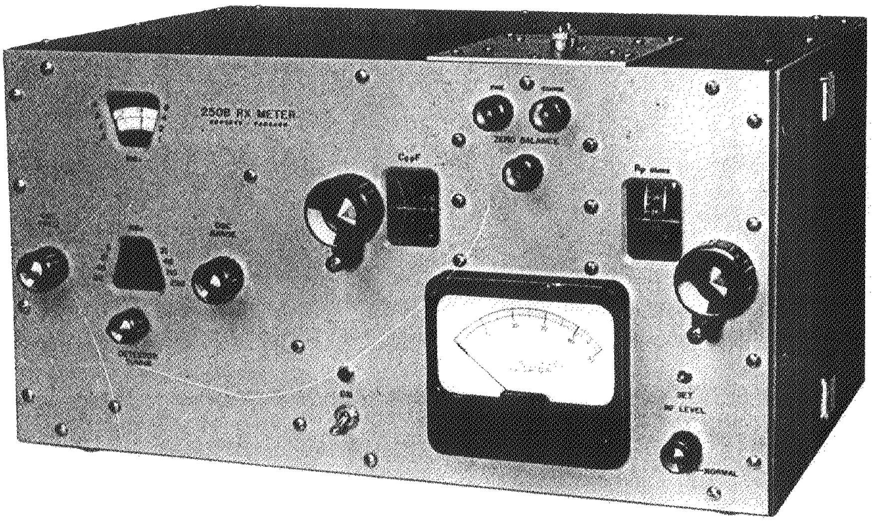
SERVICE COPY

OPERATING AND SERVICE MANUAL

RX METER
250B



Instrument: 250B
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Service Center 02/10/91

OPERATING AND SERVICE MANUAL

MODEL 250B
RX METER

SERIAL PREFIXED 737

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Green Pond Road Rockaway, New Jersey, U.S.A.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

TABLE 1-1. SPECIFICATIONS

250B RX Meter

RADIO FREQUENCY CHARACTERISTICS

RF RANGE: 500 kHz to 250 MHz in 8 bands; 0.5 to 1 MHz, 1 to 2 MHz, 2 to 4 MHz, 4 to 9 MHz 9 to 21 MHz, 21 to 48 MHz, 48 to 110 MHz, 110 to 250 MHz.

RF ACCURACY: 2% of frequency.

RF CALIBRATION: Increments of approximately 1%.

RESISTANCE MEASUREMENT CHARACTERISTICS

RESISTANCE RANGE: 15 to 100,000 ohms

RESISTANCE ACCURACY:

$$\pm\left[2 + \frac{F}{200} + \frac{R}{5000} - \frac{Q}{20}\right]\% \pm 0.2 \text{ ohm}$$

F = frequency (MHz), R = RX Meter R_p reading (ohm), Q = ω CR x 10^{-12}, where C = RX Meter C_p reading (pF).

RESISTANCE CALIBRATION: Increments of approximately 3% throughout most of range.

CAPACITANCE MEASUREMENT CHARACTERISTICS

CAPACITANCE RANGE: 0 to 20 pF (May be extended by use of auxiliary coils).

CAPACITANCE ACCURACY:

$$\pm(0.5 + 0.5\,F^2\,C \times 10^{-5})\% \pm 0.15\text{ pF};$$

F = frequency (MHz),
C = RX Meter C_p reading (pF).

CAPACITANCE CALIBRATION: Increments of 0.1 pF.

INDUCTANCE MEASUREMENT CHARACTERISTICS

INDUCTANCE RANGE: 0.001 μH to 100 mH (actual range depends on frequency; auxiliary resistors employed).

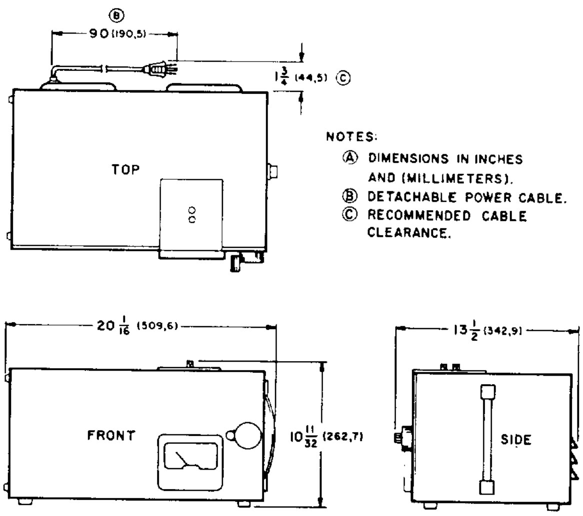
INDUCTANCE ACCURACY: Basic accuracy is capacitance accuracy.

MEASUREMENT VOLTAGE LEVEL

RF: 0.05 to 0.75 V approx., depending on frequency, with SET RF LEVEL Control in NORMAL position. RF level adjustable to below 20 mV; relative level indicated when SET RF LEVEL switch is depressed.

DC: 0 V (external dc current up to 50 mA may be passed through RX Meter terminals).

DIMENSIONS



WEIGHT

net 40 lbs. (18 kg) shipping 50 lbs. (22,5 kg).

POWER

105 to 125 V or 210 to 250 V, 50 to 1000 Hz, 60 watts.

00515A Coax Adapter Kit

ADAPTER

CONNECTOR: Type "N" female.

CHARACTERISTIC IMPEDANCE: 50 ohms.

TERMINATION (00516A)

CONNECTOR: Type "N" male.

CHARACTERISTIC IMPEDANCE: 50 ohms.

DC RESISTANCE: 50 ohms ± 1%.

MAXIMUM PARALLEL CAPACITANCE (mount-on adapter): ± 0.2 pF.

VSWR: less than 1:10 up to 800 MHz.

MAXIMUM POWER: 1/2 Watt.

13510A Transistor Test Jig

FREQUENCY RANGE

500 kHz to 250 MHz.

EXTERNAL BIAS RANGE

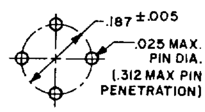
50 mA dc maximum; 30 V dc maximum.

TEST CIRCUITS

Provide for readout of R_p and C_p on RX Meter to yield Y_{ib}, Y_{ie}, and Y_{oe}.

$$Y_{(\ )} = \frac{1}{R_p} + j\omega C_p.$$

TRANSISTOR MOUNTING:



GENERAL INFORMATION SECTION I

1-1. DESCRIPTION.

1-2. The Model 250B RX Meter (Figure 1-1) is a bench type, self-contained instrument designed to permit accurate measurement of equivalent parallel resistance and parallel reactance of two-terminal networks over the frequency range of 500 kHz to 250 MHz. The instrument includes a continuously tuned oscillator, high frequency bridge, mixer, amplifier-detector, null indicating meter, and regulated power supply.

1-3. The oscillator is mounted inside a rigid casting in order to obtain a high degree of accuracy, stability, and low leakage. Long life sub-miniature triodes are used, and the oscillator is carefully shielded to avoid any leakage of signal to the amplifier-detector by any path other than through the bridge. The high frequency bridge is also mounted inside a casting, and is designed to minimize the effects of coupling between the bridge arms. All calibrated variable elements of the bridge are low inductance high quality variable capacitors driven by anti-backlash gears. The amplifier-detector has high, automatically controlled gain, and a very low noise level. A solid state power supply provides a regulated dc voltage to all circuits, as well as the filaments of the oscillator triodes.

1-4. Complete specifications for the Model 250B RX Meter and its accessory equipment are given in Table 1-1.

1-5. ACCESSORY EQUIPMENT AVAILABLE.

1-6. 00515A COAX ADAPTER KIT.

1-7. The Coax Adapter Kit (Figure 1-2) permits any coaxial transmission line or fixture fitted with a Type "N" male connector to be connected to the RX Meter measuring circuit. This provides a convenient means of performing impedance measurements of a position remote from the RX Meter terminals. In addition, it permits utilizing the transforming properties of quarter-wave and half-

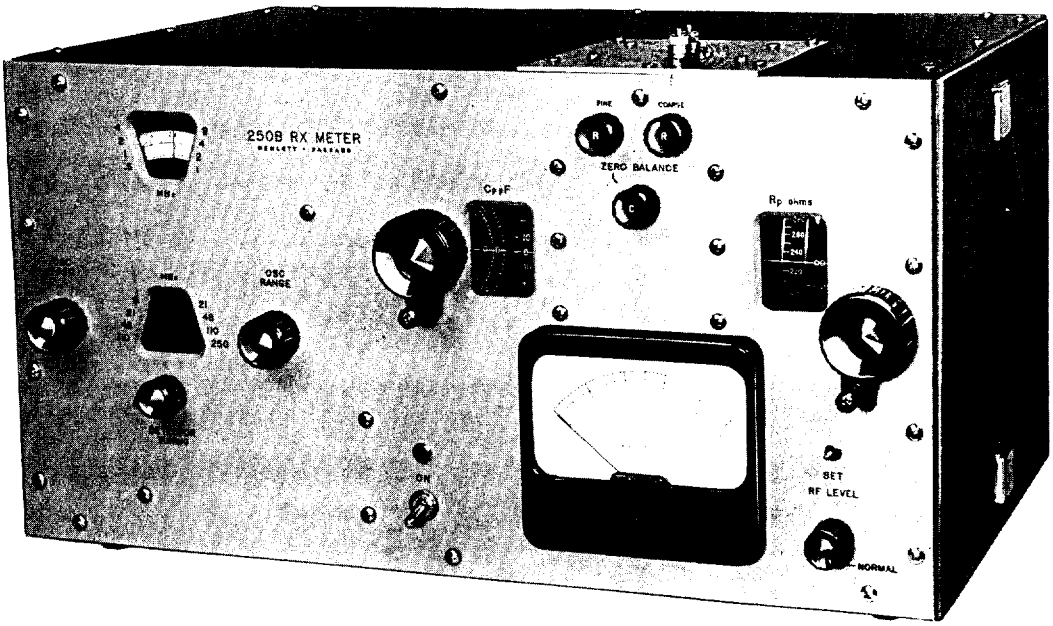


Figure 1-1. Model 250B RX Meter

wave transmission lines for certain measurements, and the measurement of transmission line characteristics themselves. The kit includes a standard 50 ohm termination, combined with a Type "N" male connector, which may be mounted on the adapter to permit balancing the RX Meter bridge circuit.

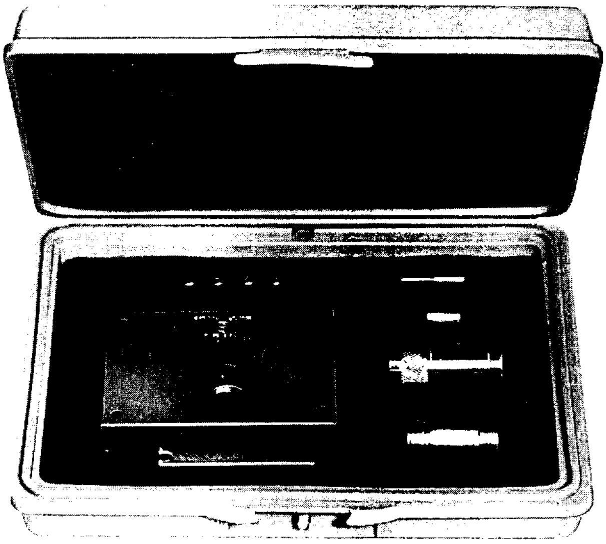


Figure 1-2. Coax Adapter Kit

1-8. 13510A TRANSISTOR TEST JIG.

1-9. The Transistor Test Jig (Figure 1-3) provides a convenient means for measuring the "Y" parameters of transistors on the 250B RX Meter. The jig consists of four basic components: a mounting adapter and three separate plug-in test circuit boards for measuring y_{ib}, y_{ie}, and y_{oe}.

y_{ib} = Input admittance, common base configuration with output circuit shorted.

y_{ie} = Input admittance, common emitter configuration with output circuit shorted.

y_{oe} = Output admittance, common emitter configuration with input circuit shorted.

The mounting adapter mounts conveniently on the RX Meter and includes bias filtering for an external power supply, such as the -hp- 721A. Each of the test circuits is constructed on a printed circuit board for maximum stability and repeatability. Residual reactance have been held to a minimum, providing maximum measurement accuracy.

1-10. INSTRUMENT IDENTIFICATION.

1-11. Each Model 250B carries a two-section, eight-digit serial number (000-00000) which is stamped on a plate fastened to the rear of the instrument. The five-digit number is an identification unique to each instrument, and the three-digit number is a serial prefix used to document instrument revisions.

1-12. When the SERIALS PREFIXED number on the title page of this manual is the same as the first three digits of the instrument serial number, the manual applies directly to the instrument. A change sheet will be included with the manual for newer instruments having a higher serial prefix than shown on the title page. If a change sheet is missing, it can be supplied by any Hewlett-Packard Sales and Service Office listed at the back of this manual.

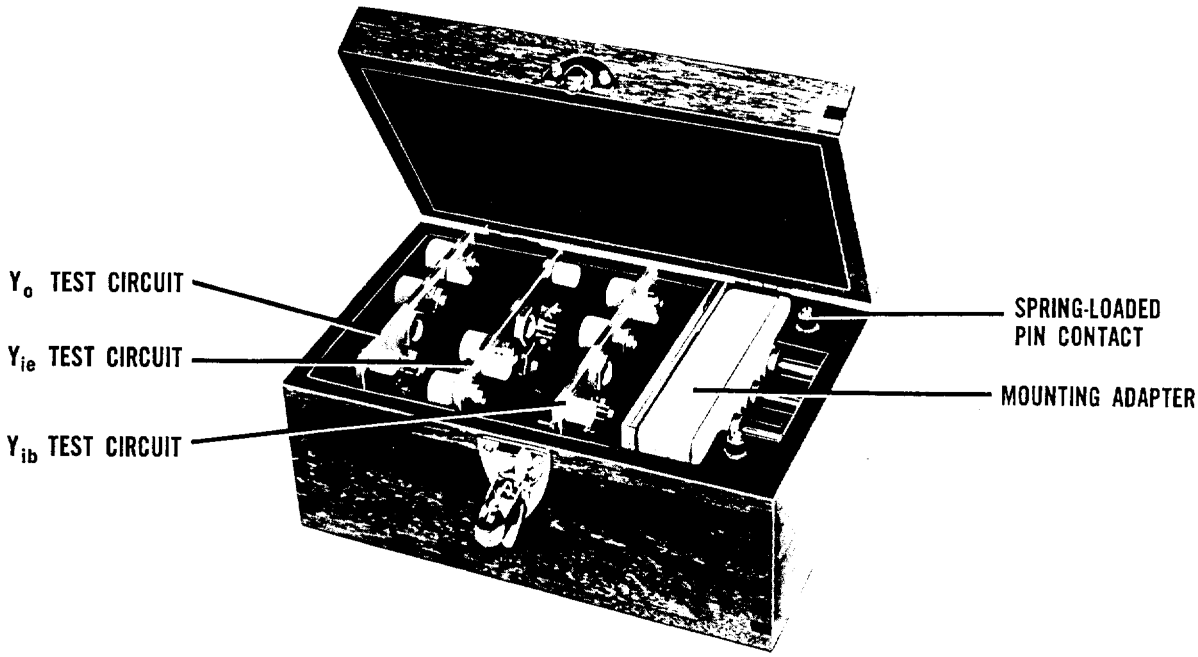


Figure 1-3. Transistor Test Jig

INSTALLATION SECTION II

2-1. INITIAL INSPECTION.

2-2. MECHANICAL CHECK. If damage to the shipping carton is evident, ask that the carrier's agent be present when the instrument is unpacked. Inspect the instrument for scratches, dents, broken knobs and switches, and any other mechanical damage. Also check the cushioning material for signs of severe stress as an indication of rough handling in transit.

2-3. PERFORMANCE CHECK. The electrical performance of the 250B should be verified as soon as possible after receipt. A performance check that is suitable for initial inspection is contained in Section V.

2-4. CLAIM FOR DAMAGE. If upon receipt, the 250B is damaged or fails to meet performance specifications, notify the carrier and the nearest Hewlett-Packard Sales and Service Office immediately (A list of offices is provided at the back of this manual). Retain the shipping carton and padding material for the carrier's inspection. The sales and service office will arrange for the repair or replacement of the instrument without waiting for the claim against the carrier to be settled.

2-5. PREPARATION FOR USE.

2-6. POWER REQUIREMENTS.

2-7. The 250B requires a power source of 105 to 125 V or 210 to 250 V, 50 to 1000 Hz, which can supply approximately 60 watts.

2-8. 115/230 VOLT OPERATION.

2-9. A two-position slide switch, located on the rear panel, permits operation from either a 115 or 230 volt power source. Before connecting the 250B to the power source, check that the number visible on the slide switch matches the nominal line voltage of the source. If required, slide the switch to the other position using a thin-bladed screwdriver.

2-10. When the instrument leaves the factory, the proper fuse is installed for 115-volt operation. An envelope containing a fuse for 230-volt operation is attached to the front handle. Markings on the rear panel adjacent to the fuse holder indicate the correct fuse rating for operation from either power source. Make sure that the correct fuse is installed if the position of the slide switch is changed.

2-11. POWER CABLE.

2-12. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that instrument panels and cabinets be grounded. The 250B is equipped with a detachable, three-conductor power cable which, when plugged into an appropriate receptacle, grounds the panel and cabinet of the instrument. The offset pin on the power cable three-prong connector is the ground pin.

2-13. To preserve the protective feature when operating the instrument from a two-contact outlet, use a three-prong adapter (-hp- Stock No. 1251-0048) and connect the green pigtail on the adapter to ground.

2-14. REPACKAGING FOR SHIPMENT

2-15. The original shipping carton and packing material should be used for repackaging. A Hewlett-Packard Sales and Service Office will provide information and recommendations on materials to be used if the original packaging materials is not available or reusable.

The packaging materials should include the following:

- a double-walled carton
- heavy paper or cardboard to protect all instrument surfaces
- extra material around projecting parts of instrument
- at least four inches of tightly-packed shock-absorbing material surrounding the instrument
- durable shipping tape to securely seal the carton

NOTES

If the instrument is to be shipped to a Hewlett-Packard Sales and Service Office, attach a tag showing owner, model number, complete serial number, and repairs required. Mark the shipping container FRAGILE to ensure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

2-16. INSTALLATION OF COAX ADAPTER KIT

2-17. Refer to Figures 1-2 and 2-1, and install the Coax Adapter Kit on the 250B as follows:

a. Unscrew the knurled clamping nuts from both RX Meter binding posts and, using the pin spanner wrench supplied, remove the base nut from the rear post.

b. Remove and put aside the four screws marked (A) in Figure 2-1.

c. Clean the surface of the metal terminal plate to remove grease and dirt, insuring good contact with the adapter mounting plate.

CAUTION

No other item should be loosened or removed.

d. Place the adapter mounting plate in position on the terminal plate of the instrument with the beveled edges up, so that the large threaded hole clears the HI terminal.

e. Install the four screws (B) provided with the kit in the corner holes of the adapter mounting plate. Do not tighten.

f. Replace the LO binding post base nut turning it in by hand and making sure that it enters the hole in the adapter plate. Do not tighten.

g. Position the adapter plate by slipping the centering guide over the HI post and adjusting the plate carefully until the outer conductor, when placed over the sleeve, can be screwed into the threaded platehole. Once it is started, do not advance the outer conductor more than a turn or two, since it will bind if it projects beyond the lower side of the plate.

h. Now tighten the four mounting screws and the LO post base nut.

i. Remove the outer conductor and slip off the centering guide. Screw the tapered center conductor on the threaded HI post stud and turn down finger tight. Re-install the outer conductor, also finger tight. The adapter is now ready for use.

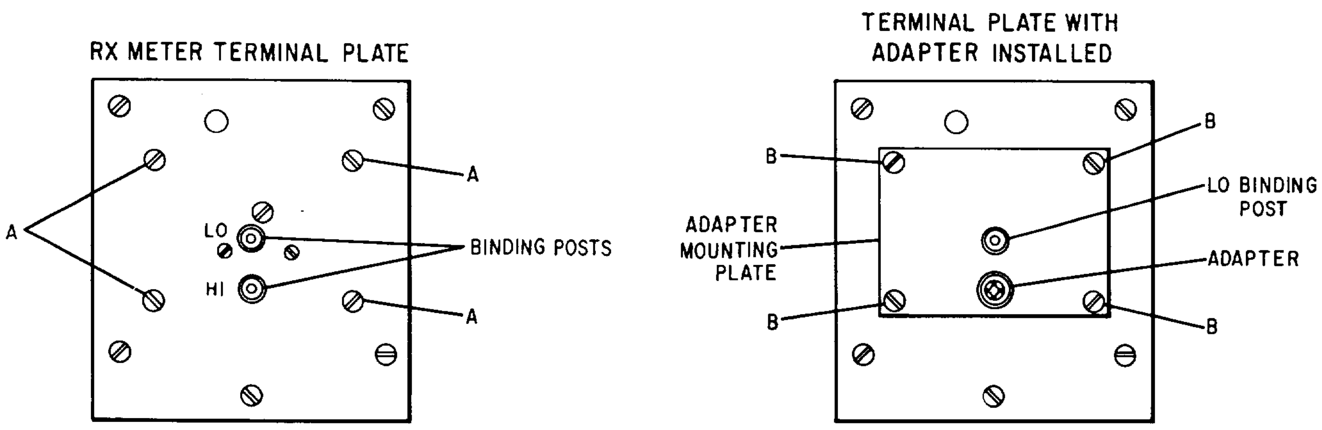


Figure 2-1. Installation of Coax Adapter Kit

2-18. INSTALLATION OF TRANSISTOR TEST JIG.

2-19. Refer to Figure 2-2 and install the Transistor Test Jig on the 250B as follows:

a. Remove two screws from RX Meter terminal plate and align mounting adapter (12) with screw holes; loosely fasten mounting adapter with two mounting screws (9).

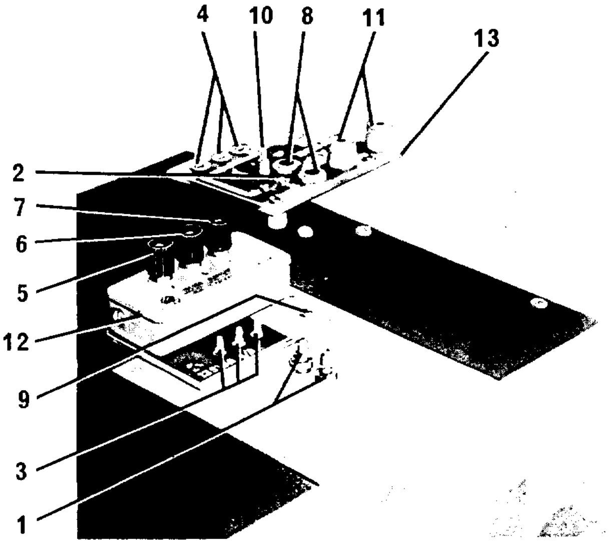
b. Remove standard knurled nuts from measuring terminals and install spring-loaded pin contacts (1).

CAUTION

Use a screwdriver to install spring-loaded pin contacts; twisting with fingers or gripping tools will damage contacting springs.

c. Slide y_{ie} test circuit board (13) in place without a transistor in its socket to align mounting adapter with respect to RX Meter measuring terminals.

d. Remove test circuit board and tighten two mounting screws (9).



1. Spring-loaded Pin Contacts - RX Meter Measurement Terminals
2. Transistor Test Socket
3. Male Connectors - Transistor Bias
4. Female Connectors - Transistor Bias
5. Bias Input Connector - Emitter
6. Bias Input Connector - Base
7. Bias Input Connector - Collector
8. Female Contacts - RX Meter measurement Terminals
9. Mounting Adapter Mounting Screws
10. RF Switch - S1 (on y_{ie} and y_{ib} only)
11. Auxiliary Coil Terminals
12. Mounting Adapter
13. Y_{ie} Test Circuit Board

Figure 2-2. Installation of Transistor Test Jig

OPERATION SECTION III

3-1. INTRODUCTION.

3-2. The 250B RX Meter is completely self-contained, requiring no external units for its operation. This eliminates difficulties arising from leakage, hand effects, or improper matching which can occur when several different units must be interconnected. Because the RX Meter individually measures the parallel resistance and reactance components of an impedance, rather than the absolute impedance, and because it makes available a broad frequency band and relatively wide measurement range, the instrument is a particularly valuable research and development tool.

3-3. The field of application for the RX Meter is a broad one, including measurement of a wide variety of components and networks such as resistors, attenuators, antennas, cables, transformers, varistors, thermistors, diodes and transistors. The instrument is adaptable to the measurement of high- and medium-loss insulating materials such as phenolic tube bases and may be applied to the determination of the electrical properties of many chemical compounds and solutions.

3-4. The measurement of equivalent parallel resistance is of considerable importance, since it represents the impedance seen by a vacuum tube or transistor when working into a parallel tuned circuit as an amplifier or oscillator. A direct measurement of R_p also facilitates the determination of power dissipation in a tuned circuit, since then, by merely measuring the voltage (E) developed across the tank, Power Dissipated = E^2/R_p. The direct measurement of R_p is also of interest to those working with magnetic materials such as ferrites, powdered iron and permalloy, since the quality factor μQ (permeability x Q) has been shown to be directly proportional to the R_p of a test winding. In addition to measuring parallel resistance and equivalent capacitance, the RX Meter can be used to measure small inductance values with a readability, in some cases, of 0.0001 microhenry, by extending the measuring range as described in paragraph 3-21.

3-5. OPERATING CONTROLS.

3-6. Figure 3-1 identifies and briefly describes the purpose of each 250B panel control, switch, and connector.

3-7. OPERATING INSTRUCTIONS.

3-8. GENERAL.

3-9. The following paragraphs will describe the typical operating procedures of the 250B RX Meter, 00515A Coax Adapter Kit, and 13510A Transistor Test Jig. In addition, interpretation of results, extension of range procedures, and special application procedures are provided.

3-10. PRELIMINARY ADJUSTMENTS.

3-11. Perform the preliminary 250B adjustments as follows:

a. If necessary, adjust the mechanical zero of the null indicating meter before turning the power on.

b. Turn the power on and allow the instrument to warm up for about ten minutes (extra time is sometimes required to attain satisfactory stability above 110 MHz).

c. Select the desired measuring frequency by means of the OSC RANGE and OSC FREQ controls. Note that the active range is indicated by a pointer mounted on one side of the indicator mask.

d. Set the C_p pF dial to "0" and the R_p ohms dial to "∞". Make sure that the pointer indicates the proper scale sector.

e. Unbalance the bridge circuit by placing two fingers across the binding posts, and adjust the DETECTOR TUNING control until a maximum deflection is obtained on the NULL/RF LEVEL INDICATOR. This deflection should have a magnitude of about 35 scale divisions. A peak of substantially less than this amount is usually an indication of an unusable harmonic response instead of the desired fundamental. At higher frequencies two fundamental frequency peaks will be observed, either of which represents satisfactory tuning of the detector. Between the fundamental peaks will be found several secondary, or harmonic, peaks which may be recognized by their relative sharpness and low amplitude. Care should be taken not to tune for one of these harmonics, since it will produce erroneous readings or make bridge balance impossible. When maximum meter deflection has been obtained, remove fingers from across the binding posts.

f. Adjust the three ZERO BALANCE controls, (FINE R, COARSE R, and C), alternately until a minimum deflection is obtained on the null indicator. This minimum deflection (indicating bridge balance) will vary from about 0.5 to 3 scale divisions, depending on the frequency used. At frequencies above 100 MHz the COARSE R control should be adjusted to approximately its mid-point position before a null is sought. If this control is set fully clockwise, it may be impossible to obtain balance. It will be noted that a slight interaction exists, at high frequencies, between the FINE R and C controls. For this reason it is important to use all three controls in obtaining final balance. When an apparent null has been obtained, the circuit should be tested for true balance by slowly rocking the R_p ohms dial above and below the setting and observing the NULL/RF LEVEL INDICATOR. If a deeper null exits at some Rp value other than ∞, the Rp dial should be returned to the latter indication and a new balance obtained with the ZERO BALANCE controls.

g. The above procedure establishes maximum bridge sensitivity at a given frequency and usually need not be repeated for successive measurements at this frequency. Whenever the measuring frequency is changed, however, steps "c" through "f" should be repeated.

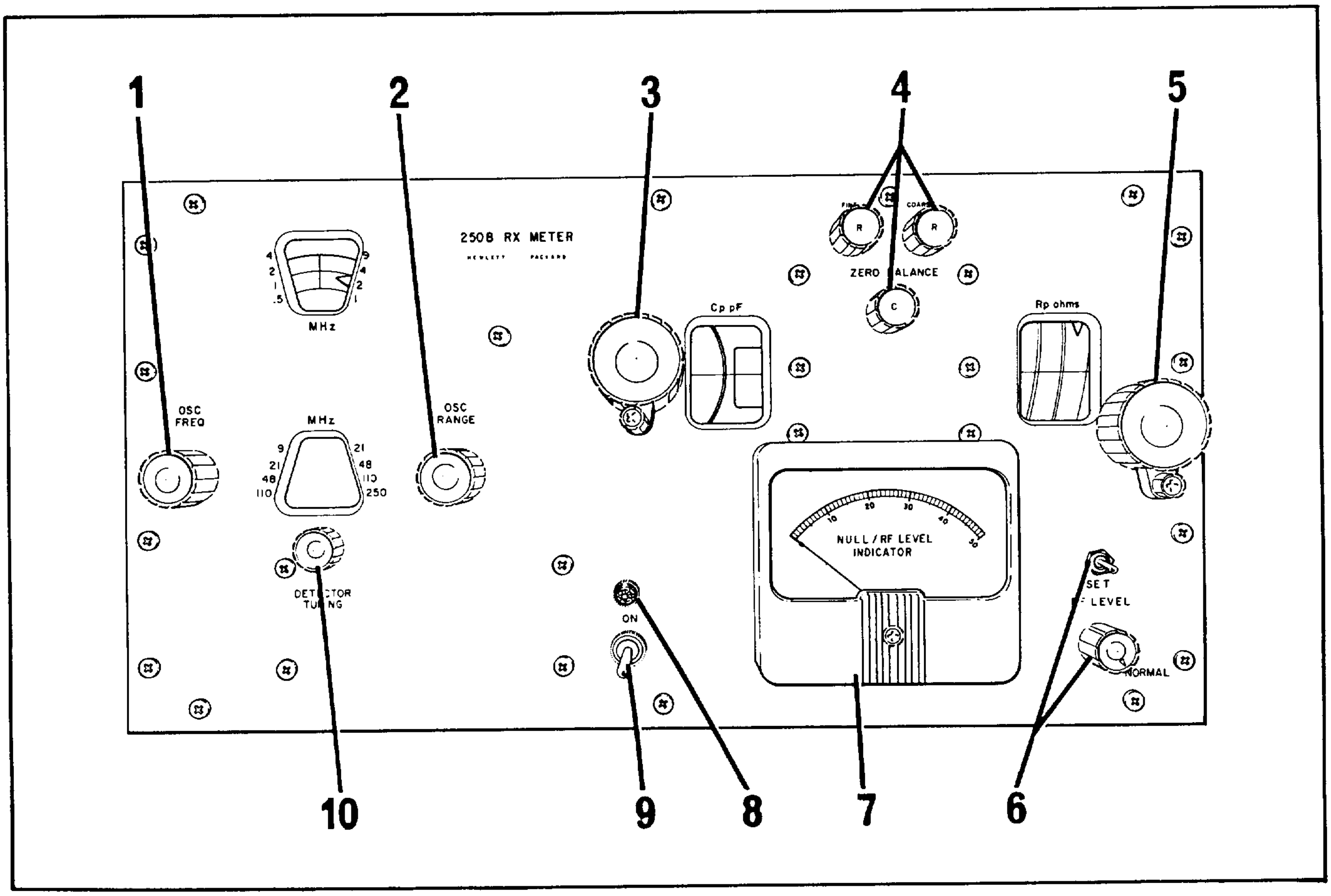
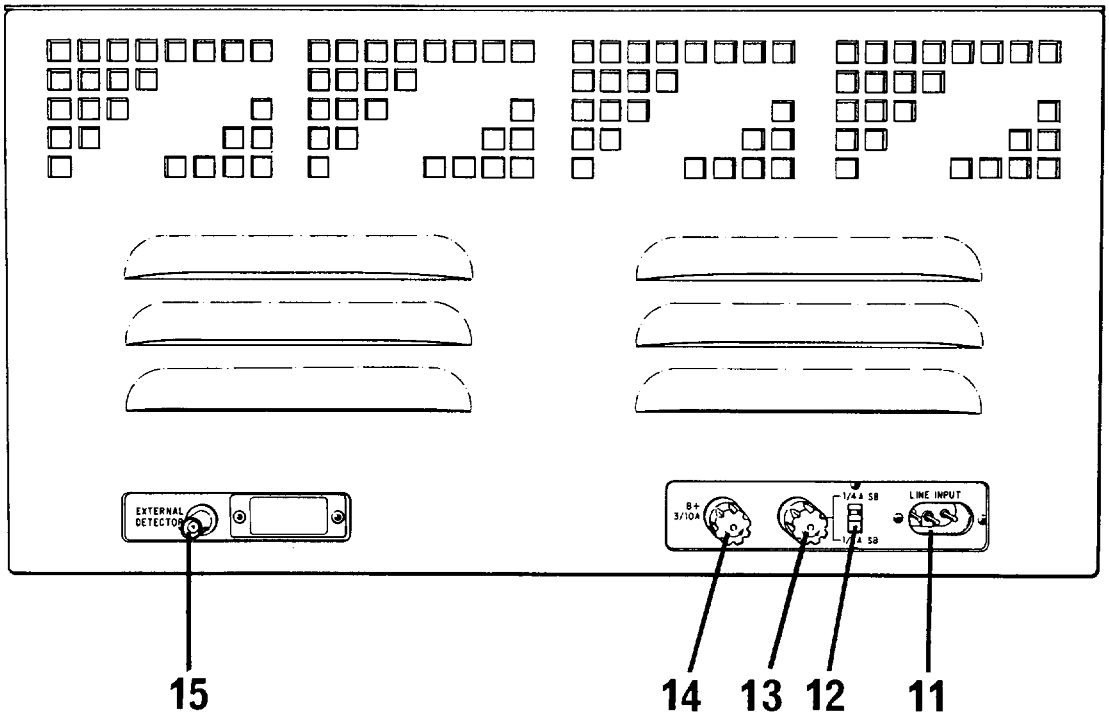


Figure 3-1. 250B Operating Controls (Sheet 1 of 2)



1. OSC FREQ Control - Selects oscillator frequency from eight available ranges. Selected frequency is displayed on unmasked portion of range indicator dial.
2. OSC RANGE Control - Selects one of eight available oscillator frequency ranges.
3. Cp pF Control - Balances out and indicates parallel reactance of component under test.
4. ZERO BALANCE Controls- (FINE R, COARSE R, and C) Permit initial balancing of bridge.
5. Rp ohms Control - Balances out and indicates parallel resistance of component under test.
6. SET RF LEVEL Controls - Provide for adjustment and indication of relative RF signal level at test terminals.
7. NULL/RF LEVEL INDICATOR - Indicates a balanced or unbalanced bridge; indicates relative RF signal level when SET RF LEVEL switch is depressed.
8. Indicator Lamp - Lights when line power is applied.
9. ON Switch - Applies line power to instrument.
10. DETECTOR TUNING Control - Provides fine tuning of local oscillator frequency.
11. Line Input Connector - Provides for connection of ac power line.
12. 115/230 V Slide Switch - Matches instrument to nominal line voltage.
13. LINE Fuse - Fuse rating marked adjacent to fuse holder.
14. B+ Fuse - Fuse rating marked adjacent to fuse holder.
15. EXTERNAL DETECTOR Connector - Provides IF output for sensitive tuned voltmeter required to resolve a null during reduced signal level operation.

