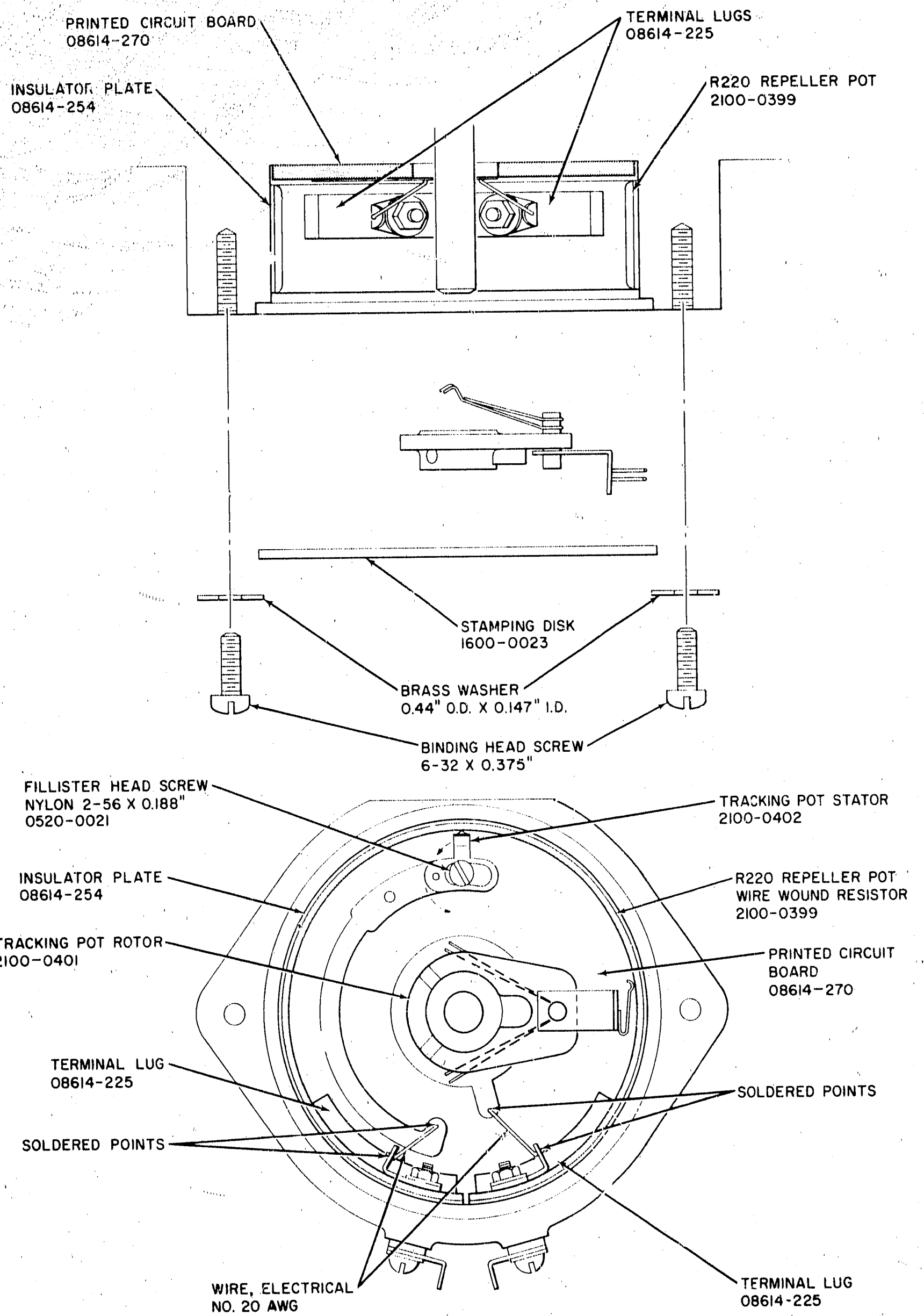



**Figure 5-17. Repeller Pot Assembly**

**Procedure (Cont'd)**

d. Using a flat blade screwdriver to turn the nylon screw, turn the tracking pot stator a quarter turn counterclockwise.

e. Remove hardware holding R220 in place and remove R220 and insulator plate from casting assembly.

f. Prepare new repeller pot, R220, for installation by cutting about 1/8 inch of material off each end. Also prepare new repeller pot, R220, for installation by gently bending to take some of the stiffness out. Note: If resistor is bent sharply, it will break in half.

g. Gently bend the wirewound resistor (R220) with the insulator plate behind it and insert in casting. Note the resistor must be inserted so that the "bronze colored section" contacts, or is closest to, printed circuit board.

h. Insert retaining hardware through casting holes and wirewound resistor and insulator plate. Do not tighten wirewound resistor firmly in place as adjustment is necessary.

i. Refer to Figure 5-17; R220 must be relatively flat against wall of casting. The resistor can be flattened against casting wall by pushing on edge, CAREFULLY, and tightening in place.

**CAUTION**

*Do not push on R220 with a sharp metal object, such as a screwdriver, as the wire windings can be easily destroyed if the screwdriver blade slips.*

j. Once R220 has been adjusted for flatness and the retaining screws firmly tightened, replace tracking pot rotor in assembly. The tracking pot rotor must be set in place so that contact is made with inner printed circuit board ring at all times. Also, the rotor contact with resistor must be uniform with contact made as illustrated in Figure 5-17; only the curved end of the contacts may touch the repeller pot at any point.

k. Using a flat blade screwdriver to turn the nylon screw, turn tracking pot stator back to original contacting position as illustrated in Figure 5-17.

m. Set FREQUENCY (MC) front panel dial to 1600 and note position of repeller tracking pot rotor: the tracking pot rotor resistor contacts should be positioned almost exactly above the tracking pot stator.

n. Watching the tracking pot rotor to be sure that it does not hit either terminal lug (HP Part No. 08614-225), very slowly rotate FREQUENCY (MC) front panel dial from one end of travel to the other. If necessary, adjust terminal lug and tracking pot rotor position to ensure that tracking pot rotor will not contact either terminal lug.

p. Replace the stamping disc (repeller pot access cover) and tighten in place with the two binding-head screws.

**NOTE**

*When placing the stamping disc, be sure that it does not contact the repeller pot resistor. If it does, repeat above procedure and adjust repeller pot resistor position.*

q. Refer to paragraph 5-56 and check all listed adjustments.

**NOTE**

*Do not change an operating voltage or calibration adjustment unless it is definitely outside specified tolerance or accuracy of a dependent function is unsatisfactory. Improving a marginal adjustment can adversely affect calibration.*

## 5-76. LOW PASS FILTER REPLACEMENT

### 5-77. Tools Required

a. Soldering equipment (see Table 5-7)

b. Small pair needle noise pliers

c. Small pair pliers

### 5-78. Procedure

5-79. Figure 5-19 illustrates Low Pass Filter and ALC Crystal diode (CR701) parts with part numbers. The illustration is an assembly drawing. Part removal is the reverse of illustrated assembly instructions. The first step for disassembly is to unsolder the cable to Low Pass Filter and grounding lug connections. The last step of assembly is to solder the cable to Low Pass Filter and grounding lug connections.

**CAUTION**

*Before touching CR701 refer to paragraph 5-48, Step c — CAUTION.*

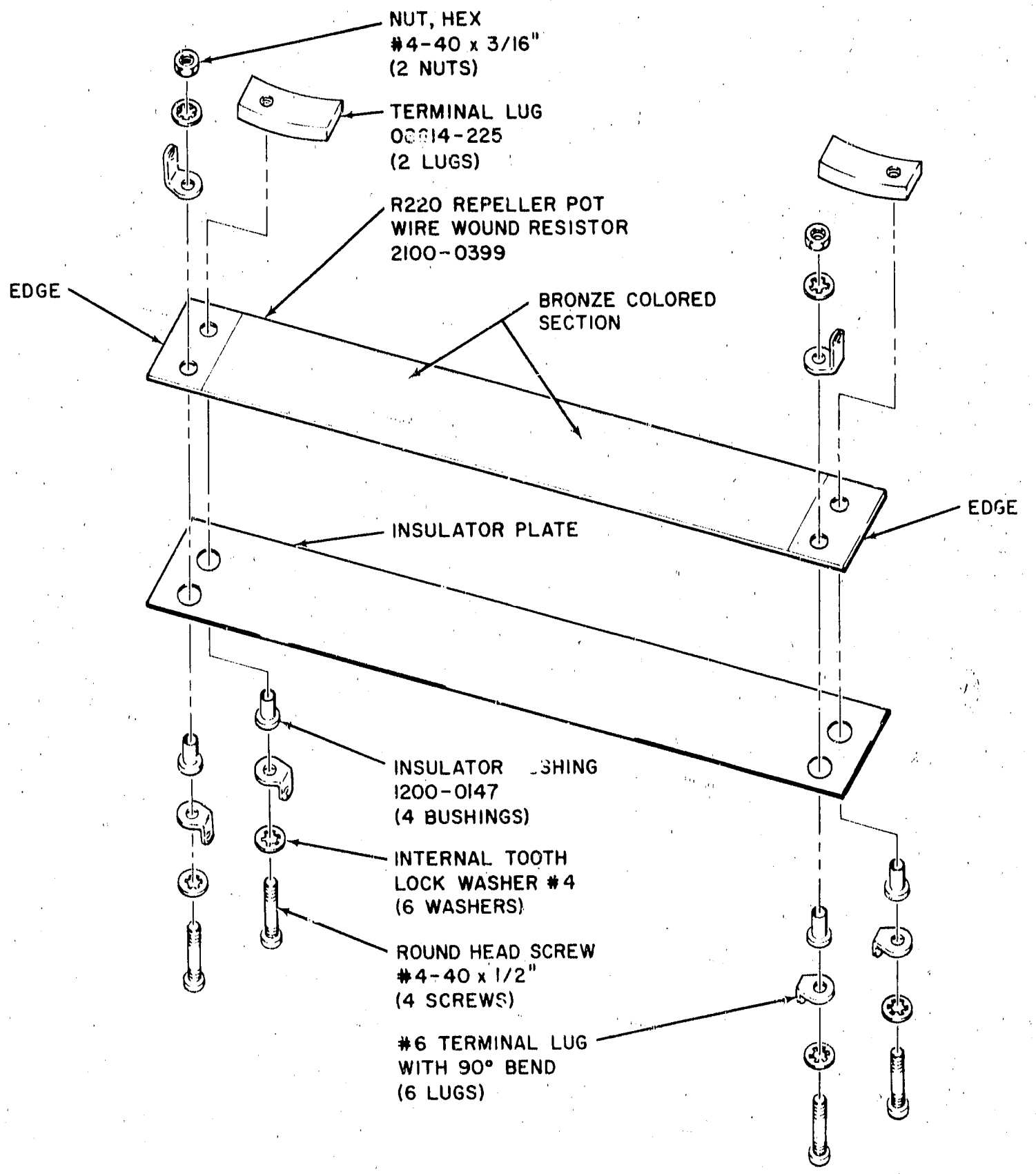
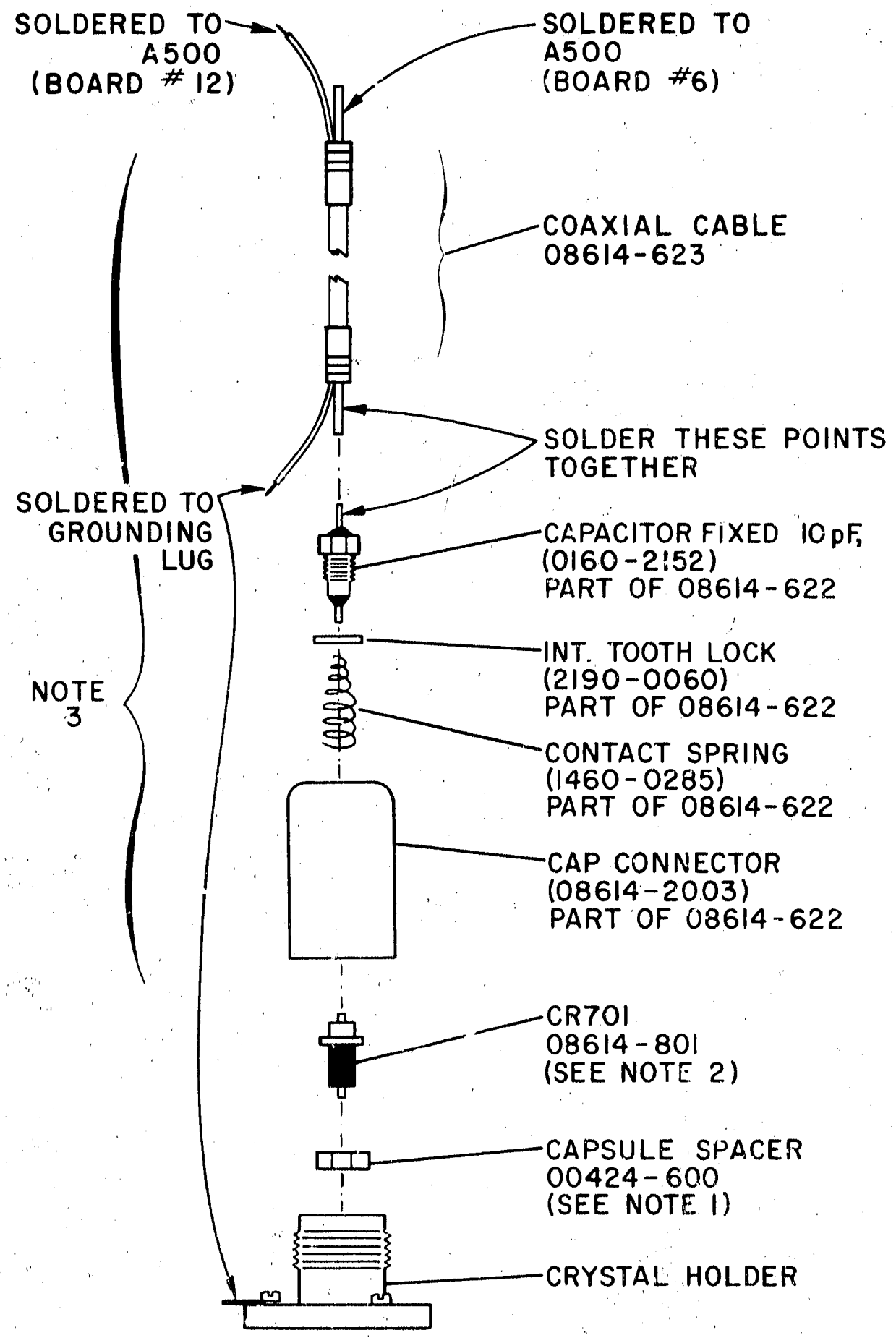



**Figure 5-18. R220 Repeller Resistor Assembly**




1. CAPSULE SPACER INCLUDES POLYIRON INSERT WHICH MUST ALWAYS BE INSERTED SO THAT INSERT WILL CONTACT WITH CRYSTAL HOLDER (POLYIRON DOWN).
2. STOCK NO. 08614-801 INCLUDES A SPECIAL MATCHING RESISTOR, R519, THAT MUST BE REPLACED WHENEVER CR701 IS REPLACED.
3. COAXIAL CABLE AND ALC FILTER ASSEMBLY PARTS ARE AVAILABLE AS PART OF LOW PASS FILTER KIT *hp* STOCK NO. 08614-625.

**Figure 5-19. Low Pass Filter Assembly Drawing**

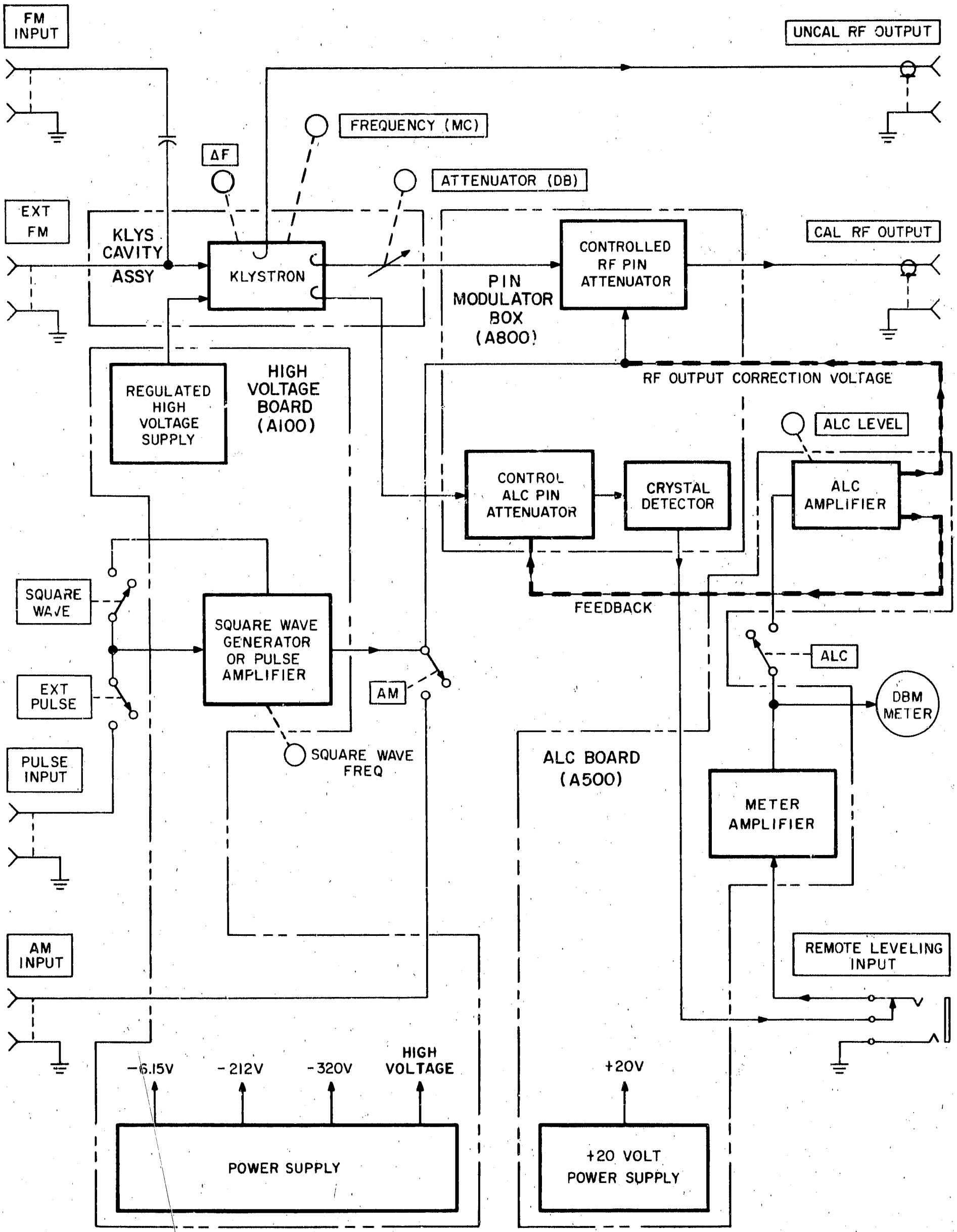



**Figure 5-20. Instrument Block Diagram**

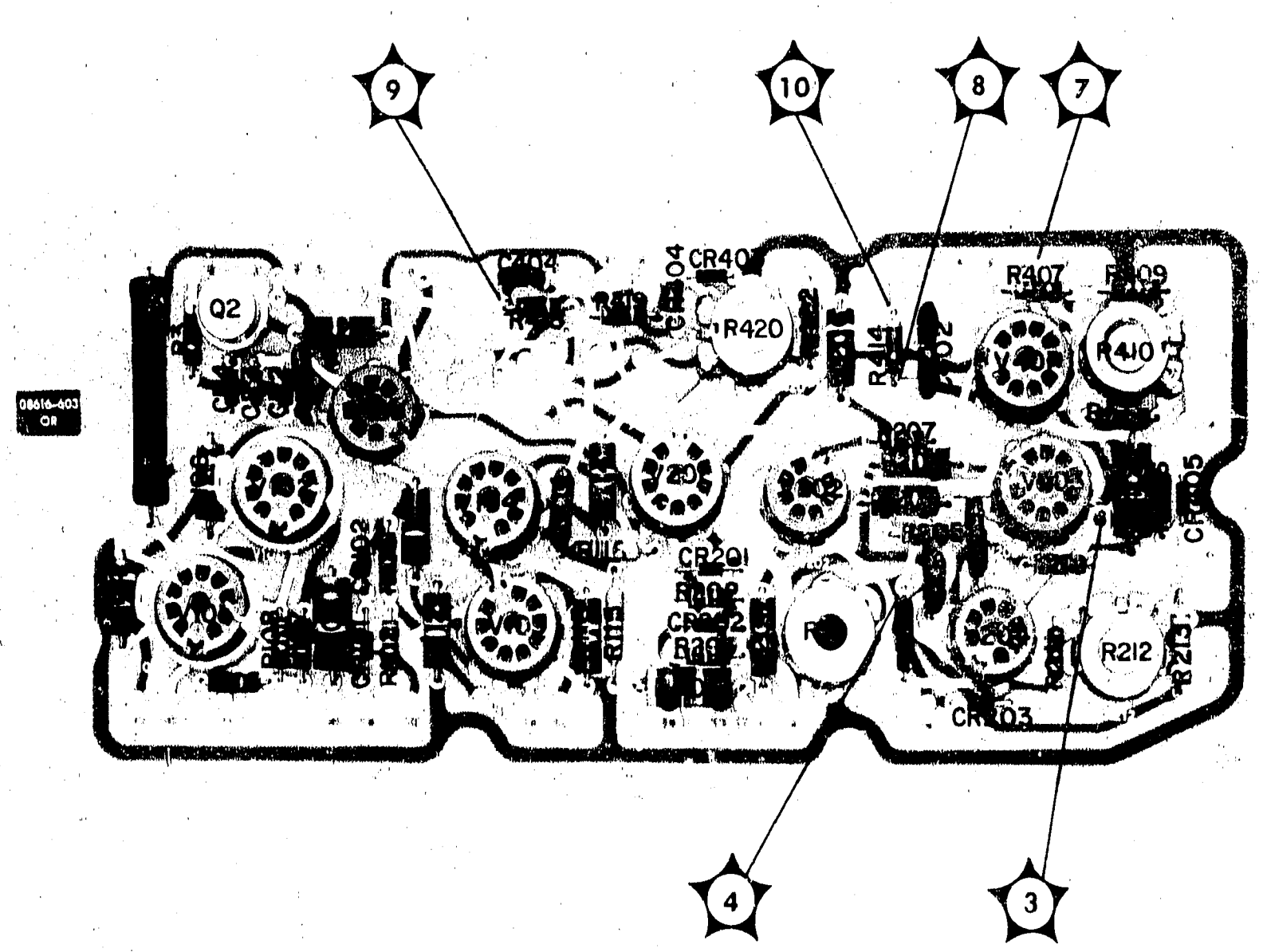



Figure 5-21. High-Voltage Board (A100)

