TECHNICAL MANUAL

GENERAL SUPPORT

MAINTENANCE MANUAL

MEASURING SET, STANDING WAVE RATIO

AN/USM-37E

(NSN 6625-00-197-6910)

HEADQUARTERS, DEPARTMENT OF THE ARMY

MAY 1978

WARNING
HIGH VOLTAGE

is used in the operation of this equipment

DEATH ON CONTACT

May result if personnel fail to observe safety precautions.

Learn the areas containing high voltage in each piece of equipment. Be careful not to contact high-voltage connections when installing or operating this equipment.

Before working inside the equipment, turn power off and ground points of high potential before touching them.

WARNING

The fumes of TRICHLOROETHANE are toxic. Provide thorough ventilation whenever it is used; avoid prolonged or repeated breathing of vapor. Do not use near an open flame or hot surface; trichloroethane is nonflammable but heat converts the fumes to a highly toxic phosgene gas the inhalation of which could result in serious injury or death. Prolonged or repeated skin contact with trichloroethane can cause skin inflammation. When necessary, use gloves, sleeves and aprons which the solvent cannot penetrate.

TECHNICAL MANUAL

No. 11-6625-369-40-1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, 30 May 1978

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REPORTING OF ERRORS

You can improve this manual by recommending improvements using DA Form 2028-2 (Test) located in the back of the manual. Simply tear out the selfaddressed form, fill it out as shown on the sample, fold it where shown, and drop it in the mail.

If there are no blank DA Form 2028-2 (Test) in the back of your manual, use the standard DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forward to the Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-MA-Q, Fort Monmouth, New Jersey 07703.

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

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LIST OF ILLUSTRATIONS

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1-1. Scope
This manual presents a functional description of Measuring Set, Standing Wave Ratio AN/USM-37E, and covers general support maintenance of the equipment. The major component of the test set, SWR Indicator IM-157E/U, is the principal concern of general support maintenance personnel and therefore, the majority of information contained herein pertains to the IM-157E/U. Where appropriate, instructions for maintenance of the minor components are included.

1-2. Indexes of Publications
a. DA Pam 310-4. Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.
b. DA Pam 310-7. Refer to DA Pam 310-7 to determine whether there are modification work orders (MWO's) pertaining to the equipment.

1-3. Forms and Records
a. Reports of Maintenance and Unsatisfactory Equipment. Maintenance forms, records, and reports which are to be used by maintenance personnel at all maintenance levels are listed in and prescribed by TM 38-750.
b. Report of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Packaging Improvement Report) as prescribed in AR700-58/NAVSUPINST4030.29/AFR7113/MCO P4030.29A, and DLAR 4145.8.
c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR55-38/NAVSUPINST4610.33B/AFR 75-18/MCO P4610.19C and DLAR 4500.15.

1-4. Adminstrative Storage
Prior to temporary storage (less than 90 days) of the AN/USM-37E, the following preparations must be taken:
a. Determine serviceability of equipment by performing operating procedures described in TM 11-6625-369-1.
b. Remove battery pack from the SWR indicator IM-157E/U. Refer to TM 11-6625-369-1 for proper battery storage.

CAUTION
Avoid short-circuiting the battery pack terminals. The cells of this battery have a very low internal resistance and will discharge at an extremely high-current level when shorted, resulting in high temperature and possible battery damage.

1-5. Destruction of Army Materiel
Destruction of Army materiel to prevent enemy use shall be as prescribed in TM 750-244-2.

1-6. Calibration

Refer to TB 43-180 for calibration requirements for the AN/USM-37E.

1-7. Reporting Equipment Improvement Recommendations (EIR).
EIR's will be prepared using DA Form 2407, (Maintenance Request). Instructions for preparing EIR's are provided in TM 38-750, The Army Maintenance Management System. EIR's should be mailed direct to Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN:DRSEL-MA-Q, Fort Monmouth, NJ 07703. A reply will be furnished directly to you.

Section II. DESCRIPTION AND DATA

1-8. Description.
A description of the capabilities, purpose, and use of the AN/USM-37E may be found in TM 11-6625-369-12-1.

1-9. Tabulated Data.
The technical specifications for the AN/USM-37E may be found in TM 11-6625-369-12-1.

CHAPTER 2
FUNCTIONING OF EQUIPMENT

2-1. General

The mechanical functioning of the various minor components of the AN/USM-37E is described in the operating instructions of TM 11-6625369-12-1. Only the major component, the SWR Indicator, is dealt with in this chapter.

2-2. Theory

a. The ratio E max/E min is referred to as the standing wave ratio of the electric field intensity. Since the electric field intensity is proportional to voltage, Emax/Emin is ordinarily termed the voltage standing wave ratio or VSWR.