Figure 3-1. 250B Operating Controls (Sheet 2 of 2)

3-12. MEASUREMENT PROCEDURE.

3-13. Impedances to be measured are connected to the RX Meter by means of the binding posts mounted on the terminal plate of the instrument. The front post is insulated from ground and is marked "HI" and the rear post is grounded to the cabinet and is marked "LO". An RF voltage of approximately 0.05 to 0.75 volts appears across these terminals. This voltage may be reduced for special measuring applications. The DC resistance looking into the terminals is approcimately 66 ohms. Perform measurements in accordance with the following procedure:

NOTE

Easy and quick change connections of coaxial lines and fittings equipped with Type N connectors may be readily made by means of the Coax Adapter Kit (see Paragraph 3-38).

a. Connect the component to be measured to the RX Meter binding posts. Note that the LO (grounded) post is the one nearest the rear of the cabinet. The leads should be kept as short as possible to minimize stray capacitance between the component and the top of the RX Meter cabinet.

b. If the impedance of the test component is known to be primarily resistive, adjust the R_p control until a minimum deflection is obtained on the indicator. Then adjust the C_p and R_p controls alternately until a final null point is reached.

c. If the impedance of the test component is known to be reactive, adjust the C_p control first to obtain an initial minimum; then the R_p and C_p controls alternately to obtain final balance.

d. Read the equivalent parallel resistance of the component (as seen at the binding posts) from that sector of the R_p dial indicated by the pointer.

e. Read the positive or negative resonating capacitance of the component (in ± pF) from the C_p dials. If the component is capacitive, the indication will fall in the yellow (+) portion of the drum scale and the corresponding yellow (inner) scale of the vernier disk which together provide a direct indication of parallel capacitance. If the component is predominantly inductive, the dial will read in the white (-) portion and, with the white vernier scale, provides a reading in pF. This value represents the capacitance which resonants with the parallel inductance of the component at the frequency used. Then $X_p = \frac{1}{2\pi f C_p}$

NOTE

The procedure outlined above is, in general, that followed for a normal measurement with the RX Meter. A more detailed discussion of the techniques involved in a number of specific measurements will be found in Paragraph 3-27, Special Applications. The user will evolve the most satisfactory procedures for his own specialized applications as he becomes familiar with the operation of the instrument.

3-14. INTERPRETATION OF RESULTS.

3-15. SIGNIFICANCE OF DIAL READINGS. The RX Meter yields results which are read in terms of parallel resistance (R_p) and positive or negative parallel capacitance (C_p). An R_p reading is a direct indication of the effective parallel resistance component of the unknown impedance as seen at the RX Meter binding posts. A positive capacitance reading (made on the yellow portion of the C_p dial, marked "+") indicates directly the effective parallel capacitance of a capacitive impedance. A negative capacitance reading (made on the white portion of the C_p dial, marked "-") indicates the capacitance which resonates with the effective parallel inductance of an impedance. In the latter case, the effective parallel inductance may then be determined by the simple relation, $L_p = \frac{1}{\omega^2 C_p}$

NOTE

It should be kept in mind that the RX Meter measures the above values as they appear at its binding posts. For this reason, the connecting leads should always be kept as short as possible in order to minimize the effect of their residual resistance and inductance.

3-16. EXTENSION OF RESULTS. The remaining basic parameters of the impedance measured may be readily obtained by simple computation from the frequency setting and the values of R_p and C_p indicated by the RX Meter. The relationships involved are as follows:

a. Equivalent parallel reactance (X_p)

$$X_p = 1/\omega C_p \text{ (neglecting sign of } C_p\text{)}$$

b. Equivalent parallel inductance (L_p)

$$L_p = X_p/\omega \text{ (for white portion of dial)}$$

c. Q

$$Q = R_p/X_p$$

d. Equivalent series resistance (Rs)

$$Rs = \frac{R_p}{1 + Q^2}$$

and, with less than 1% error

$Rs = X_p^2 / R_p$, when $Q > 10$

$Rs = R_p$, when $Q < 0.1$

e. Equivalent series reactance

$$Xs = \frac{X_p Q^2}{1 + Q^2}$$

and, with less than 1% error,

$Xs = X_p$, when $Q > 10$

$Xs = R_p^2 / X_p$, when $Q < 0.1$

f. Absolute Impedance

$$Z = \frac{R_p}{\sqrt{1 + Q^2}}$$

g. Series Inductance (Ls)

$$Ls = \frac{C_p R_p^2}{1 + Q^2}$$

and, with less than 1% error,

$Ls = 1/\omega^2 C_p$, when $Q > 10$

$Ls = C_p R_p^2$, when $Q < 0.1$

h. Series capacitance (Cs)

$Cs = C_p (1 + 1/Q^2)$

and, with less than 1% error,

$Cs = C_p$, when $Q > 10$

$Cs = \frac{1}{R_p^2 \omega^2 C_p}$ when $Q < 0.1$

3-17. SOURCES OF ERROR. The RX Meter measuring circuit includes two residual parameters which may, in certain cases, cause minor errors in results. When warranted by the nature and desired accuracy of the measurements at hand, known corrections may be applied to nullify these errors. In most practical applications, however, it will probably be found that these errors may be disregarded.

a. Series Inductance of C_p Capacitor. Inductance values (i.e. those read on the white portion of the C_p dial) may be corrected for the residual series inductance of the C_p capacitor by adding the appropriate value of ΔC, as determined from Figure 3-2, to the indicated value of C_p. Positive capacitance measurements (read on the yellow portion of the dial) require no correction for this effect. EXAMPLE. At 200 MHz a small inductance measured on the RX Meter produces a C_p reading of -65 pF. Referring to Figure 3-2 it is found that a correction of -6 pF is required. Thus, true C_p = -65 -6 = -71 pF.

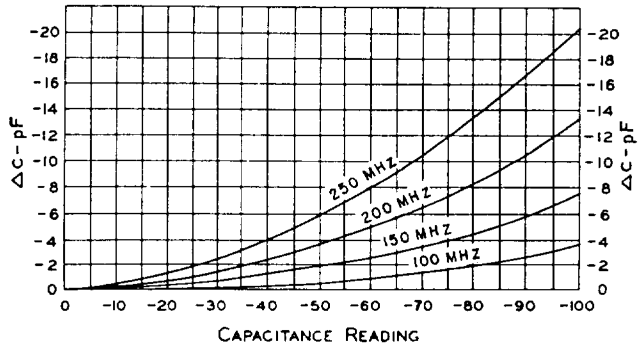


Figure 3-2. Correction Chart for Capacitance Inductance

b. Residual Series Inductance of Binding Posts. When relatively low values of impedance are measured on the RX Meter, the series inductance of the binding posts (approximately 0.003 μH) may have an appreciable affect on the results. The true value of R_p may be computed from the following formula:

$$\text{True } R_p = \frac{R_p}{1 - \frac{C_p}{K}}$$

where R_p (in ohms) and C_p (in pF) are the values read on the RX Meter and K is one-half the resonating capacitance of the binding post inductance as determined from Figure 3-3.

EXAMPLE: A low value 1/2 watt resistor, measured at 200 MHz produces the following readings: R_p = 29.0 Ω, C_p = 25.6 pF. Find the true R_p.

$$\text{True } R_p = \frac{R_p}{1 - \frac{C_p}{K}} = \frac{29}{1 - \frac{-25.6}{100}} = 23.1\Omega$$

Low values of parallel reactance, as measured on the RX Meter, may also be affected by the binding post inductance. Indicated positive capacitance values may be corrected for this effect by the following relation:

$$C_p\,(\text{true}) = \frac{C_p}{1 + \omega^2 L C_p}$$

where $\omega = 2\pi f$
L = 0.003×10^{-6} (henries)
C_p = RX Meter reading x 10^{-12} (farads).

A negative capacitance (inductance) reading may be corrected by determining the corresponding parallel inductance value ($Lp = 1/\omega^2 Cp$) and parallel reactance ($Xp = 1/\omega Cp$) and converting to the equivalent series form by the general formula,

$$Ls = \frac{C_p R_p^2}{1 + Q^2}$$

where C_p and R_p are read directly on the RX Meter and

$$Q = R_p/X_p$$

The corrected inductance value is then obtained by subtracting from the above quantity the binding post series inductance of 0.003 μH.
EXAMPLE: It is desired to find the inductance of the resistor used in the preceding example. Given, R_p = 29.0Ω, and C_p = -25.6 pF. Applying the formulas above, L_p = 0.025 μH, and X_p = 31.2Ω. Then Ls = 0.011 μH, and the corrected inductance of the resistor = 0.011 - 0.033 = 0.008 μH.

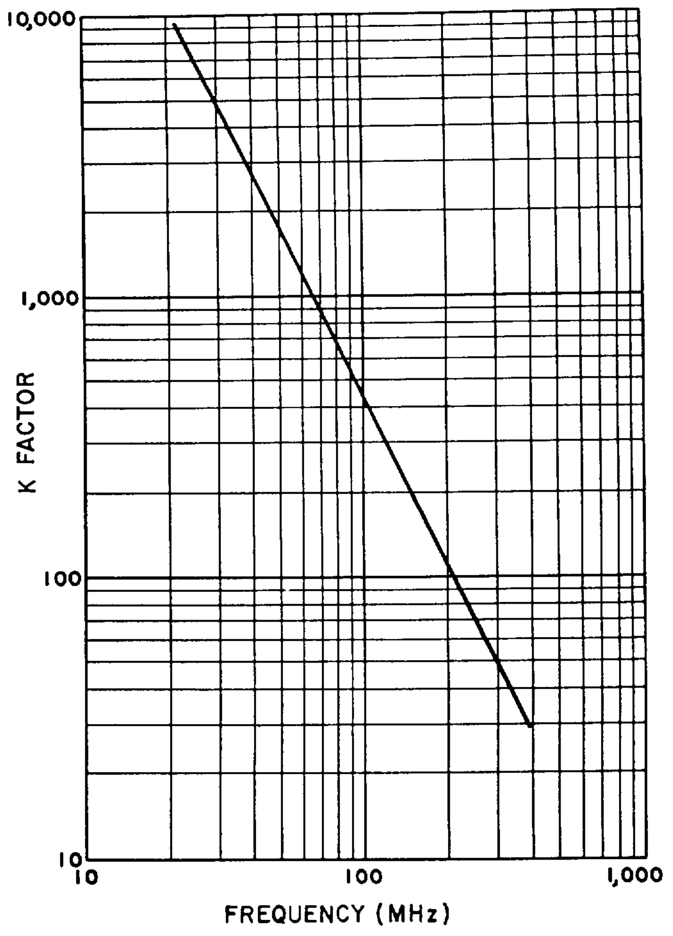


Figure 3-3. K Factor Chart

3-18. REDUCTION OF SIGNAL LEVEL.

3-19. The normal RF signal level of 0.05 - 0.75 volts which appears across the RX Meter terminals will be excessive for certain applications, such as measurement of vacuum tube or transistor input impedance. In some cases it is also desirable to be able to vary the applied voltage during a series of measurements. For such applications the SET RF LEVEL controls permit the user to obtain operation at levels as low as 20 mV. When the SET RF LEVEL switch is depressed, the relative RF signal level is observed on the NULL/RF LEVEL INDICATOR. This level is adjustable with the SET RF LEVEL control; for normal operation the control is detented in the fully clockwise NORMAL position.

3-20. During reduced signal level operation, greater sensitivity may be required to resolve a null on the indicator. In such a case, a sensitive tuned voltmeter (such as the -hp- 320A Wave Analyzer) may be connected to the EXTERNAL DETECTOR output jack located at the rear of the 250B.

3-21. EXTENSION OF RANGES.

3-22. LOW RESISTANCE. In dealing with low Q devices it is sometimes desirable to be able to measure resistance values below 15 ohms, which is the lower limit of the direct-reading R_p scale. At high frequencies (in the neighborhood of 200 mc and above) the residual inductance of most components having series resistance values below 15Ω, such as low-value resistors, may be sufficient to increase the equivalent parallel resistance value above 15 ohms so that it may be measured directly. If not, a small inductance (having negligible series resistance) connected in series with the unknown will be sufficient to increase the R_p of the combination to the range of direct measurement.

3-23. At lower frequencies, the R_p of the unknown may be effectively increased for measurement by adding in series a small auxiliary resistor having a value preferably between 15 and 25 ohms. The series combination is measured and the values R_p1 and C_p1 are noted. The auxiliary resistor is then measured alone to obtain R_p2 and C_p2. C_p1 and X_p2 are transformed to the equivalent series form, then

$$R_s = R_{s1} - R_{s2}, \text{ and } L_s = L_{s1} - L_{s2}$$

EXAMPLE: Measure, at a frequency of 50 MHz a small resistor known to have a series resistance less than 15 Ω. Connect an auxiliary resistor of 20 Ω in series with the unknown unit and measure the series combination. R_p1 = 35.4 Ω, C_p1 = 38 pF. Measuring the auxiliary resistor alone, R_p2 = 22.2 Ω, C_p2 = 47 pF. Then X_p1 = 100 Ω and X_p2 = 68 Ω. Converting to series form, R_s1 = 30 Ω, X_s1 = 12.5 Ω and R_s2 = 20 Ω, X_s2 = 6.3 Ω. Then the unknown resistance Rs = R_s1 - R_s2 = 10 Ω. Its inductance Ls = L_s1 - L_s2 = 0.04 - 0.02 = 0.02 μH.

3-24. At frequencies where practical line lengths may be used an alternative method is made possible by the impedance transforming effect produced by a quarter wave length of coaxial line. To use this method a resonant connection line exactly one quarter-wave in length must first be established by cutting a section to approximately the correct length, attaching one end directly to the RX Meter binding post, and, with the far end shorted, adjusting the length (or frequency) in small increments until the C_p dial indicates "O" at balance. The unknown impedance is then connected across the far end of the cable and the bridge rebalanced. The results should then be converted to series form from which, by calculation or by use of the Smith Chart, the correct value of resistance may be derived.

3-25. LOW INDUCTANCE. Inductance values which require more than 100 pF of resonating capacitance at a given frequency may be measured on the RX Meter by connecting an auxiliary resistor in series with the inductance. The additional resistance serves to reduce the overall Q and, correspondingly, the required resonating capacitance (C_p) in accordance with the relation,

$$Ls = \frac{C_p R_p^2}{1 + Q^2}$$

The value of the auxiliary resistor used depends on the appropriate value of the inductance to be measured (See Figure 3-4), and may be selected from the table below.

Inductance Range	Resistor
10 µH - 100 µH	1KΩ
1 µH - 10 µH	316Ω
0.1 µH - 1 µH	100Ω
0.001 µH - 0.1 µH	31.6Ω

The value and accuracy of the auxiliary resistor is not critical and need only be of the correct order. The following procedure is suggested for such measurements:

a. Connect the unknown inductance in series with the auxiliary resistor across the RX Meter binding post. Using a minimum length of heavy, conducting strap, short the terminals of the inductance to remove it temporarily from the circuit.

b. Balance the bridge circuit and note the values of C_p1 obtained for the series resistor alone.

c. Remove the shorting strap from the inductive component, restoring the latter to the circuit, and rebalance the bridge. Note the values of R_p2 and C_p2 for the series combination. Then the unknown inductance is obtained by

$$Ls = \Delta C \, (R_p 2)^2 \quad \text{where } \Delta C = C_p{}^1 - C_p{}^2$$

It should be noted that the inductance is shorted out, rather than removed, to avoid alternation of the physical configuration of the components which might otherwise affect the results. In dealing with extremely small inductance values, the inductance of the shorting strap itself will become significant and must be considered in interpreting the results.

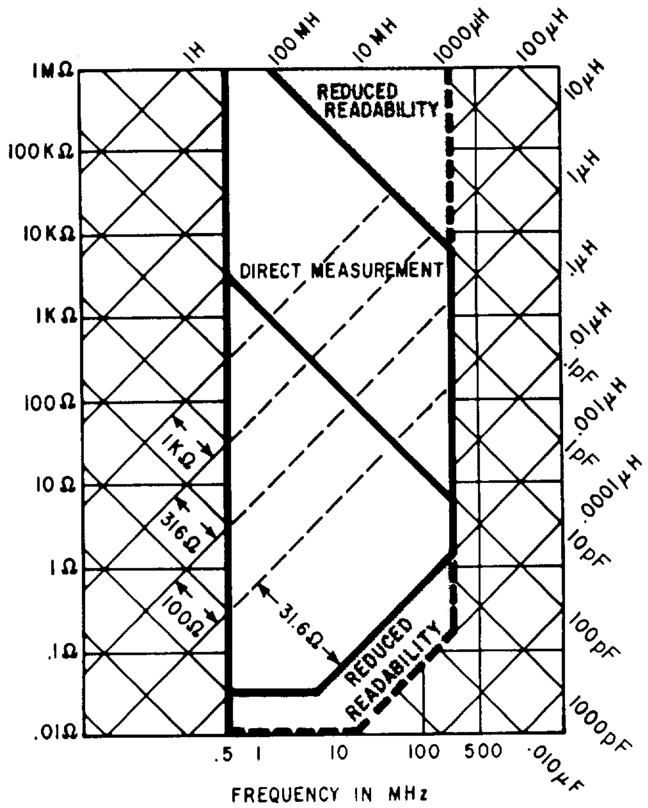


Figure 3-4. Inductance Measurement Range

3-26. HIGH CAPACITANCE. The range of capacitance measurement (0-20 pF) may be increased to a maximum of 120 pF by the use of an auxiliary coil placed across the measuring terminals. This coil should be selected to resonate with the desired maximum capacitance at the measuring frequency. (Thus, if it is desired to measure capacities up to 100 pF at a frequency of 1 MHz a coil of approximately 250 µH should be used.) After the initial balance of the bridge connect the coil alone to the measuring circuit. Rebalance the bridge using the R_p and C_p controls. The C_p dial reading should be recorded as C_p1. The R_p reading may be disregarded. With the coil in place, the unknown capacitance is then connected across the terminals and the bridge re-balanced to obtain C_p2. If the C_p dial reads in the white (negative) portion, the unknown capacitance, $C_p = C_p1 - C_p2$. If the reading is in the yellow (positive) portion, $C_p = C_p1 + C_p2$. This method has certain restrictions which are imposed by the residual inductance of the RX Meter binding posts. These may be summarized as follows:

a. Auxiliary coils having less than 0.1 μH inductance should not be used.

b. If it is necessary to use a coil of less than 0.6 μH, it must have a reactance within 20% of the capacitance reactance being measured, and the following correction must be applied to the RX Meter reading:

$$\text{true capacity} = \Delta C \left(1 + \frac{0.003}{L}\right)$$

where ΔC = difference reading when unknown capacitance is connected.

c. The auxiliary coil and unknown capacitor leads must be connected together at the binding posts to avoid increasing the effective binding post inductance.

3-27. SPECIAL APPLICATIONS.

3-28. COAXIAL TRANSMISSION LINE. The characteristic impedance, attenuation and velocity of propagation of relatively short sections of coaxial cable may be conveniently measured on the RX Meter. In performing such measurements the cable may be connected either directly to the RX Meter binding posts, or at the end of a half-wavelength section of low-loss line. If the cable is fitted with a type "N" male connector, it may be attached by means of the Coax Adapter Kit.

3-29. The formulas used in the measuring procedures described below are approximations which are valid only when the cable to be measured has moderately low loss. When high-loss or delay lines are measured, the more general transmission line equations must be used.

a. Characteristic Impedance.

The most satisfactory method of measuring characteristic impedance on the RX Meter is based on the familiar equation for a quarter-wave line,

$$Z_0 = \sqrt{Z_1 \ Z_2}$$

where Z_0 = characteristic impedance
Z_1 = input impedance, with cable termination
and Z_2 = terminating impedance.

The procedure is as follows:

(1) Select the desired measuring frequency on the RX Meter. Measure and cut a section of cable which is approximately 1/4 wavelength long at this frequency.

(2) Connect the cable to the RX Meter terminals (the inner conductor being connected to the HI post), and short the cable at the far end.

(3) Balance the RX Meter, using the C_p and R_p controls. If the cable length is correct, a value of zero will be indicated on the C_p dial. If the latter reads in the yellow region (capacitive), the frequency should be lowered (or cable shortened); if it reads in the white region (inductive), the frequency should be raised slightly (or a longer piece of cable used). Since the Zo characteristic impedance will not change significantly with the frequency above 20 MHz, it is usually more convenient to adjust the frequency. The R_p dial must be adjusted to obtain a null during the above measurements but its reading may be disregarded.

(4) Select a half-watt carbon resistor having a value approximately equal to the estimated characteristic impedance of the cable. If the latter cannot be estimated, use about 50 ohms. Unshort the far end of the quarter-wave section and connect the resistor across it, keeping the leads as short as possible. Balance the bridge and record R_p as R_1.

(5) Remove the resistor from the end of the cable and measure it directly on the bridge terminal with the cable disconnected, recording this value of R_p as R_2.

(6) The characteristic impedance of the cable is then $Z_0 = \sqrt{R_1 \times R_2}\ \Omega$.

EXAMPLE: It is desired to check the characteristic impedance of a length of RG-58/U cable. Arbitrarily selecting a frequency of 40 MHz, set the RX Meter to this value. From Figure 3-5 it is determined that a 1/4 wavelength of polyethylene dielectric cable at this frequency is about 52" long. Cutting a section of cable to this length, dress back the ends about 1/2" to expose the center conductor and shield. Initial balance of the RX Meter is obtained, and the cable is connected to the measuring terminals and shorted at the far end. Rebalancing the instrument, it is noted that the C_p dial reads in the capacitive region, indicating that the cable is too long. Reduce the frequency in small steps adjusting the DETECTOR TUNING control after each step, and if necessary rebalance the bridge until C_p is found to be essentially zero. A half-watt carbon resistor of about 50Ω is connected in place of the short at the far end of the cable. With the bridge balanced, R_p is found to be 63.8Ω. This is recorded as R1. The resistor, removed from the cable and measured directly, has an R_p of 47Ω, which is recorded as R_2. Then

$$Z_0 = \sqrt{R_1 \ R_2} = \sqrt{47 \times 63.8} = 54.75\Omega.$$

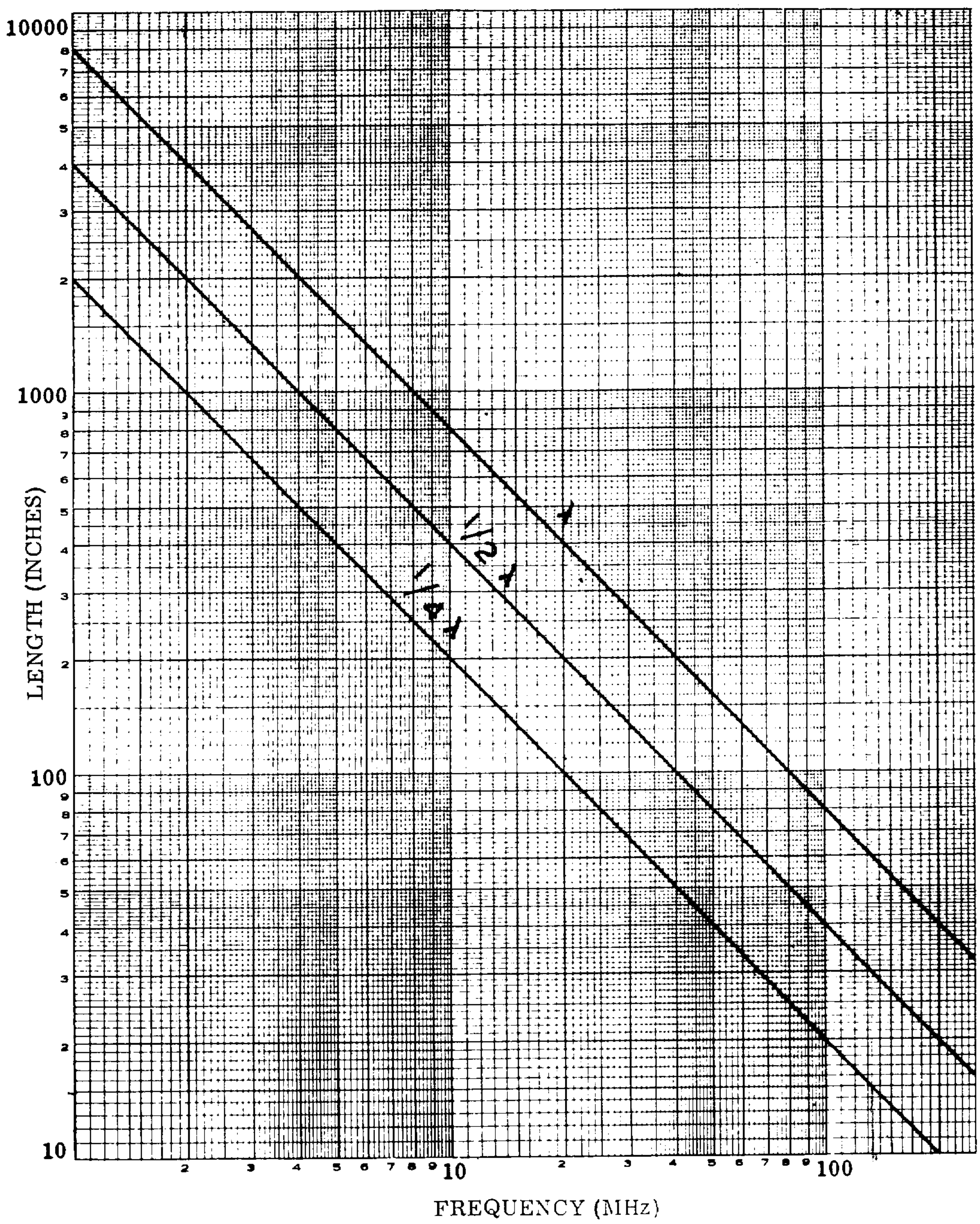


Figure 3-5. Length-vs-Frequency, Polyethylene Dielectric Cable

b. Attenuation.
In measuring attenuation a half-wave section of the unknown cable is used. If the frequency is such, however, that a half wavelength is less than approximately four feet, a one wavelength or three-halves wavelength piece should be used, with no change in the following procedure. This serves to minimize the effect of irregularities in the cable.

(1) Set the RX Meter to the desired measuring frequency and obtain initial balance of the instrument.

(2) Cut a one-half wavelength section of the cable to be measured, and attach one end to the RX Meter terminals, leaving the far end open-circuited.

(3) Balance the bridge. If $C_p = 0$ the cable

is the proper length and R_p should be recorded. If C_p does not equal 0 the cable length or frequency should be adjusted until the correct length is obtained. The attenuation may then be computed by means of the following approximation for $R_p \geq 5Z_o$:

$$dB \approx \frac{Z_o \times 8.69 \times 1200}{R_p \times \text{length in inches}}$$

where Z_o = characteristic impedance

c. Velocity Factor.
The velocity factor of a given section of cable may be determined from the relation

$$V = \frac{\text{physical length of } 1/2\,\lambda \text{ cable section}}{\text{length of } 1/2\,\lambda \text{ in air}}$$

3-30. BALANCED TRANSMISSION LINE. Dual or balanced transmission lines, such as "twinlead", cannot be measured by direct connection to the RX Meter terminals, but must be attached through a "balun". The function of the balun is to supply an RF signal which is equal and opposite in phase to each conductor of the balanced line, while providing an equally high resistance path to ground for both elements. There are a number of forms which can be used, depending on the situation. Several commercial types are available if desired. Probably the simplest type of balun can be made by doubling a one half wavelength section of coaxial line and connecting the outer conductors at the ends.

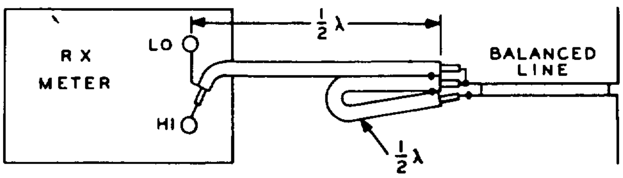


Figure 3-6. 1/2 Wavelength Balun

The outer conductors are then connected to the RX Meter LO post, and one center conductor is connected to the HI post. The balanced line may then be connected to both center conductors. Figure 3-6 illustrates such a balun connected at the end of a half wavelength resonant section which eliminates the inductance effects of the instrument's binding posts. Since this type of balun acts as a 2:1 voltage transformer, or a 4:1 impedance transformer, the factor 4 must be used in computing the desired characteristics from the measurements made.

a. Characteristic Impedance

(1) Measure the balun open-circuited on the RX Meter. If the length is correct, C_p should equal essentially zero. If not, readjust the frequency slightly until the length is correct. Record the R_p reading as R_1.

(2) Measure and cut a section of the balanced line to be measured slightly longer than one quarter and attach it to the balun with the far end shorted. Shorten the line gradually by cutting off small pieces until C_p once again is essentially zero. (do not readjust the frequency).

(3) Connect a half-watt resistor of approximately 100Ω to the far end of the quarter-wave line and measure the R_p of the combination. Call this value R_2.