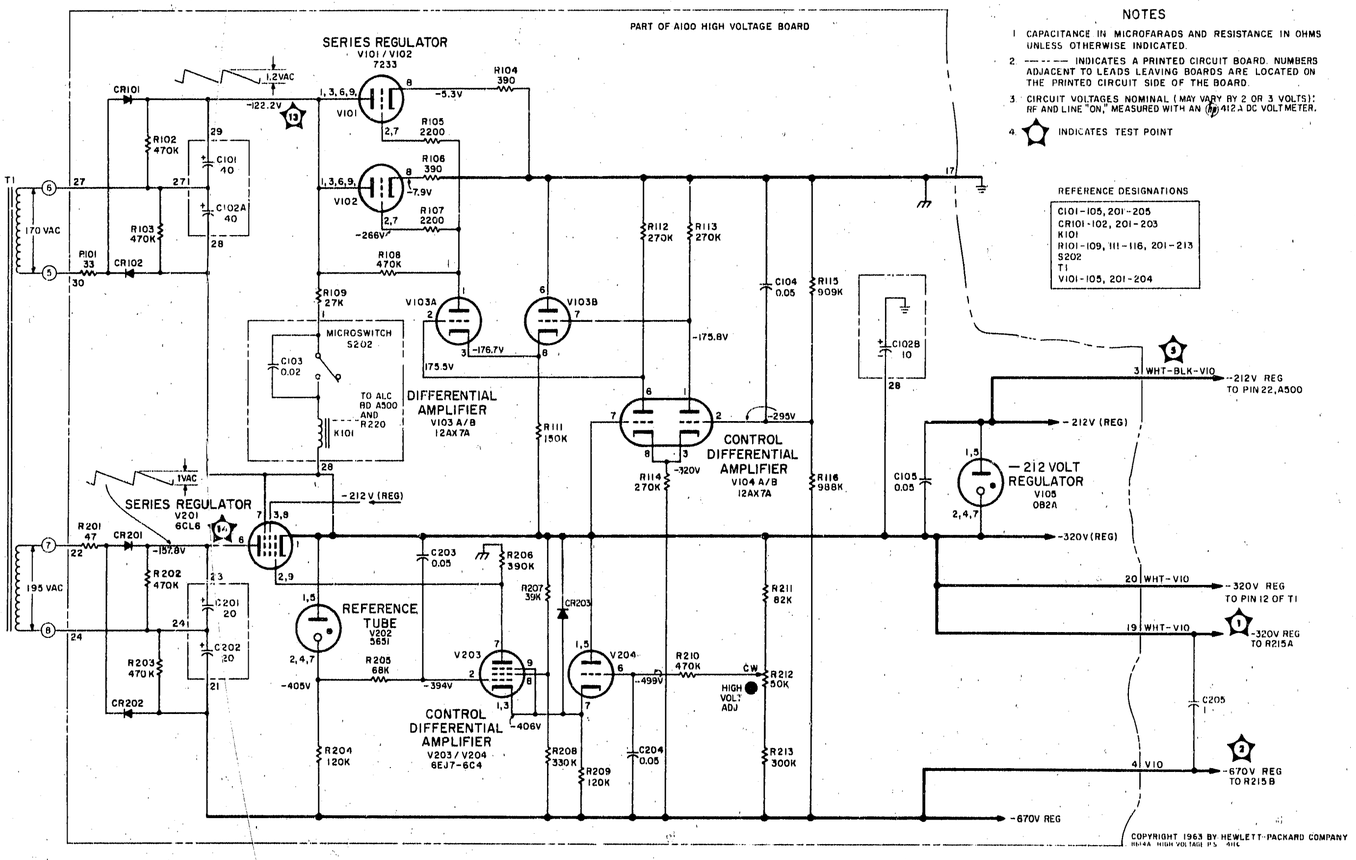



**Figure 5-22. High-Voltage Power Supply**

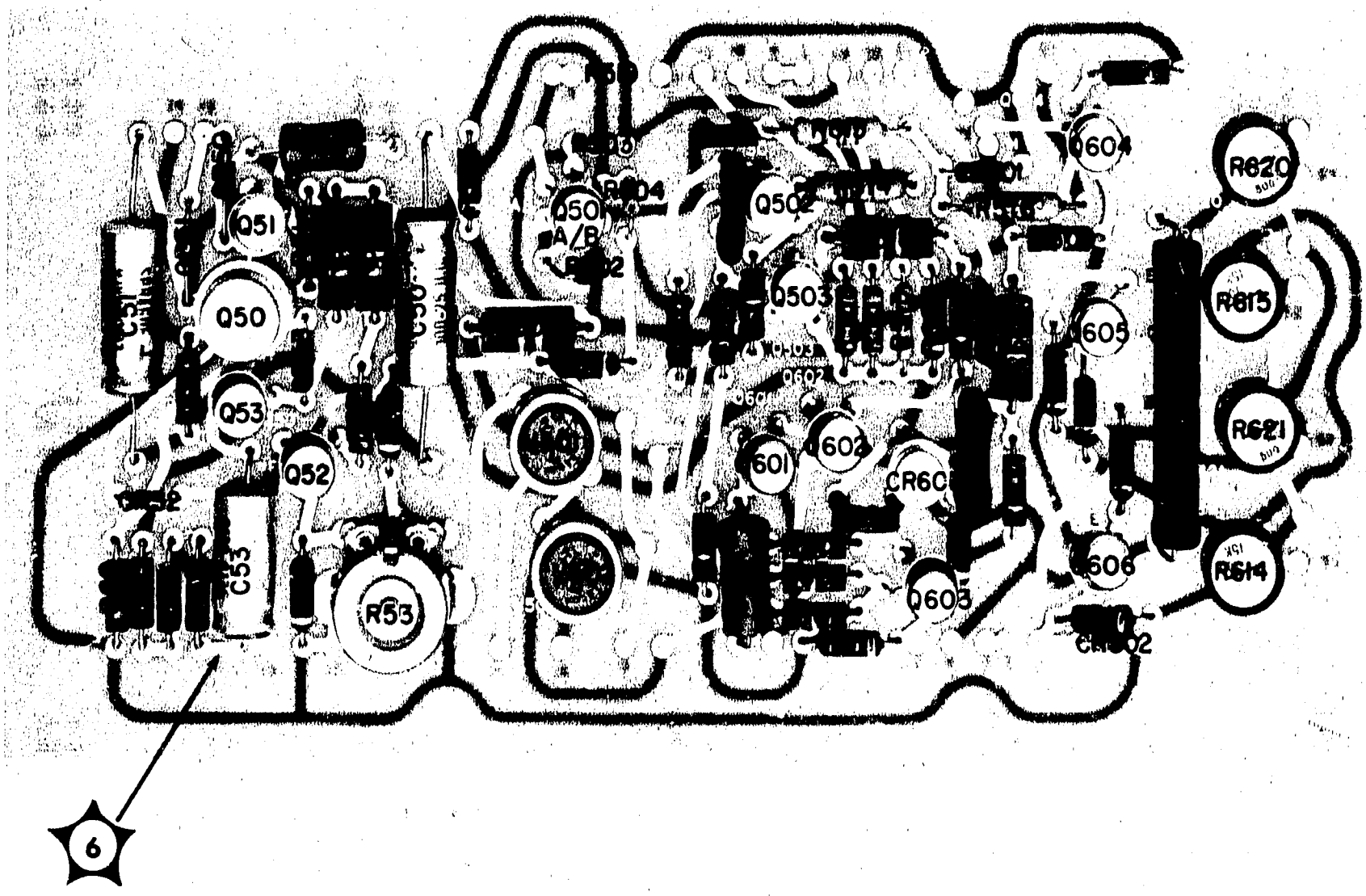



Figure 5-23. ALC Board (A500)

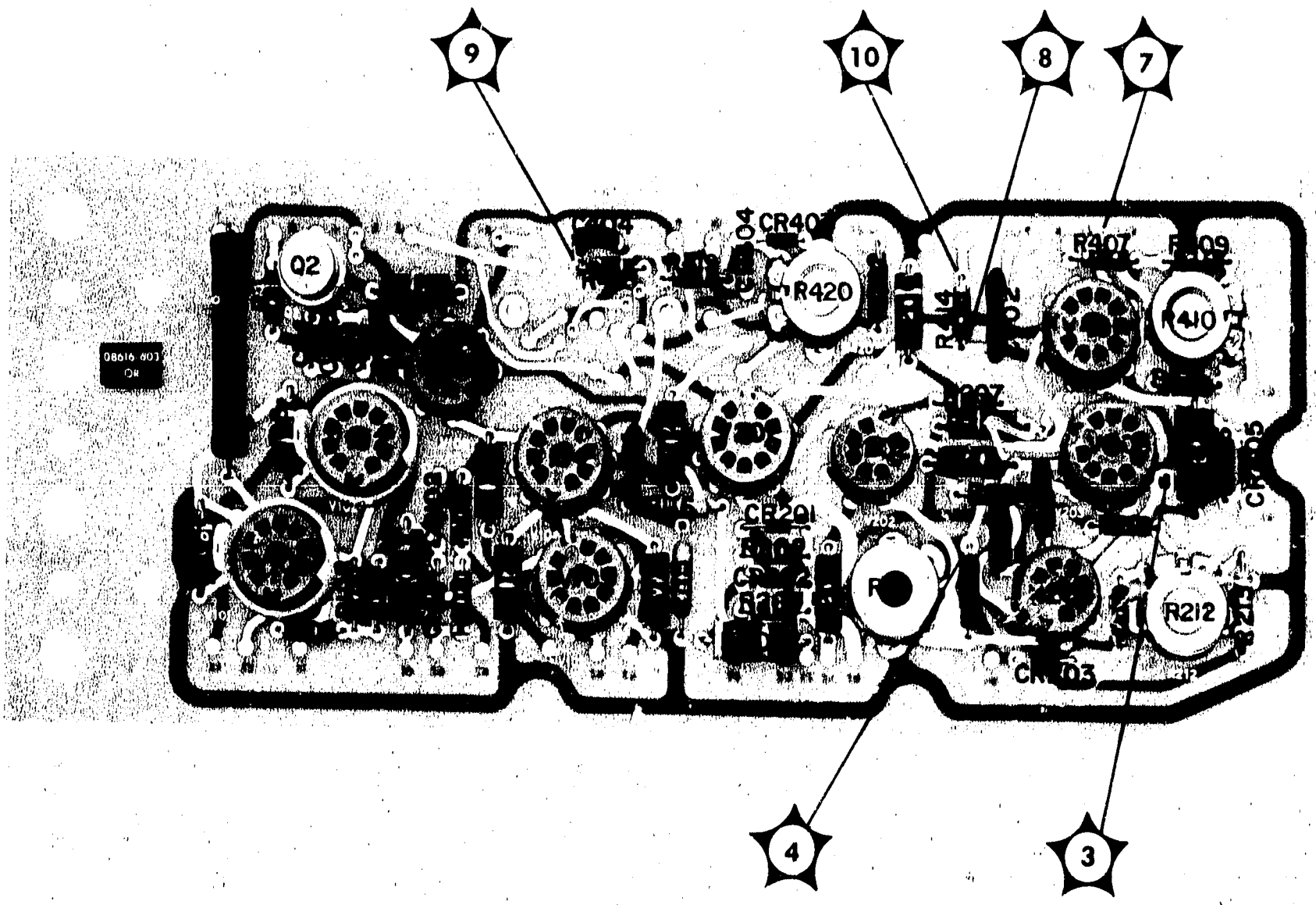
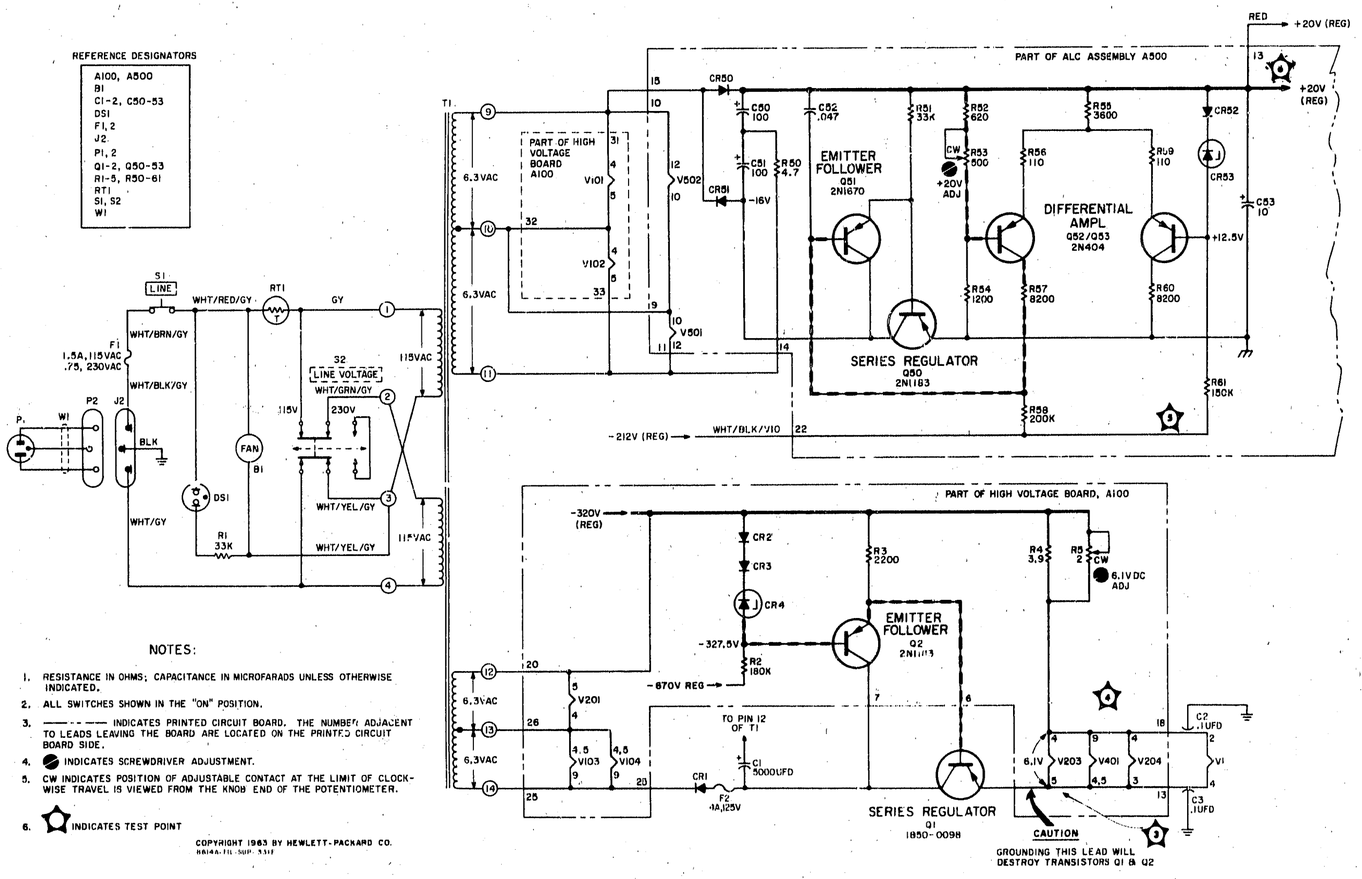



Figure 5-24. High-Voltage Board (A100)

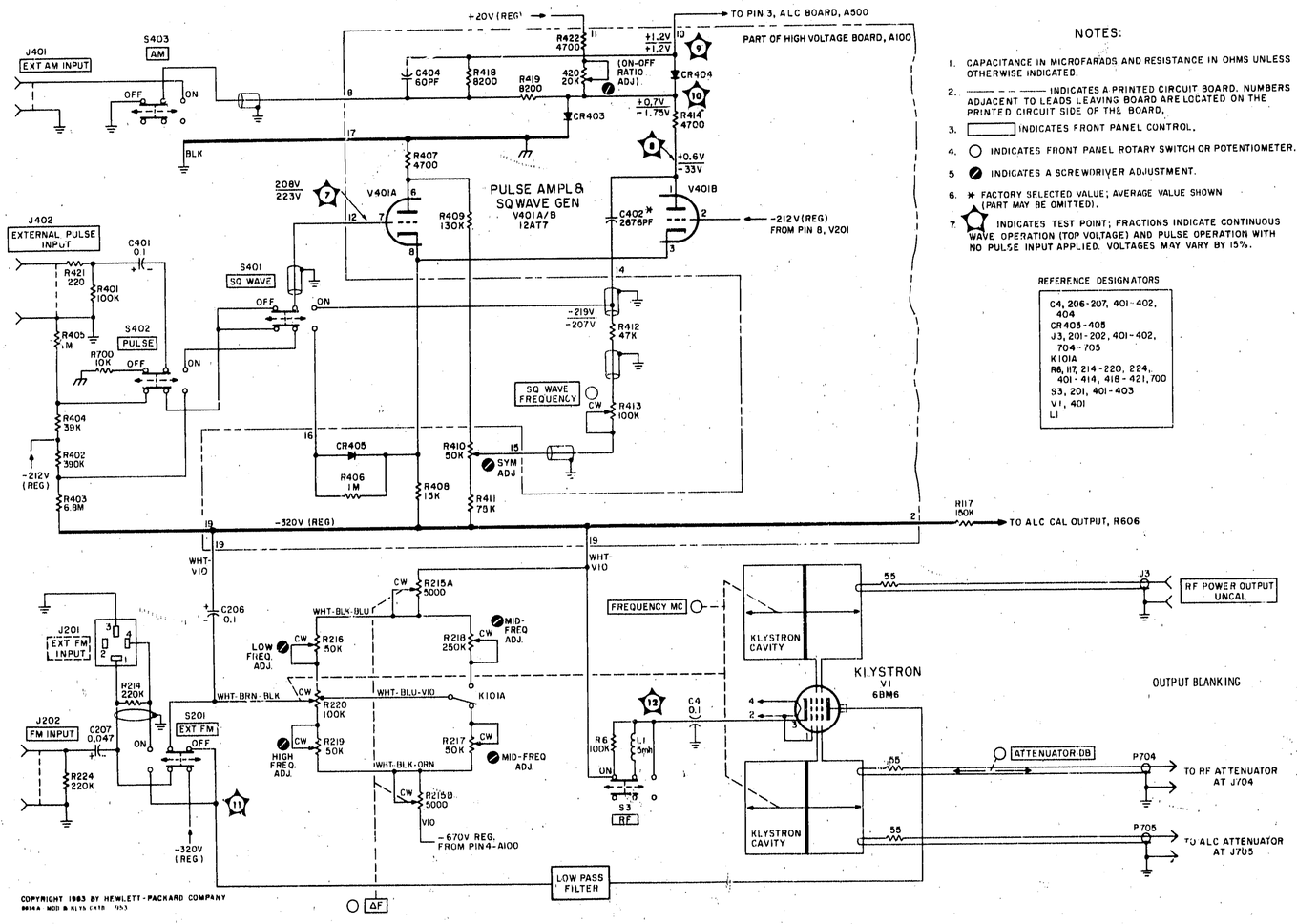



NOTES:

1. RESISTANCE IN OHMS; CAPACITANCE IN MICROFARADS UNLESS OTHERWISE INDICATED.
2. ALL SWITCHES SHOWN IN THE "ON" POSITION.
3. ——— INDICATES PRINTED CIRCUIT BOARD. THE NUMBER ADJACENT TO LEADS LEAVING THE BOARD ARE LOCATED ON THE PRINTED CIRCUIT BOARD SIDE.
4. INDICATES SCREWDRIVER ADJUSTMENT.
5. CW INDICATES POSITION OF ADJUSTABLE CONTACT AT THE LIMIT OF CLOCKWISE TRAVEL IS VIEWED FROM THE KNOB END OF THE POTENTIOMETER.
6. INDICATES TEST POINT