Thus,

$$VSWR = \frac{E\ max = (A) + (B)}{E\ min\ (A) - (B)}$$

where (A) = peak voltage magnitude of incident wave.
(B) = peak voltage magnitude of reflected wave.

b. If the end of an rf line is shorted, the incident voltage wave is totally reflected. In this case the magnitude of the reflected signal equals that of the incident signal; i.e., (B) = (A) resulting in a VSWR = o . On the other hand, an ideal match means complete absorption of the incident wave. The reflected signal magnitude is then zero; i.e., B = O and VSWR = 1. Both these VSWR's (1 and Xo are extreme ideal cases). Most of the values encountered in actual practice lie between 1.03 and 100. Standing wave ratios can also be expressed in db using the formula
db = 20 log/l0 (VSWR).

c. The reflection coefficient r, is the ratio between the reflected and incident wave amplitudes, and contains the same information as VSWR. It can be written as

$$r = \frac{(R)}{(A\}}$$

or, in terms of VSWR

$$r = \frac{(VSWR) - 1.}{(VSWR) + 1}$$

It is readily apparent from the above expressions that r can only lie between 0 (for an ideal match) and 1 (for total signal reflection).

2-3. Circuit Analysis

(fig. 2-1)

The SWR Indicator is a high-gain tuned amplifier which produces a meter reading, calibrated in VSWR, proportional to an input signal received from a square-law detector. The high-gain amplifier permits detection of small signals, while the flexibility provided by the wide attenuation range of the amplifier permits on-scale readings of large signals. Discussion of the circuitry of the SWR Indicator is given below.

a. Input Circuit. The input circuit provides an input impedance much higher than that of any crystal detector or bolometer normally used with the instrument. This results in a lower noise figure and in the highest possible input signal to the SWR Indicator. When INPUT SELECTOR S101 is placed in either BOLO position, bolometer bias current (4.5mA or 8.7 mA) is applied to INPUT connector J1. The bolometer bias current is generated by the + 13V regulated (nominal) supply and emitter follower Q101. An internal meter bias current calibration adjustment (R351 on circuit board assembly) is provided. This calibration adjustment is set for a 4.5 or 8.7 mA reading (depending on setting of S101) on the BOLO BIAS meter scale when the rear panel BIAS CHECK switch S201 is activated.

b. Range Switching Circuit. RANGE DB switch S201 is divided into two sections. The first section of this switch receives the signal from INPUT SELECTOR S101 and feeds it to the input amplifier. The first section provides up to 30-db gain in 10-db steps. The second section of RANGE DB switch S201 is located between the input amplifier and the second amplifier and provides a gain of 30-60 db in 10-db steps. EXPAND switch S202 provides signal level measurement on an expanded scale (O to 2 db) with continuous coverage. The EXPAND switch applies an exact dc offset current from Q317 to the meter while simultaneously increasing the third amplifier input signal.

c. Amplifier Circuits.

(1) The input amplifier comprises four cascaded transistors (Q301, Q302, Q303 and Q304) and receives the signal from the first section of RANGE DB switch S201. The signal input is

applied to the base of Q301 and the amplifier output is taken from the collector of Q304. The gain of this amplifier is varied by the COARSE GAIN and FINE GAIN controls over a range of 10 to 1. The COARSE GAIN control, a 250k ohm variable resistor, varies the negative feedback from the collector of Q304 to the emitter of Q301. The FINE GAIN control consists of a 5, 000 ohm variable resistor in series with the output signal.

(2) The second stage amplifier, consisting of transistors Q305 and Q306, receives the signal from the second section of the RANGE DB switch. Gain stability and high input impedance are provided by feedback from the collector of Q306 to the emitter of Q305. The amplifier output is applied to the third stage amplifier (Q308 and Q309) through EXPAND switch S202.

(3) The fourth stage, or final amplifier, consists of four transistors (Q310, Q311, Q312 and Q313). The collectors of output transistors, Q312 and Q313, are ac grounded, allowing the units to function as a push-pull class B amplifier. The gain of this output amplifier stage is almost unity due to large negative feedback. The ac output voltage is developed across resistor R351. Also, the collector current of Q312 can drive the meter directly, without rectifier diodes. This meter driving current is filtered by capacitor C326 and passes through the meter and resistor R501 to develop a dc voltage for the DC OUTPUT jack on the rear panel.

d. Power Supply. The power supply receives primary ac input of either 115 volts or 230 volts 10%, 50-1000 Hz. LINE VOLTAGE switch S501 connects the two primary windings of power transformer T501 either in series or in parallel, depending on the ac input voltage. When POWER switch S401 is placed in the LINE ON position, a small dc tricle charge of about 3 ma is applied to the battery, through R352. With the switch placed to BATT CHARGE, R352 is connected in parallel with R402 which allows a charging current of about 20-30 ma (depending on battery condition) to flow to the battery. If S401 is set to the BATT ON position, the battery supplies current to the regulator circuit. Indicator DS1 lights whenever S401 is placed to LINE ON or BATT CHARGE. The power supply provides two regulated outputs: +13V and -17.1 mA offset current. Transistor Q317 and voltage reference diode CR310 form a constant current source which provides the offset current. Diode CR310 is temperature compensated by diodes CR307 and CR308. Transistor Q316 and diode CR310 provide shunt-type regulation which maintains a -7.5V (nominal reference for +13V regulator Q314 and Q315).