(4) Then the equivalent resistance (R_3) of the quarter-wave cable terminated by the resistor is given by,

$$R_3 = 4\,\frac{(R_1 \quad R_2)}{(R_1 \quad R_2)}$$

(5) Measure the R_p of the resistor connected directly to the RX Meter terminal. Call this value R_4.

(6) Then $Z_o = \sqrt{R_3 \quad R_4}$

b. Attenuation

(1) Measure the balun open-circuited on the RX Meter, making sure that C_p is approximately equal to zero. Record R_p as R_1.

(2) Measure a half-wavelength section (or multiple thereof, to provide a minimum length of 4 feet), open-circuited at the far end, and record the resulting R_p as R_2. (Capacitance effects can be minimized by leading the balanced line vertically away from the bridge.)

(3) Then the parallel resistance of the cable (R_3), as seen through the balun, is

$$R_3 = 4\,\frac{(R_1 \quad R_2)}{(R_1 - R_2)}$$

(4) Attenuation is dB/100 feet ≈

$$\frac{Z_o}{R_3} \times 8.69 \times \frac{1200}{\text{length in cable in inches}}$$

c. Velocity of Propagation
The velocity of propagation of balanced line may be determined in the same manner as that described for coaxial lines.

3-31. VACUUM TUBE INPUT IMPEDANCE. The dynamic input impedance of a vacuum tube is frequently an important parameter to the design engineer. The RX Meter provides a convenient, accurate method of measuring the resistive and capacitive components of this impedance under actual operating conditions. A typical experimental circuit for the measurement of a triode is illustrated in Figure 3-7. In many cases it will be necessary to reduce

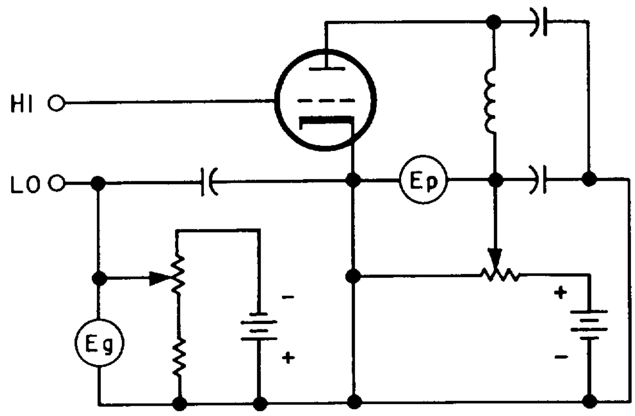


Figure 3-7. Typical Circuit for Measuring Vacuum Tube Input Impedance

the RF voltage at the RX Meter measuring terminals by the method described in Paragraph 3-18, Reduction of Signal Level. Since the inductance and resistance of connecting leads will seriously affect the results, it is important that the tube socket be located directly at the RX Meter binding post. If a number of measurements are to be made, it may be found practical to improvise a special jig for this purpose. If it is not possible to locate the socket in this manner, measurements may be made at the end of a half-wave coaxial line.

3-32. MEASUREMENT OF NONLINEAR IMPEDANCE. Strictly speaking, the unqualified term "impedance of a nonlinear component" is not definitive. This is because the instaneous average and RMS impedance of a nonlinear component will vary with the following:

1. Level of applied dc voltage
2. Level of applied dc bias
3. Rectification, or axis shift, of the ac current

In dealing with nonlinear elements such as diodes, the impedance should be stated as "a small signal impedance at a specified value of direct current". In order to avoid differences in impedance caused by large variations in signal level, the applied signal should be kept below the value which increases the dc current present by 25%. Nonlinear impedances, such as diodes, may be measured satisfactorily on the RX Meter if certain precautions are taken in the measuring technique and in the interpetation of results.

3-33. When a nonlinear element is placed across the RX Meter terminals, an intermodulation effect is observed which causes the values measured with the element connected in one position across the terminals to differ, to some extent, from the values measured with the element reversed. This is due to the fact that, through internal leakage, a small portion of the local oscillator signal appears across the measuring terminals. When the unknown impedance across the terminals is nonlinear, this leakage signal beats with the main bridge signal at the IF frequency. This false IF signal is then coupled back to the modulator where it combines with the true signal from the bridge. A bridge unbalance (i.e. false balance) is then required to cancel the false signal. Reversing the nonlinear element will reverse the false IF voltage and require a bridge unbalance in the opposite direction to obtain a null.

3-34. There are several possible corrections which may be made for this effect, depending on the difference observed in readings with reversal of the component, and on the accuracy desired. If the two values which result from measuring the nonlinear element in reversed positions are no more than 10% apart, the arithmetic average of the two values will be within 1% of the normal accuracy of the RX Meter. When the difference between the two values is of the order of 2:1, this averaging method will give results within ±20% of the normal accuracy of the RX Meter. When the two readings differ by more than 10% and good accuracy is desired, the difference can usually be reduced by lowering the detector oscillator voltage. This may be done by inserting a pad in the line from the detector oscillator to the bridge. In some cases, a 6 dB pad may be found necessary. Any type of attenuator may be used, as long as its impedance is of the order of 50 ohms.

3-35. Reducing the oscillator voltage may, in some cases, cause excessive reduction in sensitivity and an alternative method is required. In such cases, the oscillator voltage may be dispensed with entirely and replaced by a good communications receiver with an isolating RF stage, which may be used as the detector. This will prevent the oscillator voltage from leaking into the measuring circuit. To do this it is usually sufficient merely to disconnect the oscillator cable. If further leakage is suspected, however, the oscillator jack should be capped. The receiver should be connected to the mixer output cable of the bridge to which IF amplifier is normally connected. Coaxial cable should be used to connect the receiver, and care should be taken to shield the receiver input from the bridge terminals so that the receiver does not pick up voltage from them. Since no modulation is present on the signal oscillator, the receiver carrier level meter should be used as a null indicator. If an aural indication is desired, the BFO in the receiver may be used and a null of the beat note used as indication of balance. When measuring with the receiver as a detector no change of reading should be observed when the nonlinear element is reversed, other than a normal change of capacitance due to a change in position. If the receiver is properly shielded, the balance will not be affected by placing a hand on the interconnecting cable or on the receiver cabinet. If this does affect the balance, the shielding should be improved.

3-36. When a nonlinear element is biased so as to produce an essentially linear response, no intermodulation will occur and the element may be measured without correction for this effect. Biasing may be applied as shown in Figures 3-8 and 3-9.

3-37. METHOD OF APPLYING DC BIAS. When it is desired to apply DC bias to a component being measured, one of two methods may be used, depending on the amount of current to be passed through the component. If the current is less than 50 mA it may be passed directly through the RX Meter measuring circuit (which presents a resistance of about 66Ω) without affecting the results, as indicated in Figure 3-8. In this circuit, R should

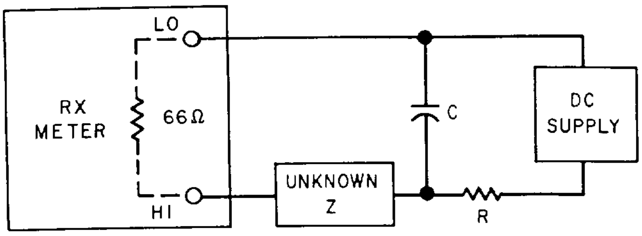


Figure 3-8. Applying Biasing Current Less than 50 mA

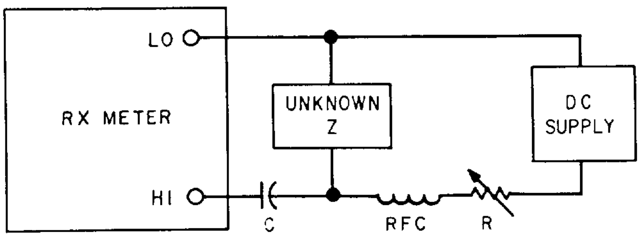


Figure 3-9. Applying Biasing Current Greater than 50 mA

be kept as large as possible to isolate the power supply, and C should be made large enough to present negligible reactance at the measuring frequency. When the current is greater than 50 mA it cannot be applied to the RX Meter terminals, and the alternative circuit of Figure 3-9 must be used. Here C must be large enough to offer negilible reactance at the measuring frequency while the reactance of the choke must be high. In this case, before connecting the component to be measured, the instrument should be balanced by means of the ZERO BALANCE controls with the DC supply circuit connected. If the zero balance controls have insufficient range, obtain initial balance of the instrument with nothing connected; then measure the C_p and R_p of the DC supply circuit. Subsequent measurements of the unknown impedance can then be corrected for the effect of the DC supply circuit as follows:

$$C_p \text{ (unknown)} = C_p \text{ (unknown + DC supply)} - C_p \text{ (DC supply)}$$

$$R_p \text{ (unknown)} = \frac{R_p \text{ (DC supply)} \times R_p \text{ (unknown + DC supply)}}{R_p \text{ (DC supply)} - R_p \text{ (unknown + DC supply)}}$$

3-38. 250B OPERATION WITH COAX ADAPTER KIT INSTALLED

3-39. INITIAL ADJUSTMENTS. With the Coax Adapter Kit installed, adjust the 250B as follows:

a. With the bridge slightly unbalanced, select desired frequency and adjust DETECTOR TUNING control for peak meter response.

b. Set R_p control to infinity, and balance the bridge by means of ZERO BALANCE "R" controls and C_p control.

NOTES

After setting ZERO BALANCE controls, do not readjust.

c. Mount 50-ohm termination on the adapter and set C_p control to zero. Balance the bridge by means of ZERO BALANCE "C" control and R_p control. The R_p dial should indicate 50 ohms ±1.5 ohms, the tolerance being that of the bridge and resistor. Since the reactance has been balanced at 50 ohms and the resistance balanced at infinity, the 250B is ready for use and the termination may be removed.

3-40. APPLICATIONS. The Coax Adapter Kit may be used as follows:

a. Remote Measurements. Under certain conditions it may be inconvenient or undesirable to position the component or circuit to be measured directly at the RX Meter terminals. In such cases measurements may be made at distance of several feet or more by means of an interconnecting length of low-loss coaxial cable. In order to provide maximum accuracy and convenience of measurement the cable used should be a resonant section one-half wavelength (or an integral multiple thereof) long when sufficiently high frequencies are being used to make the cable length practical and the loss sufficiently low. Since a 1/2 wavelength transmission line is, effectively, a 1:1 impedance transformer, an impedance connected to one end will be reflected almost identically at the other regardless of the characteristics of the line itself. If such a line is connected between the coax adapter and an unknown impedance, the impedance may be regarded as being connected directly to one corner of the bridge itself. The resonant 1/2 wavelength line may be obtained by measuring and cutting the cable to roughly the correct dimensions, attaching it to the adapter, and adjusting either the cable length (an adjustable air line is convenient in this application) or the frequency until the RX Meter indicates zero reactance at balance. If an adjustable line is not used, it is usually found most practical to adjust the frequency. This should be done in small increments, and care should be taken to retune the DETECTOR TUNING control after each frequency change. When the C_p dial reads zero at balance, the correct length has been obtained. It should be noted, however, that for higher impedance measurements, cable losses may become significant and should be accounted for when accurate results are desired. These losses should be calculated by conventional methods.

When a half-wave resonant line is connected to the RX Meter, the effect of the 0.003 microhenry residual binding post inductance is no longer present. In addition, the possibility of slight inaccuracies caused by capacitive effects between the unknown component and the terminal plate is eliminated.

If necessary, random-length (rather than half-wavelength) cable sections may be used for remote measurements. In this case, only 50Ω line should be used. The measurements obtained must be transformed by means of a Smith Chart (or by calculation), and for this purpose the exact electrical length of the section must be know. In obtaining this length, allowance must be made for the fact that the RX Meter binding posts are not connected directly to the bridge circuit, but are separated from it by leads which are roughly equivalent to about 2 inches of 50-ohm line. Thus, to obtain the effective length of random-length section, the measurement must be made from the far end of the cable to a point roughly 2 inches below the terminal plate of the instrument. When the length of this virtual extension must be known more precisely, it may be determined by use of a rigid, adjustable 50 ohm air line. The line should be adjusted to 1/4 wavelength at the desired frequency (indicated by $C_p = 0$ at balance).

The actual length of 1/4 wavelength may be computed from the relation, wavelength = C/f, where C is the velocity of light, and f is the measuring frequency. The virtual extension of the line, inside the instrument, is then equal to the difference between the computed 1/4 wave-length and the distance from the end of the line to the terminal plate of the instrument. This value should be added to the physical length of all cables connected to the RX Meter in determining their effective electrical length.

b. Transmission Line Characteristics. The adpater may also be used for the purpose of connecting a coaxial line to the RX Meter for the measurement of its own characteristics, although direct connection of the cable elements to the binding posts is usually slightly more accurate where convenient. When the adapter is used, very accurate transmission line characteristic measurements may be made at the end of a 1/2 wave-length section, as described above.

3-41. NORMAL MEASUREMENTS. Measurements which do not require the use of the adapter may be made by merely unscrewing the outer and center conductors of the adapter and replacing the HI post clamping nut. The adapter mounting plate may be left in place. This plate adds a capacitance of 0.3 pF to the bridge circuit, but under ordinary conditions this will not affect bridge balance because of the compensating capacitance available in the ZERO BALANCE "C" control. However, if it should be found impossible to effect preliminary bridge balance by means of this control, the C_p control may be used to provide the slight additional compensation necessary. The amount of this compensation (0.1, 0.2, or 0.3 pF) should then be subtracted from all C_p readings.

3-42. 250B OPERATION WITH TRANSISTOR TEST JIG INSTALLED

3-43. GENERAL. The 13510A Transistor Test Jig is designed so that when the RX Meter is balanced with one test circuit board at a given frequency, no additional balancing will be required when using the other two test circuit boards at the same frequency. There is one control located on the transistor test jig. This control is an RF switch found on the y_{ib} and y_{ie} boards only. For measurements above 10 MHz, the switch is closed by tightening the knurled nut. (For additional information, refer to the 13510A Transistor Test Jig Operating and Service Manual.)

3-44. MEASUREMENT PROCEDURE. 250B measurements with the Transistor Test Jig are performed as follows:

a. Using an RF millivoltmeter (such as an -hp- 411A), measure the RF level across the RX Meter measurement terminals. For most small signal measurements this level should be reduced to 15-20 mv. (See Paragraph 3-18.)

b. Slide the desired test circuit board in place without a transistor and balance the RX Meter. (See Paragraph 3-10.)

c. Connect power supplies to E, B, and C terminals of mounting adapter. (Observe polarity for type of semiconductor to be tested.) Power supplies should be OFF with output controls set at minimum.

d. Place the transistor to be tested in the socket. Pay particular attention to the orientation by observing the E, B, and C markings on the transistor socket.

e. Turn ON the bias supplies and increase the bias voltages and currents to the desired levels.

f. Balance the main C_p and R_p dials and record the R_p and C_p values.

g. Calculate required "y" parameter as follows:

$$y_{(\ )} = \frac{1}{R_p} + j\omega C_p.$$

h. Refer to applicable Operating and Service Manual for additional information.

NOTE

Field effect transistors, when measured on the 13510A Transistor Test Jig, will require different socket designations. The equivalent terminology is as follows:

Conventional Transistor	F. E. T.
Collector (C)	Drain
Base (B)	Gate
Emitter (E)	Source

3-45. PREPARATION OF TEST TRANSISTOR. For precise measurements, transistor leads should be trimmed so the transistor is 1/16" to 1/8" above the surface of the test circuit board. Lead penetration into the transistor socket is limited to 5/16", so the leads should be cut accordingly. The socket is designed to spread the leads of a transistor with three leads located on a .100" diameter circle and to squeeze the leads of a transistor with three leads located on a .200" diameter circle. This insures good contact to the coin silver transistor socket contact.

PRINCIPLES OF OPERATION SECTION IV

4-1. INTRODUCTION.

4-2. The 250B RX Meter is a versitile bench type test instrument that measures equivalent parallel resistance and parallel reactance over the frequency range of 500 kHz to 250 MHz. The following paragraphs describe the 250B at a block diagram level, and provide individual descriptions of its major functional groups. In addition, the Transistor Test Jig principles of operation are also described.

4-3. OVERALL DESCRIPTION.

4-4. A block diagram of the 250B appears in Figure 4-1. The output of the signal oscillator, continuously variable in frequency from 0.5 to 250 MHz, is coupled directly into the bridge circuit. The unknown impedance is connected in parallel across one arm of the bridge. When unbalance occurs, a voltage proprotional to the amount of unbalance is applied to the mixer where it is mixed with the output of the detector oscillator. The latter is gang-tuned with the signal oscillator and its output is maintained at 105 kHz above the main signal frequency. When both signals are applied to the mixer, a 105 kHz beat note is produced which is fed through a selective, high gain amplifier and applied to the null indicating meter. When the bridge circuit is balanced (in both amplitude and phase), no signal from the main oscillator will be applied to the mixer and the 105 kHz signal will not be produced. Thus a minimum indication on the null meter signifies a balanced condition. A delayed automatic gain control is used to keep the null indicator from going off scale even when the bridge is at maximum unbalance, thus providing continuous sensing. Maximum gain of the amplifier is used only when the bridge is very close to the balanced condition.

4-5. OSCILLATOR ASSEMBLY.

4-6. The oscillator assembly consists of two separate, modified Colpitts oscillators, constructed on a single aluminum casting. Ganged turrets provide for band switching with a single control, and the tuning capacitors are also ganged to provide a constant difference frequency of 105 kHz between the signal and detector oscillator. A manually adjustable trimmer condenser (DETECTOR TUNING Control) is provided in the detector oscillator to adjust for tracking deviations caused by temperature, aging of tubes, and slight misalignment of tuning capacitors.

4-7. The output of the signal oscillator is coupled into the bridge circuit by means of a specially devised transformer which overcomes the limitations imposed by more conventional coupling methods. The design of this transformer is illustrated in Figure 4-2. It will be noted that the bridge network is divided in two halves, one half being driven by voltage E_1 and the other by E_2. Assume that voltages E_1 and E_2 are exactly equal in magnitude but opposite in phase, thus producing instantaneous currents I1 and I2 in the direction indicated. This arrangement makes it possible to detect bridge balance conditions by coupling to the null detector through two very small but exactly equal capacitors, Z_B and Z_C. In the balanced condition, voltage E_D becomes zero, as indicated by the null detector, and the voltage across Z_B is exactly equal to that across Z_C. This is evident, since the same current, I3, flows through both Z_B and Z_C when zero current is drawn by the detector branch. Since X and G are the same potential, it follows that Z_B may be considered effectively in parallel with Z_A, and similarly C_2 is in parallel with ZD. Thus the voltage across Z_A and Z_B in parallel = Z_1, and Z_C and Z_D in parallel = Z_4.

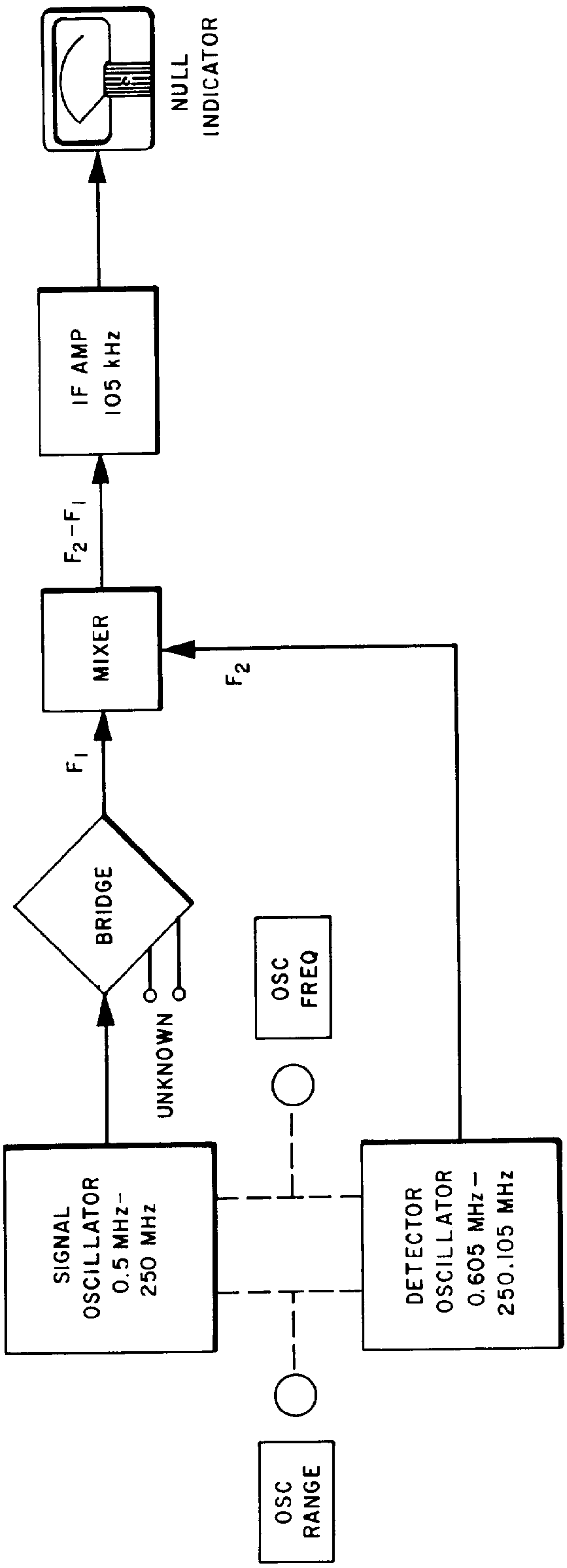


Figure 4-1. 250B Block Diagram

$$E_1 = I_1 Z_2 + I_1 Z_1$$

$$E_2 = I_2 Z_3 + I_2 Z_4$$

$$E_1 = E_2 \text{ (by design)}$$

and $I_1 Z_1 = I_2 Z_4$ at balance

then $I_1 Z_2 = I_2 Z_3$

$$\frac{I_1 Z_1}{I_1 Z_2} = \frac{I_2 Z_4}{I_2 Z_3} \text{ and } Z_1 Z_3 = Z_2 Z_4$$

This impedance arm relationship is the same as that of a conventional bridge network.

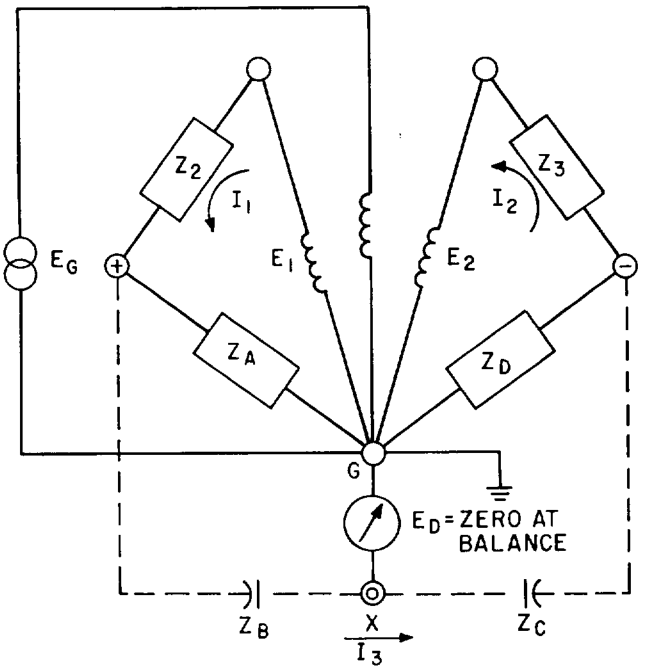


Figure 4-2. Oscillator-to-Bridge Coupling Circuits

4-8. BRIDGE ASSEMBLY.

4-9. A modified Schering Bridge circuit is used in the RX Meter and was selected primarily because of the following characteristics:

1. A virtually constant relationship between the bridge elements is maintained, regardless of the frequency impressed on the network.

2. Both of the basic variable bridge elements are air capacitors, which are definitely superior to other types of variable impedances for high frequency measurement work.

3. The circuit residual impedance is small enough to permit compensation over a wide frequency band.

4. Because parallel impedance components are measured, shielding problems are considerably reduced.

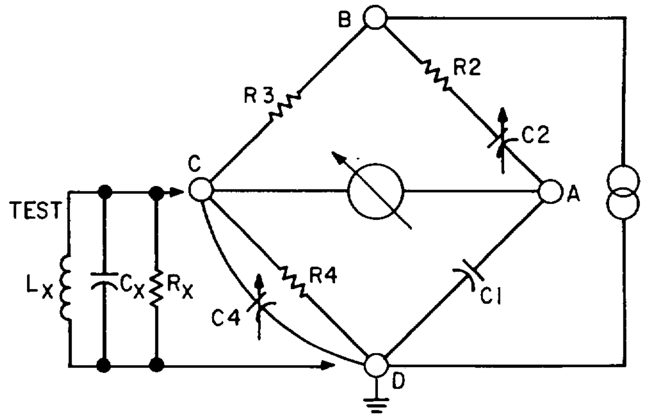


Figure 4-3. Schering Bridge Circuit

4-10. The simplicity and wide frequency range of this bridge network can be appreciated by an analysis of the impedance relationships for the balanced condition. Referring to Figure 4-3,

$$Z_{AB} Z_{CD} = Z_{AD} Z_{BC} \text{ at balance,}$$

or

$$\left(R2 + \frac{1}{j\omega C_2}\right)\left(\frac{1}{\frac{1}{R_4} + j\omega C_4}\right) = \frac{R_3}{j\omega C_1}$$

$$R_2 + \frac{1}{j\omega C_2} = \frac{R_3}{j\omega C_1}\left(\frac{1}{R_4} + j\omega C_4\right)$$

$$= \frac{R_3}{j\omega C_1 R_4} + \frac{C_4 R_3}{C_1}$$

Equating reals . . .

$$R_2 = \frac{C_4 R_3}{C_1}, \text{ and } \frac{R_2}{C_4} = \frac{R_3}{C_1}$$

Equating imaginaries . . .

$$\frac{1}{j\omega C_2} = \frac{R_3}{j\omega C_1 R_4}$$

$$\frac{R_3}{C_1} = \frac{R_4}{C_2}$$

$$\therefore \frac{R_2}{C_4} = \frac{R_3}{C_1} = \frac{R_4}{C_2}$$

4-11. The unknown impedance is connected across corners C and D of the bridge, and its parallel components of resistance and reactance effectively change the values of C4 and R4 in the circuit. In order to restore phase and amplitude balance, the variable capacitor C4 must be decreased by an amount equal to the equivalent parallel capacitance of the test sample. If the test sample is inductive, the capacitance of C4 is increased by an amount equal to the resonating capacitance of the parallel inductances. The parallel resistance of the test is shunted across R4, reducing its value by a percentage which changes the R4/C2 ratio and amplitude balance, capacitor C2 is reduced in value by the same percentage that R4 was reduced when shunted by the test resistance. The variable capacitor C2 can thus be calibrated directly in terms of the parallel resistance of the component being measured.

4-12. The mixer stage is constructed as an integral part of the bridge assembly in order to reduce to a minimum the length of connections between the capacitance coupling networks and the modulator tube grid. This is important in order to maintain voltage sensitivity with respect to the bridge corners. A nuvistor was selected for this application because of its high transconductance, low input capacitance, and low noise factor.

4-13. IF AMPLIFIER ASSEMBLY.

4-14. The two-stage 105 kHz amplifier is designed with a wide (40 kHz) passband to facilitate oscillator tuning and tracking but minimize response to spurious signals and harmonics. Delayed automatic gain control keeps the null indicator on scale at all times and provides maximum sensitivity at settings close to the balance point. The sensitivity of the null indicator has been kept high by reducing the value of the resistance in series with the meter and providing the required additional protection by means of a shunt crystal diode across the meter circuit.

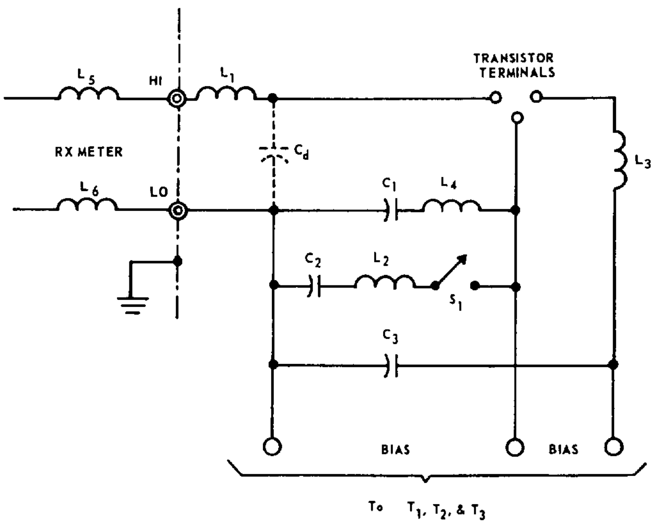
4-15. POWER SUPPLY ASSEMBLY.

4-16. The RX Meter power supply is of convential design, providing regulated +150 VDC for the oscillators, IF amplifiers, and mixer. A regulated -6.3 VDC is also provided for the oscillator and mixer heaters. The IF amplifier heaters are supplied with unregulated 6.3 VAC. The +150 volt supply is protected from short circuits by Fuse F2 and a "Crowbar" consisting of Thyristor Q1, Diode CR3, and Resistors R4 through R7. The "Crowbar" does not operate during normal regulator operation, and does not affect regulator performance. If a short circuit occurs, the voltage across R7 increases until it exceeds the breakdown voltage of CR3. When CR3 breaks down, a gate current is supplied to the Thyristor causing it to conduct heavily. The high current through the Thyristor causes the fuse to open before the Series Regulator transistor is damaged.

4-17. TRANSISTOR TEST JIG.

4-18. The 13510A Transistor Test Jig provides a convenient means of connecting a transistor to the terminals of the RX Meter. It also provides terminals for biasing and a means of preventing the bias supplies and leads from becoming a part of the measurement. Since the transistor jig was designed to measure "y" or "short-circuit" parameters, each test circuit must also provide a short circuit at the proper points.

4-19. An equivalent RX circuit appears in Figure 4-4 showing the residual inductances and capacitances that must be accounted for to achieve optimum accuracy. The capacitances can be balanced out by the RX Meter. The residual inductances are kept to a minimum and controlled to maintain consistency to approximately ±10%. Control of residual inductances helps to simplify corrections. Also, to simplify corrections, an RF switch is incorporated on the y_{ie} and y_{ib} test circuit boards to eliminate the first resonance of the high frequency bypass system. Refer to the Transistor Test Jig Operating and Service Manual for additional information.



Cd	-	Distributed Capacity of High Terminals
C1	-	29 µf - 30 v Capacitor
C2	-	0.1 µf 50 v Capacitor
C3	-	Same as C2
L1	-	3 nh Lead and Terminal Inductances
L2	-	4 nh Lead and Terminal Inductances
L3	-	8.5 nh Lead and Terminal Inductances
L4	-	34 nh Lead and Terminal Inductances
L5, L6	-	3 nh RX Meter Terminal Inductance
S1	-	RX Switch
T1-3	-	Bias Terminals

Figure 4-4. Equivalent RF Circuit

MAINTENANCE SECTION V

5-1. INTRODUCTION.

5-2. This section contains all the maintenance and service information required for the 250B RX Meter. The type of information covered is briefly summarized below:

a. Assembly and Component Identification - identifies and physically locates the 250B assemblies and adjustments.

b. Test Equipment Required - lists and describes the instruments required to perform the operations contained in this section.

c. Performance Checks - used as an operational check of the 250B.

d. Troubleshooting and Adjustments - used to repair and adjust defective instruments.

e. Circuit Board Repair - provides techniques for etched circuit board repair and component replacement.

5-3. ASSEMBLY AND COMPONENT IDENTIFICATION.

5-4. Figures 5-1 and 5-2 illustrate the location of the 250B assemblies and adjustments. Assemblies are identified by a number, prefixed by the letter "A"; for example A2. Components of A2 will be identified A2R1, A2C1, A2L1, etc. Chassis components do not receive a prefix letter.

5-5. Each board-mounted component is identified on an illustration of the board assembly. These assembly illustrations appear in Section VII, with the schematic of the assembly. In addition, the illustration also shows the etched wiring on both sides of the board.

5-6. TEST EQUIPMENT REQUIRED.

5-7. The test equipment required to perform the operations of Section V are listed in Table 5-1. This table describes the type instrument required, its pertinent characteristics, its use, and the model number and manufacturer of a recommended instrument. If the recommended instrument is not available, equipment which meets or exceeds the pertinent characteristics may be substituted.