**Figure 5-25. Regulated +20 Volt and Filament Supplies**



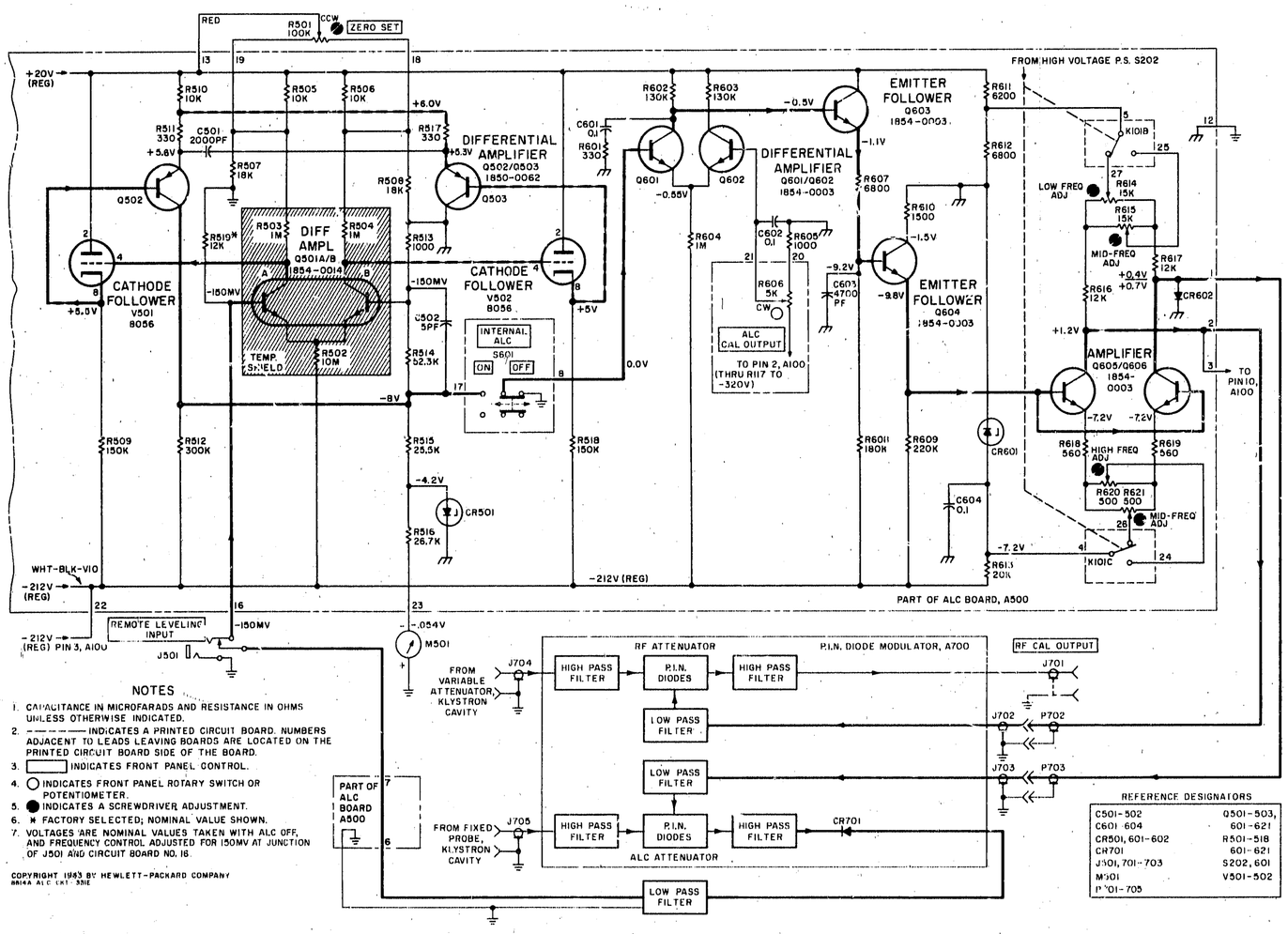

NOTES:

1. CAPACITANCE IN MICROFARADS AND RESISTANCE IN OHMS UNLESS OTHERWISE INDICATED.
2. ——— – – ——— INDICATES A PRINTED CIRCUIT BOARD. NUMBERS ADJACENT TO LEADS LEAVING BOARD ARE LOCATED ON THE PRINTED CIRCUIT SIDE OF THE BOARD.
3. ▭ INDICATES FRONT PANEL CONTROL.
4. ○ INDICATES FRONT PANEL ROTARY SWITCH OR POTENTIOMETER.
5. ⊘ INDICATES A SCREWDRIVER ADJUSTMENT.
6. * FACTORY SELECTED VALUE; AVERAGE VALUE SHOWN (PART MAY BE OMITTED).
7. ⬠ INDICATES TEST POINT; FRACTIONS INDICATE CONTINUOUS WAVE OPERATION (TOP VOLTAGE) AND PULSE OPERATION WITH NO PULSE INPUT APPLIED. VOLTAGES MAY VARY BY 15%.

REFERENCE DESIGNATORS

| |
|---|
| C4, 206-207, 401-402, 404 |
| CR403-405 |
| J3, 201-202, 401-402, 704-705 |
| K101A |
| R6, 117, 214-220, 224, 401-414, 418-421, 700 |
| S3, 201, 401-403 |
| V1, 401 |
| L1 |

**Figure 5-26. Modulation and Klystron Circuits**





8614A ALC CKT-SNE

**Figure 5-27. ALC Circuit**

# PARTS LIST

# SECTION VI
# REPLACEABLE PARTS

## 6-1. INTRODUCTION

6-2. This section contains information for ordering parts. Table 6-1 lists abbreviations used in the parts list and throughout the manual. Table 6-2 lists all replaceable parts in reference designator order. Table 6-3 contains the names and addresses that correspond to the manufacturer's code number.

## 6-3. ABBREVIATIONS

6-4. Table 6-1 gives a list of abbreviations used in the parts list, schematics, and throughout the manual. In some cases, two forms of the abbreviation are given, one all capital letters and one partial or no capitals. This occurs because the abbreviations in the parts list are always all capitals. However, in the schematics and other parts of the manual, other abbreviation forms are used with both lower case and upper case letters.

## 6-5. REPLACEABLE PARTS LIST

6-6. Table 6-2 is the list of replaceable parts and is organized as follows:

a. Electrical assemblies and their components in alpha-numeric order by reference designation.

b. Chassis-mounted parts in alpha-numeric order by reference designator.

c. Miscellaneous parts.

The information given for each part consists of the following:

a. The Hewlett-Packard Part Number.

b. Part number check digit (CD).

c. The total quantity (Qty) in the instrument.

d. The description of the part.

e. Typical manufacturer of the part in a five-digit code.

f. Manufacturer code number for the part.

The total quantity for each part is given only once; at the first appearance of the part number in the list.

## 6-7. ORDERING INSTRUCTIONS

6-8. To order a part listed in the replaceable parts table, quote the Hewlett-Packard part number and check digit, indicate quantity required, and address the order to the nearest Hewlett-Packard office.

6-9. To order a part that is not listed in the replaceable parts table, include the instrument model number, instrument serial number, the description and function of the part, and the number of parts required. Address the order to the nearest Hewlett-Packard office.

## Table 6-1. Reference Designations and Abbreviations (1 of 2)

### REFERENCE DESIGNATIONS

A . . . . . assembly
AT . . attenuator; isolator; termination
B . . . . . fan; motor
BT . . . . . battery
C . . . . . capacitor
CP . . . . . coupler
CR . . . . . diode; diode thyristor; varactor
DC . . . directional coupler
DL . . . . . delay line
DS . . . . . annunciator; signaling device (audible or visual); lamp; LED
E . . . . . miscellaneous electrical part
F . . . . . fuse
FL . . . . . filter
H . . . . . hardware
HY . . . . . circulator
J . . . electrical connector (stationary portion); jack
K . . . . . relay
L . . . . . coil; inductor
M . . . . . meter
MP . . . . . miscellaneous mechanical part
P . . . electrical connector (movable portion); plug
Q . . . . . transistor; SCR; triode thyristor
R . . . . . resistor
RT . . . . . thermistor
S . . . . . switch
T . . . . . transformer
TB . . . . . terminal board
TC . . . . . thermocouple
TP . . . . . test point
U . . . . . integrated circuit; microcircuit
V . . . . . electron tube
VR . . . voltage regulator; breakdown diode
W . . . . cable; transmission path; wire
X . . . . . socket
Y . . . crystal unit (piezoelectric or quartz)
Z . . . tuned cavity; tuned circuit

### ABBREVIATIONS

A . . . . . ampere
ac . . . . alternating current
ACCESS . . . . . accessory
ADJ . . . . . adjustment
A/D . . . . analog-to-digital
AF . . . . . audio frequency
AFC . . . . . automatic frequency control
AGC . . . . . automatic gain control
AL . . . . . aluminum
ALC . . . . . automatic level control
AM . . . amplitude modulation
AMPL . . . . . amplifier
APC . . . . automatic phase control
ASSY . . . . . assembly
AUX . . . . . auxiliary
avg . . . . . average
AWG . . . . American wire gauge
BAL . . . . . balance
BCD . . . . . binary coded decimal
BD . . . . . board
BE CU . . . . . beryllium copper
BFO . . . . . beat frequency oscillator
BH . . . . . binder head
BKDN . . . . . breakdown
BP . . . . . bandpass
BPF . . . . . bandpass filter
BRS . . . . . brass
BWO . . . . . backward-wave oscillator
CAL . . . . . calibrate
ccw . . counter-clockwise
CER . . . . . ceramic
CHAN . . . . . channel
cm . . . . . centimeter
CMO . . cabinet mount only
COAX . . . . . coaxial
COEF . . . . . coefficient
COM . . . . . common
COMP . . . . . composition
COMPL . . . . . complete
CONN . . . . . connector
CP . . . . . cadmium plate
CRT . . . cathode-ray tube
CTL . . . . complementary transistor logic
CW . . . . . continuous wave
cw . . . . . clockwise
cm . . . . . centimeter
D/A . . . . digital-to-analog
dB . . . . . decibel
dBm . . . . decibel referred to 1 mW
dc . . . . . direct current
deg . . degree (temperature interval or difference)
° . . . . . degree (plane angle)
°C . . . . . degree Celsius (centigrade)
°F . . . . degree Fahrenheit
°K . . . . . degree Kelvin
DEPC . . deposited carbon
DET . . . . . detector
diam . . . . . diameter
DIA . . diameter (used in parts list)
DIFF AMPL . . differential amplifier
div . . . . . division
DPDT . . . . double-pole, double-throw
DR . . . . . drive
DSB . . . . double sideband
DTL . . . . diode transistor logic
DVM . . . digital voltmeter
ECL . . . . emitter coupled logic
EMF . . electromotive force
EDP . . . . . electronic data processing
ELECT . . . . . electrolytic
ENCAP . . . . encapsulated
EXT . . . . . external
F . . . . . farad
FET . . . . . field-effect transistor
F/F . . . . . flip-flop
FH . . . . . flat head
FIL H . . . . . fillister head
FM . . frequency modulation
FP . . . . . front panel
FREQ . . . . . frequency
FXD . . . . . fixed
g . . . . . gram
GE . . . . . germanium
GHz . . . . . gigahertz
GL . . . . . glass
GRD . . . . . ground(ed)
H . . . . . henry
h . . . . . hour
HET . . . . . heterodyne
HEX . . . . . hexagonal
HD . . . . . head
HDW . . . . . hardware
HF . . . . . high frequency
HG . . . . . mercury
HI . . . . . high
HP . . . . . Hewlett-Packard
HPF . . . . . high pass filter
HR . . . . . hour (used in parts list)
HV . . . . . high voltage
Hz . . . . . Hertz
IC . . . . integrated circuit
ID . . . . . inside diameter
IF . . . . . intermediate frequency
IMPG . . . . impregnated
in . . . . . inch
INCD . . . . incandescent
INCL . . . . include(s)
INP . . . . . input
INS . . . . . insulation
INT . . . . . internal
kg . . . . . kilogram
kHz . . . . . kilohertz
kΩ . . . . . kilohm
kV . . . . . kilovolt
lb . . . . . pound
LC . . . . . inductance-capacitance
LED . . light-emitting diode
LF . . . . . low frequency
LG . . . . . long
LH . . . . . left hand
LIM . . . . . limit
LIN . . . linear taper (used in parts list)
lin . . . . . linear
LK WASH . . . lock washer
LO . . . low; local oscillator
LOG . . . . logarithmic taper (used in parts list)
log . . . . . logrithm(ic)
LPF . . . . . low pass filter
LV . . . . . low voltage
m . . . . . meter (distance)
mA . . . . . milliampere
MAX . . . . . maximum
MΩ . . . . . megohm
MEG . . . . meg ($10^6$) (used in parts list)
MET FLM . . . . metal film
MET OX . . metallic oxide
MF . . . medium frequency; microfarad (used in parts list)
MFR . . . . . manufacturer
mg . . . . . milligram
MHz . . . . . megahertz
mH . . . . . millihenry
mho . . . . . mho
MIN . . . . . minimum
min . . . . . minute (time)
' . . . . . minute (plane angle)
MINAT . . . . . miniature
mm . . . . . millimeter

**NOTE**

All abbreviations in the parts list will be in upper-case.

## Table 6-1. Reference Designations and Abbreviations (2 of 2)

MOD . . . . . modulator
MOM . . . . . momentary
MOS . . . . . metal-oxide semiconductor
ms . . . . . millisecond
MTG . . . . . mounting
MTR . . . meter (indicating device)
mV . . . . . millivolt
mVac . . . . . millivolt, ac
mVdc . . . . . millivolt, dc
mVpk . . . . millivolt, peak
mVp-p . . . millivolt, peak-to-peak
mVrms . . . . millivolt, rms
mW . . . . . milliwatt
MUX . . . . . multiplex
MY . . . . . mylar
μA . . . . . microampere
μF . . . . . microfarad
μH . . . . . microhenry
μmho . . . . . micromho
μs . . . . . microsecond
μV . . . . . microvolt
μVac . . . . . microvolt, ac
μVdc . . . . . microvolt, dc
μVpk . . . microvolt, peak
μVp-p . . . microvolt, peak-to-peak
μVrms . . . . microvolt, rms
μW . . . . . microwatt
nA . . . . . nanoampere
NC . . . . . no connection
N/C . . . . normally closed
NE . . . . . neon
NEG . . . . . negative
nF . . . . . nanofarad
NI PL . . . . . nickel plate
N/O . . . . . normally open
NOM . . . . . nominal
NORM . . . . . normal
NPN . . . negative-positive-negative
NPO . . . . negative-positive zero (zero temperature coefficient)
NRFR . . not recommended for field replacement
NSR . . . . not separately replaceable
ns . . . . . nanosecond
nW . . . . . nanowatt
ORD . . . order by description
OD . . . . . outside diameter
OH . . . . . oval head
OP AMPL . . . operational amplifier
OPT . . . . . option
OSC . . . . . oscillator
OX . . . . . oxide
oz . . . . . ounce
Ω . . . . . ohm
P . . . . peak (used in parts list)
PAM . . . . pulse-amplitude modulation
PC . . . . . printed circuit
PCM . . pulse-code modulation; pulse-count modulation
PDM . . . . . pulse-duration modulation
pF . . . . . picofarad
PH BRZ . . . phosphor bronze
PHL . . . . . Phillips
PIN . . . positive-intrinsic-negative
PIV . . . . . peak inverse voltage
pk . . . . . peak
PL . . . . . phase lock
PLO . . . . . phase lock oscillator
PM . . . . phase modulation
PNP . . . positive-negative-positive
P/O . . . . . part of
POLY . . . . . polystyrene
PORC . . . . . porcelain
POS . . positive; position(s) (used in parts list)
POSN . . . . . position
POT . . . . . potentiometer
p-p . . . . . peak-to-peak
PF . . . peak-to-peak (used in parts list)
PPM . . . . . pulse-position modulation
PREAMPL . . . preamplifier
PRF . . . . pulse-repetition frequency
PRR . . . . pulse repetition rate
ps . . . . . picosecond
PT . . . . . point
PTM . . . . . pulse-time modulation
PWM . . . . . pulse-width modulation
PWV . . . . . peak working voltage
RC . . . . . resistance-capacitance
RECT . . . . . rectifier
REF . . . . . reference
REG . . . . . regulated
REPL . . . . . replaceable
RF . . . . radio frequency
RFI . . . . radio frequency interference
RH . . . . round head; right hand
RLC . . . . . resistance-inductance-capacitance
RMO . . . rack mount only
rms . . . . root-mean-square
RND . . . . . round
ROM . . read-only memory
R&P . . . . . rack and panel
RWV . . . reverse working voltage
S . . . scattering parameter
s . . . . . second (time)
. . . " . . second (plane angle)
S-B . . . . slow-blow (fuse) (used in parts list)
SCR . . . silicon controlled rectifier; screw
SE . . . . . selenium
SECT . . . . . sections
SEMICON . . . . . semiconductor
SHF . . . . . superhigh frequency
SI . . . . . silicon
SIL . . . . . silver
SL . . . . . slide
SNR . . signal-to-noise ratio
SPDT . . . . . single-pole, double-throw
SPG . . . . . spring
SR . . . . . split ring
SPST . . . . . single-pole, single-throw
SSB . . . . . single sideband
SST . . . . . stainless steel
STL . . . . . steel
SQ . . . . . square
SWR . . standing-wave ratio
SYNC . . . . . synchronize
T . . timed (slow-blow fuse)
TA . . . . . tantalum
TC . . . . . temperature compensating
TD . . . . . time delay
TERM . . . . . terminal
TFT . . thin-film transistor
TGL . . . . . toggle
THD . . . . . thread
THRU . . . . . through
TI . . . . . titanium
TOL . . . . . tolerance
TRIM . . . . . trimmer
TSTR . . . . . transistor
TTL . . transistor-transistor logic
TV . . . . . television
TVI . . . television interference
TWT . . traveling wave tube
U . . . . micro ($10^{-6}$) (used in parts list)
UF . . . microfarad (used in parts list)
UHF . . ultrahigh frequency
UNREG . . . . unregulated
V . . . . . volt
VA . . . . . voltampere
Vac . . . . . volts, ac
VAR . . . . . variable
VCO . . . voltage-controlled oscillator
Vdc . . . . . volts, dc
VDCW . . volts, dc, working (used in parts list)
V(F) . . . . . volts, filtered
VFO . . variable-frequency oscillator
VHF . . . . . very-high frequency
Vpk . . . . . volts, peak
Vp-p . . volts, peak-to-peak
Vrms . . . . . volts, rms
VSWR . . . voltage standing wave ratio
VTO . . . . . voltage-tuned oscillator
VTVM . . . . vacuum-tube voltmeter
V(X) . . . . . volts, switched
W . . . . . watt
W/ . . . . . with
WIV . . . . working inverse voltage
WW . . . . . wirewound
W/O . . . . . without
YIG . . yttrium-iron-garnet
$Z_o$ . . . . . characteristic impedance

**NOTE**

All abbreviations in the parts list will be in upper-case.