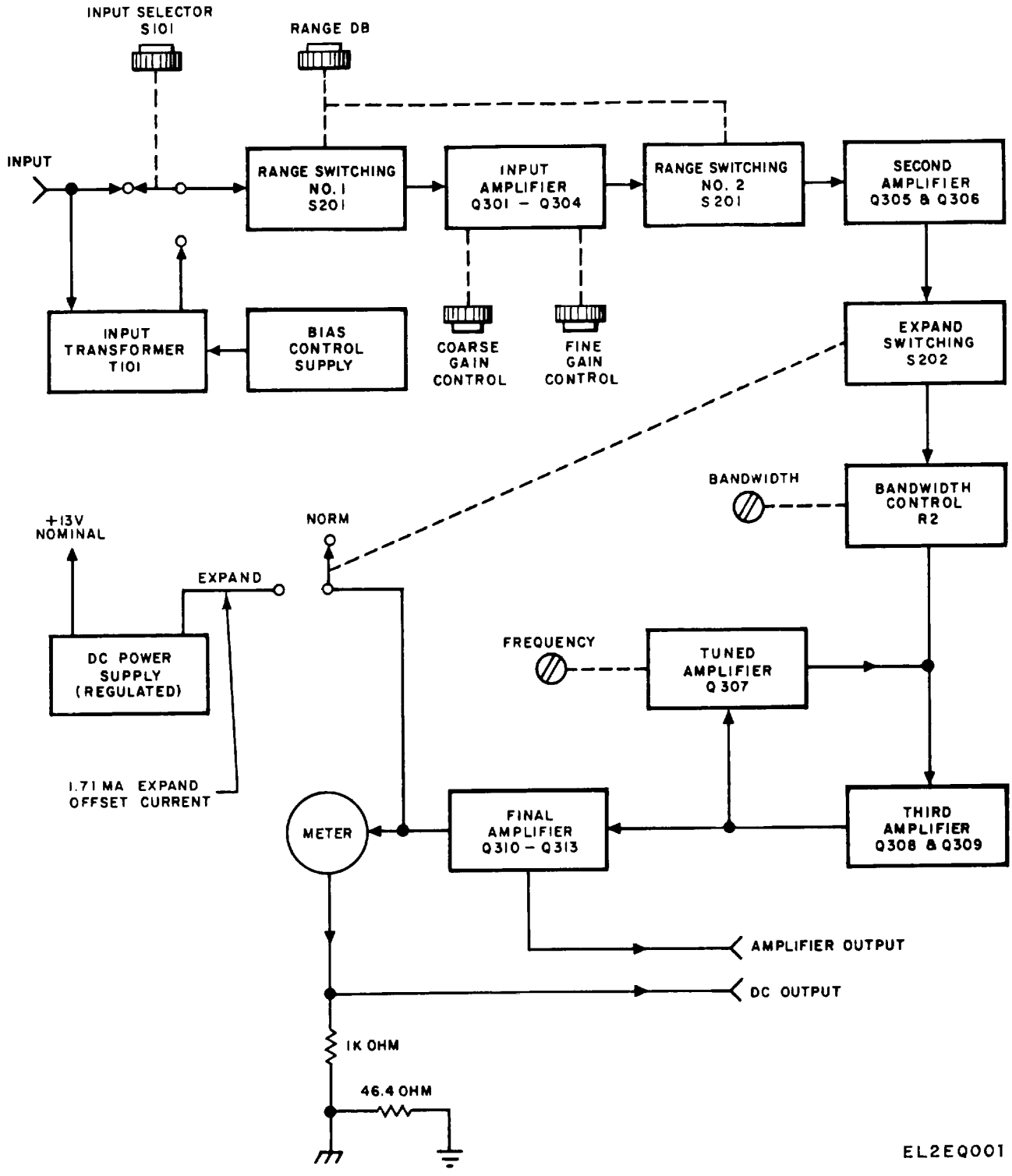


Figure 2-1. SWR Indicator block diagram.

CHAPTER 3

GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Section I. GENERAL

3-1. Introduction

The maintenance instructions in this chapter supplement the organizational maintenance procedures in TM11-6625-369-12-1.The troubleshooting which begins at the organizational level is carried to a higher level in this chapter; localizing and isolating techniques are more advanced.

3-2. Organization of Procedures

a. General. The first step in servicing a defective SWR indicator is to localize the fault; to trace it to a major circuit section. The second step is to isolate the fault; trace it to a specific defective part. Use the troubleshooting procedures in section III of this chapter.

b. Intermittent Trouble. In making any test, do not overlook the possibility of intermittent troubles. If present, this type of trouble may often be made to appear by tapping or jarring the equipment.

Section II. TOOLS AND EQUIPMENT

3-3. General

Tools and test equipment required for general support maintenance of the SWR Indicator are listed in table 3-1, along with additional items necessary for testing the SWR Indicator. Prior to its use in a test setup, all test equipment must be known to operate within its specified accuracy.