NOTE

Operating instructions for test equipment has been limited to those functions required to check the 250B. For complete test equipment operating instructions refer to the applicable manual.

5-8. PERFORMANCE CHECKS.

5-9. Table 5-2 contains the performance checks for the 250B. These checks are used to verify instrument specifications for the following situations:

- Initial inspection
- Periodic check for instruments used in systems where reliability is of utmost importance
- Troubleshooting assistance to locate operation problems
- Repairs and adjustments
- Prior to returning instrument to service after extended storage.

NOTE

Allow 1/2 hour warmup time prior to starting the performance checks. All checks are performed with the SET RF LEVEL control in the NORMAL position, unless otherwise stated.

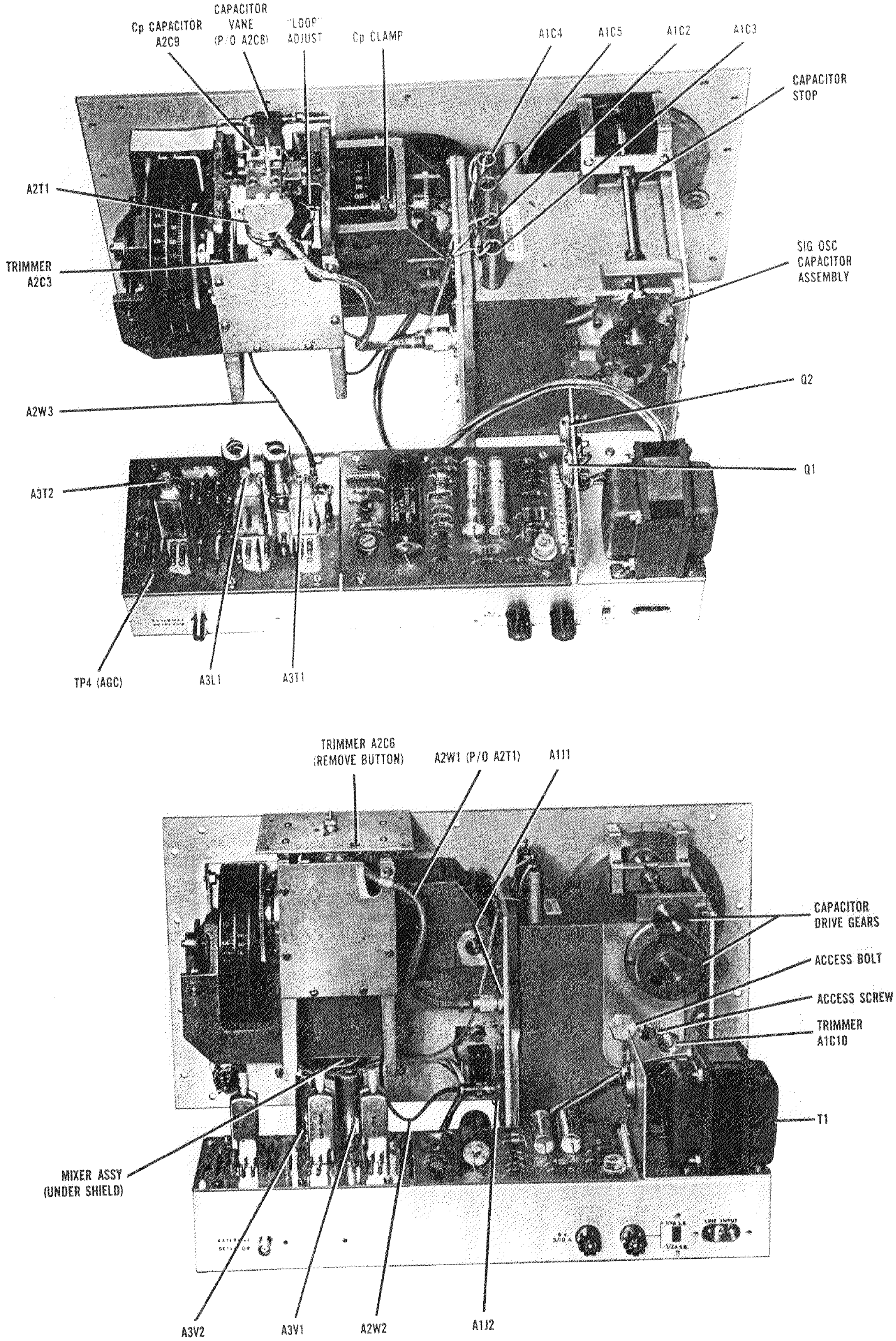


Figure 5-1. 250B RX Meter, Rear View

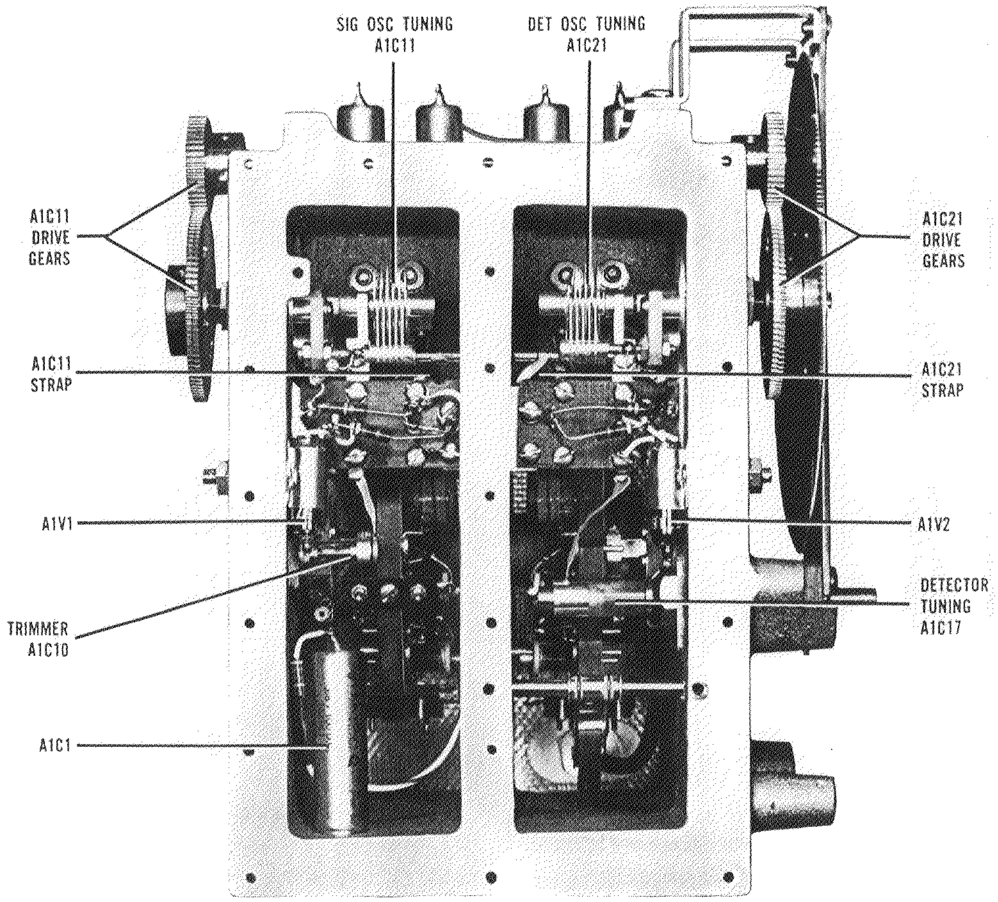


Figure 5-2. Oscillator Assembly, Left Side

TABLE 5-1. TEST EQUIPMENT REQUIRED

Instrument Type	Pertinent Characteristics	Use	Instrument Recommended
Electronic Counter	0.5 MHz to 250 MHz	Performance Checks, Adjustments	-hp- 5245L with 5253B Plug-in
Precision Resistors	200Ω 1/2%, 3KΩ 1/2%, 10KΩ 1/2%	Performance Checks, Adjustments	-hp- 5080-1717
Precision Capacitor	35 pF to 115 pF	Performance Checks, Adjustments	General Radio 1422-D
Inductor	1 mH	Performance Checks, Adjustments	-hp- 00103-A31
Inductor	500 μH	Performance Checks, Adjustments	-hp- 00103-A25
Electronic Voltmeter	DC range - 1 V to 200 V AC range - 1 mV to 10 V	Adjustments	-hp- 410C
Oscilloscope	Balanced input, good linearity	Adjustments	-hp- 130C
Audio Oscillator	105 kHz output	Adjustments	-hp- 400CD
Sweep Oscillator	10 MHz output, 10 Hz sweep rate, 1 MHz sweep width	Adjustments	-hp- 3211A with 3213A Plug-in
Cable	Dual banana plug to BNC male	Adjustments	-hp- 11001A
Cable	Dual banana plug to alligator clips	Adjustments	-hp- 11002A
Cable	BNC male to BNC male	Adjustments	-hp- 10503A
Adapter	Connect BNC male to TNC male	Adjustments	Amphenol 76400

TABLE 5-2. PERFORMANCE CHECKS

1. FREQUENCY ACCURACY

This is a check of the specified frequency accuracy of the 250B.

Specification: ±2% of dial reading.

Connect an electronic counter (-hp- 5245L with 5253B Plug-in) to the HI and LO terminals. Check the accuracy of the Signal Oscillator at various frequencies on all ranges of the 250B. If any frequencies are not within the specified ±2%, refer to Paragraph 5-16.

2. Rp ACCURACY

This is a check of the resistance measurement accuracy at selected increments across the Rp ohms dial. It is performed by measuring components of known characteristics and accuracy.

Specification: $\pm\ (2 + \frac{F}{200} + \frac{R}{5000} + \frac{Q}{20})\%$ ±0.2 ohms

For this check the equation may be simplified as follows:

±2% at 200 ohms
±2.6% at 3K ohms
±4% at 10K ohms

NOTE

The following checks of the Rp ohms dial at 200 ohms, 3K ohms, and 10K ohms are usually sufficient to assure proper calibration.

a. Set OSC RANGE control to .5-1 MHz range; set OSC FREQ control to 0.5 MHz.

b. Balance bridge using conventional 250B operating procedures (see Paragraph 3-10).

c. Measure the following 1/2% precision resistors; 200 ohms, 3K ohms, and 10K ohms. (-hp- No. 5080-1717 is a set of all three resistors.)

NOTE

Use shortest lead length possible to connect precision resistors to terminal posts.

d. If any of the above resistance measurements do not meet specifications, refer to Paragraph 5-28a.

e. Set OSC RANGE control to 110-250 MHz range; set OSC FREQ control to 250 MHz.

f. Balance bridge using conventional procedures.

g. Measure the 200 ohm 1/2% precision resistor; if the measurement does not meet specification, refer to Paragraph 5-28b.

NOTE

The Rp ohms dial is hand-marked and engraved for each instrument. The adjustments referred to above can be used to slightly improve the Rp accuracy; large errors in accuracy will require the engraving of a new dial. For information contact your Hewlett-Packard Sales and Service Office (a list of offices is provided at the rear of this manual).

TABLE 5-2. PERFORMANCE CHECKS

1. FREQUENCY ACCURACY

This is a check of the specified frequency accuracy of the 250B.

Specification: ±2% of dial reading.

Connect an electronic counter (-hp- 5245L with 5253B Plug-in) to the HI and LO terminals. Check the accuracy of the Signal Oscillator at various frequencies on all ranges of the 250B. If any frequencies are not within the specified ±2%, refer to Paragraph 5-16.

2. Rp ACCURACY

This is a check of the resistance measurement accuracy at selected increments across the Rp ohms dial. It is performed by measuring components of known characteristics and accuracy.

Specification: $\pm\left(2 + \frac{F}{200} + \frac{R}{5000} + \frac{Q}{20}\right)\% \pm 0.2$ ohms

For this check the equation may be simplified as follows:

±2% at 200 ohms
±2.6% at 3K ohms
±4% at 10K ohms

NOTE

The following checks of the Rp ohms dial at 200 ohms, 3K ohms, and 10K ohms are usually sufficient to assure proper calibration.

a. Set OSC RANGE control to .5-1 MHz range; set OSC FREQ control to 0.5 MHz.

b. Balance bridge using conventional 250B operating procedures (see Paragraph 3-10).

c. Measure the following 1/2% precision resistors; 200 ohms, 3K ohms, and 10K ohms. (-hp- No. 5080-1717 is a set of all three resistors.)

NOTE

Use shortest lead length possible to connect precision resistors to terminal posts.

d. If any of the above resistance measurements do not meet specifications, refer to Paragraph 5-28a.

e. Set OSC RANGE control to 110-250 MHz range; set OSC FREQ control to 250 MHz.

f. Balance bridge using conventional procedures.

g. Measure the 200 ohm 1/2% precision resistor; if the measurement does not meet specification, refer to Paragraph 5-28b.

NOTE

The Rp ohms dial is hand-marked and engraved for each instrument. The adjustments referred to above can be used to slightly improve the Rp accuracy; large errors in accuracy will require the engraving of a new dial. For information contact your Hewlett-Packard Sales and Service Office (a list of offices is provided at the rear of this manual).

TABLE 5-2. PERFORMANCE CHECKS (CONT)

3. Cp ACCURACY

This is a check of the capacitance measurement accuracy of the Cp pF dial. It is performed by comparing incremental changes on the dial with that of a variable Precision Capacitor of greater accuracy. Bridge balance is used as an indication of equal and opposite incremental changes in capacitance; if the Precision Capacitor is reduced 10 pF, the Cp pF setting must be increased the same amount to re-balance the bridge. An inductor is connected in parallel with the Precision Capacitor to resonate with its capacitive reactance plus that of all interconnecting conductors.

Specification: $\pm (0.5 + 0.5 F^2 C \times 10^{-5})\% \pm 0.15$ pF

For this check the equation may be simplified as follows:

$\pm (0.5\% + 0.15 \text{ pF})$

a. Set OSC RANGE control to .5-1 MHz range; set OSC FREQ control to 0.5 MHz.

b. Balance bridge using conventional 250B operating procedures (see Paragraph 3-10).

c. Connect test setup shown below using -hp- 00103-A31 Inductor.

NOTE

Keep leads to terminal posts as short as possible.

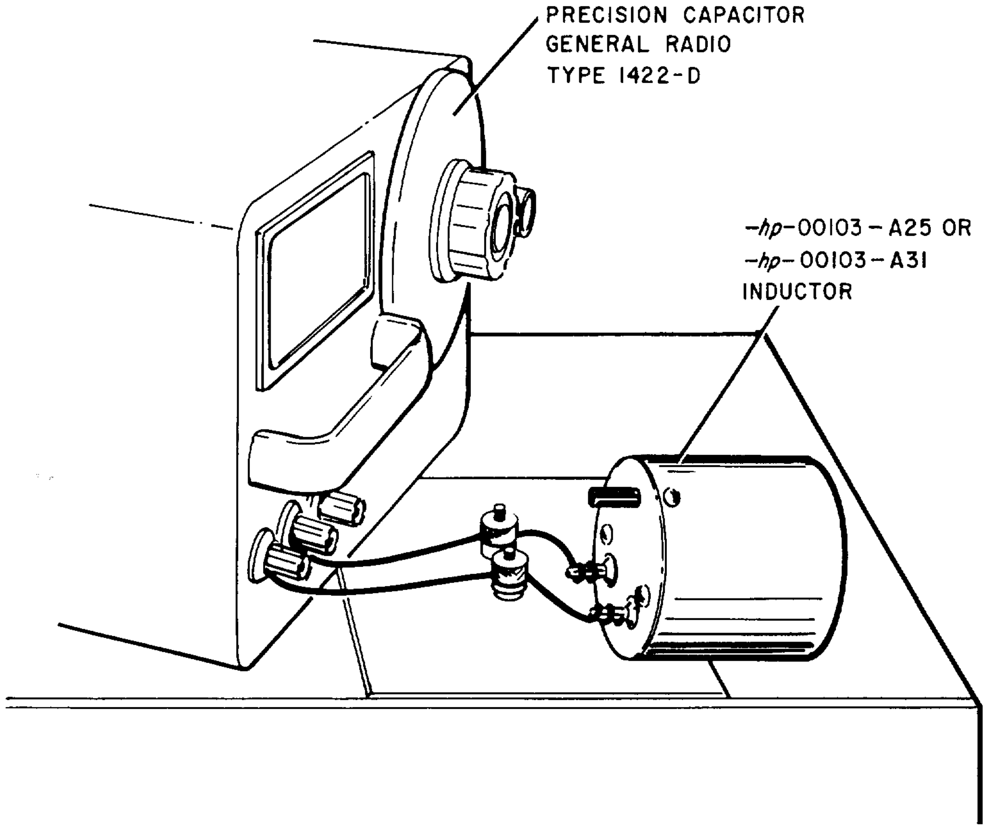


TABLE 5-2. PERFORMANCE CHECKS (CONT)

d. Set Precision Capacitor to 95 pF.

e. Alternately adjust OSC FREQ control and Rp ohms control for sharpest null on NULL/RF LEVEL INDICATOR.

f. Increase Precision Capacitor setting from 95 pF to 105 pF. Using Rp ohms and Cp pF controls only, obtain the sharpest null; Cp pF dial should indicate +10 pF (within specification limits).

g. Increase Precision Capacitor setting to 115 pF, obtain null with Rp ohms and Cp pF controls, and check Cp pF dial for indication of +20 pF.

h. Decrease Precision Capacitor setting in 10 pF increments to check Cp pF dial from 0 to -60 pF. At each increment use Rp ohms and Cp pF controls to obtain sharpest null.

i. In test setup, replace -hp- 00103-A31 Inductor with -hp- 00103-A25 Inductor.

j. Set Precision Capacitor to 115 pF; set Cp pF dial to exactly -60 pF.

k. Alternately adjust OSC FREQ control and Rp ohms control for sharpest null on NULL/RF LEVEL INDICATOR.

NOTE

Steps j and k have established -60 pF as a reference point for further Cp measurements.

l. Decrease Precision Capacitor setting in 10 pF increments to check Cp pF dial from -60 to -100 pF. At each increment use Rp ohms and Cp pF controls to obtain sharpest null.

m. If any of the above Cp pF dial measurements do not meet specifications, refer to Paragraph 5-27.

5-10. TROUBLESHOOTING AND ADJUSTMENTS.

5-11. GENERAL.

5-12. The following paragraphs describe the recommended troubleshooting techniques for isolating some of the most common 250B malfunctions. Procedures have been included to permit the adjustment of "out of spec" instruments and those instruments that have undergone repair. If any of the following procedures do not successfully adjust the 250B, contact your Hewlett-Packard Sales and Service Office; major repairs and adjustments must be done by trained personnel with special equipment.

5-13. The initial approach to isolating troubles in the 250B is as follows:

a. Ensure that the trouble is not a result of conditions external to the 250B by disconnecting all external instruments, circuits, and components.

b. Obtain all possible operating information from the front panel controls and logically apply this information to locate the defective assembly or component. Refer to Section III for 250B operating instructions and a description of the front panel controls.

c. Check power supply operation in accordance with Paragraph 5-15.

5-14. POWER SUPPLY ASSEMBLY.

5-15. Check the power supply as follows:

a. Measure the voltage at feedthru capacitors A1C2 and A1C5 (Figure 5-1); voltage should be -6.0 to -6.6 volts. If required, adjust with control A4R8 (Figure 5-1).

NOTE

The -6.3 volt supply is referenced to the +150 volt supply; first check the +150 volt supply for trouble if the -6.3 volt supply will not regulate.

b. Place SET RF LEVEL control in NORMAL position and check voltage at feedthru capacitors A1C3 and A1C4 (Figure 5-1); voltage should be +135 to +155 volts.

c. Rotate SET RF LEVEL control to fully counterclockwise position and check voltage at feedthru capacitors A1C3 and A1C4; voltage at A1C3 should be zero; voltage at A1C4 should be less than +80 volts.

5-16. OSCILLATOR ASSEMBLY.

5-17. RF OUTPUT CHECK. Check the operation of the Signal Oscillator and Detector Oscillator as follows:

a. Set OSC RANGE control to 110-250 MHz range; set OSC FREQ control to 110 MHz.

b. Balance bridge using conventional 250B operating procedures (see Paragraph 3-10).

c. Using an -hp- 410C Voltmeter (or equivalent), measure the RF output voltage (open circuit) at the Signal Oscillator output connector A1J1 (Figure 5-1) and the Detector Oscillator output connector A1J2.

d. The RF output voltage of both oscillators should be approximately 6 volts rms. If either oscillator indicates a low output, check its turret contacts, tube, and associated components.

5-18. RF LEAKAGE. The following check determines if RF leakage from the Oscillator Assembly is high enough to interfere with bridge balance.

a. Connect electronic counter (-hp- 5245L with 5253B Plug-in) to HI and LO terminals.

b. Set OSC RANGE control to 48-110 MHz range; set OSC FREQ control to 110 MHz (as indicated on electronic counter).

c. Balance bridge using conventional 250B operating procedures (see Paragraph 3-10).

d. Set OSC RANGE control to 110-250 MHz range; set OSC FREQ control to 110 MHz (as indicated on electronic counter).

e. Place two fingers across binding posts, and peak NULL/RF LEVEL INDICATOR with DETECTOR TUNING control. DO NOT move ZERO BALANCE controls.

f. Upon removing fingers from binding posts, the bridge should still be in balance. If it is necessary to rotate ZERO BALANCE controls to restore bridge balance, excessive RF leakage is present and may be reduced as follows:

(1) Tighten all screws on side plates of oscillator casting.

(2) Tighten four screws securing each oscillator capacitor assembly (Figure 5-1).

g. Recheck RF leakage in accordance with Steps "a" through "f"; if excessive RF leakage is still present, oscillator overhaul may be required.

5-19. MECHANICAL ADJUSTMENTS. The following mechanical checks and adjustments should be accomplished prior to performing the oscillator assembly calibration. Proceed as follows:

a. Remove left side-plate from oscillator assembly.

b. Set OSC RANGE control to 4-9 MHz range.

c. Rotate OSC FREQ control clockwise until scale divider line (below 4.0 MHz) coincides with fiducial hair line; the plates of capacitors A1C11 and A1C21 (Figure 5-2) should be fully meshed.

d. If either of the capacitors do not fully mesh, adjust the capacitor drive-gears (Figure 5-2).

e. Rotate OSC FREQ control to fully clockwise and counterclockwise positions, checking that scale over-run is approximately equal in both directions; adjust stops (Figure 5-1) if required.

f. Ensure that all set screws on oscillator gear train are tight.

5-20. SIGNAL OSCILLATOR ADJUSTMENT. Adjust the Signal Oscillator as follows:

a. Preliminary Adjustments.

(1) Disconnect bridge input cable A2W1 from Signal Oscillator output connector A1J1 (Figure 5-1).

(2) Remove access screw and bolt (Figure 5-1) located on rear of oscillator casting.

(3) Rotate trimmer capacitor A1C10 (Figure 5-2) until slug is half-way into ring on tip of glass tube.

(4) Connect electronic counter (-hp- 5245L with 5253B Plug-in) to binding posts.

CAUTION

The coil slugs for the 9-21 MHz, 21-48 MHz, and 48-110 MHz ranges are secured with Amphenol Coil Dope "912". Loosen with Amphenol Thinner "916" (or equivalent) to avoid breaking ceramic coil form. After adjustment, secure slugs with a small amount of Amphenol Coil Dope "912" (or equivalent).

b. 4-9 MHz range. The accuracy with which this range is adjusted, by bending the serrated plates of tuning capacitor A1C11 (Figure 5-2), will determine the over-all frequency dial accuracy.

(1) Set OSC RANGE control to 4-9 MHz range; set OSC FREQ control to 9.0 MHz on frequency dial.

(2) Tune coil slug (large access port) for exactly 9.0 MHz as indicated by counter.

(3) Decrease frequency in steps of 0.5 MHz, bending serrated plates on tuning capacitor A1C11 to set output frequency to dial calibrations.

c. 110-250 MHz range. The frequency of this range is adjusted by changing the position of the "tabs" located on the turret just below the pin contacts. One "tab" is on each side of the turret with a bar passing through the turret to connect them.

(1) Set OSC RANGE control to 110-250 MHz range; check output frequency against dial calibrations at 10 MHz increments.

(2) If output frequency does not meet specifications, adjust position of "tabs". To increase output frequency "tabs" must be moved closer together (decrease inductance); to decrease output frequency "tabs" must be moved apart (increase inductance). The amount of solder on the "tabs" will also affect output frequency; add solder to decrease frequency; remove solder to increase frequency.

NOTE

The side-plate will affect the frequency on this range. Momentarily replace it when measuring output frequency.

(3) If, after adjusting "tabs", output frequency still does not meet specifications, trimmer capacitor A1C10 (Figure 5-1) may be adjusted to improve linearity. After adjusting A1C10 recheck 4-9 MHz range.

NOTE

The "tabs" and trimmer capacitor A1C10 provide fine frequency adjustments; if a coarse frequency adjustment is required, change the position of the strap (Figure 5-2) that is soldered to the rear stator contact of capacitor A1C11.

d. .5-1 MHz range.

(1) Set OSC RANGE control to .5-1 MHz range; set OSC FREQ control to 0.5 MHz on frequency dial.

(2) Tune coil slug (large access port) for exactly 0.5 MHz as indicated by counter.

(3) Set OSC FREQ control to 1.0 MHz on frequency dial and adjust trimmer capacitor (small access port) for exactly 1.0 MHz as indicated by counter.

(4) Optimize above adjustments until all frequencies in .5-1 MHz range are within specifications.

e. 1-2 MHz range. The procedure for this range is the same as for the .5-1 MHz range (step d); tune coil slug for 1.0 MHz and trimmer capacitor for 2.0 MHz.

f. 2-4 MHz range. The procedure for this range is the same as for the .5-1 MHz range (step d); tune coil slug for 2.0 MHz and trimmer capacitor for 4.0 MHz.

g. 9-21 MHz range. The coil slug for this range is secured with Amphenol Coil Dope "912". Loosen with Amphenol Thinner "916" (or equivalent).

(1) Adjust coil slug (large access port) to a position where all frequencies in the range meet specifications.

(2) Note exact frequency at any point on the dial; back slug out of the coil until a few threads are exposed and apply a small amount of Amphenol Coil Dope "912" (or equivalent); reset slug for frequency previously noted.

(3) Recheck frequency across the range so that any slight adjustment may be made before coil dope sets-up.

h. 21-48 MHz range. The procedure for this range is the same as for the 9-21 MHz range (step g).

i. 48-110 MHz range. The procedure for this range is the same as for the 9-21 MHz range (step g).

j. Final Adjustments.

(1) Recheck the 110-250 MHz range; keep in mind that further adjustment of trimmer capacitor A1C10 may affect frequency of other ranges.

(2) Replace access screw and bolt located on rear of oscillator casting.

(3) Connect bridge input cable A2W1 to Signal Oscillator output connector A1J1.

5-21. DETECTOR OSCILLATOR ADJUSTMENT. Adjust the Detector Oscillator as follows:

NOTE

Before attempting to adjust the Detector Oscillator, be sure that the IF Amplifier Assembly is aligned (see Paragraph 5-22).

a. Preliminary Adjustments.

(1) Remove oscillator casting from front panel.

(2) Remove dial-mask and fiducial.

(3) Make a scratch across dial hub onto dial such that dial can be removed and replaced without changing its position on the hub; remove dial.

(4) Remove access screw and bolt located on front of oscillator casting.

(5) To assure bridge unbalance while tracking Detector Oscillator to previously adjusted Signal Oscillator, set Rp ohms control to 100 ohms.

CAUTION

The coil slugs for the 9-21 MHz, 21-48 MHz, and 48-110 MHz ranges are secured with Amphenol Coil Dope "912". Loosen with Amphenol Thinner "916" (or equivalent) to avoid breaking ceramic coil form. After calibration, secure slugs with a small amount of Amphenol Coil Dope "912" (or equivalent).

b. 4-9 MHz range. The accuracy with which this range is adjusted, by bending the serrated plates of tuning capacitor A1C21 (Figure 5-2), will determine the over-all ability of the DETECTOR TUNING control to adjust the Detector Oscillator exactly 105 kHz above the Signal Oscillator at all frequencies on all ranges.

(1) Set DETECTOR TUNING control mid-range (approximately 12 turns from either extreme).

(2) Set OSC RANGE control to 4-9 MHz range; set OSC FREQ control such that tuning capacitor A1C21 has the first small serrated plate in mesh with its stator (approximately 9.0 MHz).

(3) Tune coil slug (large access port) for a peak on NULL/RF LEVEL INDICATOR. There will be two peaks; choose the first peak when turning slug in a clockwise direction.

(4) Decrease frequency in incremental steps, bending serrated plates on tuning capacitor A1C21 to maintain the peak on NULL/RF LEVEL INDICATOR.

(5) Slowly change frequency across 4-9 MHz range; NULL/RF LEVEL INDICATOR should remain within 5 scale divisions.

c. 110-250 MHz range. The tracking of this range is adjusted by changing the position of the "tabs" located on the turret just below the pin contacts. One "tab" is on each side of the turret with a bar passing through the turret to connect them.

(1) Set OSC RANGE control to 110-250 MHz range; set OSC FREQ control such that tuning capacitor A1C21 has the first small serrated plate in mesh with its stator (approximately 250 MHz).

(2) Adjust DETECTOR TUNING control for a peak on NULL/RF LEVEL INDICATOR. There will be two peaks; choose the one furthest counterclockwise on DETECTOR TUNING control.

(3) Slowly change frequency across 110-250 MHz range while maintaining peak on NULL/RF LEVEL INDICATOR with DETECTOR TUNING control; the peak should remain within the range of DETECTOR TUNING control.

(4) If DETECTOR TUNING control has insufficient clockwise range, move "tabs" on turret further apart; if control has insufficient counterclockwise range, move "tab" closer together.

d. .5-1 MHz range.

(1) Set OSC RANGE control to .5-1 MHz range; set OSC FREQ control such that tuning capacitor A1C21 is fully meshed.

(2) Set DETECTOR TUNING control fully counterclockwise, then 4 turns clockwise.

(3) Tune coil slug (large access port) for peak on NULL/RF LEVEL INDICATOR. There will be two peaks; choose the first peak when turning slug in a clockwise direction.

(4) Set OSC FREQ control such that tuning capacitor A1C21 has the first small serrated plate in mesh with its stator.

(5) Tune trimmer capacitor (small access port) for peak on NULL/RF LEVEL INDICATOR.

(6) Slowly change frequency across .5-1 MHz range while maintaining peak with DETECTOR TUNING control; deflection on NULL/RF LEVEL INDICATOR should remain above 35 scale divisions at all frequencies.

e. 1-2 MHz range. The procedure for this range is the same as for the .5-1 MHz range (step d).

f. 2-4 MHz range. The procedure for this range is the same as for the .5-1 MHz range (step d), except set DETECTOR TUNING control mid-range (approximately 12 turns from either extreme).

g. 9-21 MHz range. The coil slug for this range is secured with Amphenol Coil Dope "912". Loosen with Amphenol Thinner "916" (or equivalent).

(1) Set DETECTOR TUNING and OSC FREQ controls mid-range.

(2) Tune coil slug (large access port) for a peak on NULL/RF LEVEL INDICATOR. There will be two peaks; choose the second peak when turning slug in a clockwise direction.

(3) Slowly change frequency across 9-21 MHz range while maintaining peak on NULL/RF LEVEL INDICATOR with DETECTOR TUNING control; readjust the coil slug if DETECTOR TUNING control runs out of range.

(4) Establish a reference peak; then turn coil slug clockwise until a few threads are exposed and apply a small amount of Amphenol Coil Dope "912" (or equivalent); reset slug for peak previously established.

(5) Repeat Step (3) so that any slight adjustment may be made before coil dope sets-up.

h. 21-48 MHz range. The procedure for this range is the same as for the 9-21 MHz range (Step g).

i. 48-110 MHz range. The procedure for this range is the same as for the 9-21 MHz range (Step g).

j. Final Adjustments.

(1) Recheck the 110-250 MHz range to assure that DETECTOR TUNING control does not run out of range.

(2) Replace access screw and bolt located on front of oscillator casting.

(3) Replace dial, fiducial, and dial-mask.

(4) Replace oscillator casting on front panel.

5-22. IF AMPLIFIER ASSEMBLY.