## MULTIPLIERS

| Abbreviation | Prefix | Multiple |
|---|---|---|
| T | tera | $10^{12}$ |
| G | giga | $10^{9}$ |
| M | mega | $10^{6}$ |
| k | kilo | $10^{3}$ |
| da | deka | 10 |
| d | deci | $10^{-1}$ |
| c | centi | $10^{-2}$ |
| m | milli | $10^{-3}$ |
| μ | micro | $10^{-6}$ |
| n | nano | $10^{-9}$ |
| p | pico | $10^{-12}$ |
| f | femto | $10^{-15}$ |
| a | atto | $10^{-18}$ |

## Table 6-2. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| A100 | 08614-621 | 7 | 1 | BOARD, HIGH VOLTAGE | 28480 | 08614-621 |
| A101-A499 | | | 1 | NOT ASSIGNED | | |
| A500 | 08614-602 | 4 | 1 | BOARD, LOW VOLTAGE & ALC | 28480 | 08614-602 |
| B1 | 3140-0030 | 7 | 1 | MOTOR IND SHADED-P 115V 3000-RPM .001-HP | 28480 | 3140-0030 |
| C1 | 0180-0213 | 9 | 1 | CAPACITOR-FXD 5000UF+75-10% 25VDC AL | 28480 | 0180-0213 |
| C2 | 0160-0152 | 3 | 3 | CAPACITOR-FXD .1UF +-20% 600VDC PPR | 28480 | 0160-0152 |
| C3 | 0160-0152 | 3 | | CAPACITOR-FXD .1UF +-20% 600VDC PPR | 28480 | 0160-0152 |
| C4 | 0160-0152 | 3 | | CAPACITOR-FXD .1UF +-20% 600VDC PPR | 28480 | 0160-0152 |
| C5-C49 | | | | NOT ASSIGNED | | |
| C50 | 0180-0094 | 4 | 2 | CAPACITOR-FXD 100UF+75-10% 25VDC AL | 56289 | 30D107G025DD2 |
| C51 | 0180-0094 | 4 | | CAPACITOR-FXD 100UF+75-10% 25VDC AL | 56289 | 30D107G025DD2 |
| C52 | 0170-0040 | 9 | 1 | CAPACITOR-FXD .047UF +-10% 200VDC POLYE | 56289 | 292P47392 |
| C53 | 0180-0136 | 5 | 1 | CAPACITOR-FXD 10UF+100-10% 50VDC AL | 28480 | 0180-0136 |
| C54-C100 | | | | NOT ASSIGNED | | |
| C101 | 0180-0024 | 0 | 1 | CAPACITOR-FXD 40UF+50-10% 450VDC AL | 28480 | 0180-0024 |
| C102 | 0180-0135 | 4 | 1 | C-FXD AL ELEC ,2SECT,40/450UF -10+50% | 28480 | 0180-0135 |
| C103 | 0150-0024 | 7 | 1 | CAPACITOR-FXD .02UF +80-20% 600VDC CER | 28480 | 0150-0024 |
| C104 | 0150-0052 | 1 | 4 | CAPACITOR-FXD .05UF +-20% 400VDC CER | 28480 | 0150-0052 |
| C105 | 0150-0052 | 1 | | CAPACITOR-FXD .05UF +-20% 400VDC CER | 28480 | 0150-0052 |
| C106-C200 | | | | NOT ASSIGNED | | |
| C201 | 0180-0011 | 5 | 2 | CAPACITOR-FXD 20UF+50-10% 450VDC AL | 28480 | 0180-0011 |
| C202 | 0180-0011 | 5 | | CAPACITOR-FXD 20UF+50-10% 450VDC AL | 28480 | 0180-0011 |
| C203 | 0150-0052 | 1 | | CAPACITOR-FXD .05UF +-20% 400VDC CER | 28480 | 0150-0052 |
| C204 | 0150-0052 | 1 | | CAPACITOR-FXD .05UF +-20% 400VDC CER | 28480 | 0150-0052 |
| C205 | 0160-0079 | 3 | 1 | CAPACITOR-FXD 1UF +-10% 600VDC PPR | 01002 | 23F467 |
| | 1210-0003 | 1 | 1 | CLAMP-CAP .75-WD STL | 28480 | 1210-0003 |
| C206 | 0170-0022 | 7 | 2 | CAPACITOR-FXD .1UF +-20% 600VDC POLYE | 28480 | 0170-0022 |
| C207 | 0160-0037 | 3 | 1 | CAPACITOR-FXD .04UF +-20% 1.6KVDC PPR | 28480 | 0160-0037 |
| C208-C400 | | | | NOT ASSIGNED | | |
| C401 | 0170-0022 | 7 | | CAPACITOR-FXD .1UF +-20% 600VDC POLYE | 28480 | 0170-0022 |
| C402* | 0140-0158 | 7 | 1 | CAPACITOR-FXD 2676PF +-1% 500VDC MICA | 72136 | DM20F2676RF0500WV1CR |
| C403 | | | | NOT ASSIGNED | | |
| C404 | 0140-0214 | 6 | 1 | CAPACITOR-FXD 60PF +-5% 300VDC MICA | 72136 | DM15E600J0300WV1CR |
| C405-C500 | | | | NOT ASSIGNED | | |
| C501 | 0140-0180 | 5 | 1 | CAPACITOR-FXD 2000PF +-2% 300VDC MICA | 72136 | DM19F202G0300WV1CR |
| C502 | 0140-0209 | 9 | 1 | CAPACITOR-FXD 5PF +-10% 500VDC MICA | 72136 | DM15C050K0500WV1CR |
| C503-C600 | | | | NOT ASSIGNED | | |
| C601 | 0170-0019 | 2 | 1 | CAPACITOR-FXD .1UF +-5% 200VDC POLYE | 28480 | 0170-0019 |
| C602 | 0150-0121 | 5 | 2 | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0150-0121 |
| C603 | 0140-0162 | 3 | 1 | CAPACITOR-FXD 4700PF +-10% 300VDC MICA | 72136 | DM20F472K0300WV1CR |
| C604 | 0150-0121 | 5 | | CAPACITOR-FXD .1UF +80-20% 50VDC CER | 28480 | 0150-0121 |
| CR1 | 1901-0032 | 1 | 1 | DIODE-PWR RECT 1N3209 100V 15A DO-5 | 03508 | 1N3209 |
| CR2 | 1901-0025 | 2 | 6 | DIODE-GEN PRP 100V 200MA DO-7 | 28480 | 1901-0025 |
| CR3 | 1901-0025 | 2 | | DIODE-GEN PRP 100V 200MA DO-7 | 28480 | 1901-0025 |
| CR4 | 1902-0057 | 2 | 2 | DIODE-ZNR 6.49V 5% DO-7 PD=.4W TC=+.029% | 28480 | 1902-0057 |
| CR5-CR49 | | | | NOT ASSIGNED | | |
| CR50 | 1901-0026 | 3 | 2 | DIODE-PWR RECT 200V 750MA DO-29 | 28480 | 1901-0026 |
| CR51 | 1901-0026 | 3 | | DIODE-PWR RECT 200V 750MA DO-29 | 28480 | 1901-0026 |
| CR52 | 1901-0025 | 2 | | DIODE-GEN PRP 100V 200MA DO-7 | 28480 | 1901-0025 |
| CR53 | 1902-0045 | 8 | 1 | DIODE-ZNR 7.32V 2% DO-7 PD=.4W TC=+.048% | 28480 | 1902-0045 |
| CR54-CR100 | | | | NOT ASSIGNED | | |
| CR101 | 1901-0030 | 9 | 4 | DIODE-PWR RECT 800V 600MA DO-29 | 28480 | 1901-0030 |
| CR102 | 1901-0030 | 9 | | DIODE-PWR RECT 800V 600MA DO-29 | 28480 | 1901-0030 |
| CR103-CR200 | | | | NOT ASSIGNED | | |
| CR201 | 1901-0030 | 9 | | DIODE-PWR RECT 800V 600MA DO-29 | 28480 | 1901-0030 |
| CR202 | 1901-0030 | 9 | | DIODE-PWR RECT 800V 600MA DO-29 | 28480 | 1901-0030 |
| CR203 | 1902-0175 | 5 | 1 | DIODE-ZNR 100V 5% DO-15 PD=1W TC=+.083% | 28480 | 1902-0175 |
| CR204-CR402 | | | | NOT ASSIGNED | | |
| CR403 | 1901-0025 | 2 | | DIODE-GEN PRP 100V 200MA DO-7 | 28480 | 1901-0025 |
| CR404 | 1901-0040 | 1 | 1 | DIODE-SWITCHING 30V 50MA 2NS DO-35 | 28480 | 1901-0040 |
| CR405 | 1901-0025 | 2 | | DIODE-GEN PRP 100V 200MA DO-7 | 28480 | 1901-0025 |
| CR406-CR500 | | | | NOT ASSIGNED | | |
| CR501 | 1902-0057 | 2 | | DIODE-ZNR 6.49V 5% DO-7 PD=.4W TC=+.029% | 28480 | 1902-0057 |

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

## Table 6-2. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| CR502-CR600 | | | | NOT ASSIGNED | | |
| CR601 | 1902-0216 | 5 | 1 | DIODE-ZNR 7.15V 5% PD=1.5W TC=+.042% | 28480 | 1902-0216 |
| CR602 | 1901-0025 | 2 | | DIODE-GEN PRP 100V 200MA DO-7 | 28480 | 1901-0025 |
| CR603-CR700 | | | | NOT ASSIGNED | | |
| CR701 | 08614-801 | 5 | 1 | DIODE, SPECIAL (INCLUDES MATCHING RESISTOR R519) | 28480 | 08614-801 |
| DS1 | 1450-0566 | 9 | 1 | LIGHT-IND WHT-TL .4-DIA SLDR-LUG-TERM | 91802 | 2910317 |
| F1 | 2110-0043 | 8 | 1 | FUSE 1.5A 250V FAST-BLO 1.25X.25 UL IEC (FOR 115V OPERATION ONLY) | 28480 | 2110-0043 |
| F1 | 2110-0033 | 6 | 1 | FUSE .75A 250V NORM-BLO 1.25X.25 (FOR 230V OPERATION ONLY) | 28480 | 2110-0033 |
| F2 | 2110-0014 | 3 | 1 | FUSE 4A 250V SLO-BLO 1.25X.25 UL | 75915 | 313004 |
| | 1400-0008 | 9 | 1 | FUSEHOLDER-BLOCK 15A 250V 1-PC | 28480 | 1400-0008 |
| J1 | | | | NOT ASSIGNED | | |
| J2 | 1251-0148 | 1 | 1 | CONNECTOR-AC PWR HP-8 MALE FLG-MTG | 28480 | 1251-0148 |
| J3-J200 | | | | NOT ASSIGNED | | |
| J201 | 1251-0011 | 7 | 1 | CONNECTOR 4-PIN F JONES TYPE | 28480 | 1251-0011 |
| J202 | 1250-0083 | 1 | 3 | CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM | 28480 | 1250-0083 |
| J203-J400 | | | | NOT ASSIGNED | | |
| J401 | 1250-0083 | 1 | | CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM | 28480 | 1250-0083 |
| J402 | 1250-0083 | 1 | | CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM | 28480 | 1250-0083 |
| J403-J500 | | | | NOT ASSIGNED | | |
| J501 | 1251-0070 | 8 | 1 | CONNECTOR-TEL JACK 3-CKT .25-8HK-DIA | 28480 | 1251-0070 |
| K101 | 0490-1198 | 8 | 1 | RELAY 3C 110VDC-COIL 5A 120VAC | 28480 | 0490-1198 |
| L1 | 9140-0072 | 3 | 1 | COIL-MLD 5MH 10% Q=80 .375DX.625LG-NOM | 28480 | 9140-0072 |
| M501 | 1120-0134 | 8 | 1 | METER METER,0-200UA 2%,EDGE VIEW | 28480 | 1120-0134 |
| Q1 | 1850-0098 | 0 | 1 | TRANSISTOR PNP GE TO-3 PD=90W FT=300KHZ | 28480 | 1850-0098 |
| Q2 | 1850-0064 | 0 | 2 | TRANSISTOR PNP 2N1183 GE TO-8 PD=7.5W | 01928 | 2N1183 |
| Q3-Q49 | | | | NOT ASSIGNED | | |
| Q50 | 1850-0064 | 0 | | TRANSISTOR PNP 2N1183 GE TO-8 PD=7.5W | 01928 | 2N1183 |
| Q51 | 1850-0128 | 7 | 1 | TRANSISTOR PNP 2N3906 GE TO-5 PD=250MW | 28480 | 1850-0128 |
| Q52 | 1850-0062 | 8 | 4 | TRANSISTOR PNP GE TO-5 PD=150MW | 28480 | 1850-0062 |
| Q53 | 1850-0062 | 8 | | TRANSISTOR PNP GE TO-5 PD=150MW | 28480 | 1850-0062 |
| Q54-Q500 | | | | NOT ASSIGNED | | |
| Q501 | 1854-0014 | 8 | 1 | TRANSISTOR-DUAL NPN TO-77 PD=600MW | 28480 | 1854-0014 |
| Q502 | 1850-0062 | 8 | | TRANSISTOR PNP GE TO-5 PD=150MW | 28480 | 1850-0062 |
| Q503 | 1850-0062 | 8 | | TRANSISTOR PNP GE TO-5 PD=150MW | 28480 | 1850-0062 |
| Q504-Q600 | | | | NOT ASSIGNED | | |
| Q601 | 1854-0003 | 5 | 6 | TRANSISTOR NPN SI TO-39 PD=800MW | 28480 | 1854-0003 |
| Q602 | 1854-0003 | 5 | | TRANSISTOR NPN SI TO-39 PD=800MW | 28480 | 1854-0003 |
| Q603 | 1854-0003 | 5 | | TRANSISTOR NPN SI TO-39 PD=800MW | 28480 | 1854-0003 |
| Q604 | 1854-0003 | 5 | | TRANSISTOR NPN SI TO-39 PD=800MW | 28480 | 1854-0003 |
| Q605 | 1854-0003 | 5 | | TRANSISTOR NPN SI TO-39 PD=800MW | 28480 | 1854-0003 |
| Q606 | 1854-0003 | 5 | | TRANSISTOR NPN SI TO-39 PD=800MW | 28480 | 1854-0003 |
| R1 | 0687-3331 | 2 | 1 | RESISTOR 33K 10% .5W CC TC=0+765 | 01121 | EB3331 |
| R2 | 0690-1841 | 2 | 2 | RESISTOR 180K 10% 1W CC TC=0+882 | 01121 | GB1841 |
| R3 | 0687-2221 | 7 | 3 | RESISTOR 2.2K 10% .5W CC TC=0+647 | 01121 | EB2221 |
| R4 | 0813-0030 | 1 | 1 | RESISTOR 3.9 5% 3W PW TC=0+-50 | 91637 | CW291-3W-T2-3R9-J |
| R5 | 2100-0317 | 8 | 1 | RESISTOR-TRMR 2 20% WW TOP-ADJ 1-TRN | 11236 | T15-2W-2R0-M |
| R6 | 0757-0059 | 4 | 1 | RESISTOR 1M 1% .5W F TC=0+-100 | 28480 | 0757-0059 |
| R7-R49 | | | | NOT ASSIGNED | | |
| R50 | 0698-0001 | 0 | 1 | RESISTOR 4.7 5% .5W CC TC=0+412 | 01121 | EB47G5 |
| R51 | 0686-3335 | 4 | 1 | RESISTOR 33K 5% .5W CC TC=0+765 | 01121 | EB3335 |
| R52 | 0757-0088 | 9 | 1 | RESISTOR 620 2% .25W F TC=0+-100 | 24546 | C5-1/4-T0-621-G |
| R53 | 2100-0151 | 8 | 1 | RESISTOR-VAR CONTROL CP 500 20% LIN | 28480 | 2100-0151 |
| R54 | 0757-0077 | 6 | 1 | RESISTOR 1.2K 2% .25W F TC=0+-100 | 28480 | 0757-0077 |
| R55 | 0686-3625 | 5 | 1 | RESISTOR 3.6K 5% .5W CC TC=0+647 | 01121 | EB3625 |
| R56 | 0686-1115 | 4 | 2 | RESISTOR 110 5% .5W CC TC=0+529 | 01121 | EB1115 |
| R57 | 0686-8225 | 1 | 2 | RESISTOR 8.2K 5% .5W CC TC=0+647 | 01121 | EB8225 |
| R58 | 0689-2045 | 7 | 1 | RESISTOR 200K 5% 1W CC TC=0+882 | 01121 | GB2045 |
| R59 | 0686-1115 | 4 | | RESISTOR 110 5% .5W CC TC=0+529 | 01121 | EB1115 |
| R60 | 0686-8225 | 1 | | RESISTOR 8.2K 5% .5W CC TC=0+647 | 01121 | EB8225 |
| R61 | 0690-1541 | 9 | 4 | RESISTOR 150K 10% 1W CC TC=0+882 | 01121 | GB1541 |

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

## Table 6-2. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| R62- R100 | | | | NOT ASSIGNED | | |
| R101 | 0693-3301 | 9 | 1 | RESISTOR 33 10% 2W CC TC=0+412 | 01121 | HB3301 |
| R102 | 0687-4741 | 0 | 6 | RESISTOR 470K 10% .5W CC TC=0+882 | 01121 | EB4741 |
| R103 | 0687-4741 | 0 | | RESISTOR 470K 10% .5W CC TC=0+882 | 01121 | EB4741 |
| R104 | 0690-3911 | 1 | 2 | RESISTOR 390 10% 1W CC TC=0+529 | 01121 | GB3911 |
| R105 | 0687-2221 | 7 | | RESISTOR 2.2K 10% .5W CC TC=0+647 | 01121 | EB2221 |
| R106 | 0690-3911 | 1 | | RESISTOR 390 10% 1W CC TC=0+529 | 01121 | GB3911 |
| R107 | 0687-2221 | 7 | | RESISTOR 2.2K 10% .5W CC TC=0+647 | 01121 | EB2221 |
| R108 | 0687-4741 | 0 | | RESISTOR 470K 10% .5W CC TC=0+882 | 01121 | EB4741 |
| R109 | 0774-0003 | 4 | 1 | RESISTOR 27K 10% 5W MO TC=0+-250 | 27167 | FP5-5-250-2702-K |
| R110 | | | | NOT ASSIGNED | | |
| R111 | 0690-1541 | 9 | | RESISTOR 150K 10% 1W CC TC=0+882 | 01121 | GB1541 |
| R112 | 0690-2741 | 3 | 3 | RESISTOR 270K 10% 1W CC TC=0+882 | 01121 | GB2741 |
| R113 | 0690-2741 | 3 | | RESISTOR 270K 10% 1W CC TC=0+882 | 01121 | GB2741 |
| R114 | 0690-2741 | 3 | | RESISTOR 270K 10% 1W CC TC=0+882 | 01121 | GB2741 |
| R115 | 0757-0138 | 0 | 1 | RESISTOR 909K 1% .5W F TC=0+-100 | 28480 | 0757-0138 |
| R116 | 0698-3545 | 3 | 1 | RESISTOR 988K 1% .5W F TC=0+-100 | 28480 | 0698-3545 |
| R117 | 0760-0023 | 9 | 1 | RESISTOR 150K 1% 1W F TC=0+-50 | 19701 | MF8C1-T2-1503-F |
| R118- R200 | | | | NOT ASSIGNED | | |
| R201 | 0693-4701 | 5 | 1 | RESISTOR 47 10% 2W CC TC=0+412 | 01121 | HB4701 |
| R202 | 0687-4741 | 0 | | RESISTOR 470K 10% .5W CC TC=0+882 | 01121 | EB4741 |
| R203 | 0687-4741 | 0 | | RESISTOR 470K 10% .5W CC TC=0+882 | 01121 | EB4741 |
| R204 | 0690-1241 | 6 | 2 | RESISTOR 120K 10% 1W CC TC=0+882 | 01121 | GB1241 |
| R205 | 0687-6831 | 3 | 1 | RESISTOR 68K 10% .5W CC TC=0+765 | 01121 | EB6831 |
| R206 | 0690-3941 | 7 | 1 | RESISTOR 390K 10% 1W CC TC=0+882 | 01121 | GB3941 |
| R207 | 0687-3931 | 8 | 2 | RESISTOR 39K 10% .5W CC TC=0+765 | 01121 | EB3931 |
| R208 | 0690-3341 | 1 | 1 | RESISTOR 330K 10% 1W CC TC=0+882 | 01121 | GB3341 |
| R209 | 0690-1241 | 6 | | RESISTOR 120K 10% 1W CC TC=0+882 | 01121 | GB1241 |
| R210 | 0687-4741 | 0 | | RESISTOR 470K 10% .5W CC TC=0+882 | 01121 | EB4741 |
| R211 | 0758-0052 | 9 | 1 | RESISTOR 91K 5% .25W F TC=0+-100 | 24546 | C5-1/4-TO-9102-J |
| R212 | 2100-0991 | 4 | 2 | RESISTOR-VAR CONTROL CP 50K 30% LIN | 28480 | 2100-0991 |
| R213 | 0761-0017 | 3 | 1 | RESISTOR 300K 5% 1W MO TC=0+-200 | 28480 | 0761-0017 |
| R214 | 0687-2241 | 1 | 3 | RESISTOR 220K 10% .5W CC TC=0+882 | 01121 | EB2241 |
| R215 | 2100-2140 | 9 | 1 | RESISTOR-VAR DUAL 5K-10%-CC 5K-10%-CC | 28480 | 2100-2140 |
| R216 | 2100-0028 | 8 | 3 | RESISTOR-VAR CONTROL CCP 50K 10% LIN | 28480 | 2100-0028 |
| R217 | 2100-0028 | 8 | | RESISTOR-VAR CONTROL CCP 50K 10% LIN | 28480 | 2100-0028 |
| R218 | 2100-0029 | 9 | 1 | RESISTOR-VAR CONTROL CCP 250K 10% LIN | 28480 | 2100-0029 |
| R219 | 2100-0028 | 8 | | RESISTOR-VAR CONTROL CCP 50K 10% LIN | 28480 | 2100-0028 |
| R220 | 2100-0399 | 4 | 1 | RESISTOR ELEMENT 100K) WW (REPELLER POT) | 28480 | 2100-0399 |
| R221- R223 | | | | NOT ASSIGNED | | |
| R224 | 0687-2241 | 1 | | RESISTOR 220K 10% .5W CC TC=0+882 | 01121 | EB2241 |
| R225- R400 | | | | NOT ASSIGNED | | |
| R401 | 0687-1041 | 7 | 1 | RESISTOR 100K 10% .5W CC TC=0+882 | 01121 | EB1041 |
| R402 | 0687-3941 | 0 | 1 | RESISTOR 390K 10% .5W CC TC=0+882 | 01121 | EB3941 |
| R403 | 0687-6851 | 7 | 1 | RESISTOR 6.8M 10% .5W CC TC=0+1000 | 01121 | EB6851 |
| R404 | 0687-3931 | 8 | | RESISTOR 39K 10% .5W CC TC=0+765 | 01121 | EB3931 |
| R405 | 0687-1051 | 9 | 3 | RESISTOR 1M 10% .5W CC TC=0+1000 | 01121 | EB1051 |
| R406 | 0687-1051 | 9 | | RESISTOR 1M 10% .5W CC TC=0+1000 | 01121 | EB1051 |
| R407 | 0686-4725 | 8 | 2 | RESISTOR 4.7K 5% .5W CC TC=0+647 | 01121 | EB4725 |
| R408 | 0693-1531 | 3 | 1 | RESISTOR 15K 10% 2W CC TC=0+765 | 01121 | HB1531 |
| R409 | 0686-1345 | 2 | 3 | RESISTOR 130K 5% .5W CC TC=0+882 | 01121 | EB1345 |
| R410 | 2100-0991 | 4 | | RESISTOR-VAR CONTROL CP 50K 30% LIN | 28480 | 2100-0991 |
| R411 | 0686-7535 | 4 | 1 | RESISTOR 75K 5% .5W CC TC=0+765 | 01121 | EB7535 |
| R412 | 0687-4731 | 8 | 1 | RESISTOR 47K 10% .5W CC TC=0+765 | 01121 | EB4731 |
| R413 | 2100-3798 | 5 | 2 | RESISTOR VAR 100K +-10% LIN 0.500W | 28480 | 2100-3798 |
| R414 | 0686-4725 | 8 | | RESISTOR 4.7K 5% .5W CC TC=0+647 | 01121 | EB4725 |
| R415- R417 | | | | NOT ASSIGNED | | |
| R418 | 0687-8221 | 9 | 2 | RESISTOR 8.2K 10% .5W CC TC=0+647 | 01121 | EB8221 |
| R419 | 0687-8221 | 9 | | RESISTOR 8.2K 10% .5W CC TC=0+647 | 01121 | EB8221 |
| R420 | 2100-0093 | 7 | 1 | RESISTOR-VAR CONTROL CP 20K 20% LIN | 28480 | 2100-0093 |
| R421 | 0687-2211 | 5 | 1 | RESISTOR 220 10% .5W CC TC=0+529 | 01121 | EB2211 |
| R422 | 0687-4721 | 6 | 1 | RESISTOR 4.7K 10% .5W CC TC=0+647 | 01121 | EB4721 |
| R423- R500 | | | | NOT ASSIGNED | | |
| R501 | 2100-3798 | 5 | | RESISTOR VAR 100K +-10% LIN 0.500W | 28480 | 2100-3798 |
| R502 | 0687-1061 | 1 | 1 | RESISTOR 10M 10% .5W CC TC=0+1059 | 01121 | EB1061 |
| R503 | 0757-0344 | 0 | 2 | RESISTOR 1M 1% .25W F TC=0+-100 | 24546 | C5-1/4-TO-1004-F |
| R504 | 0757-0344 | 0 | | RESISTOR 1M 1% .25W F TC=0+-100 | 24546 | C5-1/4-TO-1004-F |
| R505 | 0758-0006 | 3 | 2 | RESISTOR 10K 5% .25W F TC=0+-100 | 24546 | C5-1/4-TO-1002-J |
| R506 | 0758-0006 | 3 | | RESISTOR 10K 5% .25W F TC=0+-100 | 24546 | C5-1/4-TO-1002-J |
| R507 | 0758-0019 | 8 | 2 | RESISTOR 18K 5% .25W F TC=0+-100 | 24546 | C5-1/4-TO-1802-J |
| R508 | 0758-0019 | 8 | | RESISTOR 18K 5% .25W F TC=0+-100 | 24546 | C5-1/4-TO-1802-J |