Table .3-1-. Tools, Test Equipment and Additional Materials Required for General Support Maintenance

Nomenclature	Common name	Application
Signal Generator AN/USM-205	Audio oscillator	Signal input to SWR indicator
Counter. Electronic Digital Readout AN/USM-207	Frequency counter	Monitors output of audio oscillator
Oscilloscope AN'UJSM 281C	Oscilloscope	Waveform measurements
Attenuator CN-970/U	Attenuator	Sensitivity, noise, bandwidth, range, and expanded range checks
Attenuator CN 1128/U	Attenuator	Sensitivity, bandwidth, range, and expanded range checks
Electronic Voltmeter ME--264/U1	AC Voltmeter	Sensitivity check
Electronic Voltmeter M E-202/U	Differential voltmeter	Adjustment of bias power supply
Multimeter TS-35213/U	Multimeter	Continuity check of power cable and test leads, waveform measurements
Dummy Load, Electrical I)A 75, '4	Dummy antenna	Simulates load under test for check of crystal detector
Tool Kit TK 100/G	Tool kit	General support repair techniques
50 ohm feed through termination	50 ohm feed through	Impedance matching device for test setups
200 ohm = 1% Resistor	Resistor	Adjustment of bias power supply
1000 ohm + 1% Resistor	Resistor	Adjustment of bias power supply
UG-88 Connector	Connector	Used with 200 ohm and 1000 ohm resistors
Radio Test Set AN/URM 44A	Radio Test Set	Signal source for test setup used in check of crystal detector

Section III. TROUBLESHOOTING

3-4. General

When troubleshooting the SWR Indicator always begin with a visual inspection for loose or burned-out components, loose connections, or an open fuse. If the fault is not visible, the malfunction should be isolated to a circuit section. This can be

accomplished with an operational check, the performance tests in section V of this chapter, and the oscilloscope waveforms in figures 3-1, 3-2 and 3-3. Refer to figure 3-4 which illustrates the SWR Indicator with the cover plates removed, and figure 3-5 which illustrates the components on the printed circuit board.

3-5. Conditions for Measurement

Make the measurements in figures 3-1, 3-2 and 3-3 after meeting the conditions below:

a. Disassemble the SWR Indicator by carrying out steps a and b in paragraph 3-7.

b. Connect Signal Generator AN/USM-205 to SWRIndicator INPUTjack; set the AN/USM-205 to approximately 1000 Hz and adjust for a 0 db meter reference on the SWR Indicator.

c. Set the SWR Indicator controls as follows:

(1) POWER switch to LINE ON.

(2) EXPAND control to NORM.

(3) RANGE DB control to 0.

(4) BANDWIDTH adjustment fully clockwise.

(5) FREQ. adjustment mid-range.

(6) FINE and COARSE GAIN controls fully counterclockwise.

(7) INPUT SELECTOR switch to XTAL HIGH.

d. Set Oscilloscope AN/USM-281C for 0.2 msec/cm sweep, ac, 400 kHz and appropriate vertical sensitivity.

e. Set Multimeter TS-352B/U to appropriate range.

NOTE

All measurements are made with respect to the black terminal of the rear panel AMPLIFIER OUTPUT connector (instrument ground). (See figure 3-4).