5-23. Align the IF amplifier as follows:

a. Prepare setup shown in Figure 5-3.

b. Short TP4 (Figure 5-1) on IF amplifier board to ground (this disables AGC circuit).

c. Set 250B OSC RANGE control to 9-21 MHz range; set OSC FREQ control to 10 MHz.

d. Set 3211A Sweep Oscillator as follows:

(1) ATTENUATION Switch - 20 dB.

(2) SWEEP RATE Control - 10 Hz (higher sweep rates may distort display).

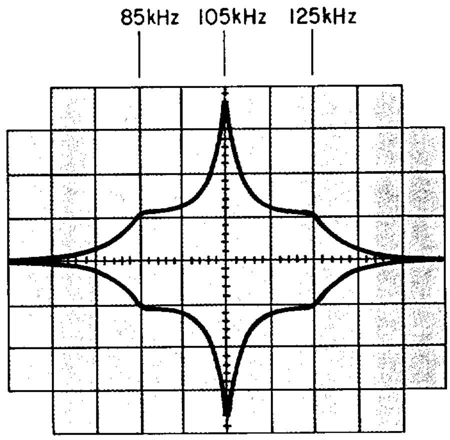
(3) SWEEP WIDTH Control - approximately 1 MHz.

(4) CENTER FREQ Control - approximately 10 MHz.

e. Set 200CD Audio Oscillator to 105 kHz.

f. Set 130C Oscilloscope vertical sensitivity to 0.2 V/cm and adjust horizontal sensitivity to provide a 10 cm display.

g. Alternately adjust tuning slugs of IF amplifier Inductor L1 (Figure 5-1) and Transformers T1 and T2 (Figure 5-1) to obtain waveform shown below.



NOTE

Transformers T1 and T2 have separate Tuning slugs for the primary and secondary windings. The top slug of each transformer adjusts the secondary winding. The bottom slugs adjust the primary windings, and are accessible through the center of the top slugs or from the bottom of the IF amplifier board.

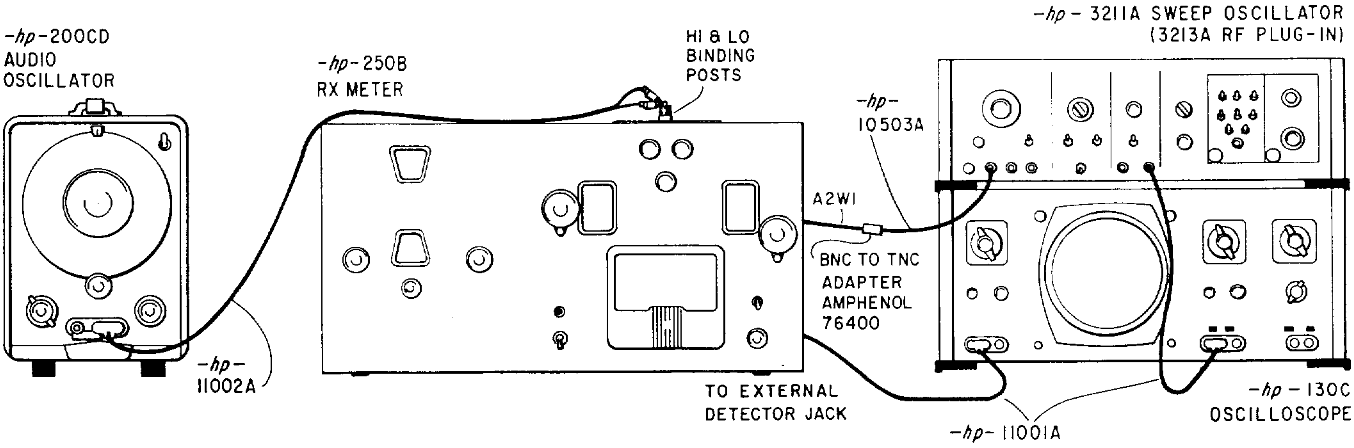


Figure 5-3. Setup for IF Amplifier Alignment

h. Check null sensitivity as follows:

(1) Set OSC RANGE control to .5-1 MHz range; set OSC FREQ control to 0.5 MHz.

(2) Balance bridge using conventional 250B operating procedures (see Paragraph 3-10).

(3) Change Rp ohms dial from infinity to 100 KΩ; NULL/RF LEVEL INDICATOR should increase to approximately 6 to 12 scale divisions.

5-24. BRIDGE ASSEMBLY.

CAUTION

Due to the complexity and interactive adjustments of the bridge assembly, and because of the wide frequency range over which it operates, lead dress and component positioning become significant to proper operation. Therefore, extreme care should be taken when performing all mechanical and electrical repairs. Minor repairs may be successfully accomplished in the field, but major repairs must be done by trained personnel with special equipment.

5-25. COMPONENT REPLACEMENT. The following steps provide replacement procedures for some of the most commonly replaced bridge components.

a. ZERO BALANCE - COARSE R control.

(1) Remove cabinet top and front panel containing oscillator and bridge assemblies.

(2) Remove knobs from ZERO BALANCE controls, Cp pF control, and Rp ohms control. Remove screws securing the bridge to the front panel. (It is not necessary to disconnect the shielded wire going to the pilot lamp assembly.)

(3) Remove the bridge terminal plate by removing screws, binding post nuts, spanner nuts, and insulating washer on the HI terminal post. (The "L" bracket at the front of the terminal plate need not be removed.)

(4) Rotate ZERO BALANCE C control to its fully counterclockwise position.

(5) A slot in the control mounting bracket simplifies replacement of the COARSE R control. The bracket mounting screws should be loosened to allow the bracket to be pulled forward slightly. Care should be taken not to damage the capacitor vane of ZERO BALANCE - C control

(6) Reassembly the bridge starting with the terminal plate. The HI terminal post insulating washer is installed with the collar down and seated in the terminal plate hole.

(7) Assemble the bridge to the front panel making sure the spring washer on the Cp pF control shaft is cleaned, lubricated with Beacon 325 grease (or equivalent), and installed with the convex surface against the front panel.

b. Bridge transformer A2T1. The follow- procedure shall also be used to replace the LO terminal post which is part of the bridge transformer.

(1) Remove bridge terminal plate by removing screws, binding post nuts, spanner nuts, and insulating washer on the HI terminal post. (The "L" bracket at the front of the terminal plate need not be removed.)

(2) Unsolder transformer wires and remove two screws securing transformer to bridge casting.

(3) Install new transformer exercising extreme care not to damage contact fingers and transformer wires; check that all contact fingers are touching rotor of Cp capacitor.

(4) Replace the bridge terminal plate. The HI terminal post insulating washer is installed with the collar down and seated in the terminal plate hole.

c. HI terminal post.

(1) Remove the bridge terminal plate.

(2) Using a soldering iron of at least 300 watts, remove the HI terminal post from the base of the capacitor vane of ZERO BALANCE - C control.

CAUTION

Clamp the capacitor vane to prevent it from changing position when heat is applied to the HI terminal post.

(3) Exercising extreme care, solder the replacement HI terminal post to the capacitor vane.

(4) Replace the bridge terminal plate.

d. Nuvistor tube A2V1.

(1) Remove front panel containing oscillator and bridge assemblies.

(2) Turn front panel on its left side so it is supported by oscillator assembly.

(3) Nuvistor tube is located under cover directly behind NULL/RF LEVEL INDICATOR; remove three screws securing cover.

(4) Replace nuvistor tube.

CAUTION

When replacing cover, ensure that the three cables from the mixer board are dressed through proper notches in bridge casting.

5-26. Cp LEAKAGE. The following check determines if Cp leakage from the Bridge Assembly is high enough to interfere with bridge balance.

a. Set OSC RANGE control to 110-250 MHz range; set OSC FREQ control to 250 MHz.

b. Balance bridge using conventional 250B operating procedures (see Paragraph 3-10).

c. Offset Cp pF control +1.0 pF and then return to zero; NULL/RF LEVEL INDICATOR should increase and then return to null smoothly without any erratic movements.

d. Offset Cp pF control -1.0 pF and then return to zero; NULL/RF LEVEL INDICATOR should increase and then return to null smoothly without any erratic movements.

e. If erratic movements occur it is an indication of excessive leakage from the Cp capacitor; leakage may be reduced as follows:

(1) Loosen screws securing two Cp clamps (Figure 5-1).

(2) Rotate clamps until they are tight against Cp bearing bushings; secure Cp clamps with screws.

f. Recheck Cp leakage in accordance with Steps "a" through "e"; if excessive leakage is still present, replacement of Cp bearings may be required.

5-27. Cp CALIBRATION. If the capacitance measurement accuracy of the Cp pF dial does not meet specifications, repeat the Cp Accuracy Performance Check of Table 5-2. Bend the serrated plates of the Cp capacitor A2C9 (Figure 5-1) to obtain capacitance tracking within specifications.

5-28. Rp CALIBRATION. The Rp ohms dial is hand-marked and engraved to the characteristics of each individual bridge assembly. Adjustment, repair, and/or replacement of any parts associated with its calibration may require the marking and engraving of a new dial. The following adjustments can be used to slightly improve the Rp accuracy. Keep in mind that each adjustment interacts to some degree with the other.

a. Low frequency trimmer capacitor A2C3. If the Rp accuracy is out of specification on the .5-1 MHz range, adjustment of trimmer capacitor A2C3 (Figure 5-1) may be attempted. The setting of A2C3 is extremely critical and determines both the accuracy of the Rp dial and proper balancing of the bridge. With ZERO BALANCE - COARSE R Control set halfway, rotate A2C3 approximately 1/8 turn clockwise and then repeat Rp Accuracy Performance Check of Table 5-2. If required, continue 1/8 turn rotations of A2C3 clockwise and then counterclockwise attempting to locate Rp calibration point.

NOTE

After adjustment of A2C3, check low frequency bridge balance in accordance with Table 5-2.

b. "Strap" adjustment. The "strap" is a ribbon-like conductor located at the junction of the Cp capacitor A2C9 and the capacitor vane of ZERO BALANCE - C control. The main effect of its position is upon Rp accuracy around 200 ohms when measured at 250 MHz. To increase Rp dial reading when measuring a 200 ohm resistor, move the "strap" further away from Cp capacitor A2C9 towards the front panel. To decrease dial reading, move "strap" closer to Cp capacitor A2C9.

NOTE

After performing "strap" adjustment, check high frequency bridge balance in accordance with Table 5-2.

5-29. LOW FREQUENCY BALANCE ADJUST. If it is impossible to balance the bridge at low frequencies, adjustment of trimmer capacitor A2C3 (Figure 5-1) may be attempted. The setting of A2C3 is extremely critical and upon it depends both the accuracy of the Rp ohms dial and proper balancing of the bridge at low frequencies. Rotate A2C3 approximately 1/8 turn clockwise and then check low frequency bridge balance in accordance with Table 5-2. If required, continue 1/8 turn rotations of A2C3 clockwise and then counterclockwise attempting to improve low frequency bridge balance.

CAUTION

Trimmer capacitor A2C3 was not intended as a field adjustment. Keep in mind that if its proper setting is lost, the marking and engraving of a new Rp ohms dial will be required. After adjustment of A2C3, check Rp accuracy in accordance with Table 5-2.

5-30. HIGH FREQUENCY BALANCE ADJUST. At frequencies above 100 MHz the bridge is sensitive to extremely small variations of internal circuit capacitance. It is possible that slight shifts in the relative position of circuit components may alter the effective capacity enough to make it impossible to balance the bridge. In most cases this can be corrected by adjusting trimmer capacitor A2C6 (Figure 5-1). If A2C6 has insufficient range to correct bridge balance, a "loop" adjustment may be performed. The "loop" (Figure 5-1) is an arched wire between trimmer capacitor A2C6 and transformer A2T1; a lead of resistor A2R2 is soldered to the "loop". It is the position of this resistor lead that is changed to correct bridge balance. The following procedures describe the adjustment of trimmer capacitor A2C6 and resistor A2R2 ("loop" adjustment).

a. High frequency trimmer capacitor A2C6.

(1) Pry up small metal plug located towards rear of terminal plate; this provides access to trimmer capacitor A2C6.

(2) Set OSC RANGE control to 110-250 MHz range; set OSC FREQ control to 200 MHz.

(3) Attempt to balance bridge using conventional 250B operating procedures.

(4) Using a screwdriver, rotate A2C6 1/8 turn clockwise if ZERO BALANCE - COARSE R control has insufficient clockwise range; counterclockwise if control has insufficient counterclockwise range. Remove screwdriver and attempt to obtain balance with ZERO BALANCE controls; continue 1/8 turn rotations of A2C6 until proper balance can be obtained.

CAUTION

Correct balance cannot be obtained while the screwdriver is near or in contact with the shaft of A2C6.

(5) Set OSC FREQ control to 250 MHz and check the balance; repeat the above adjustment if necessary.

(6) If proper balance cannot be obtained by the adjustment of A2C6, perform the "loop" adjustment described in Step b.

b. "Loop" adjustment.

(1) Set OSC RANGE control to 110-250 MHz range; set OSC FREQ control to 250 MHz.

(2) Set Cp pF dial to zero.

(3) Position ZERO BALANCE - R controls so they are mid-range (Engraved "R" on knobs should be straight up and down).

(4) Set trimmer capacitor A2C6 mid-range.

(5) Unsolder lead of resistor A2R2 from "loop"; reposition lead on "loop" while attempting to balance bridge with only the Rp ohms control. Continue repositioning lead until proper balance is obtained.

CAUTION

Do not change shape of "loop", just the position of A2R2. The lead of A2R2 should be straight and will protrude beyond the "loop"; Do Not cut this lead.

(6) Using conventional 250B operating procedures, check balance of bridge at 200 MHz, 170 MHz, 150 MHz, 130 MHz, and 110 MHz. If balance cannot be obtained across the frequency range, slightly readjust position of resistor A2R2 on "loop".

5-31. RANGE OF ZERO BALANCE - C CONTROL. If the range of the ZERO BALANCE - C control is insufficient to obtain bridge balance under all conditions, it will be necessary to adjust the capacity between the capacitor vane and the terminal plate. First check that the insulator tape is in place and not damaged. Then check that the vane can be adjusted flat against the tape; change string length and/or slightly reshape vane as required. After performing the above checks and adjustments, recheck the range of the ZERO BALANCE - C control as follows:

a. Set OSC RANGE control to .5-1 MHz range; set OSC FREQ control to 0.5 MHz.

b. Balance bridge using conventional 250B operating procedures (see Paragraph 3-10).

c. Rotate ZERO BALANCE - C control fully clockwise.

d. Rebalance bridge using Cp pF control only; Cp pF indication should be more negative than -3.0 pF.

e. Rotate ZERO BALANCE - C control fully counterclockwise.

f. Rebalance bridge using Cp pF control only; Cp pF indication should be more positive than +7.5 pF.

5-32. CIRCUIT BOARD REPAIR.

5-33. GENERAL. The etched circuit boards used in the 250B are of the plate-through type consisting of metallic conductors banded 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 5-3 lists recommended 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 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 prevent contamination and corrosion.

5-34. ETCHED CIRCUIT 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 in place.

5-35. COMPONENT REPLACEMENT. Replace defective components as follows:

a. Remove component from board.

TABLE 5-3. ETCHED CIRCUIT SOLDERING EQUIPMENT

Item	Use	Specification	Item Recommended
Soldering tool	Soldering Unsoldering	Wattage rating: 47-1/2 - 56-1/2 Tip Temp: 850 - 900°	Ungar #776 Handle with + Ungar #4037 Heating Unit
Soldering + Tip	Soldering Unsoldering	+ Shape: pointed	+ Ungar #PL111
De-soldering aid	To remove molten solder from connection	Suction device	Soldapullt by Edsyn Co. Arleta, California
Resin (flux) solvent	Remove excess flux from soldered area before application of protective coating	Must not dissolve etched circuit base board material or conductor bonding agent	Freon Acetone Lacquer Thinner Isopropyl Alcohol (100% dry)
Solder	Component replacement Circuit board repair 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 #1302++ Humiseal Protective Coating Type 1 B12 by Columbia Technical Corp., Woodside 77 New York

+ For working on Printed Circuit Boards: for general purpose work, use Ungar #1237 Heating Unit (37.5 W, tip temp of 750 - 800°) and Ungar #/L113 1/8" chisel tip.
++ Krylon, Inc., Norristown, Pennsylvania

NOTE

Axial lead components, such as resistors and tubular capacitors, can be replaced without unsoldering. Clip leads near body of defective 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.

b. If component was unsoldered, remove solder from mounting holes with a suction de-soldering aid (Table 5-3) or wooden toothpick.

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

CAUTION

Do not apply excessive heat to transistors. Use long-nose pliers as a heat sink between transistor and soldering iron.

d. Insert component leads into mounting holes and position component as original was positioned. Ensure sufficient lead length to dissipate soldering heat. DO NOT FORCE LEADS INTO MOUNTING HOLES; sharp lead ends may damage plate-through conductor.

REPLACEABLE PARTS — SECTION VI

6-1. INTRODUCTION

6-2. This section contains the information necessary to order replacement parts for the 250B RX Meter. Table 6-1 lists the electrical parts in alpha-numerical order by reference designation, and gives the -hp- stock number and description for each part. Figures 6-1 through 6-5, associated with Tables 6-2 through 6-6, respectively, illustrate and identify the 250B mechanical parts.

6-3. ORDERING INFORMATION

6-4. Order replacement parts for the 250B as follows:

a. Quote the Hewlett-Packard stock number for the part.

b. Address the order or inquiry to the nearest Hewlett-Packard Sales and Service Office listed at the rear of this manual.

REFERENCE DESIGNATORS

A	= assembly	E	= misc electronic part	P	= plug	V	= vacuum tube, neon bulb, photocell, etc.
B	= motor	F	= fuse	Q	= transistor		
BT	= battery	FL	= filter	R	= resistor	W	= cable
C	= capacitor	J	= jack	RT	= thermistor	X	= socket
CP	= connecting part	K	= relay	S	= switch	Y	= crystal
CR	= diode	L	= inductor	T	= transformer	Z	= network
DL	= delay line	M	= meter	TB	= terminal board		
DS	= device signaling (lamp)	MP	= mechanical part	TP	= test point		

ABBREVIATIONS

A	= amperes	GRD	= ground (ed)	NFR	= not field replaceable	RH	= roundhead
BE CU	= beryllium copper	H	= henries	NI PL	= nickel plate	RMO	= rack mount only
BH	= binder head	HEX	= hexagonal	NO	= normally open	RMS	= root mean square
BP	= bandpass	HR	= hour (s)	NPO	= negative positive zero (zero temperature coefficient)	S-B	= slow-blow
BRS	= brass	IF	= intermediate freq			SCR	= screw
CCW	= counterclockwise	IMPG	= impregnated			SE	= selenium
CER	= ceramic	INCD	= incandescent	NRFR	= not recommended for field replacement	SECT	= section (s)
CMO	= cabinet mount only	INCL	= include (s)			Si	= silicon
COEF	= coefficient	INS	= insulation (ed)	OBD	= order by description	SIL	= silver
COM	= common	INT	= internal	OV HD	= oval head	SL	= slide
COMP	= composition	K	= kilo = 1000	OX	= oxide	SPL	= special
CONN	= connector	LIN	= linear taper	P	= peak	SST	= stainless steel
CP	= cadmium plate	LKWASH	= lockwasher	PAN HD	= pan head	SR	= split ring
CW	= clockwise	LOG	= logarithmic taper	PC	= printed circuit	STL	= steel
DEPC	= deposited carbon	LPF	= low pass filter	PF	= picofarads = 10^{-12} farads	TA	= tantalum
DR	= drive	M	= milli = 10^{-3}	PH BRZ	= phosphor bronze	TD	= time delay
ELECT	= electrolytic	MEG	= meg = 10^{6}	PHL	= Phillips	TGL	= toggle
ENCAP	= encapsulated	MET FLM	= metal film	PIV	= peak inverse voltage	TI	= titanium
EXT	= external	MET OX	= metallic oxide	P/O	= part of	TOL	= tolerance
FBR	= fiber	MFR	= manufacturer	POLY	= polystyrene	TRIM	= trimmer
FDTHRU	= feedthru	MINAT	= miniature	PORC	= procelain	μ	= micro = 10^{-6}
FET	= field effect transistor	MOM	= momentary	POS	= position (s)	VAR	= variable
FH	= flat head	MTG	= mounting	POT	= potentiometer	VDCW	= dc working volts
FIL HD	= fillister head	MY	= "mylar"	PP	= peak-to-peak	W/	= with
FXD	= fixed	NC	= normally closed	PT	= point	W	= watts
Ge	= germanium	NE	= neon	PWV	= peak working voltage	WW	= wirewound
GL	= glass	nF	= nanofarad (=1000 pF)	PZ	= "pozidrive"	W/O	= without

TABLE 6-1. REFERENCE DESIGNATION INDEX

Reference Designation	Stock Number	Description
A1	**00250-61107**	**OSCILLATOR ASSEMBLY**
A1C1	0160-2310	C: fxd paper 0.68 μF 20% 100 vdcw
A1C2-5	0160-2942	C: fxd met paper 0.33 μF 20% 200 vdcw
A1C6,7	0150-0050	C: fxd cer 1 nF 600 vdcw
A1C8	0160-0482	C: fxd cer 5 pF ±0.25 pF 500 vdcw
A1C9	0160-0488	C: fxd cer 10 pF 2% 500 vdcw
A1C10	0121-0072	C: var glass 0.5 - 3 pF
A1C11	00250-60010	Condenser Assembly 30 - 80 pF
A1C12,13	0132-0002	C: var poly 0.7 - 3 pF
A1C14	0160-0276	C: fxd paper 0.01 μF 200 vdcw
A1C15	0160-0488	C: fxd cer 10 pF 2% 500 vdcw
A1C16	0132-0002	C: var poly 0.7 - 3 pF
A1C17	00250-60011	Capacitor Assembly Detector Tuning 0.5 - 12 pF
A1C18	0150-0050	C: fxd cer 1 nF 600 vdcw
A1C19	0160-0482	C: fxd cer 5 pF 500 vdcw
A1C20	0160-0488	C: fxd cer 10 pF 2% 500 vdcw
A1C21	00250-60009	Condenser Assembly 30 - 80 pF
A1C22	0132-0002	C: var poly 0.7 - 3 pF
A1C23	0160-0701	C: fxd cer 5 pF 10% 500 vdcw
A1C24	0160-0488	C: fxd cer 10 pF 2% 500 vdcw
A1C25,26	0132-0002	C: var poly 0.7 - 3 pF
A1C27	0160-0481	C: fxd cer 2 pF ±0.2 pF 500 vdcw
A1CR1	1910-0031	Diode Ge 1N34A
A1J1		Connector P/O A1W1
A1J2		Connector P/O A1W2
A1L1	00250-80023	Signal Oscillator Coil 0.5 - 1 MHz
A1L2	00250-80022	Signal Oscillator Coil 1-2 MHz
A1L3	00250-80021	Signal Oscillator Coil 2-4 MHz
A1L4	00250-80020	Signal Oscillator Coil 4-9 MHz
A1L5	00250-80027	Signal Oscillator Coil 9-21 MHz
A1L6	00250-80018	Signal Oscillator Coil 21-50 MHz
A1L7	00250-80017	Signal Oscillator Coil 50-110 MHz
A1L8	00250-80016	Signal Oscillator Coil 110-250 MHz
A1L9	00250-80012	Detector Oscillator Coil 0.5-1 MHz
A1L10	00250-80008	Detector Oscillator Coil 110-250 MHz
A1L11	00250-80015	Detector Oscillator Coil 50-110 MHz
A1L12	00250-80014	Detector Oscillator Coil 21-50 MHz
A1L13	00250-80028	Detector Oscillator Coil 9-21 MHz
A1L14	00250-80009	Detector Oscillator Coil 4-9 MHz
A1L15	00250-80010	Detector Oscillator Coil 2-4 MHz
A1L16	00250-80011	Detector Oscillator Coil 1-2 MHz
A1R1	0686-4715	R: fxd comp 470 Ω 5% 1/2 w
A1R2	0686-1025	R: fxd comp 1 KΩ 5% 1/2 w
A1R3	0686-2235	R: fxd comp 22 KΩ 5% 1/2 w
A1R4	0686-4705	R: fxd comp 47 Ω 5% 1/2 w
A1R5-12	0686-4715	R: fxd comp 470 Ω 5% 1/2 w

TABLE 6-1. REFERENCE DESIGNATION INDEX (CONT)

Reference Designation	Stock Number	Description
A1R13	0686-4705	R: fxd comp 47 Ω 5% 1/2 w
A1R14	0686-2235	R: fxd comp 22 KΩ 5% 1/2 w
A1R15	0721-0034	R: fxd comp 5 Ω 1% 1/4 w
A1R16-23	0686-4715	R: fxd comp 470 Ω 5% 1/2 w
A1V1,2	1921-0011	Tube elec 8 pin
A1W1	00250-60100	Signal Oscillator Output Cable Assembly
A1W2	00250-60101	Detector Oscillator Output Cable Assembly
A2	**00250-61105**	**BRIDGE ASSEMBLY**
A2C1,2		C: var 2 pF NFR (P/O Network Assembly 00250-60015)
A2C3	0121-0092	C: var 0-5 pF
A2C4	00250-00005	Condenser plate 20 pF NFR
A2C5	00250-60013	Variable Capacitor Assembly 0-20 pF NFR
A2C6	0121-0057	C: var glass 0.7-9 pF 1250 vdcw
A2C7	0340-0096	C: fxd approx 0.3 pF stray C of standoff
A2C8		C: var 0.5-5 pF (Capacitor Vane 00250-60087 Insulator Tape 0460-0815 and Terminal Plate 00250-00039)
A2C9		C: var 20-140 pF (Stator Support Assy 00250-60040 and Rotor Assy 00250-60036)
* A2C10	0150-0013	C: fxd cer 0.01 μF +100% -20% 500 vdcw
* A2C11	0160-0174	C: fxd cer 0.47 μF -20 +80% 25 vdcw
* A2C12	0150-0013	C: fxd cer 0.01 μF +100% -20% 500 vdcw
* A2L1	00250-80024	Choke 10 μH 5%
A2R1	0727-0967	R: fxd comp 150 Ω 1% 1/2 w
A2R2,3	0727-0989	R: fxd 127.5 Ω 0.5% 1/2 w
A2R4	0727-0970	R: fxd 155 Ω 1% 1/2 w } Selected
A2R4	0727-0971	R: fxd 165 Ω 1% 1/2 w } Selected
A2R5	0727-0945	R: fxd 470 Ω 1% 1/2 w
A2R6	2100-1413	R: var cer lin 100 Ω 10% 3 w
A2R7	2100-0819	R: var comp log 500 Ω 10% 1-1/2 w
A2R8	0686-2215	R: fxd comp 220 Ω 5% 1/2 w
A2R9	0727-0759	R: fxd comp 1.5 KΩ 1% 1/2 w
* A2R10	0683-2265	R: fxd comp 22 MΩ 5% 1/4 w
* A2R11	0686-4725	R: fxd comp 4.7 KΩ 5% 1/2 w
* A2R12	0686-6805	R: fxd comp 68 Ω 5% 1/2 w
A2T1	00250-60014	Transformer Assembly
* A2V1	1921-0041	Tube-elec nuvistor triode 7895
A2W1		Bridge Input Cable Assembly NFR P/O A2T1
A2W2	00250-61120	Mixer Input Cable Assembly
A2W3	00250-61123	Mixer Output Cable Assembly
* A2XV1	1200-0086	Socket-nuvistor 5 pin
	00250-61133	Mixer Assembly
	00250-21133	Mixer Printed Circuit Board Blank
A3	**00250-61108**	**IF AMPLIFIER ASSEMBLY**
	00250-21132	A3 Printed Circuit Board Blank
A3C1	0160-0489	C: fxd cer 100 pF 10% 500 vdcw
A3C2	0140-0159	C: fxd mica 3 nF 2% 300 vdcw
A3C3	0150-0052	C: fxd cer 0.05 μF 20% 400 vdcw
A3C4	0160-2328	C: fxd mica 200 pF 1% 300 vdcw

* P/O Mixer Assembly 00250-60133

TABLE 6-1. REFERENCE DESIGNATION INDEX (CONT)

Reference Designation	Stock Number	Description
A3C5	0150-0096	C: fxd cer 0.05 μF 100 vdcw
A3C6	0160-2328	C: fxd mica 200 pF 1% 300 vdcw
A3C7	0150-0052	C: fxd cer 0.05 μF 20% 400 vdcw
A3C8	0160-0992	C: fxd cer 0.01 μF -20 +80% 450 vdcw
A3C9	0150-0096	C: fxd cer 0.05 μF 100 vdcw
A3C10	0140-0196	C: fxd mica 150 pF 5% 300 vdcw
A3C11	0160-0992	C: fxd cer 0.01 μF -20 +80% 450 vdcw
A3C12	0160-0763	C: fxd mica 5 pF 10% 500 vdcw
A3C13	0160-2328	C: fxd mica 200 pF 1% 300 vdcw
A3C14	0150-0052	C: fxd cer 0.05 μF 20% 400 vdcw
A3C15	0160-2328	C: fxd mica 200 pF 1% 300 vdcw
A3C16	0140-0203	C: fxd mica 30 pF 5%
A3C17	0160-0992	C: fxd cer 0.01 μF -20 +80% 450 vdcw
A3CR1,2	1910-0031	Diode Ge 1N34A
A3J1	1250-0835	Connector minat RF pc board mount
A3L1	9100-2435	Inter stage coil
A3T1	9100-2436	Input Transformer
A3T2	9100-2437	Output Transformer
A3R1	0686-4715	R: fxd comp 470 Ω 5% 1/2 w
A3R2	0683-1005	R: fxd comp 10 Ω 5% 1/4 w
A3R3	0686-4735	R: fxd comp 47 KΩ 5% 1/2 w
A3R4	0686-1045	R: fxd comp 100 KΩ 5% 1/2 w
A3R5	0686-8235	R: fxd comp 82 KΩ 5% 1/2 w
A3R6	0686-1025	R: fxd comp 1 KΩ 5% 1/2 w
A3R7	0686-2715	R: fxd comp 270 Ω 5% 1/2 W
A3R8	0686-1545	R: fxd comp 150 KΩ 5% 1/2 w
A3R9	0686-2225	R: fxd comp 2.2 KΩ 5% 1/2 w
A3R10	0686-4745	R: fxd comp 470 KΩ 5% 1/2 w
A3R11	0686-1025	R: fxd comp 1 KΩ 5% 1/2 w
A3R12	0686-1525	R: fxd comp 1.5 KΩ 5% 1/2 w
A3R13	0686-6805	R: fxd comp 68 Ω 5% 1/2 w
A3R14	0686-2225	R: fxd comp 2.2 KΩ 5% 1/2 w
A3R15	0686-1035	R: fxd comp 10 KΩ 5% 1/2 w
A3R16	0686-1025	R: fxd comp 1 KΩ 5% 1/2 w
A3R17	0686-1545	R: fxd comp 150 KΩ 5% 1/2 w
A3R18	0686-1825	R: fxd comp 1.8 KΩ 5% 1/2 w
A3R19	0686-6225	R: fxd comp 6.2 KΩ 5% 1/2 w (nominal)
A3R20	0686-3025	R: fxd comp 3 KΩ 5% 1/2 w
A3V1,2	1923-0043	Tube electron 6EW6
A3W1	00250-61129	External Detector Cable Assembly
A3XV1,2	1200-0049	Socket tube 7 pin minat
A4	**00250-60131**	**POWER SUPPLY ASSEMBLY**
	00250-21131	A4 Printed Circuit Board Blank
A4C1, 2	0180-1748	C: fxd alum elect 45 μF 250 vdcw
A4C3	0180-0345	C: fxd alum elect 2000 μF 25 vdcw
A4C4	0150-0093	C: fxd cer 0.01 μF -10% + 80% 100 vdcw
A4C5	0180-0058	C: fxd alum elect 50 μF -10% + 75% 25 vdcw