See introduction to this section for ordering information
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## Table 6-2. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| R509 | 0690-1541 | 9 | | RESISTOR 150K 10% 1W CC TC=0+882 | 01121 | GB1541 |
| R510 | 0687-1031 | 5 | 2 | RESISTOR 10K 10% .5W CC TC=0+765 | 01121 | EB1031 |
| R511 | 0687-3311 | 8 | 3 | RESISTOR 330 10% .5W CC TC=0+529 | 01121 | EB3311 |
| R512 | 0686-3045 | 3 | 1 | RESISTOR 300K 5% .5W CC TC=0+882 | 01121 | EB3045 |
| R513 | 0757-0338 | 2 | 1 | RESISTOR 1K 1% .25W F TC=0+-100 | 24546 | C5-1/4-TO-1001-F |
| R514 | 0698-4039 | 2 | 1 | RESISTOR 52.3K 1% .5W F TC=0+-100 | 28480 | 0698-4039 |
| R515 | 0698-3542 | 0 | 1 | RESISTOR 25.5K 1% .5W F TC=0+-100 | 28480 | 0698-3542 |
| R516 | 0757-1080 | 3 | 1 | RESISTOR 26.7K 1% .5W F TC=0+-100 | 28480 | 0757-1080 |
| R517 | 0687-3311 | 8 | | RESISTOR 330 10% .5W CC TC=0+529 | 01121 | EB3311 |
| R518 | 0690-1541 | 9 | | RESISTOR 150K 10% 1W CC TC=0+882 | 01121 | GB1541 |
| R519* | 0687-1231 | 7 | 1 | RESISTOR 12K 10% .5W CC TC=0+765 | 01121 | EB1231 |
| R520- R600 | | | | NOT ASSIGNED | | |
| R601 | 0687-3311 | 8 | | RESISTOR 330 10% .5W CC TC=0+529 | 01121 | EB3311 |
| R602 | 0686-1345 | 2 | | RESISTOR 130K 5% .5W CC TC=0+882 | 01121 | EB1345 |
| R603 | 0686-1345 | 2 | | RESISTOR 130K 5% .5W CC TC=0+882 | 01121 | EB1345 |
| R604 | 0687-1051 | 9 | | RESISTOR 1M 10% .5W CC TC=0+1000 | 01121 | EB1051 |
| R605 | 0758-0003 | 0 | 1 | RESISTOR 1K 5% .25W F TC=0+-100 | 24546 | C5-1/4-TO-1001-J |
| R606 | 2100-0235 | 9 | 1 | RESISTOR-VAR CONTROL CCP 5K 20% LIN | 28480 | 2100-0235 |
| R607 | 0687-6821 | 1 | 1 | RESISTOR 6.8K 10% .5W CC TC=0+647 | 01121 | EB6821 |
| R608 | 0690-1841 | 2 | | RESISTOR 180K 10% 1W CC TC=0+882 | 01121 | GB1841 |
| R609 | 0687-2241 | 1 | | RESISTOR 220K 10% .5W CC TC=0+882 | 01121 | EB2241 |
| R610 | 0687-1521 | 8 | 1 | RESISTOR 1.5K 10% .5W CC TC=0+647 | 01121 | EB1521 |
| R611 | 0758-0046 | 1 | 1 | RESISTOR 6.2K 5% .25W F TC=0+-100 | 24546 | C5-1/4-TO-6201-J |
| R612 | 0758-0009 | 6 | 1 | RESISTOR 6.8K 5% .25W F TC=0+-100 | 24546 | C5-1/4-TO-6801-J |
| R613 | 0773-0007 | 6 | 1 | RESISTOR 20K 5% 5W WO TC=0+-250 | 27167 | FP5-5-250-2002-J |
| R614 | 2100-0896 | 8 | 2 | RESISTOR-TRMR 15K 5% WW TOP-ADJ 1-TRN | 28480 | 2100-0896 |
| R615 | 2100-0896 | 8 | | RESISTOR-TRMR 15K 5% WW TOP-ADJ 1-TRN | 28480 | 2100-0896 |
| R616 | 0758-0012 | 1 | 2 | RESISTOR 12K 5% .25W F TC=0+-100 | 28480 | 0758-0012 |
| R617 | 0758-0012 | 1 | | RESISTOR 12K 5% .25W F TC=0+-100 | 28480 | 0758-0012 |
| R618 | 0758-0002 | 9 | 2 | RESISTOR 560 5% .25W F TC=0+-100 | 24546 | C5-1/4-TO-561-J |
| R619 | 0758-0002 | 9 | | RESISTOR 560 5% .25W F TC=0+-100 | 24546 | C5-1/4-TO-561-J |
| R620 | 2100-0898 | 0 | 2 | RESISTOR-TRMR 500 5% WW TOP-ADJ 1-TRN | 28480 | 2100-0898 |
| R621 | 2100-0898 | 0 | | RESISTOR-TRMR 500 5% WW TOP-ADJ 1-TRN | 28480 | 2100-0898 |
| R622- R699 | | | | NOT ASSIGNED | | |
| R700 | 0687-1031 | 5 | | RESISTOR 10K 10% .5W CC TC=0+765 | 01121 | EB1031 |
| RT1 | 0839-0020 | 3 | 1 | THERMISTOR DISC 100-OHM TC=-4.4%/C-DEG | 28480 | 0839-0020 |
| S1 | 3101-0042 | 9 | 1 | SWITCH-PB SPST ALTNG 1.5A 230VAC | 28480 | 3101-0042 |
| S2 | 3101-0033 | 8 | 1 | SWITCH-SL DPDT STD .5A 125VAC/DC SLDR-LUG | 28480 | 3101-0033 |
| S3 | 3101-1153 | 5 | 2 | SWITCH, PUSHBUTTON | 28480 | 3101-1153 |
| S4- S200 | | | | NOT ASSIGNED | | |
| S201 | 3101-1153 | 5 | | SWITCH, PUSHBUTTON | 28480 | 3101-1153 |
| S202 | 3102-0009 | 0 | 1 | SWITCH-SENS SPDT SUBMIN 5A 250VAC | 28480 | 3102-0009 |
| S203- S400 | | | | NOT ASSIGNED | | |
| S401 | 3101-0043 | 0 | 4 | SWITCH:PUSHBUTTON DPDT | 28480 | 3101-0043 |
| S402 | 3101-0043 | 0 | | SWITCH:PUSHBUTTON DPDT | 28480 | 3101-0043 |
| S403 | 3101-0043 | 0 | | SWITCH:PUSHBUTTON DPDT | 28480 | 3101-0043 |
| S404- S600 | | | | NOT ASSIGNED | | |
| S601 | 3101-0043 | 0 | | SWITCH:PUSHBUTTON DPDT | 28480 | 3101-0043 |
| T1 | 9100-0176 | 4 | 1 | TRANSFORMER-POWER TRANSFORMER-POWER | 28480 | 9100-0176 |
| V1 | 1950-0020 | 0 | 1 | TUBE-ELECTRON 6BM6 KLYSTRON | 14830 | 6BM6 |
| V2- V100 | | | | NOT ASSIGNED | | |
| V101 | 1921-0014 | 1 | 2 | TUBE-ELECTRON 7233 TRIODE | 33173 | 7233 |
| V102 | 1921-0014 | 1 | | TUBE-ELECTRON 7233 TRIODE | 33173 | 7233 |
| V103 | 1932-0030 | 4 | 2 | TUBE-ELECTRON 12AX7A TRIODE-DUAL | 01928 | 12AX7A |
| V104 | 1932-0030 | 4 | | TUBE-ELECTRON 12AX7A TRIODE-DUAL | 01928 | 12AX7A |
| V105 | 1940-0007 | 2 | 1 | TUBE-ELECTRON 0B2 DIODE-V RGLTR | 94151 | 0B2 |
| V106- V200 | | | | NOT ASSIGNED | | |
| V201 | 1923-0030 | 5 | 1 | TUBE-ELECTRON 6CL6 PENTODE | 94151 | 6CL6 |
| V202 | 1940-0001 | 6 | 1 | TUBE-ELECTRON 5651A DIODE-V RGLTR | 01928 | 5651A |
| V203 | 1923-0046 | 3 | 1 | TUBE-ELECTRON 6EJ7 PENTODE | 28480 | 1923-0046 |
| V204 | 1921-0005 | 0 | 1 | TUBE-ELECTRON 6C4 TRIODE | 01928 | 6C4 |
| V205- V400 | | | | NOT ASSIGNED | | |
| V401 | 1932-0042 | 8 | 1 | TUBE-ELECTRON 12AT7 TRIODE-DUAL | 33173 | 12AT7 |
| V402- V500 | | | | NOT ASSIGNED | | |
| V501 | 1921-0015 | 2 | 2 | TUBE-ELECTRON 8056 TRIODE | 94151 | 8056 |
| V502 | 1921-0015 | 2 | | TUBE-ELECTRON 8056 TRIODE | 94151 | 8056 |

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

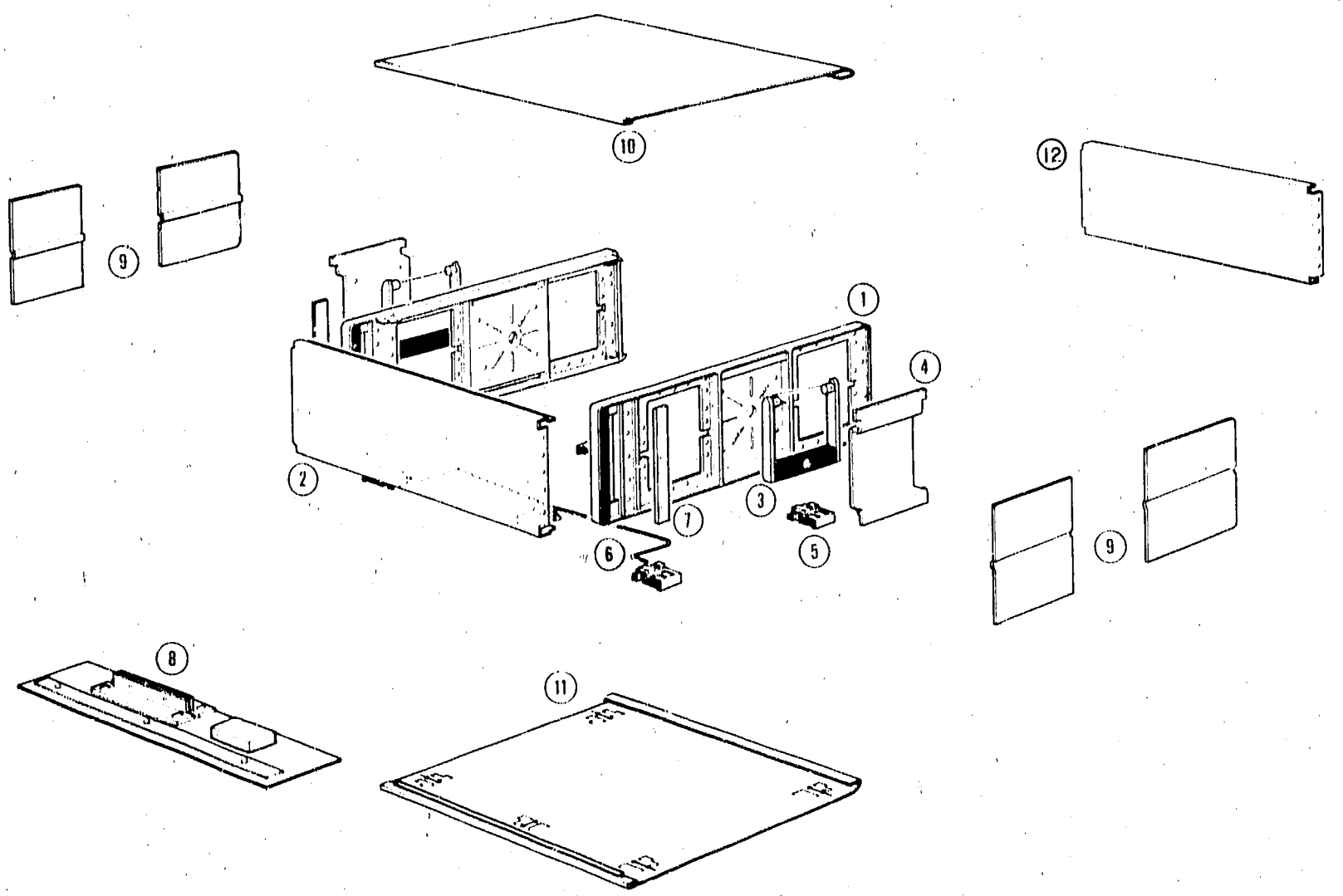
## Table 6-2. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| W1 | 8120-0078 | 6 | 1 | CABLE ASSY 18AWG 3-CNDCT BLK-JKT | 28480 | 8120-0078 |
| XV101 | 5040-0417 | 4 | 2 | SOCKET HOLDER, 9-PIN | 28480 | 5040-0417 |
| XV102 | 5040-0417 | 4 | | SOCKET HOLDER, 9-PIN | 28480 | 5040-0417 |
| XV103 | 1200-0062 | 1 | 5 | SOCKET-TUBE 9-CONT DIP-SLDR | 28480 | 1200-0062 |
| XV104 | 1200-0062 | 1 | | SOCKET-TUBE 9-CONT DIP-SLDR | 28480 | 1200-0062 |
| XV105 | 1200-0033 | 0 | 3 | SOCKET-TUBE 7-CONT DIP-SLDR | 28480 | 1200-0053 |
| XV106- XV200 | | | | NOT ASSIGNED | | |
| XV201 | 1200-0062 | 1 | | SOCKET-TUBE 9-CONT DIP-SLDR | 28480 | 1200-0062 |
| XV202 | 1200-0053 | 0 | | SOCKET-TUBE 7-CONT DIP-SLDR | 28480 | 1200-0053 |
| XV203 | 1200-0062 | 1 | | SOCKET-TUBE 9-CONT DIP-SLDR | 28480 | 1200-0062 |
| XV204 | 1200-0053 | 0 | | SOCKET-TUBE 7-CONT DIP-SLDR | 28480 | 1200-0053 |
| XV205- XV400 | | | | NOT ASSIGNED | | |
| XV401 | 1200-0062 | 1 | | SOCKET-TUBE 9-CONT DIP-SLDR | 28480 | 1200-0062 |
| XV402- XV500 | | | | NOT ASSIGNED | | |
| XV501 | 1200-0086 | 9 | 2 | SOCKET-TUBE 5-CONT E5-65 DIP-SLDR | 28480 | 1200-0086 |
| XV502 | 1200-0086 | 9 | | SOCKET-TUBE 5-CONT E5-65 DIP-SLDR | 28480 | 1200-0086 |
| | | | | MISCELLANEOUS PARTS | | |
| | 5040-0201 | 4 | 1 | BEZEL:COUNTER(ATTEN)LIGHT GRAY | 28480 | 5040-0201 |
| | 5040-0202 | 5 | 1 | BEZEL:COUNTER(FREQ)LIGHT GRAY | 28480 | 5040-0202 |
| | 08614-299 | 5 | 1 | CABLE, SST | 28480 | 08614-299 |
| | 08614-626 | 2 | 1 | CAP, UNCAL RF POWER OUTPUT | 28480 | 08614-626 |
| | 08614-605 | 7 | 1 | CAVITY ASSEMBLY | 28480 | 08614-605 |
| | 08614-623 | 9 | 1 | CABLE ASSEMBLY | 28480 | 08614-623 |
| | 9240-0007 | 6 | 1 | CONTAINER, DESICCANT | 28480 | 9240-0007 |
| | 1250-0144 | 5 | 1 | BODY-RF CONN SERIES N: BULKHEAD | 28480 | 1250-0144 |
| | 7100-0091 | 0 | 1 | COVER, KLYSTRON | 28480 | 7100-0091 |
| | 08614-612 | 6 | 1 | FAN ASSEMBLY, INCLUDES BLADE | 28480 | 08614-612 |
| | 3160-0030 | 9 | 1 | FAN BLADE .5-THK 2.75-OD .125-ID | 28480 | 3160-0030 |
| | 0510-0123 | 1 | 1 | RETAINER-PUSH ON RECT EXT .312-IN-DIA | 28480 | 0510-0123 |
| | 0370-0050 | 5 | 1 | KNOB RND:BLK:.375D:CRANK SPINNER | 28480 | 0370-0050 |
| | 1200-0043 | 8 | 1 | INSULATOR-XSTR ALUMINUM | 28480 | 1200-0043 |
| | 08614-611 | 5 | 1 | INTAKE AIR CLEANER ASSEMBLY | 28480 | 08614-611 |
| | 0370-0025 | 4 | 1 | KNOB RND:BLK:FOR .250 SHFT:.750D (INT, SQUARE WAVE, ALC | 28480 | 0370-0025 |
| | 0370-0026 | 5 | 1 | KNOB RND:BLK:FOR .250 SHFT:1 ARO:.750D | 28480 | 0370-0026 |
| | 0370-0149 | 3 | 1 | KNOB-CRANK 1.625 IN OD: .250 IN DIA | 28480 | 0370-0149 |
| | 5000-0237 | 2 | 1 | LABEL:ALC | 28480 | 5000-0237 |
| | 5000-0244 | 1 | 1 | LABEL:FM | 28480 | 5000-0244 |
| | 5000-0245 | 2 | 1 | LABEL:PULSE | 28480 | 5000-0245 |
| | 5000-0246 | 3 | 1 | LABEL:SQUARE WAVE | 28480 | 5000-0246 |
| | 5000-0247 | 4 | 1 | LABEL:RF | 28480 | 5000-0247 |
| | 5000-0248 | 5 | 1 | LABEL:LINE | 28480 | 5000-0248 |
| | 5000-0249 | 6 | 1 | LABEL:AM | 28480 | 5000-0249 |
| | 08614-604 | 6 | 1 | LEVELER ASSEMBLY, INCLUDES CABLE | 28480 | 08614-604 |
| | 08614-606 | 8 | 1 | LEVELER CABLE ASSEMBLY, RF | 28480 | 08614-606 |
| | 08614-624 | 0 | 1 | LOE PASS FILTER KIT | 28480 | 08614-624 |
| | 08614-622 | 8 | 1 | LOW PASS FILTER ASSEMBLY | 28480 | 08614-622 |
| | 08614-800 | 4 | 1 | MAINTENANCE TOOL KIT (OPTIONAL)INCL:#23 OPEN END WRENCH (7/16)HEX WRENCH(9/64)HEX WRENCH&PLIERS | 76480 | 08614-800 |
| | 08614-613 | 7 | 1 | PROBE ASSEMBLY, CAL & ALC | 28480 | 08614-613 |
| | 08614-614 | 8 | 1 | PROBE ASSEMBLY,UNCALIBRATED OUTPUT | 28480 | 08614-614 |
| | 08614-619 | 3 | 1 | WIRING HARNESS, BRANCHED (AC) | 28480 | 08614-619 |
| | 08614-620 | 6 | 1 | WIRING HARNESS, BRANCHED (DC) | 28480 | 08614-620 |
| | 1400-0090 | 9 | 1 | WASHER:RUBBER 5/8" OD | 00000 | OBD |
| | 2110-0465 | 8 | 1 | FUSEHOLDER CAP EXTR PST; BAYONET; 20A | 28480 | 2110-0465 |
| | 2110-0467 | 0 | 1 | NUT-HEX 1/2-28 THD 0.688 A/F | 75915 | 903-070 |
| | 2110-0470 | 5 | 1 | FUSEHOLDER BODY EXTR PST; BAYONET; TND | 75915 | 345003-010 |
| | 0340-0822 | 6 | 1 | INSULATOR-FLG-BSHG TFE | 28480 | 0340-0822 |
| | 3050-0591 | 4 | 1 | WASHER-FL NM 1/4 IN .235-IN-ID | 28480 | 3050-0591 |
| | 7120-4162 | 6 | 1 | LABEL,WARNING"HAZARDOUS VOLTAGE"(LARGE) | 28480 | 7120-4162 |
| | 7120-4295 | 6 | 1 | LABEL,WARNING"HAZARDOUS VOLTAGE ALWAYS PRESENT" | 28480 | 7120-4295 |
| | 7120-5087 | 6 | 1 | LABEL,WARNING"TO PREVENT ELECTRICAL SHOCK | 28480 | 7120-5087 |