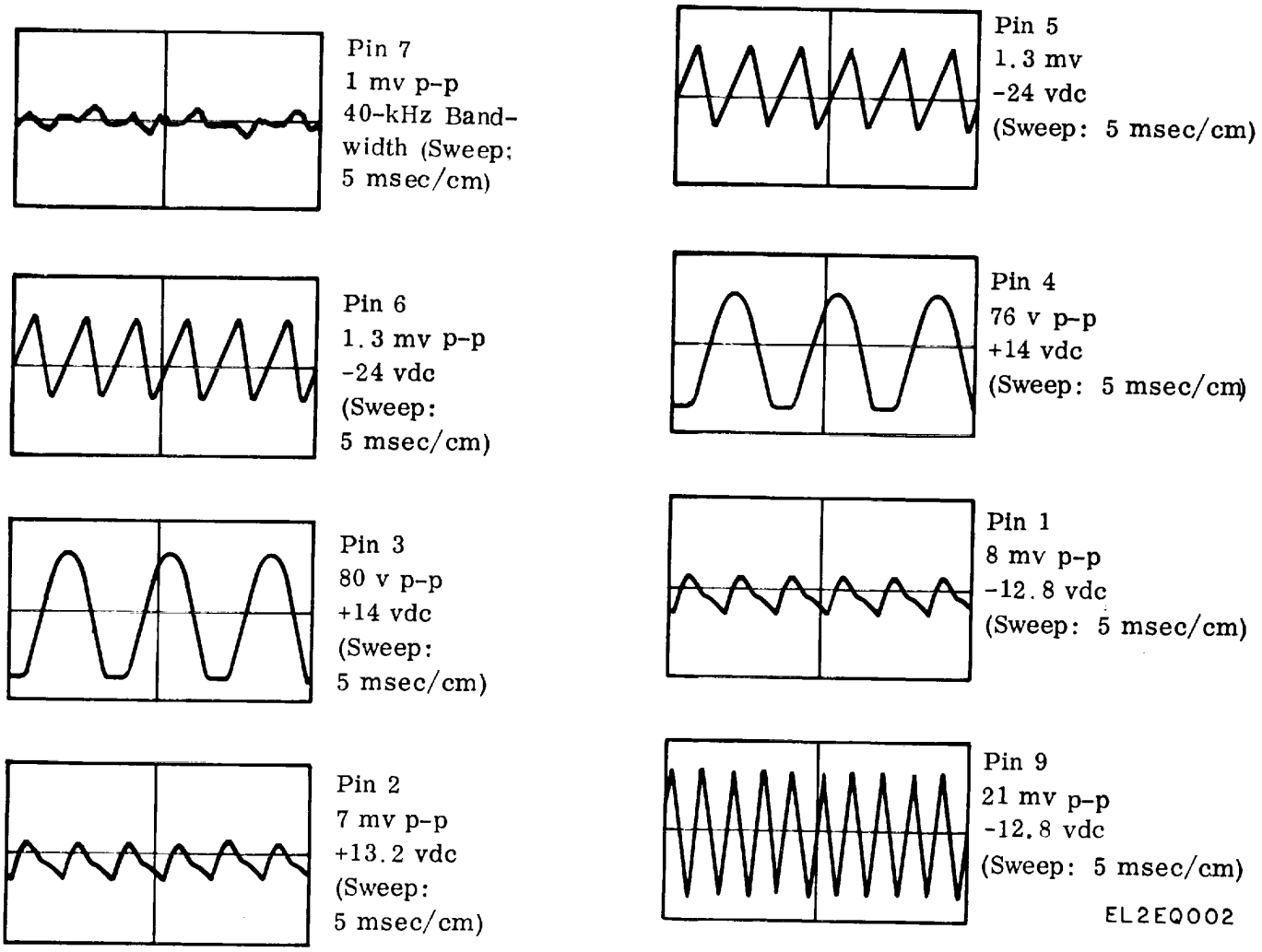


Figure 3-1. Power supply measurements.

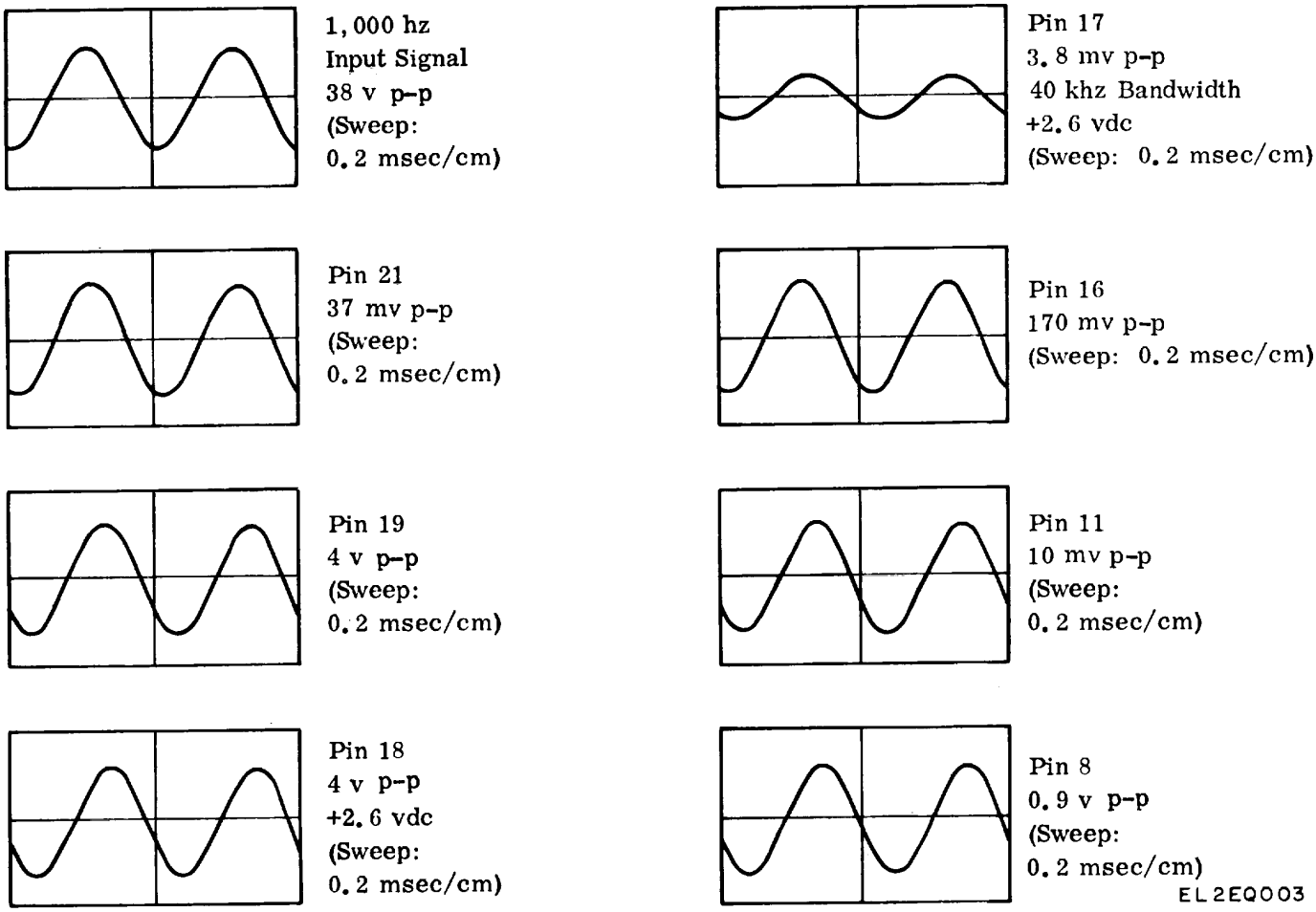


Figure 3-2. Signal flow measurements.