Figure 6-4 Index No.	Stock No.	Description	Qty
1	1850-0098	Transistor, Q2 (See Table 6-1)	1
2	3050-0105	Flatwasher #4	4
3	2200-0147	Machine screw 4-40 x 1/2 PZ PAN	2
4	1200-0043	Insulator	1
5	00250-01068	Chassis Top Plate	1
6	1200-0044	Transistor Socket	1
7	1200-0081	Bushing	2
8	0360-0366	Lug #4	1
9	2190-1086	Lockwasher Split #4	2
10	2260-0001	Hex Nut 4-40 x 1/4 x 3/32	2
11	0400-0043	Rubber Grommet	1
12	0400-0034	Rubber Grommet	1
13	9100-0407	Power Transformer T1	1
14	2360-0143	Machine Screw 6-32 x 5/16 PAN HD	16
15	2190-0007	Lockwasher #6 INT	16
16	1251-0419	Connector Female (10 Contact) S1	1
17	0360-0383	Lug #4	1
18	3101-0033	Switch-slide, DPDT, 115/230 V, S4	1
19	00250-01066	Chassis Side	1
20	1251-0148	Connector, Line Input, J2	1
21	1400-0084	Fuseholder	2
22	1250-0102	Connector, BNC, Female (Part of A3W1)	1
23	00250-61129	External Detector Cable Assembly, A3W1	1
24	00250-01067	Chassis Side	1
25	00250-61108	IF Amplifier Assembly A3 (See Table 6-1)	1
26	00250-61131	Power Supply Assembly A4 (See Table 6-1)	1
27	1854-0237	Transistor, Q1 (See Table 6-1)	1
28	2190-0006	Lockwasher, Split #6	2
29	0624-0092	Screw, Self-tapping, 6-32 x 3/8	2
30	0340-0140	Insulator, Mica	1
31	1200-0168	Transistor Socket	1

TABLE 6-1. REFERENCE DESIGNATION INDEX (CONT)

Reference Designation	Stock Number	Description
A4C6	0160-0818	C: fxd cer 0.02 μF 20% 50 vdcw
A4CR1, 2	1901-0029	Diode Si 600 piv 0.75 A
A4CR3	1902-0062	Diode brkdwn 3.7 V
A4CR4-6	1901-0040	Diode Si
A4CR7, 8	1902-0661	Diode brkdwn 75 V
A4CR9, 10	1901-0409	Diode Si 1N4719
A4CR11, 12	1901-0049	Diode Si 50 piv 0.75 A
A4Q1	1884-0012	Thyristor 2N3528
A4Q2, 3	1853-0016	Transistor PNP Si 2N3638
A4R1, 2	0686-2205	R: fxd comp 22 Ω 5% 1/2 w
A4R3	0764-0040	R: fxd met flm 39 KΩ 5% 2 w
A4R4	0764-0041	R: fxd met flm 30 Ω 5% 2 w
A4R5	0686-1015	R: fxd comp 100 Ω 5% 1/2 w
A4R6	0686-2205	R: fxd comp 22 Ω 5% 1/2 w
A4R7	0764-0041	R: fxd met ox 30 Ω 5% 2 W
A4R8	2100-1774	R: var ww lin 2 KΩ 10% 1/2 w
A4R9	0761-0006	R: fxd met flm 10 KΩ 5% 1 w
A4R10	0686-6825	R: fxd comp 6.8 KΩ 5% 1/2 w
A4R11	0686-3315	R: fxd comp 330 Ω 5% 1/2 w
A4R12	0686-1215	R: fxd comp 120 Ω 5% 1/2 w
A4R13	0686-4725	R: fxd comp 4.7 KΩ 5% 1/2 w
A4R14	0686-1625	R: fxd comp 1.6 KΩ 5% 1/2 w
A4R15	0686-7535	R: fxd comp 75 KΩ 5% 1/2 w
		CHASSIS COMPONENTS
DS1	2140-0012	Lamp Incd 2 pin base 6.3 V
F1	2110-0018	Fuse 1/4 A 125 V S-B 3 AG
F1	2110-0012	Fuse 1/2 A 250 V 3 AG
F2	2110-0067	Fuse 3/10 A 250 V 3 AG
J1	1251-0419	Connector female (10 contact)
J2	1251-0148	Connector Line Input
M1	1120-0409	Null/RF Level Indicator
P1	1251-0418	Connector male (10 contact)
Q1	1854-0237	Transistor Si NPN 2N3738
Q2	1850-0098	Transistor Ge PNP (See characteristics listed below)
R1, 2-S1	2100-1743	R: var comp 2 sect 100 K 25K 10% 2 w SET RF LEVEL
R3	0686-7535	R: fxd comp 75 KΩ 5% 1/2 w
S2	3101-0912	Switch-tgl momentary SET RF LEVEL
S3	3101-0001	Switch-tgl SPDT POWER ON
S4	3101-0033	Switch-slide DPDT 115/230 V
T1	9100-0407	Transformer Power
W1	8120-0078	Cable Assembly Line Input

1850-0098	Characteristics
P_d	90 w
BVCEO	70 V
Case	TO3
h_{FE}	100 min at 250 mA

TABLE 6-2. REPLACEABLE PARTS INDEX, 250B RX METER

Figure 6-1 Index No.	Stock No.	Description	Qty
1	00250-01063	Top plate	1
2	00250-01064	Cabinet	1
3	1440-0025	Handle	1
4	0403-0045	Rubber Feet, bottom	4
5	3050-0010	Flat washer #6	4
6	2390-0042	Machine screw 6-32 x 3/8 Pan Hd.	4
7	00250-61105	Bridge assembly A2 (See Figure 6-3)	1
8	2100-1743	SET RF LEVEL Control R1, R2, S1 (See Table 6-1)	
9	2190-0099	Lockwasher INT 7/16	3
10	2950-0001	Nut 3/8 - 32 x 1/2 x 3/32	1
11	0370-0026	Knob: SET RF LEVEL	1
12	3101-0912	Switch, momentary, SET RF LEVEL, S2 (See Table 6-1)	1
13	0360-0389	Lug INT 1/4 hole	2
14	3101-0001	Switch Tgl SPST. POWER ON, S3 (See Table 6-1)	1
15	2950-0035	Nut, Hex 15/32 x 32	1
16	2190-0088	Lockwasher INT 5/16	1
17	1450-0022	Lampholder	1
18	2140-0012	Lamp INCD DS1 (See Table 6-1)	1
19	3050-0306	Flatwasher 5/16	1
20	2950-0094	Hex nut 5/16 - 32 x 1/2 x 3/32	1
21	0370-0141	Crank Knob, C_p and R_p Controls	2
22	1120-0409	Meter, NULL/RF LEVEL INDICATOR	1
23	0590-0012	Knurl nut 5/32 - 32 x 9/16 x 5/64	1
24	1450-0020	Pilot Light Reflector	1
25	0370-0096	Knob, ZERO BALANCE (C)	1
26	0370-0093	Knob, ZERO BALANCE (R)	2
27	0370-0028	Knob, OSC FREQ & OSC RANGE	2
28	0370-0023	Knob, DETECTOR TUNING	1
29	3050-0284	Flatwasher BRS	1
30	3050-0267	Flatwasher	1
31	00250-20034	Eccentric Bushing	1
32	2515-0022	Machine screw 8-32 x 1/2 PHIL PAN	11
33	00250-01062	Front Panel	1
34	2950-0030	Hex nut, 3/8 - 32 x 9/16 x 3/32	1
35	5000-3014	Spring washer	3
36	00250-60066	Vernier Shaft Assembly	1
37	00250-61107	Oscillator Assembly A1 (See Figure 6-2)	1
38	00250-61118	Power Supply & IF Amp Assembly (See Figure 6-4)	1
39	0403-0049	Rubber Feet, side	4

TABLE 6-4.: REPLACEABLE PARTS INDEX, BRIDGE ASSEMBLY (CONT)

Figure 6-3 Index No.	Stock No.	Description	Qty
51	00250-20116	Spacer	2
52	00250-60015	Network Assembly	1
53	00250-60038	Bearing Assembly	1
54	00250-60036	Rotor Assembly	1
55	2190-0006	Lockwasher Split #6	2
56	2500-0002	Hex Nut 6-32 x .312 x .109	5
57	00250-61122	Casting	1
58	00250-01069	Mixer Shield	1
59	00250-20101	Drum Dial	1
60	00250-60089	Dial & Hub Assembly	1
61	00250-21126	Offset Gear Spacer	1
62	00250-61110	Gear Shaft	1
63	00250-61133	Mixer Assembly (See Table 6-1)	1
64	0380-0115	Spacer	2
65	2200-0143	Machine screw 4-40 x 3/8 PZ PAN HD	2
66	1460-0156	Gear Spring	4
67	00250-60037	Bearing Assembly	1
68	2950-0001	Hex Nut 3/8-32 x 1/2 x 3/32	2
69	00250-20018	Shield	1
70	2190-0070	Lockwasher EXT #4	1
71	2200-0137	Machine screw 4-40 x 3/16 PZ PAN HD	1
72	1400-0015	Cable Clamp	1
73	00250-60014	Complete Transformer	1
74	00250-20066	Trimmer Plate	1
75	00250-00007	Rear Shield	1
76	00250-00005	Capacitor Plate	1
77	6960-0019	Plug Button	1
78	00250-60032	Split Gear & Hub Assembly	1
79	00250-60035	Gear & Hub Assembly	1
80	1460-0157	Spring	1
81	00250-00003	Ground Tab	1
82		Tape, Teflon, 1 x 7/8 x 0.0005 in. of -hp- 0460-0815	1
83	1410-0163	Bearing	1
84	0510-0239	Retaining Ring INT 7/8 DIA	1
85	3030-0033	Set Screw	2
86	0510-0056	Retaining Ring Bowed INT 5/8 DIA	2
87	1410-0231	Bearing	4
88	00250-20011	Spacer	3
89	00250-20013	Locking Collar	3
90	3030-0033	Set Screw	12
91	00250-20012	Threaded Hub	2
92	00250-20015	Shaft	1
93	0510-0005	Retaining Ring EXT 1/4 DIA	4
94	0510-0813	Retaining Ring INT	1
95	1430-0087	Spur Gear	1
96	5020-2210	Shaft Spacer	1
97	00250-20016	Idler Shaft	1
98	00250-60034	Gear & Hub Assembly	1

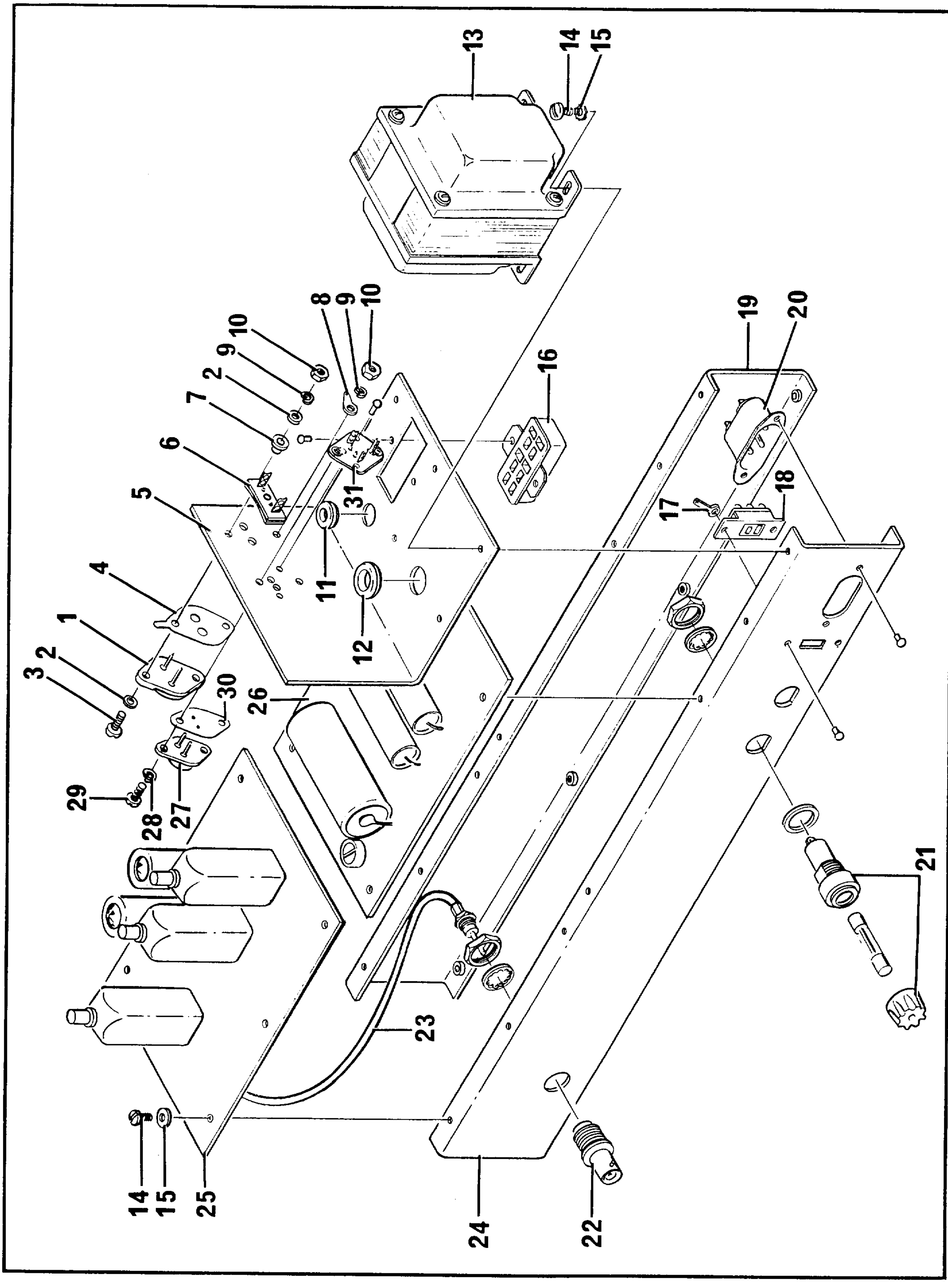


Figure 6-4. POWER SUPPLY & IF AMPLIFIER ASSEMBLY

TABLE 6-6. REPLACEABLE PARTS INDEX, OSCILLATOR ASSEMBLY DETAILS

Figure 6-5 Index	Stock No.	Description	Qty
		DETAIL A	
1	00250-20084	Spring Block	1
2	00250-00041	Contact	2
3	2190-0014	Lockwasher #2 INT	2
4	0520-0039	Machine screw 2-56 x 1/8 BH	2
5	00250-60096	Spring Block (Right Hand)	1
5	00250-60097	Spring Block (Left Hand - Illustrated)	1
6	2295-0001	Machine screw 4-40 x 1/8 BH (NFR)	1
7	00250-00043	Left Hand Spring (NFR)	1
7	00250-00042	Right Hand Spring (NFR)	1
8	00250-20086	Spring Mounting Block (NFR)	1
9	2190-0004	Lockwasher	4
10	2270-0020	Machine screw 4-40 x 1/4 PAN HD	2
11	0360-0377	Lug #6 INT	1
12	2295-0008	Machine screw 4-40 x 5/16	2
13	00250-20085	Spring Support Assembly	1
		DETAIL B	
1	00250-20079	Local Oscillator Turret	1
2	3030-0105	Set Screw 6-32 x 1/4	2
3	00250-20001	Turret Hub (NFR)	1
4	1430-0099	Spur Gear (NFR)	1
5	2190-0008	Lockwasher #6 EXT	4
6	2470-0013	Machine screw 6-32 x 3/8 PAN HD	4
7	1480-0124	Roll Pin	2
8	2340-0001	Hex Nut 4-40 x 3/16	32
9	00250-20080	Contact.Support	8
10	2190-0086	Lockwasher Split #4	8
11	2295-0006	Machine screw 4-40 x 1/4 PAN HD	8
12	0360-0037	Lug	32
13	00250-20105	Contact Pin	16
14	00250-20106	Contact Pin	16
15	00250-60094	Gear & Hub Assembly	1
		DETAIL C	
1	00250-20104	Signal Oscillator Turret	1
2	0686-4715	Resistor, A1R5-12 (See Table 6-1)	8
3	0360-0365	Lug #6 INT	1
4	2360-0191	Machine screw 6-32 x 3/16 PZ PAN HD	1
5	2340-0001	Hex Nut 4-40 x 3/16 AF	32
6	00250-20083	Turret Hub	6
7	3030-0015	Set Screw 6-32 x 1/4	2
8	2190-0086	Lockwasher Split #4	8
9	2295-0006	Machine screw 4-40 x 1/4 PAN HD	8
10	00250-20080	Contact Support	8
11	0360-0037	Lug	32
12	00250-20105	Contact Pin	16
13	2470-0013	Machine screw 6-36 x 3/8 PAN HD	4
14	2190-0008	Lockwasher #6 EXT	4
15	00250-20106	Contact Pin	16

TABLE 6-6. REPLACEABLE PARTS INDEX, OSCILLATOR ASSEMBLY DETAILS (CONT)

Figure 6-5 Index	Stock No.	Description	Qty
		DETAIL D	
1	00250-60022	Stator A1C11 (Left Hand)	1
1	00250-60019	Stator A1C21 (Right Hand - Illustrated)	1
2	2420-0003	Hex Nut 6-32 x 1/4	4
3	2200-0143	Machine screw 4-40 x 3/8 PZ PAN HD	3
4	3050-0314	Flatwasher #4	3
5	0121-0084	Stator Support	1
6	00250-20118	Spacer	3
7	00250-60070	Rotor Assembly A1C11 (Left Hand)	1
7	00250-60068	Rotor Assembly A1C21 (Right Hand - Illustrated)	1
8	00250-60021	Split Hub-Gear A1C11 (Left Hand)	1
8	00250-60018	Split Hub-Gear A1C21 (Right Hand - Illustrated)	1
9	2295-0018	Set Screw	1
10	2950-0048	Hex Nut	1
11	00250-60020	Compression Lock Spring	1
12	00250-60002	Housing Assembly	1
13	0510-0241	Tru-Arc Ring	1
14	1410-0911	Bearing	2
15	00250-20041	Spacer	1
16	00250-20040	Housing	1
		DETAIL E	
1	0590-0038	Hex Nut	1
2	1460-0220	Spring	1
3	00250-20005	Special Nut	1
4	3050-0257	Flatwasher	1
5	3050-0309	Spring Washer	1
6	0510-0229	Retaining Ring EXT	1
7	00250-20001	Housing	1
8	00250-20003	Dielectric Sleeve	1
9	00250-60017	Sleeve Strap	1
10	00250-20002	Tuning Screw	1

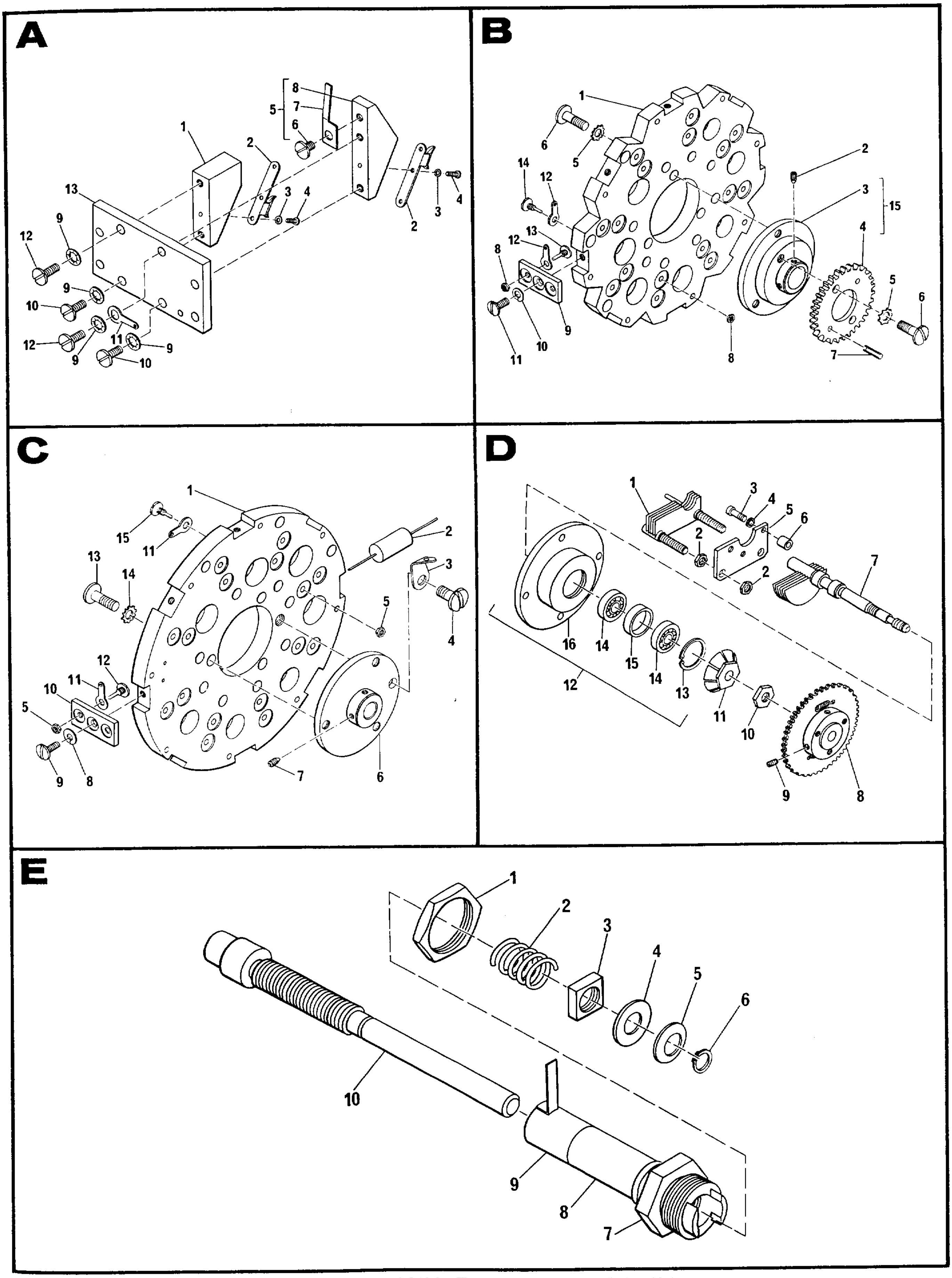


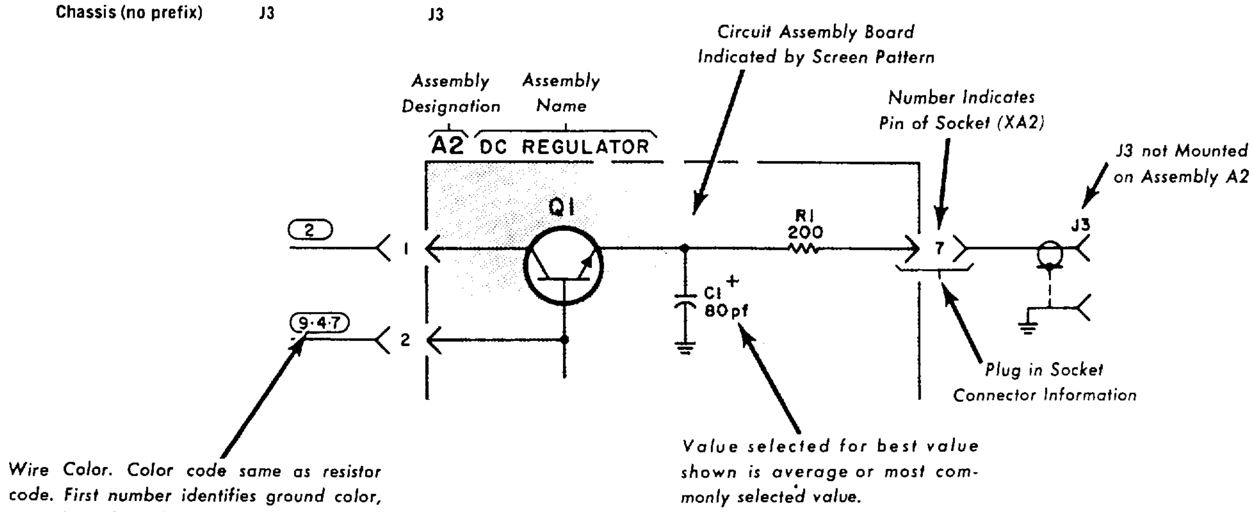
Figure 6-5. OSCILLATOR ASSEMBLY DETAILS

TABLE 7-1. SCHEMATIC NOTES AND SYMBOLS

REFERENCE DESIGNATION

Reference designations on assembly boards (printed circuit boards) are abbreviated. Add assembly number to abbreviation for complete description.

Assembly	Abbreviation	Complete Designations
A5	C1	A5C1
A13A1	R8	A13A1R
Chassis (no prefix)	J3	J3



REFERENCE DESIGNATORS

CHASSIS	A2
J3	C1 Q1 R1

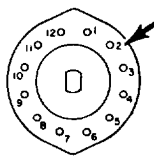
← Reference Designation Index

SYMBOLS

Resistance in ohms, capacitance in microfarads, inductance in microhenries unless otherwise noted.

- Screwdriver adjustment.
- Knob control
- Encloses front panel designation
- Encloses rear panel designation
- Circuit assembly borderline
- Other assembly borderline
- Heavy line with arrows indicates path and direction of main signal.
- Heavy dashed line with arrows indicates path and direction of main feedback.
- Indicates main path of auxiliary signal
- Powerline (chassis) ground
- Etched circuit board common ground
- Waveform test point
- 9-1-8 Denotes wire color using standard color code (e.g. 9-1-8 = white-brown-grey)
- Voltage regulator (breakdown) diode.
- Step recovery diode
- Field effect transistor with P-material base

SWITCH DESIGNATION



A3S1 BR (2)

A3S1	Switch **S1** within assembly **A3**
B	2nd wafer from front (**A** = first, etc.)
R	Rear of wafer (**F** = front)
(2)	Terminal location 2

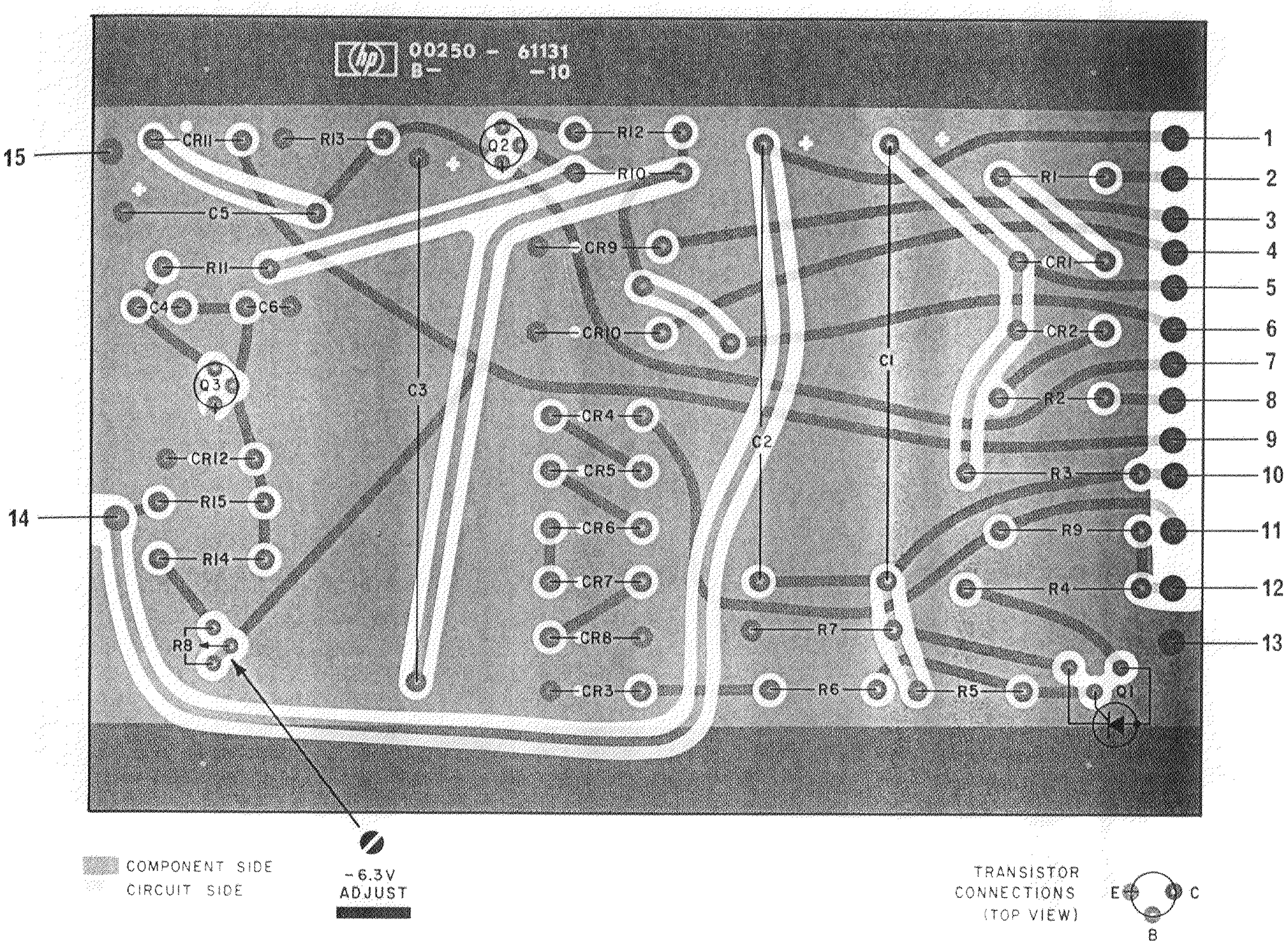
CIRCUIT DIAGRAMS SECTION VII

7-1. INTRODUCTION

7-2. This section contains the schematic diagrams of the 250B RX Meter. Wiring diagrams are not included, although wire colors are given on the schematics where practical. Refer to Table 7-1 for general notes and an explanation of symbols used in the diagrams. Each schematic diagram has a reference Designators box which lists all the reference designations that appear on the diagram.

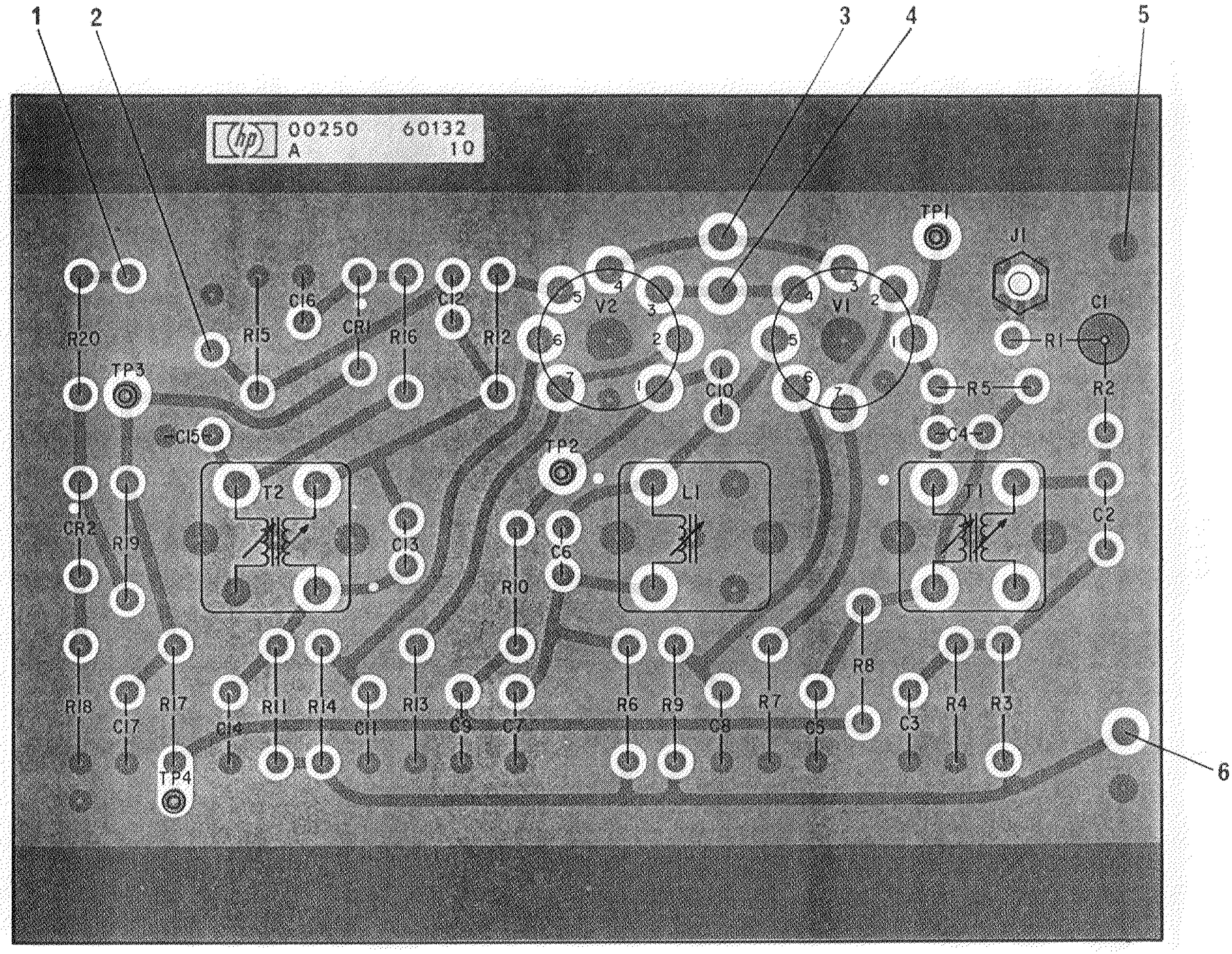
7-3. Each circuit board and its components are illustrated in this section with the schematic of the particular board. In addition, the illustration also shows the etched wiring on both sides of the board.