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

## Table 6-2. Replaceable Parts

| Reference Designation | HP Part Number | C D | Qty | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| | | | | CABINET PARTS | | |
| | 5060-0732 | 8 | 1 | SIDE FRAME ASSY | 28480 | 5060-0732 |
| 1 | 0590-0053 | 4 | 1 | NUT-SHMET-J-TP 6-32-THD .5-WD STL | 28480 | 0590-0053 |
| | 08614-009 | 5 | 1 | FRONT PANEL | 28480 | 08614-009 |
| 2 | 2530-0011 | 0 | 1 | SCREW-MACH 8-32 .375-IN-LG 82 DEG | 00000 | ORDER BY DESCRIPTION |
| | 5060-0763 | 5 | 1 | HANDLE ASSY-SIDE | 28480 | 5060-0763 |
| 3 | 5060-0766 | 8 | 1 | HANDLE ASSY:RETAINER(LIGHT GRAY) | 28480 | 5060-0766 |
| 4 | 2550-0013 | 4 | 1 | SCREW-MACH 8-32 .312-IN-LG PAN-HD-PHL | 00000 | ORDER BY DESCRIPTION |
| | 5060-0767 | 9 | 1 | FOOT ASSY:FM | 28480 | 5060-0767 |
| 5 | 1490-0030 | 6 | 1 | TILT STAND 3-IN-W 13.75-IN-OA-LG SST | 28480 | 1490-0030 |
| 6 | | | | | | |
| 7 | 5000-0052 | 9 | 1 | PLATE:FLUTED ALUMINUM | 28480 | 5000-0052 |
| 8 | 5060-0775 | 9 | 1 | KIT:RACK MOUNT, 5H(LIGHT GRAY) | 28480 | 5060-0775 |
| 9 | | | | COVER, SIDE | | |
| | 5000-0738 | 8 | 1 | COVER:REAR SIDE PLATE(LIGHT GRAY) | 28480 | 5000-0738 |
| | 5000-0739 | 9 | 1 | COVER:FRONT SIDE PLATE(LIGHT GRAY) | 28480 | 5000-0739 |
| | 2370-0020 | 1 | 1 | SCREW-MACH 6-32 .188-IN-LG 100 DEG | 00000 | ORDER BY DESCRIPTION |
| | | | | | 28480 | 5060-0740 |
| | 5060-0740 | 8 | 1 | COVER ASSY:TOP 16L(BLUE GRAY) | 00000 | ORDER BY DESCRIPTION |
| 10 | 2370-0021 | 2 | 2 | SCREW-MACH 6-32 .438-IN-LG 100 DEG | 28480 | 5060-0752 |
| | 5060-0752 | 2 | 1 | BOTTOM COVER ASSY:16L FM(LIGHT GRAY) | 00000 | ORDER BY DESCRIPTION |
| 11 | 2370-0021 | 2 | | SCREW-MACH 6-32 .438-IN-LG 100 DEG | 28480 | 08614-024 |
| | 08614-024 | 4 | 1 | REAR PANEL | 00000 | ORDER BY DESCRIPTION |
| 12 | 2515-0017 | 4 | 4 | SCREW-MACH 8-32 .25-IN-LG PAN-HD-PHL | | |




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

## Table 6-3. Code List of Manufacturers

| Mfr Code | Manufacturer Name | Address | Zip Code |
|---|---|---|---|
| 00000 | ANY SATISFACTORY SUPPLIER | | |
| 01002 | GE CO INDUSTRIAL & POWER CAP DEPT | HUDSON FALLS NY | 12839 |
| 01121 | ALLEN-BRADLEY CO | MILWAUKEE WI | 53204 |
| 0192R | RCA CORP SOLID STATE DIV | SOMERVILLE NJ | 08876 |
| 03508 | GE CO SEMICONDUCTOR PROD DEPT | SYRACUSE NY | 13201 |
| 11236 | CTS OF BERNE INC | BERNE IN | 46711 |
| 14830 | RAYTHEON CO SPL U-WAVE DEVICES DIV | WALTHAM MA | 02154 |
| 19701 | MEPCO/ELECTRA CORP | MINERAL WELLS TX | 76067 |
| 24546 | CORNING GLASS WORKS (BRADFORD) | BRADFORD PA | 16701 |
| 27167 | CORNING GLASS WORKS (WILMINGTON) | WILMINGTON NC | 28401 |
| 28480 | HEWLETT-PACKARD CO CORPORATE HQ | PALO ALTO CA | 94304 |
| 33173 | GE CO TUBE DEPT | OWENSBORO KY | 42301 |
| 56289 | SPRAGUE ELECTRIC CO | NORTH ADAMS MA | 01247 |
| 72136 | ELECTRO MOTIVE CORP SUB IEC | WILLIMANTIC CT | 06226 |
| 75915 | LITTELFUSE INC | DES PLAINES IL | 60016 |
| 91637 | DALE ELECTRONICS INC | COLUMBUS NE | 68601 |
| 91802 | INDUSTRIAL DEVICES INC | EDGEWATER NJ | 07020 |
| 94154 | GTE SYLVANIA ELEK COMPONENTS GROUP | WALTHAM MA | 02154 |





CHANGE J: Page 5-13, Paragraph 5-48, Step d and Page 5-14, Paragraph 5-49, Step h, Delete Abbreviation of both steps: "Referring to Figure 5-26 and Paragraph 5-78."

# BACK DATING MANUAL CHANGES

# APPENDIX

BACKDATING

# MANUAL CHANGES

Model 8614A
Signal Generator

Make all backdating corrections in this manual according to changes below.

| SERIAL PREFIX OR NUMBER | MAKE MANUAL CHANGES |
|---|---|
| 331- | A through R |
| 343- | B through R |
| 351- | C through R |
| 408- | D through R |
| 411- | E through R |
| 424- | F through R |
| 434- | G through R |
| 448- | H through R |
| 501- | I through R |

| SERIAL PREFIX OR NUMBER | MAKE MANUAL CHANGES |
|---|---|
| 511- | J through R |
| 548- | K through R |
| 548-below 01350 | L through R |
| 748-below 01850 | M through R |
| 749-below 01900 | N through R |
| 749-below 01950 | O through R |
| 749-below 02000 | P through R |
| 815-below 02100 | Q, R |
| 815-below 02201 | R |

CHANGE A: R109 is a 27K-ohm, 4-watt resistor. The 4-watt rating is very close to operating power and should be changed to a 27K-ohm, 5-watt resistor (listed value Table 6-1) if replacement is ever necessary.

CHANGE B (see Note 1): Figure 2 (see Change F): Delete L1, connected in series with capacitor C4 and switch S3 (replace with a short circuit).

Table 6-1, Page 6-4,
Delete: L1

Table 6-2, Page 6-14,
Delete: HP Stock No. 9140-0072

NOTE 1

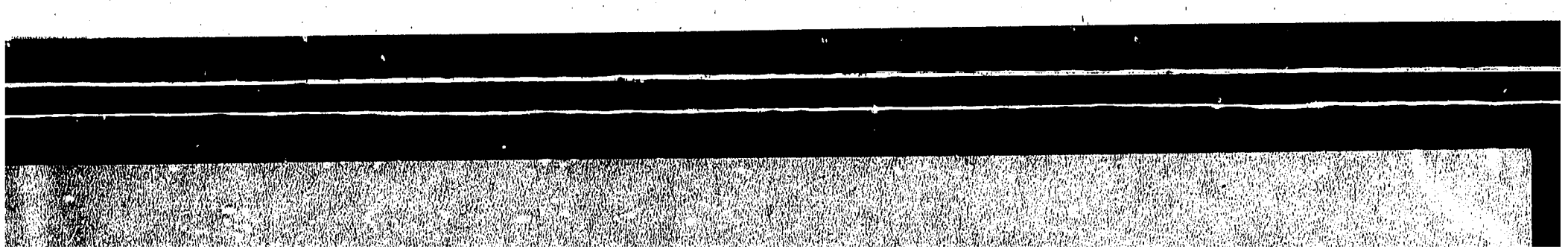
Some 6BM6 klystrons were manufactured with a low-beam current characteristic. These low-beam current klystrons would sometimes fail to start oscillating between 1500 MHz and 1600 MHz when the 8614A RF button was depressed. The following modification of your 8614A will provide reliable starting of oscillations.

1) Move lead between cathode of klystron V1 and center conductor on S3 to OFF side of S3; i.e., toward instrument panel.

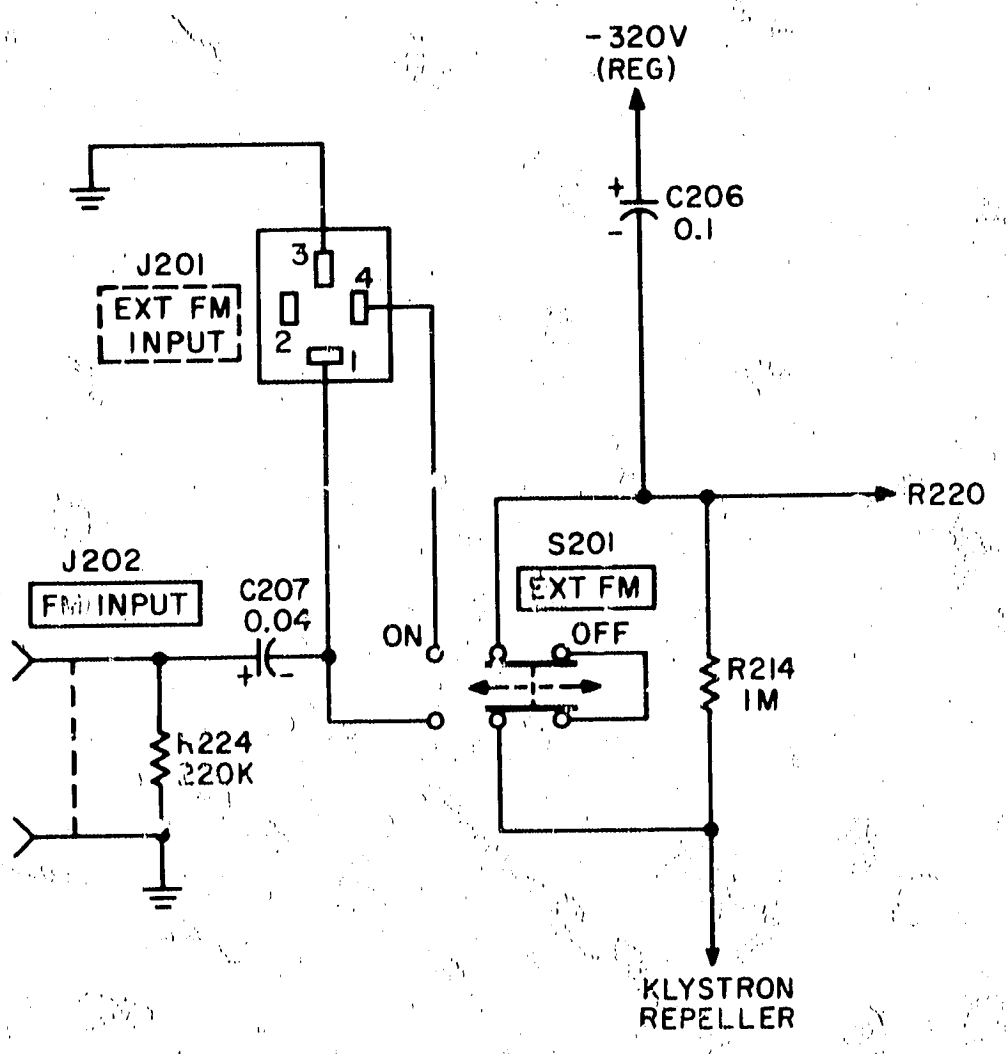
2) Connect L1, a 5-mH inductor between OFF side of S3 and center conductor terminal of S3.

3) Do not make deletions as specified above for change B.





CHANGE C: Wiring of FM-input circuitry has been accomplished as shown below.




CHANGE D: Probe Carriage Assembly (HP Stock No. 08614-265) supports the wiper fingers in the cavity assembly. Should the need arise for replacement of wiper fingers it is recommended that the instrument be returned to the Hewlett-Packard Company or your local Sales and Service Office and the entire Probe Carriage Assembly be replaced with the new version (HP Stock No. 08616-218).

CHANGE E: Table 6-1, Page 6-7,
R614 and R615: Change from HP Stock No. 2100-0896 to 2100-0409; R: var ww LIN 15K ohm 20% 2W
R620 and R621: Change from HP Stock No. 2100-0898 to 2100-0410; R: var ww LIN 500 ohm 20% 2W

Table 6-2, Page 6-14,
Delete: HP Stock No. 2100-0896
Delete: HP Stock No. 2100-0898
Add: HP Stock No. 2100-0409; R: var ww LIN 15K ohm 20% 2W; Mfr 28480; Mfr Part No. 2100-0409; TQ 2
Add: HP Stock No. 2100-0410; R: var ww LIN 500 ohm 20% 2W; Mfr 28480; Mfr Part No. 2100-0410; TQ 2

CHANGE F: Page 1-0, Figure 1-1,
The 8614A picture is in error; the physical position of the "AM" and "FM" buttons is reversed.

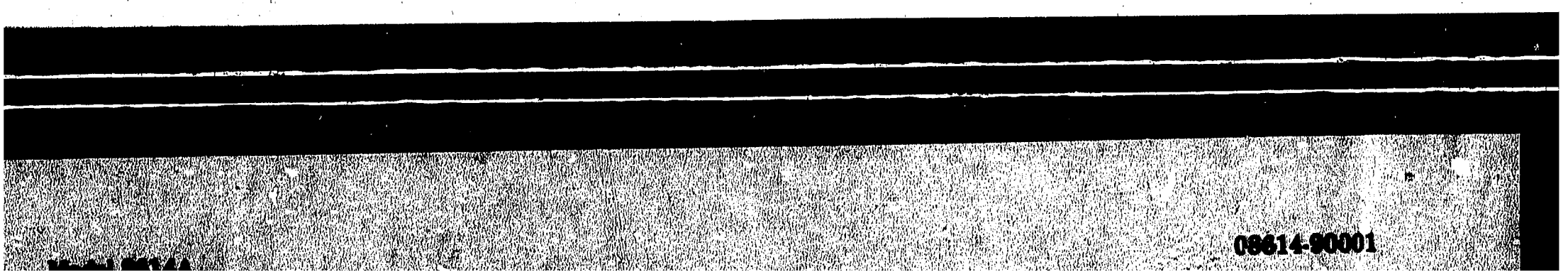
Section III, Figures 3-1 thru 3-8,
The physical position of the "AM" and "FM" buttons and their respective input BNC connectors is reversed.

Figure 5-21 and Figure 5-24, High-Voltage Board (A100),
Replace with component location and test point picture, Figure 1 (shown in this Appendix)

Figure 5-7, High Voltage Test Point Location,
Delete test points 1 and 2 and C205. Note that test points 1 and 2 and C205 are shown in Figure 1.

Figure 5-22, High-Voltage Power Supply,
Capacitor C205 is shown to be located off the circuit board. It should be shown to be within the circuit board outline: electrical connections are unchanged.
Resistor R212: Change from 50K to 20K.





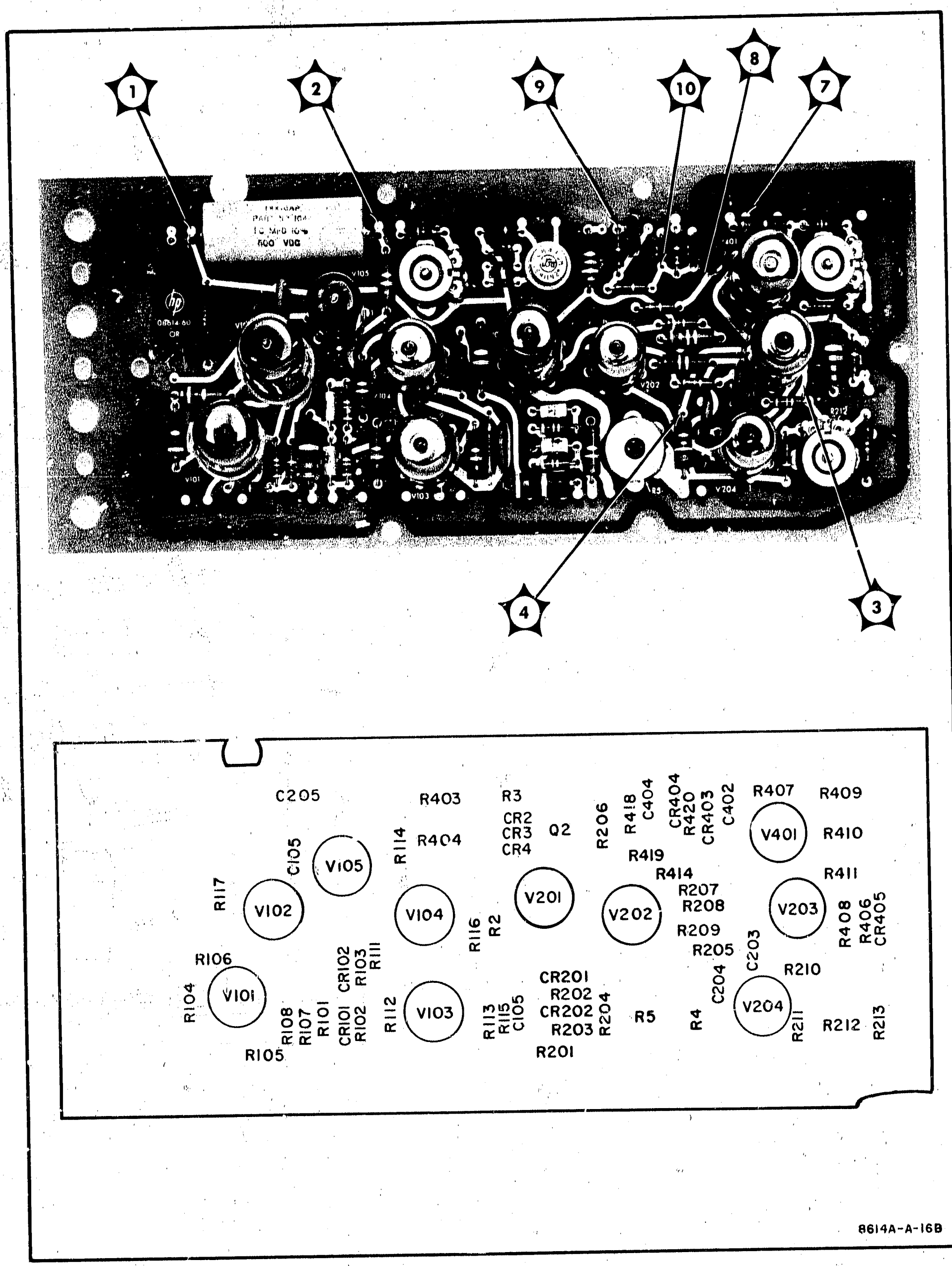
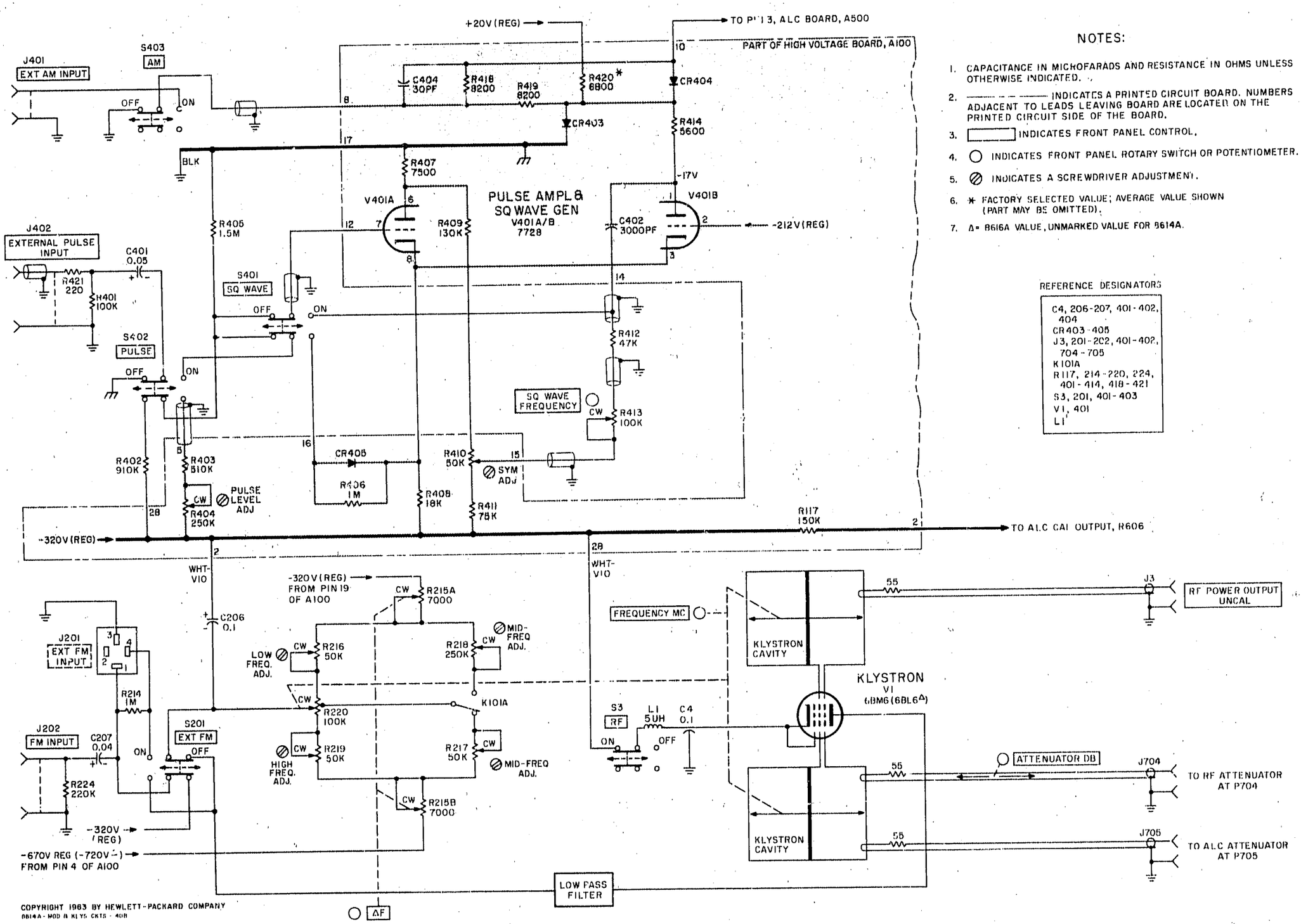