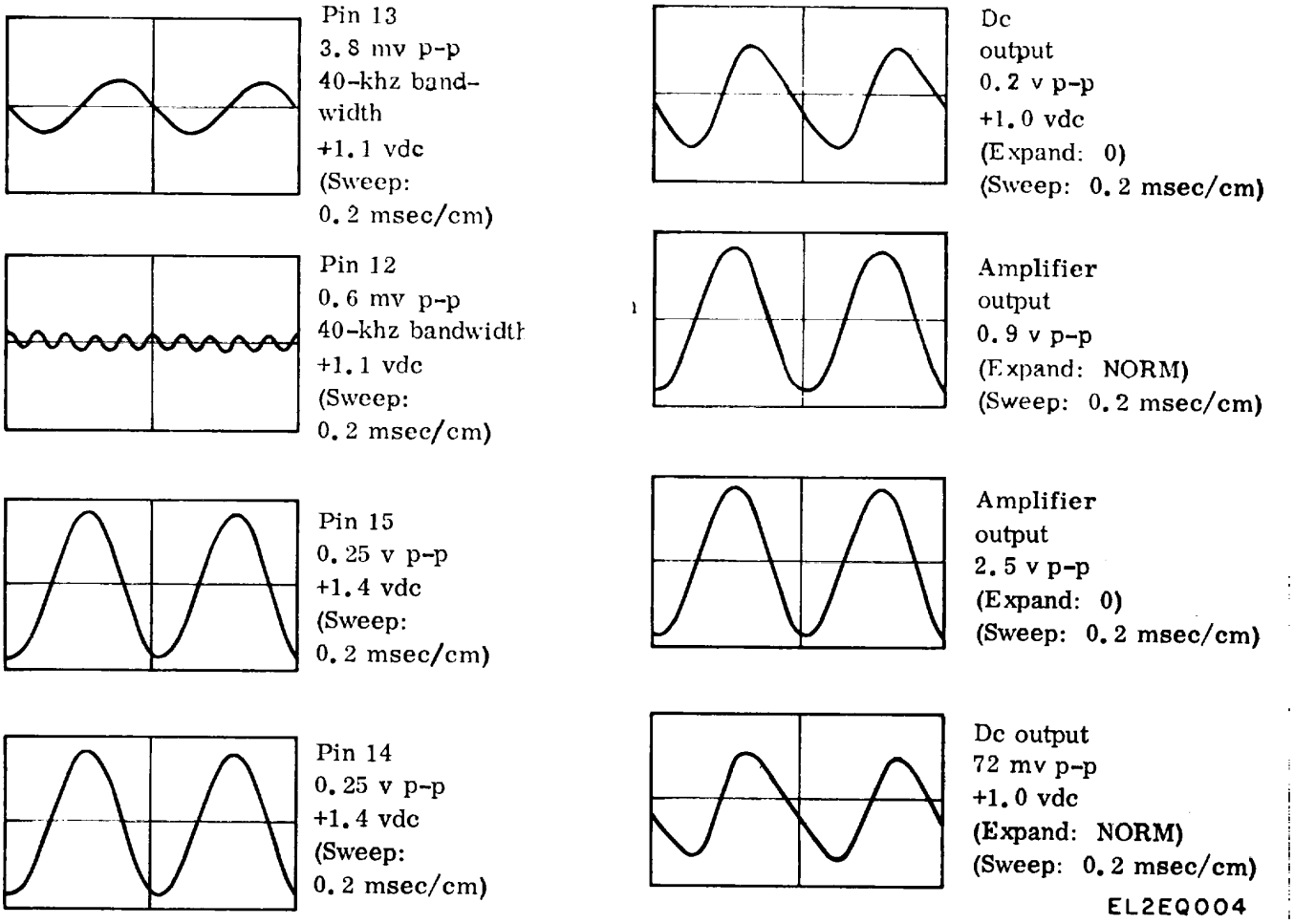


Figure 3-3. Meter and output measurements.