7-4. Voltage measurements are provided on the schematic diagrams to assist troubleshooting. These measurements should not be considered performance specifications since they may vary with component tolerances, aging, and temperature. The measurements were obtained using an -hp- Model 412A DC Volt-Ohm-Ammeter; the 250B terminal posts were shorted and the SET RF LEVEL control was in the normal position.



Connections - A4 Power Supply Assembly

Number	Color	Connection
1	Red	To J1 (1) and Q1 emitter.
2	Red	To T1 secondary for -150 V supply.
3	Blue	To T1 secondary for - 6.3 V supply.
4	Blue	To T1 secondary for - 6.3 V supply.
5	White-Red-Yellow	To F2.
6	Blue	To Q2 collector.
7	Green	To Q2 base.
8	Red	To T1 secondary for -150 V supply.
9	Violet	To J1 (4) (-6.3 V).
10	Red-Yellow	CT of T1 HV secondary.
11	White-Green	To Q1 base.
12	White-Blue	To F2 and Q1 collector.
13	Black	To J1 (3) and J1 (5) (common).
14	Strap	-150 V to A3.
15	Strap	To A3 common (ground plane).



COMPONENT SIDE
CIRCUIT SIDE

A3

Connections - A3 IF Amplifier Assembly

Number	Wire	Connection
1	Yellow	To J1-7.
2	Coaxial	External Detector Cable Assembly A3W1.
3	Brown	6.3 vac filament supply from T1.
4	Brown	6.3 vac filament supply from T1.
5	Jumper	Ground from Power Supply board.
6	Jumper	+150 V from Power Supply board.

E. C101 High Frequency Bridge Trimmer Adjustment (110-250 Range)

At frequencies above 100 MC the zero balance of the RX Meter bridge circuit is necessarily sensitive to extremely small variations in internal circuit capacitance. It is possible that minute shifts in the relative position of circuit components, caused by excessively rough handling in shipping, etc., may alter the effective capacity enough to make it impossible to obtain a null indication on the highest frequency range by adjusting ZERO BALANCE Controls, "R" and "C".

In most cases, this situation can be corrected by the following screwdriver adjustment:

1. Allow the instrument to warm up, set the oscillator frequency at 200 MC, and adjust the DETECTOR TUNING Control for a peak on the NULL INDICATOR (HI and LO terminals temporarily shorted; Cp Dial at 0 and Rp at ∞).

2. With a screwdriver pry up the small metal cap located near the rear of the top plate. This provides access to a small trimmer capacitor having a vertical slotted adjusting shaft.

3. Rotate the "R-Coarse" knob and note whether the NULL INDICATOR reading decreases with clockwise or counter-clockwise rotation.

4. Using the screwdriver rotate the trimmer shaft about 1/8 turn clockwise if the "R" knob was clockwise above or counterclockwise if the "R" knob was counterclockwise above. Remove the screwdriver and try to obtain balance with the "R" and "C" knobs. If a null indication still cannot be obtained, rotate the trimmer another 1/8 turn in the same direction. Continue this procedure until balance can be obtained.

NOTE: Correct null indication can <u>not</u> be obtained while the screwdriver (or aligning tool) is near or in contact with the trimmer shaft.

HEWLETT PACKARD S.A.

P. O. Box No 85 - 1217 Meyrin 2 - Geneva, Telephone (022) 41 54 00

FROM Jean-Pierre JOUSSON GRC

DATE :

TO

SUBJECT : 25oB

This bridge has been carefully repaired and checked, however, some points should be emphasized concerning the functionment at the most critical range 11o-25o MHz.

1) A warm-up time of approx. 1 hour is needed before both oscillator stabilize. Even after a range switching, a few minuts may be necessary until the frequency stops drifting.

2) Tuning capacitor becomes very touchy. Try to get an indication on meter greater than 4o, but not really a maximum.

3) Due to a strong AGC action in IF Amplifier, somes spurious responses will give an indication on meter very near of a good response. These spurious are generally very sharp and it is not possible to get a stable tuning point. No balance will be obtained if however tuning is made on this point.

4) If Rp balance is not correct, try the procedure indicated on attached sheet.

MANUAL CHANGE SHEET
MODEL 250B
Manual Serial Prefixed: 737
HP Part No. 00250-90037

To adapt this manual to instruments with other serial prefixes, check for errata below and make changes shown in tables.

Instrument Serial Prefix	Make Manual Changes
923	1
1034A	1,2
1029A Serials 04821 thru 04840 (except 04825, 27, 33)	1,2,3

Instrument Serial Prefix	Make Manual Changes
1144A-04841 thru 04860	1,2,3
1204A-04861 thru 04900	1,2,3,4
* 1227A-04901 thru 04990	1 thru 5
1227A-04991 thru 05000	1 thru 6
1227A-50001 up (except -5001, -5003, -5006, and -5007)	1 thru 7
1605A-5261 thru 5290	1 thru 8
1620A-5291 thru 5430	1 thru 9
1745A-5431 and up	1 thru 10

ERRATA:

Page 6-2, Table 6-1.
Change Stock No. of A1C14 to 0160-2209. Description remains the same.

Page 6-4, Table 6-1.
Change A4 Stock No. to 00250-61131.

Page 6-5, Table 6-1.
Add: A4C7, 0180-0228, C: fxd, alum elect. 22μF 15vdcw.

Page 7-5, Figure 7-2.
Add: C7 in parallel with R7 on A4 Power Supply Assembly. Indicate value 22μF, +side of capacitor to ground.

Amend Reference Designator List to indicate A4 C1-C7.

Amend Component Locator Photograph to indicate C7 connected between pins numbered 10 and 13, + side of capacitor to pin 13.

CHANGE 1:

Page 6-4, Table 6-1.
Change Stock No. and Description of A3R18 to read as follows: 2100-1774 R: var, ww 2KΩ ½W, PC mtg.

Page 6-4, Table 6-1.
Change Stock No. and Description of A4C2 to read 0180-2209 C: fxd, 1μF elect +10 −50 vdcw.

Page 6-5, Table 6-1.
Add: A4CR13, 1901-0029, Diode Si.

Page 7-5, Figure 7-2.
Make the following corrections to Schematic and Component Location diagrams.

1. Delete asterisk adjacent to A3R19
2. Change A3R18 to a variable resistor connected as a rheostat with top end connected to A3CR2, and arm grounded.
3. Add Diode A4CR13 connected with anode to emitter of chassis transistor Q1, and cathode connected to collector of Q1.
4. Change A4C2 value to 1μF.

Page 6-10, Table 6-4, Figure 6-3.
Terminal Assembly (Item 9) and Pot Bracket (Item 38) have been combined into a single combination bracket in which a new ball drive unit is used for Vernier Drive. In addition, Transformer Assembly (Item 73) has been modified to permit separate replacement of the Transformer and the Spring and Pot Assembly. Make the following notation on Table 6-4 and Figure 6-3.

1. For Item 9, 00250-60016, Terminal Drive. Substitute 00250-01072 Bracket Trim Drive with 1500-0051 Ball Drive.
2. For Item 38, Pot Bracket, delete Stock No. 00250-00031. Mark drawing "part of bracket, trim drive item 9".
3. Add Item 53A and 67A, 4330-0081, Ball, glass. Located within Bearing Assembly.
4. For Item 73, 00250-60014, Complete Transformer substitute: 73A 00250-61136 Transformer and Cable Assembly. 73B 00250-61135 Spring and Pot Assembly.

CHANGE 2:

Page 6-5, Table 6-1.
Change Reference Designation of R1, 2-S1 to R1, 2. Part No. 2100-3004 R: var (no switch-remove switch wires from circuit).

Page 6-5, Table 6-1.
Change F1 Stock No. to 2110-0201 Fuse ¼A
Change F1 Stock No. 2110-0202 Fuse ½A
Change J2 Stock No. 1251-2357 Con. ac pwr.
Change S3 Stock No. to 3101-0003 Switch, toggle
Change W1 Stock No. to 8120-1348 AC cable assy.

Page 6-6, Table 6-2.
Change Index No. 24 to PN 1450-0413 Jewel, white.

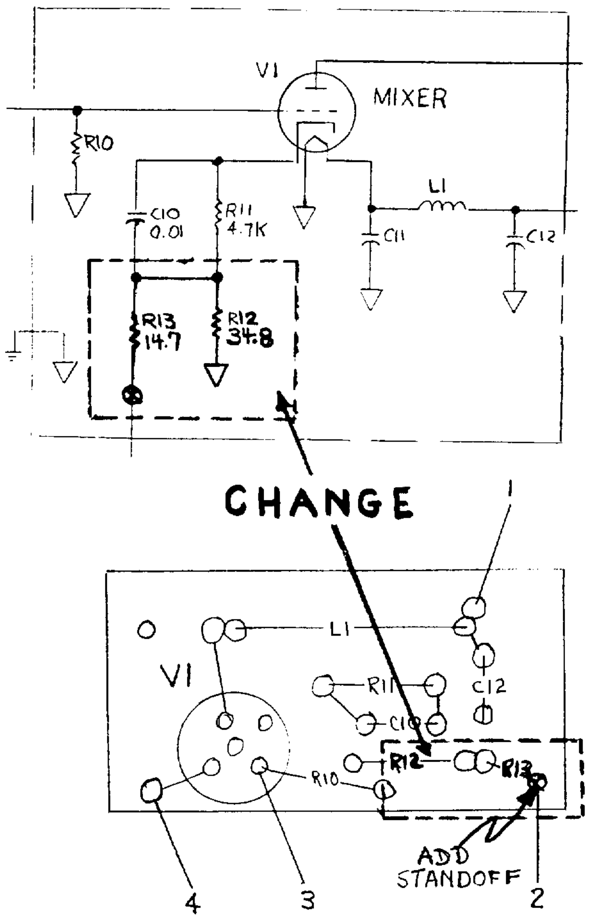


FIGURE A

Page 6-13, Table 6-5.
Change Index No. 20 to PN 1251-2357.

CHANGE 3:

Page 6-3, Table 6-1.
Change A2R12 to 0698-3434 R: fxd. met film, 34.8 ohm, 1%, 1/8W.
Add: A2R13, 0698-3428 R: fxd, met. film 14.7 ohm, 1%, 1/8W.

Page 7-3, Figure 7-1.
Change the schematic diagram and component location diagram of mixer circuit V1 as shown in Figure A.

ERRATA:

Page 3-10, Paragraph 3-30 2(4) formula should read

$$R_3 = \frac{4\,(R1R2)}{R_1 - R_2}$$

CHANGE 4:

The standard colors for this instrument are now mint gray (for front panel) and olive gray (for all other external surfaces). Option X95 designates use of the former color scheme of light gray and blue gray. Option A85 designates use of a light gray front panel with olive gray used for all other external surfaces. New part numbers are shown below:

CHANGE 5:

Table 6-1: Change resistor A2R1 to HP Part No. 00250-80029.

CHANGE 6:

IF Amplifier Assembly A3, HP Part No. 00250-61132 has been replaced by a new A3 assembly, HP Part No. 00250-61138. (The old and new assemblies are interchangeable.) The attached parts list replaces the one on pages 6-3 and 6-4 of the manual. The attached A3 schematic replaces the corresponding portion of Figure 7-2. The following steps replace paragraph 5-23 of the adjustment procedure:

5-23 Align the 00250-61138 IF amplifier as follows:

a. Prepare setup as shown in figure below. The following test equipment is required: HP 651B Test Oscillator, HP 3469B Multimeter, 7.5KΩ impedance matching resistor (HP Part No. 0757-0440), HP 908A 50Ω load.

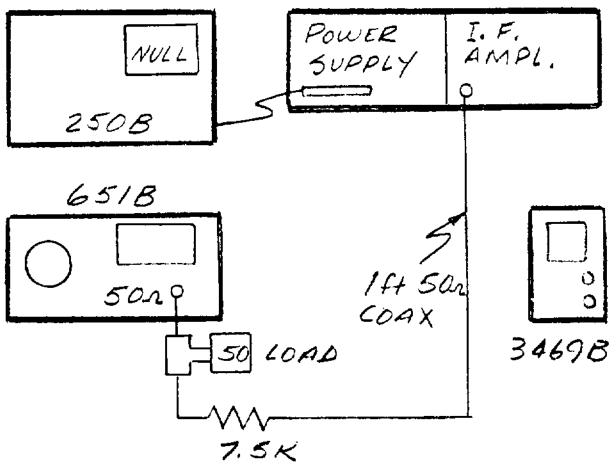


FIGURE B

DESCRIPTION	HP PART NUMBER		
	STANDARD	OPTION A85	OPTION X95
Front Panel Cabinet, Top Cabinet	00250-01073 00250-01074 00250-01075	00250-01062 00250-01074 00250-01075	Refer to Manual Parts List

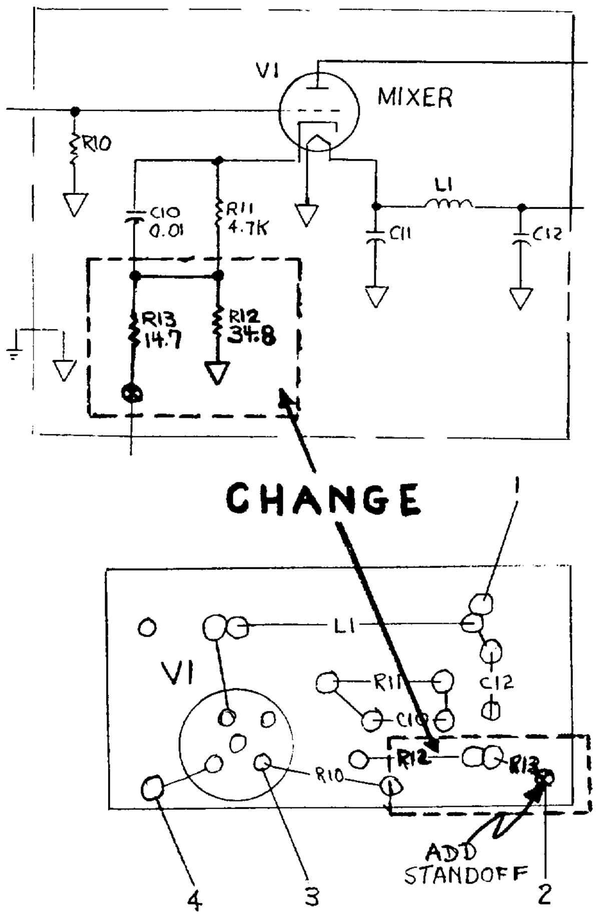


FIGURE A

Page 6-13, Table 6-5.
Change Index No. 20 to PN 1251-2357.

CHANGE 3:

Page 6-3, Table 6-1.
Change A2R12 to 0698-3434 R: fxd. met film, 34.8 ohm, 1%, 1/8W.
Add: A2R13, 0698-3428 R: fxd, met. film 14.7 ohm, 1%, 1/8W.

Page 7-3, Figure 7-1.
Change the schematic diagram and component location diagram of mixer circuit V1 as shown in Figure A.

ERRATA:

Page 3-10, Paragraph 3-30 2(4) formula should read

$$R_3 = \frac{4\,(R1R2)}{R_1 - R_2}$$

CHANGE 4:

The standard colors for this instrument are now mint gray (for front panel) and olive gray (for all other external surfaces). Option X95 designates use of the former color scheme of light gray and blue gray. Option A85 designates use of a light gray front panel with olive gray used for all other external surfaces. New part numbers are shown below:

CHANGE 5:

Table 6-1: Change resistor A2R1 to HP Part No. 00250-80029.

CHANGE 6:

IF Amplifier Assembly A3, HP Part No. 00250-61132 has been replaced by a new A3 assembly, HP Part No. 00250-61138. (The old and new assemblies are interchangeable.) The attached parts list replaces the one on pages 6-3 and 6-4 of the manual. The attached A3 schematic replaces the corresponding portion of Figure 7-2. The following steps replace paragraph 5-23 of the adjustment procedure:

5-23 Align the 00250-61138 IF amplifier as follows:

a. Prepare setup as shown in figure below. The following test equipment is required: HP 651B Test Oscillator, HP 3469B Multimeter, 7.5KΩ impedance matching resistor (HP Part No. 0757-0440), HP 908A 50Ω load.

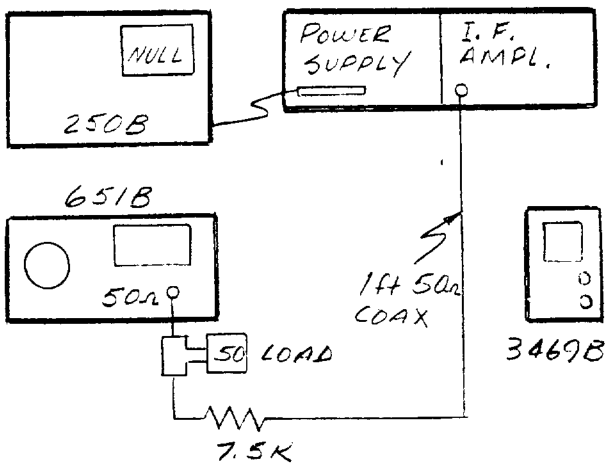


FIGURE B

DESCRIPTION	HP PART NUMBER		
	STANDARD	OPTION A85	OPTION X95
Front Panel Cabinet, Top Cabinet	00250-01073 00250-01074 00250-01075	00250-01062 00250-01074 00250-01075	Refer to Manual Parts List

b. Turn R8 and R14 to full CCW.

c. Turn on 250B. Measure power supply check points.

Cathode	VR1 =	17.9V ± .9V
Cathode	VR2 =	11.7V ± .6V
TP1	=	4.7V ± .5V

d. Set 651B fequency to 105KHz and attenuator to 300μV. On the 250B amplifier tune T1 and L1 for maximum indication on 250B null meter.

e. Set 651B to 30mV and adjust R14 for 48 divisions.

f. Set 651B to 20μV and adjust R8 for 10 divisions.

g. Change the input level from the 651B from 0 to 30mV and note meter action. There should be no instability at any level. Turn off power and connect the I.F. output of the bridge to the amplifier input. Procede with the standard 250B procedure. The setting of R8 may be trimmed to match individual bridges as necessary.

ERRATA:

In Table 6-4, change stock no. for Index No. 45 to 00250-61139, and change Index No. 67 to 00250-60038.

CHANGE 7:

Make the following changes to the attached schematic and parts list for the revised IF Amplifier Assembly described in Change 6:

Delete choke L3 and capacitor C9 and leave these component positions open-circuited.

Delete R11 and replace it with a jumper.

Change C5 to 2000pF, 100V, HP Part No. 0160-2301.

Change L2 to 1000μH, HP Part No. 9140-0137.

Change C10 to 220pF, 300V, HP Part No. 0160-0952.

Change R10 to 6.8KΩ, 1%, 1/8W, HP Part No. 0758-0009.

Change R18 to 100Ω, 1%, 1/8W, HP Part No. 0757-0401.

Change R9 to 8.2K, 1%, 1/8W, HP Part No. 0757-0946.

Change R13 to 91K, 1%, 1/8W, HP Part No. 0698-6080.

CHANGE 8:

In Table 6-1 and schematic (Fig. 701), under A2 Bridge Assy, change capacitor A2C6 to .8/8.5pF, HP Part No. 0121-0057.

CHANGE 9:

On page 6-2, change the stock number of A1CR1 to 1910-0016 and delete the old type-number from the Description column.

CHANGE 10:

The serial prefix of this unit has been changed to 1754A. This is the only change.

12-28-77

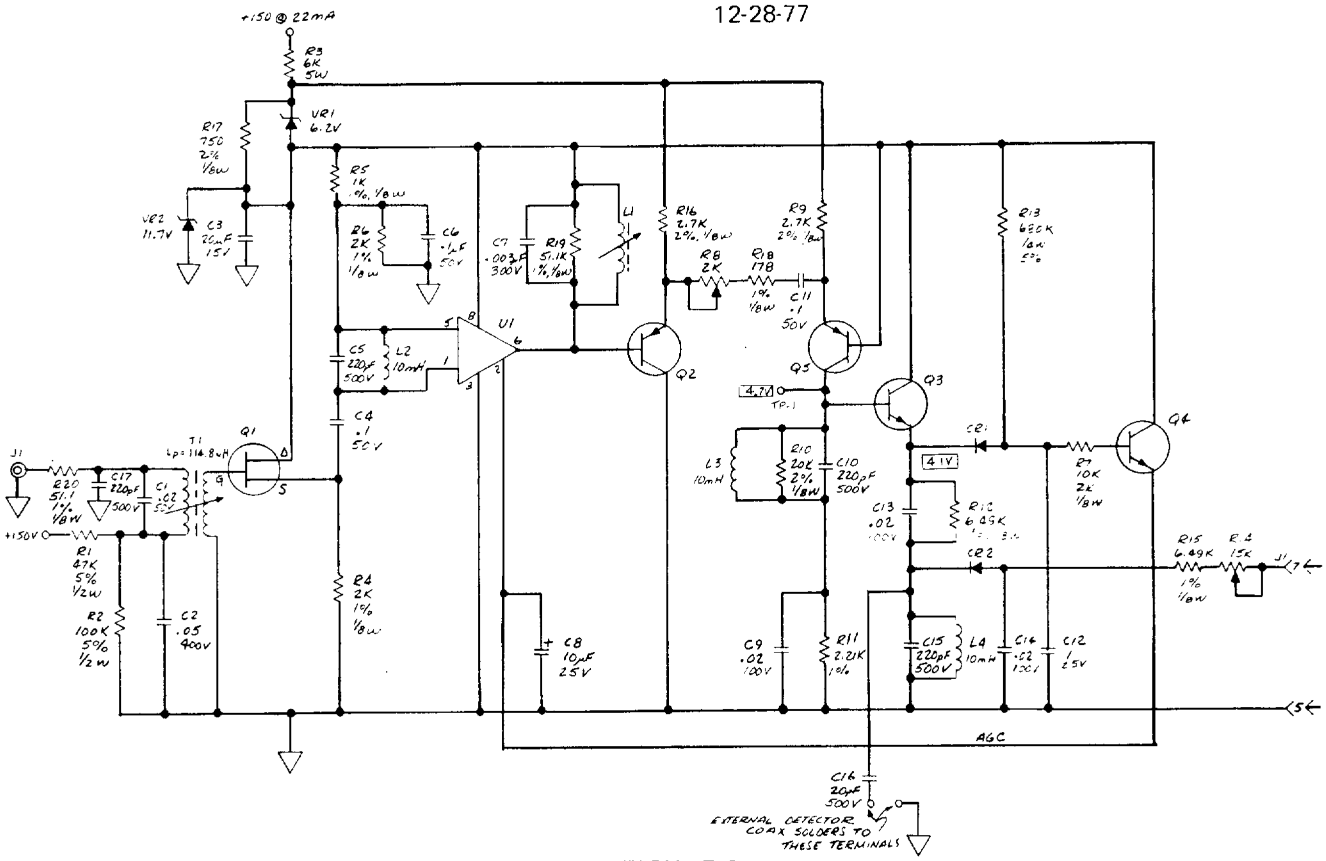


FIGURE C

b. Turn R8 and R14 to full CCW.

c. Turn on 250B. Measure power supply check points.

Cathode	VR1	=	17.9V ± .9V
Cathode	VR2	=	11.7V ± .6V
TP1		=	4.7V ± .5V

d. Set 651B fequency to 105KHz and attenuator to 300μV. On the 250B amplifier tune T1 and L1 for maximum indication on 250B null meter.

e. Set 651B to 30mV and adjust R14 for 48 divisions.

f. Set 651B to 20μV and adjust R8 for 10 divisions.

g. Change the input level from the 651B from 0 to 30mV and note meter action. There should be no instability at any level. Turn off power and connect the I.F. output of the bridge to the amplifier input. Procede with the standard 250B procedure. The setting of R8 may be trimmed to match individual bridges as necessary.

ERRATA:

In Table 6-4, change stock no. for Index No. 45 to 00250-61139, and change Index No. 67 to 00250-60038.

CHANGE 7:

Make the following changes to the attached schematic and parts list for the revised IF Amplifier Assembly described in Change 6:

Delete choke L3 and capacitor C9 and leave these component positions open-circuited.

Delete R11 and replace it with a jumper.

Change C5 to 2000pF, 100V, HP Part No. 0160-2301.

Change L2 to 1000μH, HP Part No. 9140-0137.

Change C10 to 220pF, 300V, HP Part No. 0160-0952.

Change R10 to 6.8KΩ, 1%, 1/8W, HP Part No. 0758-0009.

Change R18 to 100Ω, 1%, 1/8W, HP Part No. 0757-0401.

Change R9 to 8.2K, 1%, 1/8W, HP Part No. 0757-0946.

Change R13 to 91K, 1%, 1/8W, HP Part No. 0698-6080.

CHANGE 8:

In Table 6-1 and schematic (Fig. 701), under A2 Bridge Assy, change capacitor A2C6 to .8/8.5pF, HP Part No. 0121-0057.

CHANGE 9:

On page 6-2, change the stock number of A1CR1 to 1910-0016 and delete the old type-number from the Description column.

CHANGE 10:

The serial prefix of this unit has been changed to 1754A. This is the only change.

12-28-77

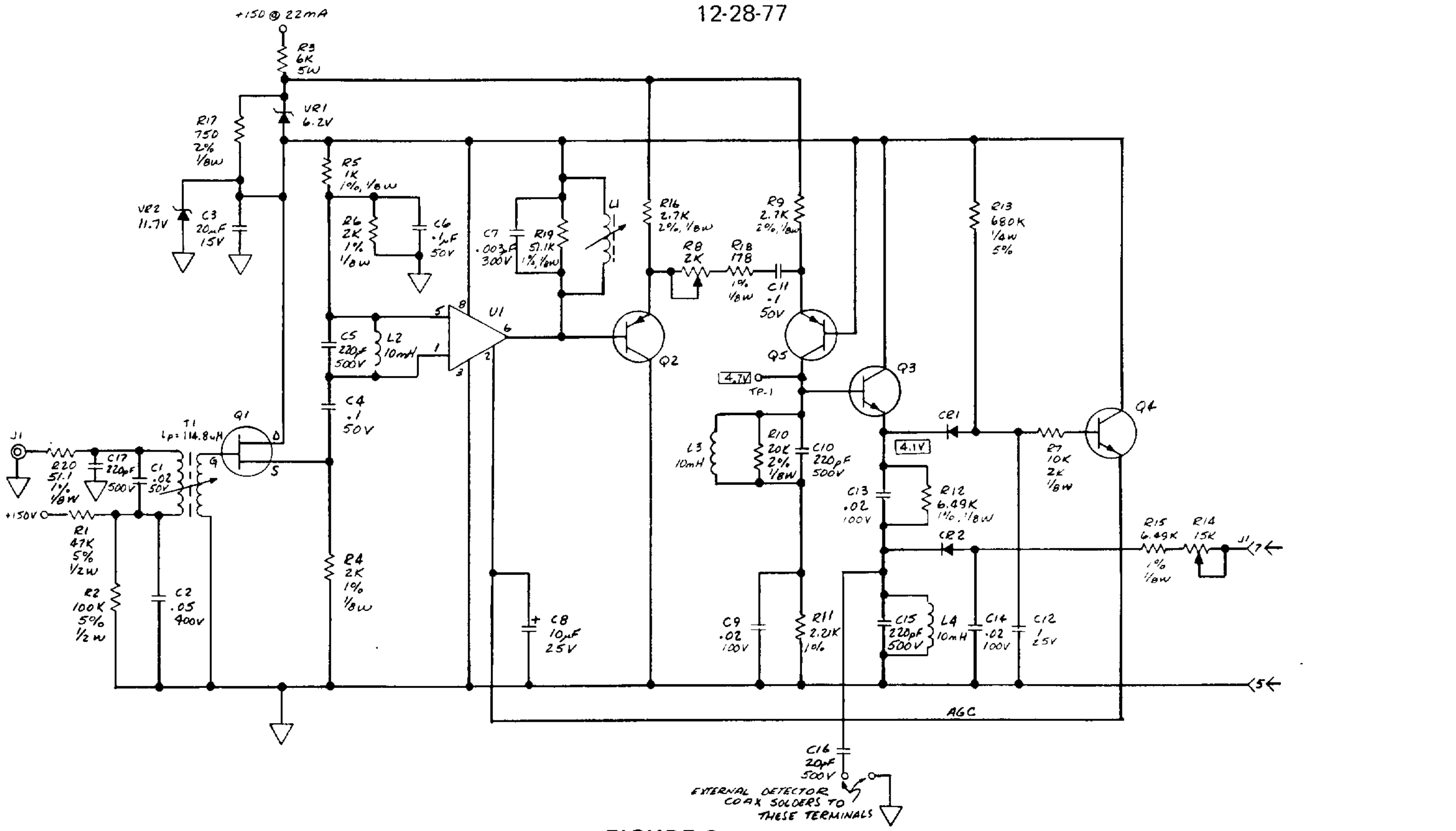


FIGURE C

Reference Designation	Stock Number	Description
A3	00250-61138	IF AMPLIFIER ASSEMBLY
	00250-21138	A3 Printed Circuit Board Blank
A3C1	0160-0683	C: fxd, poly, .02μF ±2% 50V
A3C2	0150-0052	C: fxd, cer. .05μF ±20% 400V
A3C3	0180-0300	C: fxd, alum. elect. 20μF –20+75% 15V
A3C4	0150-0121	C: fxd, cer. 0.1μF –20 +80% 50V
A3C5	0140-0083	C: fxd, mica 220pF ±5% 500V
A3C6	0150-0121	C: fxd, cer. 0.1μF –20 +80% 50V
A3C7	0140-0159	C: fxd, mica .003μF ±2% 300V
A3C8	0180-0059	C: fxd, alum. elect. 10μF –10 + 75% 25V
A3C9	0160-0818	C: fxd, .02μF ±20% 100V
A3C10	0140-0083	C: fxd, mica 220pF ±5% 500V
A3C11	0150-0121	C: fxd, cer. 0.1μF –20 +80% 50V
A3C12	0160-0127	C: fxd, cer. 1μF ±20%, 25V
A3C13, 14	1060-0818	C: fxd, .02μF ±20% 100V
A3C15	0140-0083	C: fxd, mica 220pF ±5% 500V
A3C16	0160-2033	C: fxd, mica 20pF ±5% 500V
A3C17	0140-0083	C: fxd, mica 220pF ±5% 500V
A3CR1	1901-0040	diode: switching 30V 50mA
A3CR2	1910-0016	diode: switching 60V 60mA
A3J1	1250-0835	connector: coax subminiature
A3L1	00250-80031	inductor: variable
A3L2-4	9140-0131	coil: fxd, rf choke 10mH
A3Q1	1855-0062	xstr: JFET N-chan
A3Q2	1853-0050	xstr: SS silicon PNP
A3Q3,4	1854-0071	xstr: SS silicon NPN
A3Q5	1853-0050	xstr: SS silicon PNP
A3R1	0686-4735	R: fxd, comp 47KΩ ±5% ½W
A3R2	0686-1045	R: fxd, comp 100KΩ ±5% ½W
A3R3	0811-1559	R: fxd, ww 6KΩ ±5% 5W
A3R4	0757-0283	R: fxd, film 2KΩ ±1% 1/8W
A3R5	0757-0280	R: fxd, film 1KΩ ±1% 1/8W
A3R6	0757-0283	R: fxd, film 2KΩ ±1% 1/8W
A3R7	0757-0948	R: fxd, film 10KΩ ±2% 1/8W
A3R8	2100-1774	R: var, ww 2KΩ ±5% 1W
A3R9	0757-0934	R: fxd, film 2.7KΩ ±2% 1/8W
A3R10	0757-0955	R: fxd, film 20KΩ ±2% 1/8W
A3R11	0757-0430	R: fxd, film 2.21KΩ ±1% 1/8W
A3R12	0698-3226	R: fxd, film 6.49KΩ ±1% 1/8W
A3R13	0683-6845	R: fxd, comp 680KΩ ±5% ¼W
A3R14	2100-0896	R: var, ww 15KΩ ±5% 1W
A3R15	0698-3226	R: fxd, film 6.49KΩ ±1% 1/8W
A3R16	0757-0934	R: fxd, film 2.7KΩ ±2% 1/8W
A3R17	0757-0921	R: fxd, film 750Ω ±2% 1/8W
A3R18	0698-3439	R: fxd, film 178Ω ±1% 1/8W
A3R19	0757-0458	R: fxd, film 51.1KΩ ±1% 1/8W
A3R20	0757-0394	R: fxd, film 51.1Ω ±1% 1/8W
A3T1	00250-80030	Input Transformer
A3U1	1820-0306	IC: linear differential amplifier
A3VR1	1902-0761	diode: zener 1N821 6.2V ±5% ¼W
A3VR2	1902-0018	diode: zener 1N941 11.7V ±5% ½W

AMSTERDAM

SAVENYE RINUS

INTER-OFFICE SERVICE MEMO

TO: Distribution Date: 1 April 1974

FROM: New Jersey Division

SUBJECT: 250A / 250B RX Meter Bridge Repair

This memo supersedes IOSM of 1 November 1972 and all previous memos on this subject.