Figure 1. High Voltage Board (A100)




NOTES:

1. CAPACITANCE IN MICROFARADS AND RESISTANCE IN OHMS UNLESS OTHERWISE INDICATED.
2. ——— - - - ——— INDICATES A PRINTED CIRCUIT BOARD. NUMBERS ADJACENT TO LEADS LEAVING BOARD ARE LOCATED ON THE PRINTED CIRCUIT SIDE OF THE BOARD.
3. [ ] INDICATES FRONT PANEL CONTROL.
4. ◯ INDICATES FRONT PANEL ROTARY SWITCH OR POTENTIOMETER.
5. ⊘ INDICATES A SCREWDRIVER ADJUSTMENT.
6. * FACTORY SELECTED VALUE; AVERAGE VALUE SHOWN (PART MAY BE OMITTED).
7. Δ= 8616A VALUE, UNMARKED VALUE FOR 8614A.

REFERENCE DESIGNATORS

| |
|---|
| C4, 206-207, 401-402, 404 |
| CR403-405 |
| J3, 201-202, 401-402, 704-705 |
| K101A |
| R117, 214-220, 224, 401-414, 418-421 |
| S3, 201, 401-403 |
| V1, 401 |
| L1 |

Figure 2. Modulation and Klystron Circuits

CHANGE F: (Cont'd)

Page 5-21, paragraph 5-68, step d,
Change to read: "If on-off ratio is not 20 dB or greater, adjust R404 (refer to Figure 1) for proper on-off ratio. If on-off ratio will not adjust properly, PIN modulator may be defective. Check bias current through R414 and R420: the current through R414 should be approximately 6 mA, and the current through R420 should be approximately 3 mA. If current through R414 is correct but current through R420 is about 1 mA more or less than it should be, changing R420 to a higher or lower resistance may solve the problem. If these bias currents are correct and CR403 is not shorted, then the modulator or the RF probes are defective. Check RF Probe resistance (refer to paragraph 5-62); if resistance is OK then modulator is defective (refer to paragraph 5-47)."

Page 5-21, paragraph 5-69, step b,
Change to read: "If pulse operation is not satisfactory, slight adjustment of R404 and a change in the resistance of R420 may be necessary.

NOTE

Resistor R404 and the resistance value of R420 also adjust on-off ratio; if adjustment is necessary, recheck on-off ratio."

Figure 5-26, Modulation and Klystron Circuits,
Use included component location picture, Figure 2, in place of Figure 5-24.

Table 6-1, Pages 6-2, 6-5, and 6-6,
C205: Change from HP Stock No. 0160-0079 to 0170-0073; C: fxd my 1.0 ufd 10% 6000 Vdcw.
Delete: HP Stock No. 1210-0003; Bracket; mounting C205.
R212: Change from HP Stock No. 2100-0991 to 2100-0093; R: var comp 20K ohm 20% LIN 1/5 W.
R402: Change from HP Stock No. 0687-3931 to 0686-9145; R: fxd comp 910K ohm 5% 1/2 W.
R403: Change from HP Stock No. 0687-4741 to 0686-5145; R: fxd comp 510K ohm 5% 1/2 W.
R404: Change from HP Stock No. 0687-3931 to 2100-0144; R: var comp 250K ohm 30% LIN 1/5 W.
R405: Change from HP Stock No. 0687-1051 to 0687-1551; R: fxd comp 1.5 Megohm 10% 1/2 W.
R407: Change from HP Stock No. 0686-4725 to 0689-7525; R: fxd comp 7500 ohm 5% 1 W.
R410: Change from HP Stock No. 2100-0991 to 2100-0094; R: var comp 50K ohm 20% LIN 1/5 W.
R414: Change from HP Stock No. 0686-4725 to 0687-5621; R: fxd comp 5600 ohm 10% 1/2 W.
R420: Change from HP Stock No. 2100-0093 to 0687-6821; R: fxd comp 6800 ohm 10% 1/2 W.
R422: Change from HP Stock No. 0687-4721 to "not assigned".

Table 6-2, Pages 6-11, 6-12, 6-13, and 6-14:
Delete: HP Stock No. 0160-0079
HP Stock No. 0686-4725
HP Stock No. 0687-4721
HP Stock No. 0687-1051: Change TQ from 3 to 2
HP Stock No. 0687-3931: Change TQ from 3 to 1
HP Stock No. 0687-4741: Change TQ from 7 to 6
Delete: HP Stock No. 2100-0991.

Table 6-2, Page 6-11,
Add: HP Stock No. 0170-0073; C: fxd my 1 μf 10% 600 Vdcw; Mfr 09134; Mfr Part No. 1041, TQ 1.

Table 6-2, Page 6-12,
Add HP Stock No.:
0686-5145; R: fxd comp 510K ohm 5% 1/2 W; Mfr 01121; Mfr Part No. EB5145; TQ 1
0686-9145; R: fxd comp 910K ohm 5% 1/2 W; Mfr 01121; Mfr Part No. EB 9145; TQ1
0687-1551; R: fxd comp 1.5 megohm 10% 1/2 W; Mfr 01121; Mfr Part No. EB 1551; TQ 1
0687-5621; R: fxd comp 5600 ohm 10% 1/2 W; Mfr 01121; Mfr Part No. EB 5621; TQ 1
0689-7525; R: fxd comp 7500 ohm 5% 1 W; Mfr 01121: Mfr Part No. GB 7525; TQ 1
Stock No. 0687-6821: Change TQ from 1 to 2.

Table 6-2, Page 6-14,
Add HP Stock No.:
2100-0094; R: var comp 50K 20% LIN 1/5 W; Mfr 28480; Mfr Part No. 2100-0094
2100-0144; R: var comp 250K 30% LIN 1/5 W; Mfr 28480; Mfr Part No. 2100-0144; TQ 1

CHANGE G (see Note 2):

Figure 5-26, Modulation and Klystron Circuits,
Delete: R700, connected between S402 and ground and replace with a short circuit.

Page 6-7, Table 6-1 Delete: R700.

Page 6-12, Table 6-2,
HP Stock No. 0687-1031: Change TQ from 2 to 1.

NOTE 2

Resistor R700 is a necessary component in the pulse input circuitry of the 8614A if a low impedance output solid state pulse source is to be used. Without R700, a stored potential of about 200 volts dc may be discharged into the output of such a pulse source when the 8614A PULSE button is released.

CHANGE H:

Page 1-0, Table 1-1, Specifications,
Attenuator Accuracy: Change to read "+0, -3 dB from 0 to -10 dBm; ±0.2 dB ±0.06 dB/10 dB from -10 to -127 dBm; direct reading dial, 0.2 dB increments"
RF Output Power Accuracy (with respect to attenuation dial): Change . . . . "(-15 to -127 dBm) . . . . " (-10 to -127 dBm) . . . ."

Page 3-3, Figure 3-3, Instruction 5, last line, Change "-15 dB" to "-10 dB".

CHANGE I:

Page 4-3, Figure 4-5,
R402: Change from 390K to 39K.
R403: Change from 6.8M to 470K.

Page 5-31/5-32, Figure 5-26,
C401: Change from 0.1 to 0.05
R402: Change from 390K to 39K
R403: Change from 6.8M to 470K

Page 6-2, Table 6-1,
C401 change from HP Stock No. 0170-0022 to 0150-0052; C: fxd cer 0.05 $\mu$f 20% 400 Vdcw

Page 6-6, Table 6-1,
R402: Change from HP Stock No. 0687-3941 to 0687-3931; R: fxd 39K ohm 10% 1/2 W
R403: Change from HP Stock No. 0687-6851 to 0687-4741; R: fxd 470K ohm 10% 1/2 W

Page 6-11, Table 6-2,
HP Stock No. 0150-0052: Change TQ from 4 to 5
HP Stock No. 0170-0022: Change TQ from 2 to 1

Page 6-12, Table 6-2,
HP Stock No. 0687-3931: Change TQ from 2 to 3
HP Stock No. 0687-4741: Change TQ from 6 to 7
Delete: HP Stock No. 0687-3941; R: fxd comp 390K ohm 10% 1/2 W; Mfr. 01121; Mfr. Part No. EB 3941; TQ 1
Delete: HP Stock No. 0687-6851; R: fxd comp 6.8 Megohm 10% 1/2 W; Mfr. 01121; Mfr. Part No. EB 6851; TQ 1

CHANGE J:

Page 6-8, Table 6-1, Miscellaneous,
Add the following items: HP Stock No. 08614-610; 08614-608; 08614-609.
Delete: HP Stock No. 08614-624; Low Pass Filter Kit which includes Low Pass Filter Assembly (HP Stock No. 08614-622) and Coaxial Cable (HP Stock No. 08614-623).

Page 6-11, Table 6-2,
Add the following items: HP Stock Numbers. 08614-608 (TQ 1); 08614-609 (TQ 1); 08614-610 (TQ 1)
Delete: HP Stock No. 08614-622; Low Pass Filter Assembly; TQ 1.
Delete: HP Stock No. 08614-623; Cable Assembly; TQ 1.

Page 5-33/5-34, Figure 5-27,
Change as shown in partial schematic (Figure 3 Partial) shown at end of this appendix.

Section V
Delete: Paragraphs 5-75 through 5-78 and Figure 5-19.

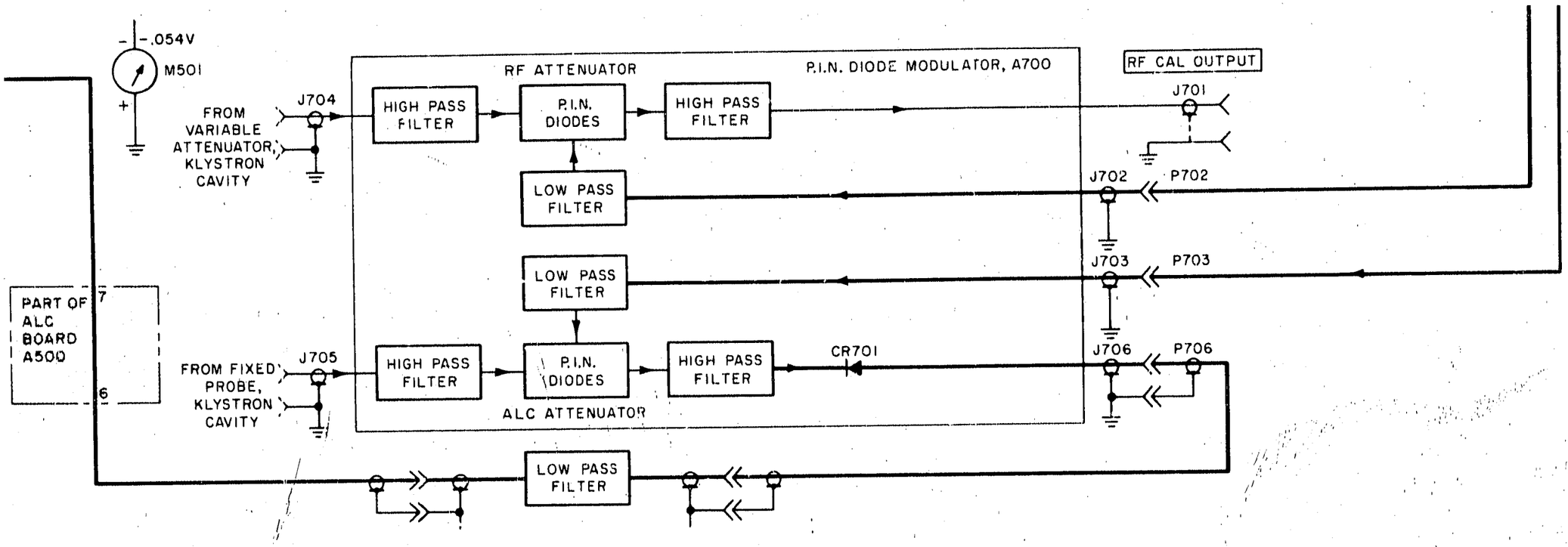



Figure 3. Partial Schematic

CHANGE J: (Cont'd)
Page 5-13, Paragraph 5-48, Step d and Page 5-14, Paragraph 5-49, Step h,
Delete at beginning of both steps: "Referring to Figure 5-26 and Paragraph 5-78."
Figure 5-25 and Parts List:
Change Q51 stock number from 1850-0128 to 1850-0078.

CHANGE K:
Figure 5-26 and Parts List:
Change R215 stock number from 2100-2140 to 2100-1549.

CHANGE L:
Figure 5-25 and Parts List:
Delete fuse, F2, 3A, slo-blow, Stock No. 2110-0029.
Figure 5-22 and Parts List:
Delete breakdown diode CR203, 100V, 1 watt, Stock No. 1902-0175.
Figure 5-21 and 5-24, High-Voltage Board (A100), Replace with Figure 4 of this Appendix.
Parts List:
Delete under F2 listing: Fuseholder, Stock No. 1400-0008.

CHANGE M:
Parts List:
Change S601 Stock No. from 3101-0043 to 3101-1153.

CHANGE N:
Figure 5-25 and Parts List:
(Refer to CHANGE L.) For instrument serials 749-below 01950 change F2 from 4A 125V, slo blow, stock number 2110-0014 to 3A, 125V Stock Number 2110-0029.
Parts List:
Change S3 and S201 from HP Stock No. 3101-1153 to 3101-0043.

CHANGE O:
Figure 5-26 and Parts List:
Delete resistor R6, 0757-0059, 1 meg ±1%, 1/2W.

CHANGE P:
Table 1-1 and Paragraph 5-12:
Change the Leveled Output specification from ±0.75 dB to ±0.5 dB.

CHANGE Q:
Figure 5-25 and Parts List:
Change Capacitor C1 from 5000 μfd, Stock No. 0180-0213 to 2800 μfd, Stock No. 0180-0128.

CHANGE R:
Figure 5-26 and Parts List (A100 Assy):
Change capacitor C404 on A100 Assy from 60 pF, HP Stock No. 0140-0214 to C404*, 30 pF, HP Stock No. 0160-0181, factor selected part.

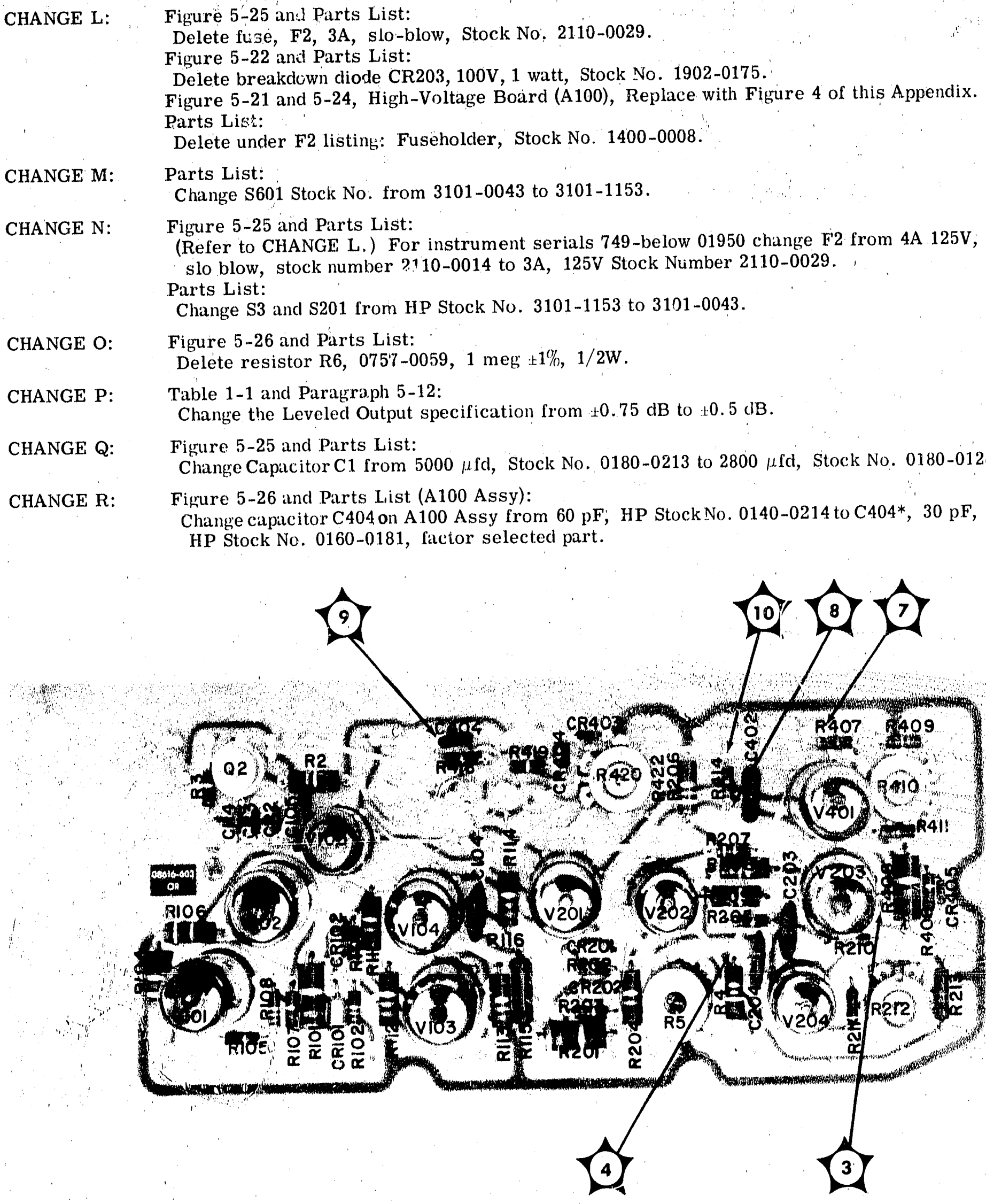



Figure 4. High Voltage Board (A100)

# WARRANTY CLAIM AND ADJUSTMENT PROCEDURE

for microwave tubes supplied by the
HEWLETT-PACKARD COMPANY
for use in Hewlett-Packard instruments

The procedure described below is for use within the United States. For warranty claims arising outside the U.S.A., before returning the tube, fill out the form on the reverse side and send it with a request for shipping instructions to your nearest Hewlett-Packard Sales and Service Office or to:

(in Western Europe)

Hewlett-Packard S. A.
54 Route des Acacias
Geneva, Switzerland
Telephone: (022) 42.81.50
Telex: 2.24.86
Cable: HEWPACKSA

(Rest of World)

Hewlett-Packard Co.
International Marketing Dept.
1501 Page Mill Road
Palo Alto, California, 94304, U.S.A.
Telephone: (415) 326-7000
Telex: 033811
Cable: HEWPACK

Microwave tubes supplied by the Hewlett-Packard Company, either as original or replacement, for use in Hewlett-Packard instruments are actually warranted by the tube manufacturer and not by Hewlett-Packard. However, all warranty claims on tubes obtained from us either as original or replacement will be processed by Hewlett-Packard.