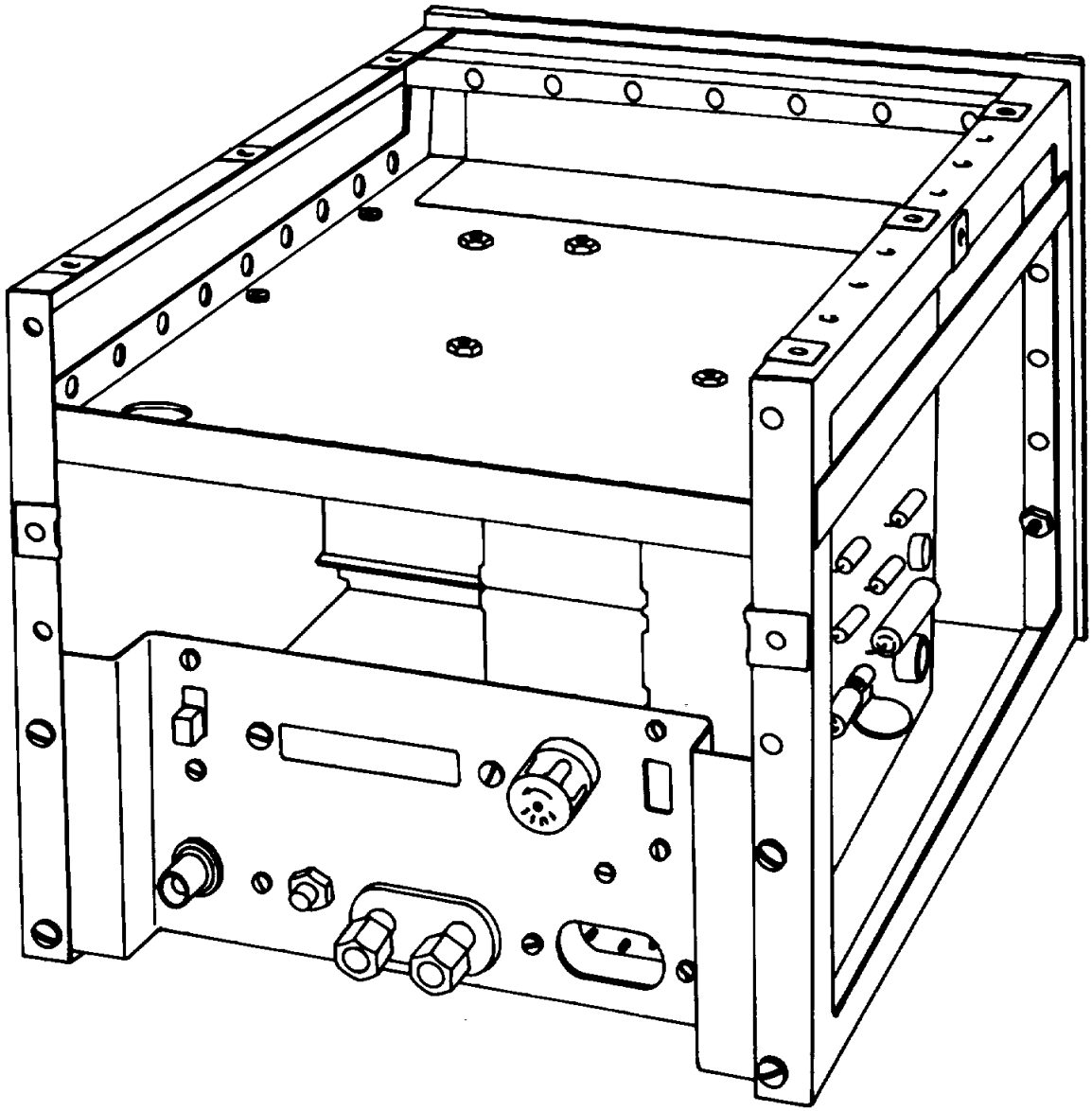


Figure 3-4. SWR Indicator, cover plates removed.