The RX Meter bridge design does not lend itself to user or field service overhaul. It employs a six-element Schering bridge circuit, whose interaction of mechanical and electrical functions usually causes it to wear beyond specification limits after years of regular usage. Previous attempts at providing overhaul service have been unsuccessful.

Model 250"A" RX meters were shipped from May 1953 thru March 1968. 250"B" models have been shipped since then. Although "B" bridges are similar in basic concept to "A", the "B" units feature a low-noise Nuvistor mixer, improved gear trains, and other refinements. "B" bridges can easily be adapted to "A" units.

Bridges with problems in the Cp calibration, front panel adjust pots, and top post assemblies can often be repaired at CSC or a regional repair center. Rp recalibration is not possible in the field and requires replacement of the entire bridge assembly.

The part number of the 250B bridge assembly is 00250-61105. This bridge will fit in a 250A if connector adaptor 1250-1301 is used. The ground clamping bars 00250-20076 can be taken from the 250A bridge and used on this 250B bridge.

If you have a 250B in warranty requiring bridge replacement, please contact the factory before proceeding.

Chris Franks 4/74-21
/ cab

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SERVICE NOTE

Supersedes:
None

Model 250B RX Meter

Power Supply Modification
Serials: Prefixed 737

A modification to the Model 250B Power Supply will prevent initial turn on surges from blowing the line fuse in instruments with serial prefix 737. The change consists of lowering the size of the output filter capacitor A4C2 to 1μF from 47μF, and adding a diode across the pass transistor Q1.

Parts Required

Capacitor, fxd 1μF (electrolytic), 250 wvdc. HP Part No. 0180-1845.

Diode, Silicon. HP Part No. 1901-0029.

Remove the existing A4C2 from power supply board, substituting the 1μF capacitor in its place. Add the diode across the terminals of transistor Q1 located on the heat sink. Connect the diode anode to Q1 emitter, and cathode to Q1 collector.

No adjustments should be necessary as a result of the change, however the instrument Performance Checks should be accomplished to verify operation within specifications.

Correct the schematic in the Operating and Service Manual to reflect the changes, designating the added diode as A4CR13, and correct the parts list with the new part numbers.

WW/keg/wo 9/69-10

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HEWLETT hp PACKARD

AMSTERDAM

SAVFNIJE RINUS

INTER-OFFICE SERVICE MEMO

TO: Distribution

Date: 1 November 1972

FROM: New Jersey Division

SUBJECT: 250A / 250B RX Meter Bridge Repair

This memo supercedes IOSM of 18 August 1970 and all previous memos on this subject.

The RX Meter bridge design does not lend itself to user or field service overhaul. It employs a six-element Schering bridge circuit, whose interaction of mechanical and electrical functions usually causes it to wear beyond specification limits after years of regular usage. Previous attempts at providing overhaul service at places other than the factory have been unsuccessful.

Model 250"A" RX meters were shipped from May 1953 thru March 1968. 250 "B" models have been shipped since then. Although "B" bridges are similar in basic concept to "A" , the "B" units feature a low-noise Nuvistor mixer, improved gear trains, and other refinements. "B" bridges can easily be adapted to "A" units. Factory overhaul of "A" bridges has been available for some time. Here is a summary of choices now available .

1. New "B" bridge 00250-61105 $1900.00
   This is an outright sale. The part is ordered from CSC (PCE). This bridge will fit a 250A if adapter 1250-0831 and two 00250-60045 plates are used.

2. New "B" bridge 00250-61105 $1200.00 with an old "A" or "B" bridge sent in for overhaul. Send to N.J.D. on a repair order and specify whether for an "A" or "B" RX Meter.

3. Overhauled "A" bridge 00250-60081 $1000.00 with an old "A" bridge sent in for overhaul. Send to N.J.D. on a repair order.

New "A" bridges, 00250-60012, have not been available for some time. See #1 above. N.J.D. maintains a supply of each of the three stock numbers for minimum T.A.T.

Each bridge carries an identification number on its casting. This number is similar to a standard serial prefix number, and the letter identifies an "A" or "B" bridge. For example: 1243A-3 is the third "A" bridge overhauled in the fourty-third week of 1972; 1311B-1 would be the first "B" bridge of the eleventh week of 1973. If trouble develops within a bridge within one year of this date, return the bridge to N.J.D. on a repair order, where it will be repaired or replaced at no charge. Be sure to claim re-repair and provide specific complaint details.

Chris Franks

10/72-21

HEWLETT hp PACKARD

SERVICE NOTE

250B RF Transformer Assembly

A recent 250B assembly change permits separate replacement of RF Transformer A2T1 and Spring and Post Assy., used as the LO post and Cp capacitor rotor contact. This assembly, shown as Item 73 of figure 6-3 in the Operating and Service Manual, is a single unit in instruments below Serial Prefix 923, with the Spring and Post Assy soldered to the case of RF Transformer A2T1. The complete assembly was identified by stock number 00250-60014. In instruments above Serial Prefix 923, this assembly has been broken down into two separate replaceable parts. If replacement is necessary in instruments where the single assembly configuration exists, order both Transformer and Cable Assy. 00250-61136, and Spring and Post Assy. 00250-61135. For subsequent repairs, and in instruments above Serial Prefix 923, it will be necessary to replace only the applicable part. This change has been prompted by field experience which indicates that the usual cause of failure in the 00250-60014 assembly has been physical damage to the LO terminal post.

In replacing the Spring and Post Assembly, be sure that:

1. The surface of the RF Transformer case, and the under surface of the Spring and Post Assy. are free of corrosion so that good grounding contact is assured.

2. All contact fingers are touching the Cp capacitor rotor.

WW/keg/wo

4/69-10

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MANUAL CHANGE SHEET
MODEL 250B
Manual Serial Prefixed: 737
HP Part No. 00250-90037

To adapt this manual to instruments with other serial prefixes, check for errata below and make changes shown in tables.

Instrument Serial Prefix	Make Manual Changes
923	1
1034A	1,2
1029A Serials 04821 thru 04840 (except 04825, 27, 33)	1,2,3

Instrument Serial Prefix	Make Manual Changes
1144A-04841 thru 04860	1,2,3
1204A-04861 thru 04900	1,2,3,4
1227A-04901 thru 04990	1 thru 5
1227A-04991 thru 05000	1 thru 6
1227A-50001 up (except -5001, -5003, -5006, and -5007)	1 thru 7
1605A-5261 thru 5290	1 thru 8
1620A-5291 thru 5430	1 thru 9
1745A-5431 and up	1 thru 10

ERRATA:

Page 6-2, Table 6-1.
Change Stock No. of A1C14 to 0160-2209. Description remains the same.

Page 6-4, Table 6-1.
Change A4 Stock No. to 00250-61131.

Page 6-5, Table 6-1.
Add: A4C7, 0180-0228, C: fxd, alum elect. 22μF 15vdcw.

Page 7-5, Figure 7-2.
Add: C7 in parallel with R7 on A4 Power Supply Assembly. Indicate value 22μF, +side of capacitor to ground.

Amend Reference Designator List to indicate A4 C1-C7.

Amend Component Locator Photograph to indicate C7 connected between pins numbered 10 and 13, + side of capacitor to pin 13.

CHANGE 1:

Page 6-4, Table 6-1.
Change Stock No. and Description of A3R18 to read as follows: 2100-1774 R: var, ww 2KΩ ½W, PC mtg.

Page 6-4, Table 6-1.
Change Stock No. and Description of A4C2 to read 0180-2209 C: fxd, 1μF elect +10 −50 vdcw.

Page 6-5, Table 6-1.
Add: A4CR13, 1901-0029, Diode Si.

Page 7-5, Figure 7-2.
Make the following corrections to Schematic and Component Location diagrams.

1. Delete asterisk adjacent to A3R19
2. Change A3R18 to a variable resistor connected as a rheostat with top end connected to A3CR2, and arm grounded.
3. Add Diode A4CR13 connected with anode to emitter of chassis transistor Q1, and cathode connected to collector of Q1.
4. Change A4C2 value to 1μF.

Page 6-10, Table 6-4, Figure 6-3.
Terminal Assembly (Item 9) and Pot Bracket (Item 38) have been combined into a single combination bracket in which a new ball drive unit is used for Vernier Drive. In addition, Transformer Assembly (Item 73) has been modified to permit separate replacement of the Transformer and the Spring and Pot Assembly. Make the following notation on Table 6-4 and Figure 6-3.

1. For Item 9, 00250-60016, Terminal Drive. Substitute 00250-01072 Bracket Trim Drive with 1500-0051 Ball Drive.
2. For Item 38, Pot Bracket, delete Stock No. 00250-00031. Mark drawing "part of bracket, trim drive item 9".
3. Add Item 53A and 67A, 4330-0081, Ball, glass. Located within Bearing Assembly.
4. For Item 73, 00250-60014, Complete Transformer substitute: 73A 00250-61136 Transformer and Cable Assembly. 73B 00250-61135 Spring and Pot Assembly.

CHANGE 2:

Page 6-5, Table 6-1.
Change Reference Designation of R1, 2-S1 to R1, 2. Part No. 2100-3004 R: var (no switch-remove switch wires from circuit).

Page 6-5, Table 6-1.
Change F1 Stock No. to 2110-0201 Fuse ¼A
Change F1 Stock No. 2110-0202 Fuse ½A
Change J2 Stock No. 1251-2357 Con. ac pwr.
Change S3 Stock No. to 3101-0003 Switch, toggle
Change W1 Stock No. to 8120-1348 AC cable assy.

Page 6-6, Table 6-2.
Change Index No. 24 to PN 1450-0413 Jewel, white.

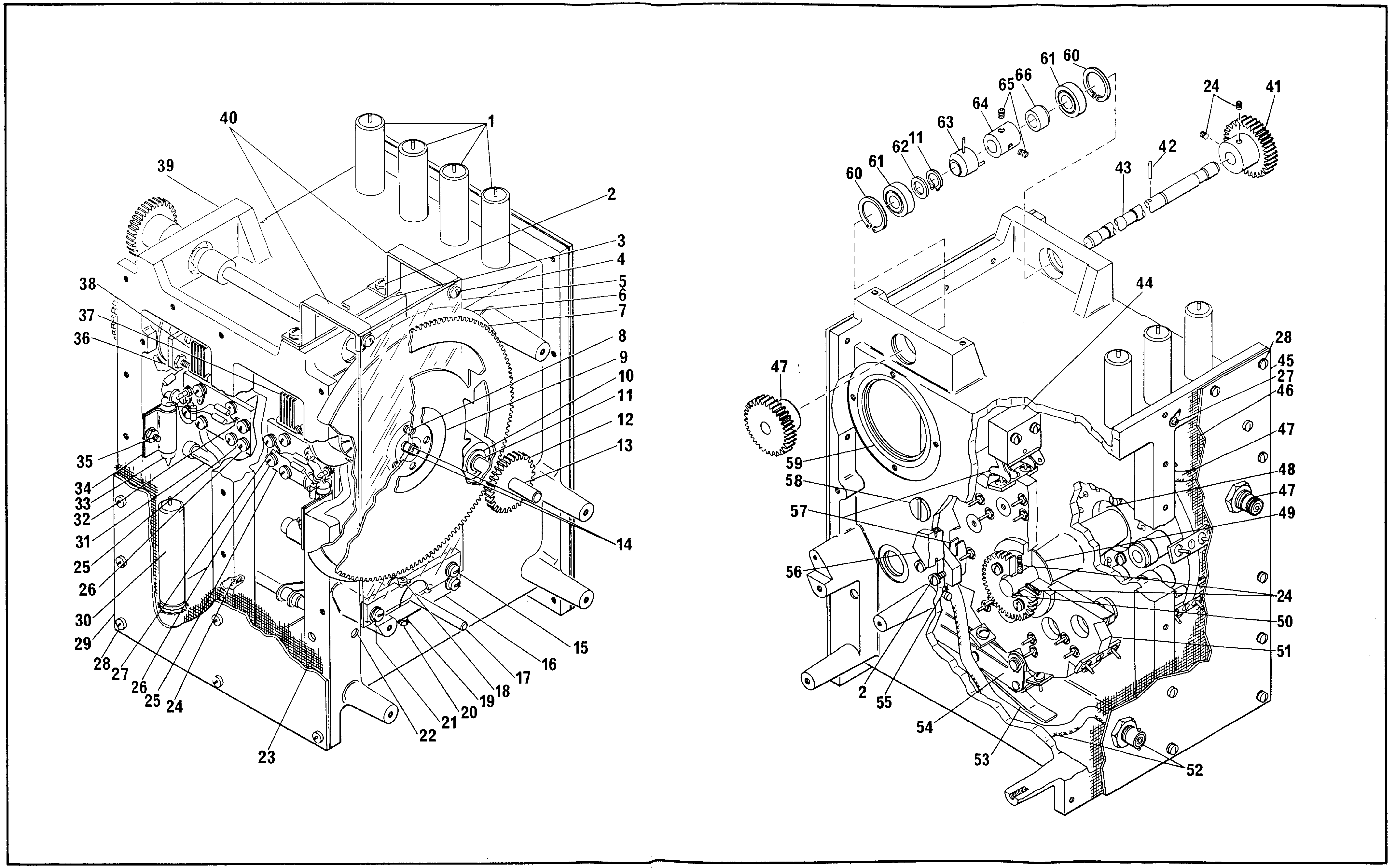


Figure 6-2. OSCILLATOR ASSEMBLY

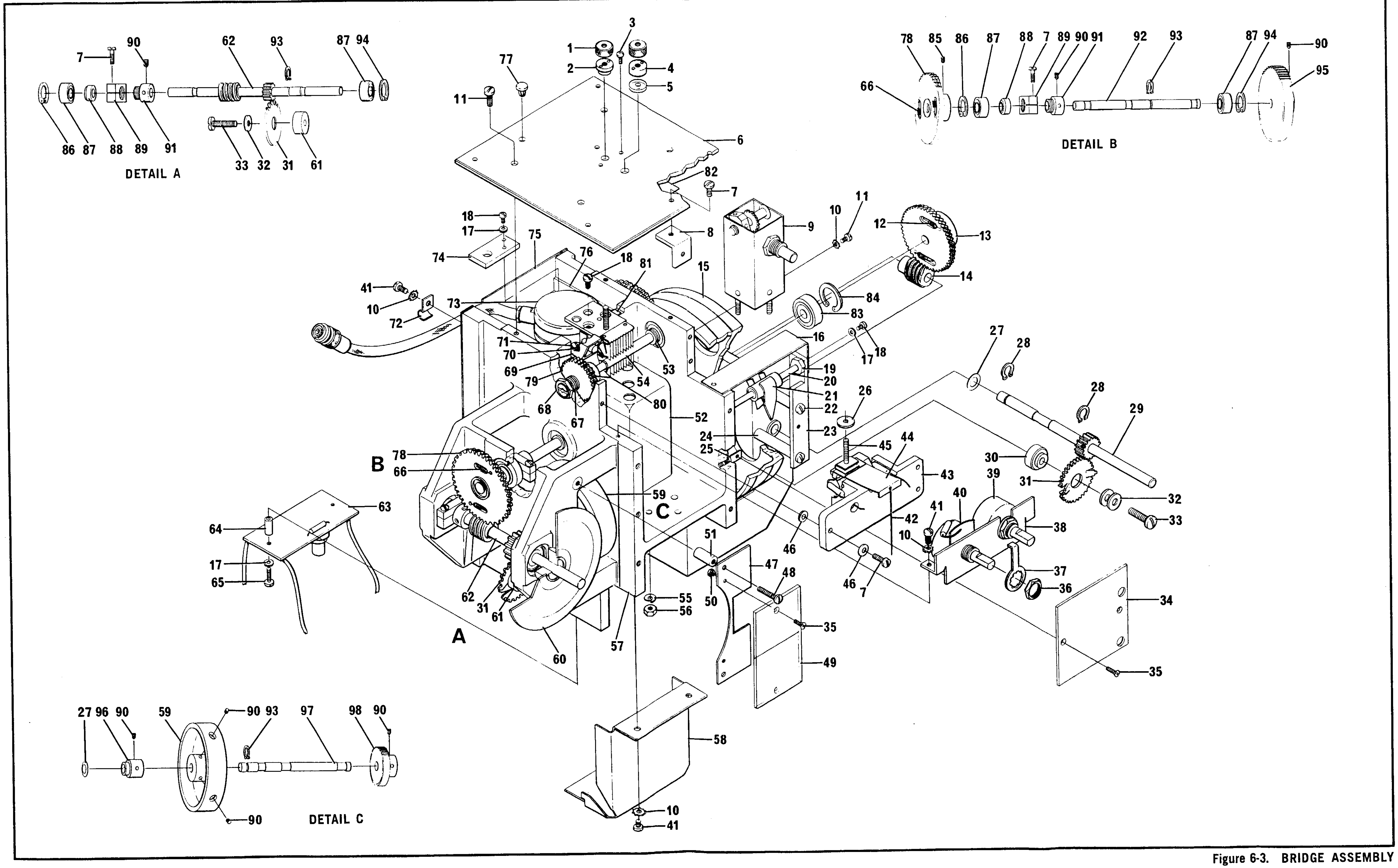
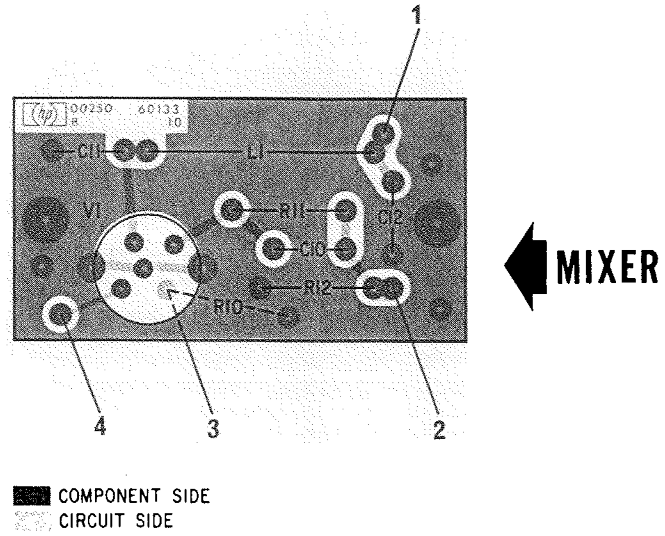
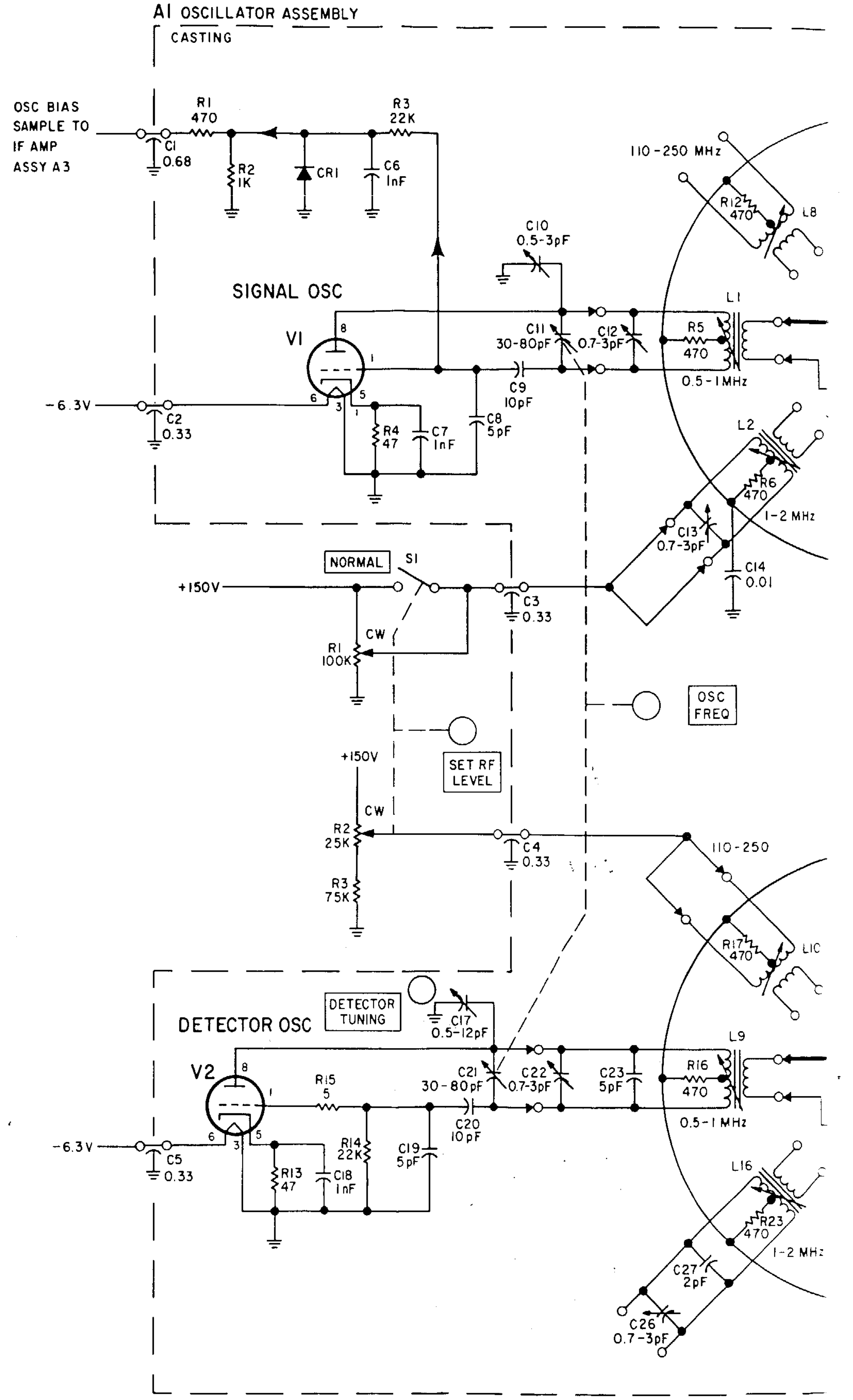


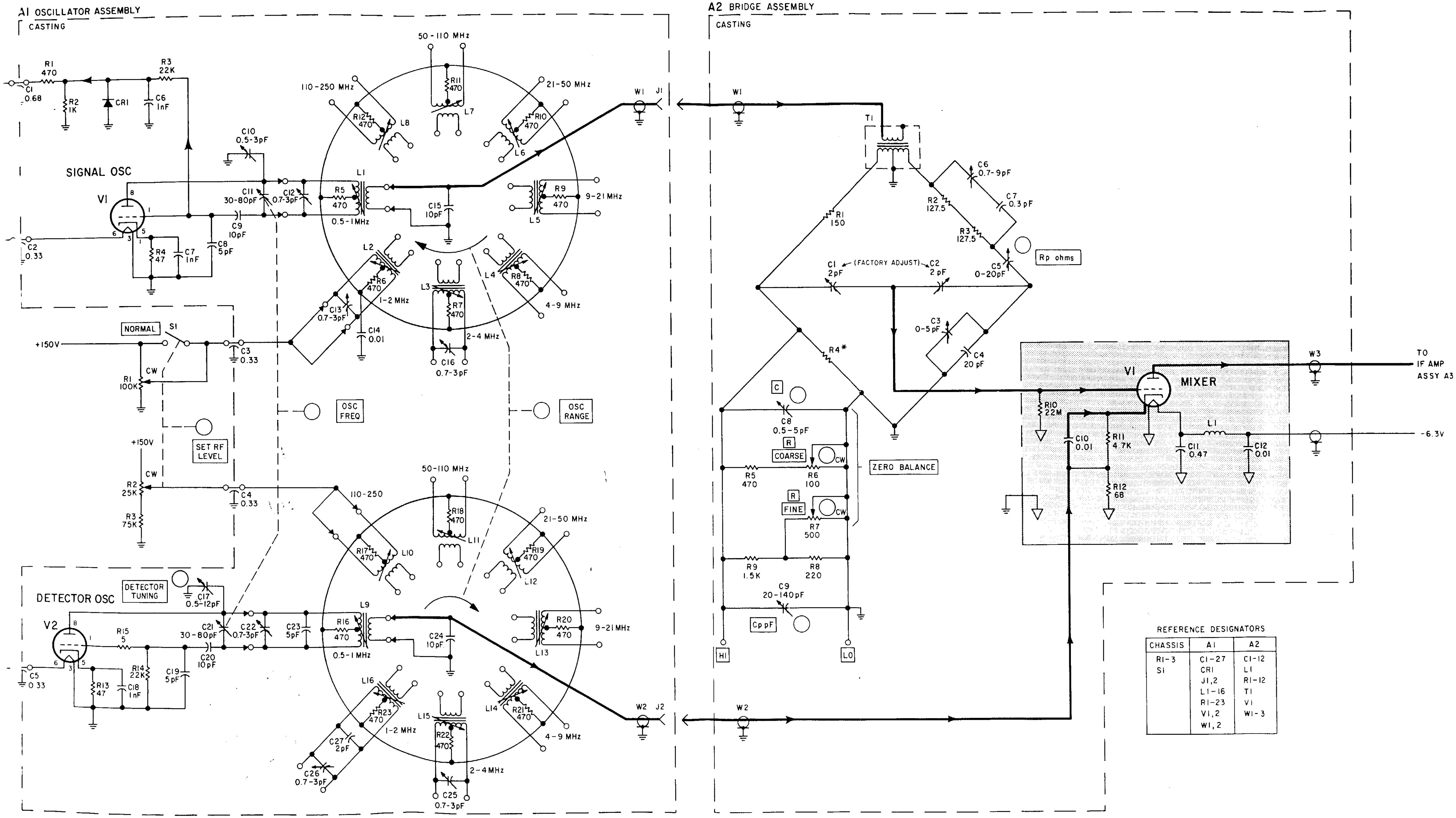
Figure 6-3. BRIDGE ASSEMBLY



Connections - Mixer Assembly

Number	Wire	Connection
1	Coaxial	To -6.3 V supply.
2	Coaxial	Mixer Input Cable Assembly A2W2.
3	Jumper	To bridge Network Assembly.
4	Coaxial	Mixer Output Cable Assembly A2W3.

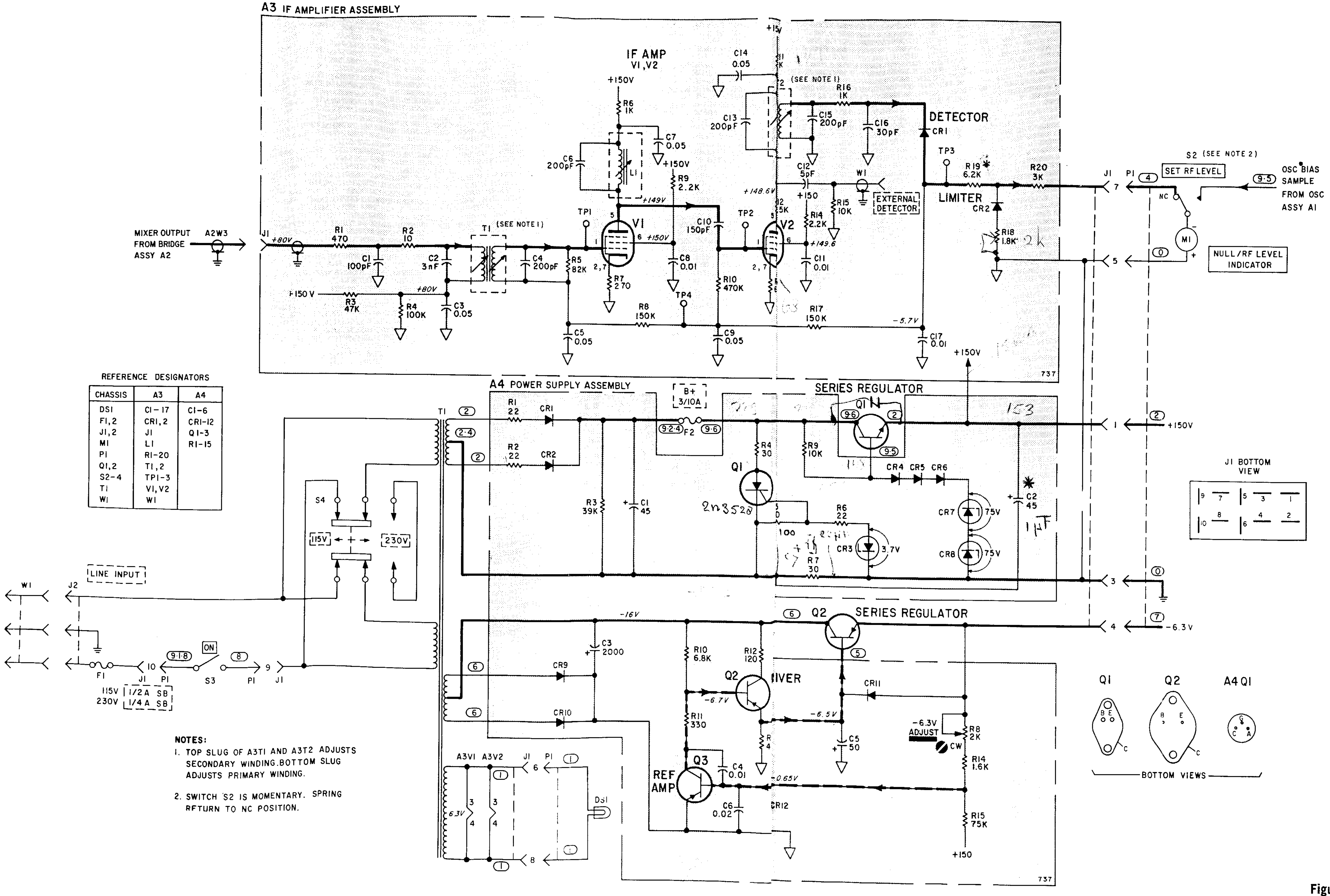




REFERENCE DESIGNATORS

CHASSIS	A1	A2
R1-3 S1	C1-27 CR1 J1,2 L1-16 R1-23 V1,2 W1,2	C1-12 L1 R1-12 T1 V1 W1-3

Figure 7-1
OSCILLATOR & BRIDGE



REFERENCE DESIGNATORS

CHASSIS	A3	A4
DS1 F1,2 J1,2 M1 P1 Q1,2 S2-4 T1 W1	C1-17 CR1,2 J1 L1 R1-20 T1,2 TP1-3 V1,V2 W1	C1-6 CR1-12 Q1-3 R1-15

NOTES:
1. TOP SLUG OF A3T1 AND A3T2 ADJUSTS SECONDARY WINDING. BOTTOM SLUG ADJUSTS PRIMARY WINDING.
2. SWITCH S2 IS MOMENTARY. SPRING RETURN TO NC POSITION.

Figure 7-2
POWER SUPPLY & IF AMPLIFIER