In the event of failure you should purchase a new tube and return your old tube immediately to Hewlett-Packard. Credit allowances will be passed on to you upon receipt of the defective tube.

For your convenience, warranty claims for all microwave tubes supplied by the Hewlett-Packard Company may be made on this single form; merely fill out the information on the reverse side and return this form, along with the defective tube, to your Hewlett-Packard Sales and Service Office or to Hewlett-Packard. Please be sure each space on the form is filled in--lack of complete information may delay processing of your claim.

Each tube manufacturer has his own warranty policy. Copies of individual Conditions of Warranty are available from your Hewlett-Packard Sales and Service Office or from the Hewlett-Packard Company.

## SHIPPING INSTRUCTIONS

The following instructions are included to aid you in preventing damage in transit. Package your tube carefully--no allowance can be made on broken tubes.

1. Carefully wrap tube in 1/4-inch thick cellulosic cushioning, cotton batting, or other soft padding material. Cable assemblies and other accessories not rigidly mounted to the tube should be padded and wrapped separately to prevent damage to the tube during shipment.
2. Wrap the above in heavy kraft paper.
3. Pack in a rigid container which is at least 4 inches larger than the tube in each dimension.
4. Surround the tube with at least 2 inches of shock absorbing material. Be certain that the packing is tight all around the tube.
5. Tubes returned from outside the continental United States should be packed in a wooden box.
6. Mark container FRAGILE and ship prepaid via Air freight or Railway Express. Do not ship via Parcel Post or Air Parcel Post since experience has shown that fragile items are more apt to be damaged when shipped by these means.

Note

Tubes with permanent magnets can interfere with magnetic compasses.
For air shipment plainly mark container: "MAGNETIZED MATERIAL"

In warranty tubes purchased from Hewlett-Packard may be returned, with a completed warranty Claim Form, to your local Hewlett-Packard Sales and Service Office, or to:

Hewlett-Packard Company
Customer Service Center
333 Logue Avenue
Mountain View, California 94040
USA

# MICROWAVE TUBE WARRANTY CLAIM INFORMATION FORM

**IMPORTANT:** Please answer all questions fully -- insufficient information may delay processing of your claim.

DATE: _____

FROM: (Tube Owner)

Company _____

Address _____

_____

_____

Tube type _____

Tube serial No. _____

Tube mfr. _____

Use in HP Model _____

Instrument serial No. _____

Tube is Original (  ) or Replacement (  )

Date tube received _____

Date of failure _____

Total hours filament operation _____

SYMPTOMS: (Please describe conditions prior to and at time of failure, along with description of tube's defect, if known) _____

_____

_____

_____

IMPORTANT:
Replacement (new) tube serial No. _____

Signature _____

Title _____

For HP use only

Repair order # _____

5/1/68
01153-4

# MANUAL CHANGES

# MANUAL CHANGES

**MANUAL IDENTIFICATION**
Model Number: 8614A
Date Printed: March 1979
Part Number: 08614-90001

## SIGNAL GENERATOR

This supplement contains important information for correcting manual errors and for adapting the manual to instruments containing improvements made after the printing of the manual.

To use this supplement:

Make all ERRATA corrections

Make all appropriate serial number related changes indicated in the tables below.

| Serial Prefix or Number | Make Manual Changes |
|---|---|
| 815-02601 to 815-02850 | 1 |
| 953-02851 to 953-02975 | 1, 2 |
| 953-02976 to 953-03025 | 1–3 |
| 953-03026 to 953-03475 | 1–4 |
| 1111A | 1–5 |
| 1150A | 1–6 |

| Serial Prefix or Number | Make Manual Changes |
|---|---|
| 1310A and 1347A | 1–7 |
| 1645A | 1–8 |
| 1748A | 1–9 |
| 1808A | 1–10 |
| 1810A | 1–11 |
| 1835A, 2015A | 1–12 |

► NEW ITEM

## ERRATA

Title Page:

Change SERIALS PREFIXED: 815- above 02201 to SERIAL NUMBERS: 815-02201 and above. Change the first sentence to "This Operating and Service Manual applies to HP 8614A instruments with serial numbers 815-02201 and above."

Change the second sentence to "For instruments with serial numbers 815-02200 and below. . ."

► Page 1-2, Table 1-1:

Change Attenuator Accuracy from, "-10" to "-15" in two places.

Page 3-9, Figure 3-8:

Change the last part of step 9 to "(6 volts peak to peak)".

Page 5-2, Table 5-1:

Change Instrument Type FM Modulator Recommended Instrument parts to:

| | | | |
|---|---|---|---|
| Power Transformer | (1) | (9100-0139) | CD9 |
| Capacitor | (1) | (0160-0043) | CD1 |
| Potentiometers | (1) | (2100-0134) | CD7 |
| | (1) | (2100-0047) | CD1 |
| Resistor | (1) | (0687-1041) | CD7 |
| Fuse 1/4A | (1) | (2100-0004) | CD0 |
| Fuseholder, extractor post type | (1) | (1400-0084) | CD1 |
| Power Cord | (1) | (8120-0050) | CD4 |

**NOTE**

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies quote the manual identification information from your supplement, or the model number and print date from the title page of the manual.

21 June 1984
6 Pages

Printed in U.S.A.

HEWLETT PACKARD

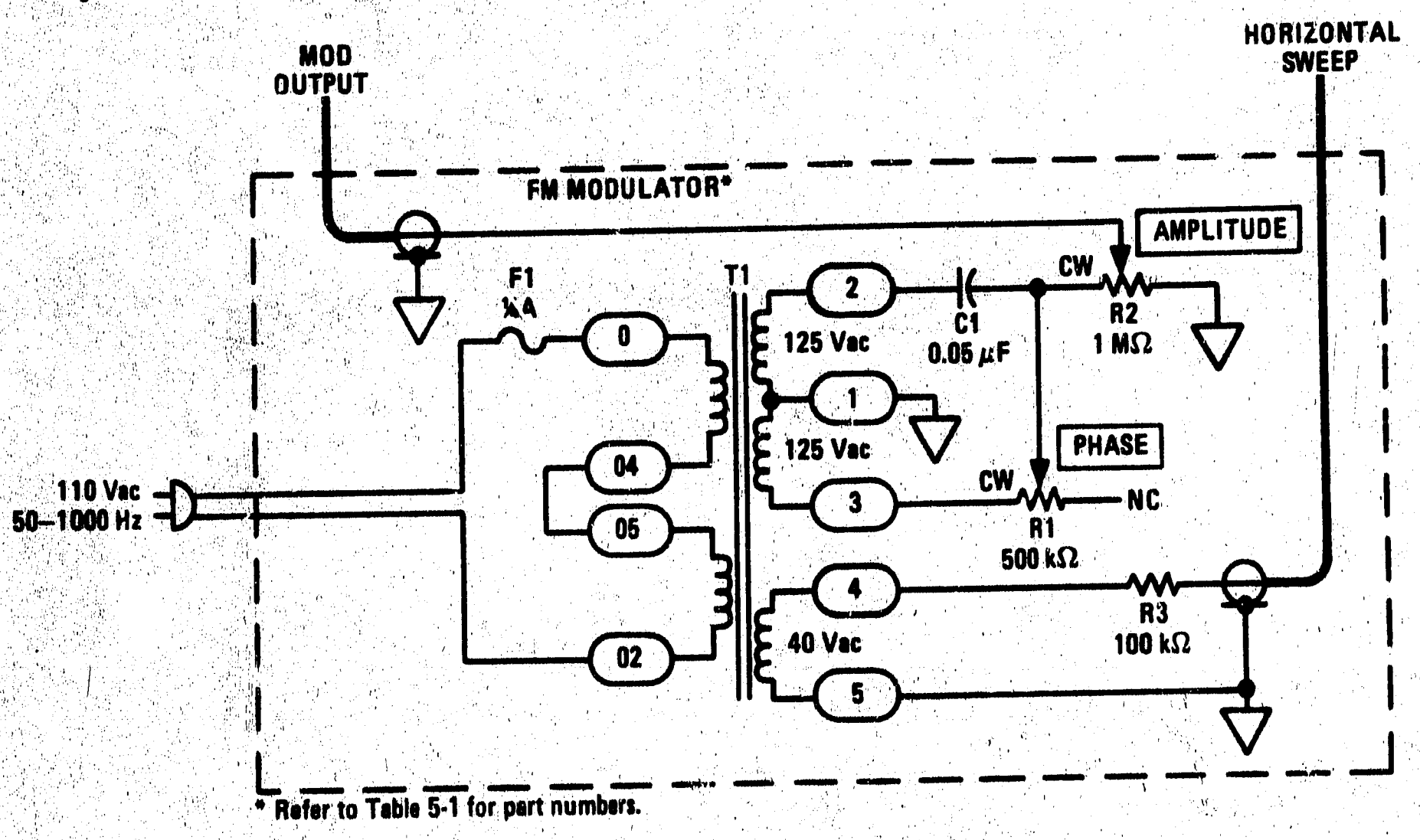
ERRATA (Cont'd)

Page 5-6, paragraph 5-17:
Change in step b, 8616A to 81614A and 1.8 GHz to 900 MHz.
Delete steps c and d.
Change step e to step c.
Change step f to step d; change 5000 Hz to 2500 Hz.

Page 5-6, Figure 5-5:
Delete the electronic counter and transfer oscillator.
Show the cal output of the 8614A connected to the modulation analyzer's input.

Page 5-19, paragraph 5-58, step b:
Delete the hyphenated word, "one-megohm". There are two potentiometers, one 1 mΩ and one 500 kΩ.

Page 5-20, Figure 5-14:
Replace the FM MODULATOR portion with the one shown below.




* Refer to Table 5-1 for part numbers.

P/O Figure 5-14. Repeller Mode Adjust Setup

Page 5-25, Figure 5-17:
Change the part number for R220 REPELLER POT to 5060-0335.
Change the part number for TRACKING POT STATOR to 5060-1113.

Page 5-27, Figure 5-18:
Change the part number for R220 REPELLER POT to 5060-0335.

Page 6-5, Table 6-2:
Change CR701 to 5080-0321.
Change L1 to 9140-0805 CD0 INDUCTOR-FIXED 5 MH.

Page 6-6, Table 6-2:
Change R220 to 5060-0335, CD7, CARD ASSY (REPELLER POT).

## CHANGE 1

**Page 5-35, Figure 5-26:**
Change R700 to 0687-1051 R:FXD COMP 1 MEGOHM 10% 0.5W.

## CHANGE 2

**Page 2-3, paragraph 2-10:**
Change the fourth sentence to read as follows:
A 2 ampere standard fuse is used for 115 volt operation; a 1 ampere standard fuse is used for 230 volt operation.

**Page 5-33, Figure 5-25:**
Change F1 to 2A, 115 VAC, and 1A 230 VAC.

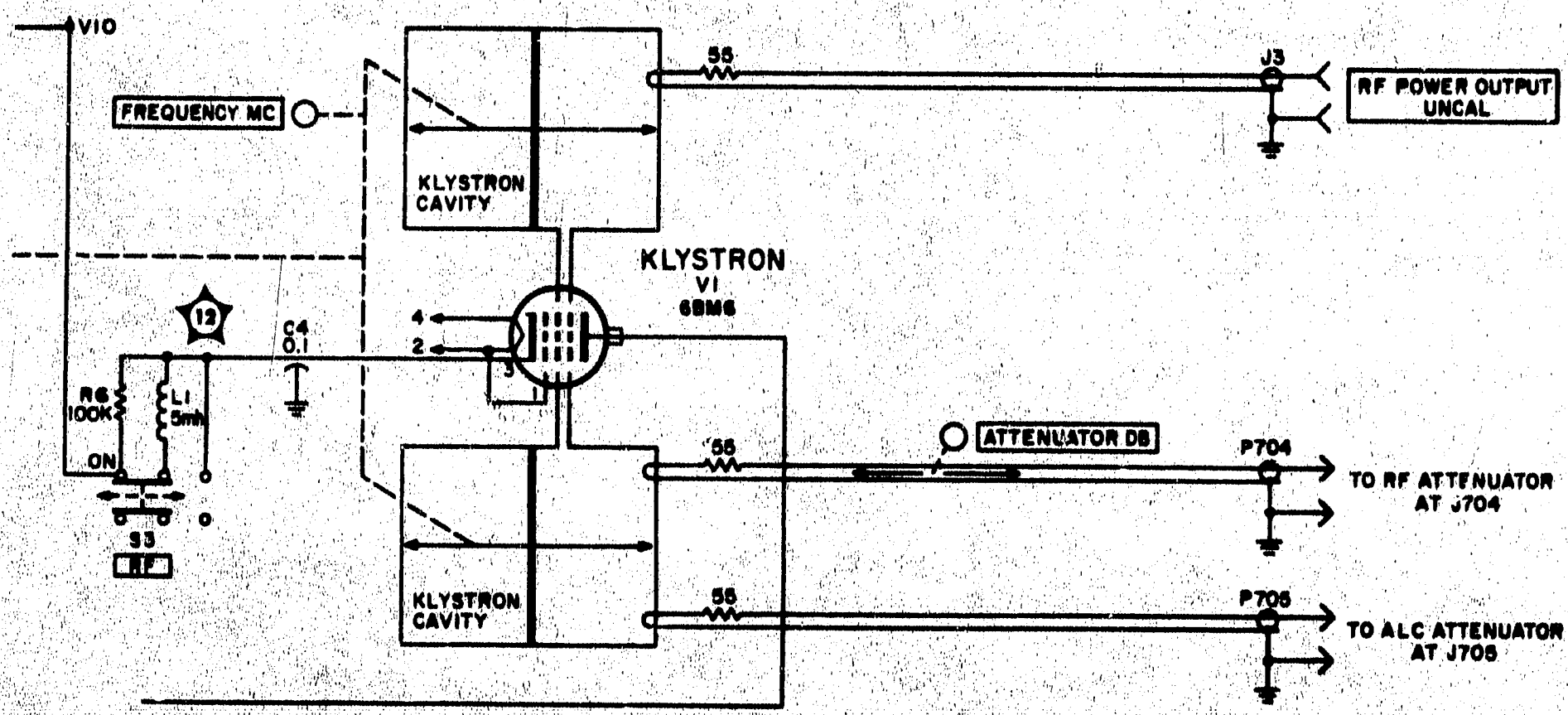
**Page 6-5, Table 6-2:**
Change F1 2110-0043 to 2110-0002 FUSE: CARTRIDGE 2 AMP 250V. (FOR 115 VOLT OPERATION ONLY).
Change F1 2110-0033 to 2110-0001 FUSE: 1 AMP 250V. (FOR 230 VOLT OPERATION ONLY).
Change J2 to 1251-2357.

**Page 6-7, Table 6-2:**
Change S2 to 3101-1234.

**Page 6-8, Table 6-2:**
Change W1 to 8120-1378.
Add 08614-6007 WIRING HARNESS PRIMARY POWER.

## CHANGE 3

**Page 5-35, Figure 5-26:**
Replace appropriate portions of figure with the attached partial schematic.




P/O Figure 5-26. Modulation and Klystron Circuits (P/O Change 3)

**Page 6-5, Table 6-2:**
Change R6 to 0757-0367 R:FXD MET FLM 100K OHM, 1% 0.5W.

## CHANGE 4

Page 6-5, Table 6-2:
Change DS1 to 1450-0419 INDICATOR: GLOW-LAMP NEON IN WHITE PLASTIC.

## CHANGE 5

Page 6-7, Table 6-2:
Change S1 to 3101-1606.
Change S3 and S201 to 3101-1590.
Change S401, S402, S403, and S601 to 3101-1590.

Page 6-9, Table 6-1:
Change 08614-009 to 08614-00026.

## CHANGE 6

Page 1-1, paragraph 1-9:
Add the following sentence:
Option A85 (light gray panel) and option X95 (complete gray-blue color scheme) are available to match prior Hewlett-Packard instruments.

Page 6-8, Table 6-2:
Add 0370-0118 PUSHBUTTON (OPT A85 AND OPT X95).
Add 0370-0928 KNOB-PB (OPT A85 AND OPT X95).
Add 0370-1400 PUSHBUTTON.
Add 0370-1877 KNOB-PB.
Add 5040-0201 BEZEL COUNTER (OPT A85 AND OPT X95).
Add 5040-0202 BEZEL COUNTER (OPT A85 AND OPT X95).
Add 5040-0369 BEZEL COUNTER.
Add 5040-0373 BEZEL COUNTER.

Page 6-9, Table 6-2:
Change item 2 as follows:
08614-00026 PANEL FRONT (OPT A85 AND OPT X95)
08614-00028 PANEL FRONT
Change item 4 as follows:
5060-0766 HANDLE ASSY: RETAINER (OPT X95)
5060-8737 HANDLE ASSY: RETAINER
Change item 8 as follows:
5060-0775 KIT: 5 H RACK MOUNT (OPT X95)
5060-8740 KIT: 5 H RACK MOUNT
Change item 9 as follows:
5000-0738 COVER: REAR SIDE PLATE (OPT X95)
5000-8709 COVER: REAR SIDE PLATE

5000-0739 COVER: FRONT SIDE PLATE (OPT X95)
5000-8711 COVER: FRONT SIDE PLATE

Change item 10 as follows:
5060-0740 TOP COVER ASSY: 16L FM (OPT X95)
5060-8589 TOP COVER ASSY: 16L FM
Change item 11 as follows:
5060-0752 BOTTOM COVER ASSY: 16L FM (OPT X95)
5060-8713 BOTTOM COVER ASSY: 16L FM

## CHANGE 7

**Page 6-4, Table 6-2:**

Change:

C205 (0160-0079) to 0160-0598, C:FXD PAPER 1 UF ± 10% 600 VDCW.

C205 (1210-0003) to 1400-0512, BRACKET:CAPACITOR.

## CHANGE 8

**Page 5-33, Figure 5-25:**

Change Q1 to 1853-0252.

Change Q2 to 1853-0224.

Change the voltage level at the base of Q2 to −328.5V (CR4 changed from 6.49V to 7.5V zener voltage).

**Page 6-4, Table 6-2:**

Change CR4 to 1902-3129 DIODE-ZNR 7.5V 2% DO-7 PD=0.4W TC = +0.05%

**Page 6-5, Table 6-2:**

Change Q1 to 1853-0252 TRANSISTOR PNP SI TO-3 PD-150W FT = 4 MHz.

Change Q2 to 1853-0224 TRANSISTOR PNP SI TO-39 PD = 1W FT = 15 MHz.

**Page 6-8, Table 6-2:**

Delete insulator 1200-0043.

Add 0340-0875 INSULATOR, TRANSISTOR.

## CHANGE 9

**Page 5-37, Figure 5-27:**

Change potentiometers R614 and R615 to 20 kΩ.

**Page 6-7, Table 6-2:**

Change R614 and R615 to 2100-1762 RESISTOR-TRMR 20K 5% WW SIDE-ADJ 1-TRN.

Change R620 and R621 to 2100-1757 RESISTOR-TRMR 500 5% WW SIDE-ADJ 1-TRN.

## CHANGE 10

**Page 6-8, Table 6-2:**

Replace the 2110-0470 Fuseholder with the following parts:

2110-0564 FUSEHOLDER BODY 12A MAX; 250V MAX 28480 2110-0564

2110-0565 FUSEHOLDER CAP BAYONET; 12A, 250V MAX 28480 2110-0565

2110-0569 NUT-HEX, PLASTIC 28480 2110-0569

1400-0090 WASHER: RUBBER 5/8" OD 00000 OBD

## CHANGE 11

**Page 5-33, Figure 5-25:**

Change the following transistor types to part numbers:

Q50 from 2N1183 to 1853-0038

Q51 from 2N1670 to 1853-0012

Q52/Q53 from 2N404 to 1853-0001

Draw in capacitor C54 (330 pF) between the board ground ( ⏚ ) and chassis ground ( ⏚ ). The capacitor is on the A500 board and chassis ground is off the board.

## CHANGE 11 (Cont'd)

**Page 5-37, Figure 5-27:**
Change Q502/Q503 part number to 1853-0001.

**Page 6-4, Table 6-2:**
Add C54 0160-3694 CAPACITOR-FXD 330 PF ±10% 100 VDC CER 28480 0160-3694.

**Page 6-5, Table 6-2:**
Change the Q50-53, and Q502, 503 listing as follows:

Q50 1853-0038 TRANSISTOR PNP SI TO-39 PD = 1W FT = 100 MHz 28480 1853-0038
Q51 1853-0012 TRANSISTOR PNP 2N2904A SI TO-39 PD = 600MW 01698 2N2904A
Q52/53 1853-0001 TRANSISTOR PNP SI TO-39 PD = 600 MW 28480 1853-0001
Q502/503 (same as Q52/53).

## CHANGE 12

**Page 5-33, Figure 5-25:**
Draw a ferrite bead on the base lead of Q50 and label it Z1.

**Page 6-8, Table 6-2:**
Add Z1 9170-0029 CORE-SHIELDING BEAD 28480-0029.