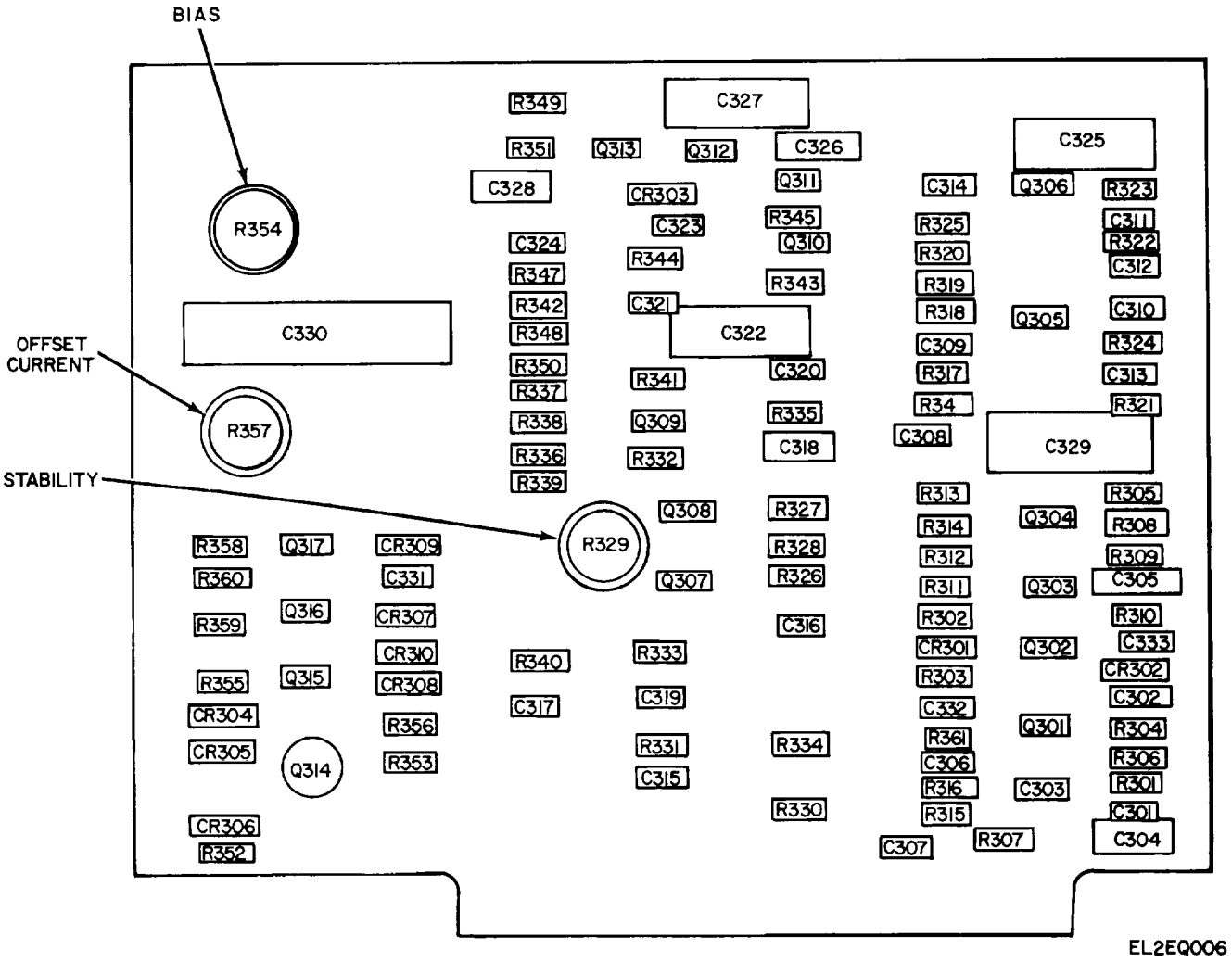


Figure 3-5. Parts location. Printed circuit board.

Section IV. MAINTENANCE THE AN/USM-37E

3-6. Cleaning

Cleaning of the SWR Indicator is carried out primarily at the organizational level. If cleaning is necessary, the procedures in TM 11-6625-369-12-1 should be applied.

3-7. Disassembly of SWR Indicator

Repair procedures consist primarily of replacement of components on the printed circuit board determined to be defective while troubleshooting the equipment. In addition, repair breaks in the printed circuit wiring when a visual inspection reveals defective areas. To replace components or repair printed wiring, disassemble the SWR Indicator as follows:

a. Remove six (6) screws on both side cover plates and remove plates.

b. Remove eight (8) screws on top cover and slide cover off to remove.

c. Turn instrument upside down and remove the stand legs by unscrewing the brackets holding the stand in place; then remove six (6) screws on the bottom cover plate and remove the plate.

d. To remove the printed circuit board, remove one (1) screw holding bracket to metal frame of_ SWR Indicator.

e. Pull printed circuit board straight out to remove.

f. Follow the procedures in paragraph 3-8 to replace components or repair breaks in the printed wiring.

3-8. Printed Circuit Board Repair Techniques

a. General. The printed circuit board (fig. 3-5) used consists of copper foil bonded to a plastic laminate. Breaks in this type of board may be disclosed by continuity tests made with a needle probe, or visually by means of a magnifying glass. The following precautions should be taken when repairing pc boards.

(1) Apply soldering iron so that it touches the solder point and not the copper foil.

(2) Do not hold soldering iron on printed circuit any longer than needed to melt the solder. Apply heat for two or three short periods during one operation rather than for one long period.

(3) Check the appearance of the solder joint. A frosty appearance indicates a cold joint.

(4) In removing wire leads from the boards, be careful when pulling on leads. Pull only toward the board, and away from the copper foil side. The applied heat combined with a strong pull may break the adhesive bond, which is thermoplastic.

(5) When inserting new components, make sure components are tight against board before bending the leads.

(6) After repairing, check for solder shorts and splattering.

(7) If the wire or board is not clean, wipe with a swab lightly dipped in alcohol. In some cases this may be required before soldering in order to avoid the formation of cold joints.

(8) When soldering diodes or transistors, use clips or some form of heat sink.

(9) When handling printed circuit boards, hold the board by the edges so as to avoid hand perspiration, oil, etc.

(10) Do not handle the board by mounted components since pressure on the leads may rupture solder joints or the copper foil from the board. For the same reason, do not check the mechanical strength of solder joints by jiggling components or wire leads.

(11) Do not try to remove the warp of a board by bending or twisting. This may result in a broken board, broken components or a ruptured copper bond. If the board must be removed and mounted, use either a vise or an adjustable printed circuit holder.

b. Replacement of Components. To replace a component, use the following procedure:

(1) Heat the solder joint on the printed side. Use a soldering aid or knife to pry and straighten lead.

(2) Heat solder joint and draw lead through the hold from th6 component side.

(3) Heat the joint and clean the hold with the soldering aid.

(4) Form leads of new component, insert and clinch the leads.

(5) Trim leads about 1/16 inch from hole center.

(6) Resolder carefully, using rosin core solder, and remove any excess rosin with alcohol.

c. Repair of Printed Wiring. To repair breaks in printed circuit wiring, use the following procedure:

(1) If the break is amall, solder with a small dome configuration (see fig. 3-6, A).

(2) If the break involves a short run, cut a piece of tinned bus wire slightly longer than the break. Solder-tin place the bus wire in the center of the conductor straddling the break (see fig. 3-6, B). Hold with soldering aid during and after soldering until the solder sets. Then remove excessive rosin with alcohol.

(3) Where the lands lift from the board (see fig. 3-6, C), cut at the joinder of the pad and land as shown. Strip the foil with a tweezer until the point of cut is reached. In the case of a circuitous conductor as shown, make the repair with plastic. insulated bus so as not to short out the intervening circuitry. However, this type of repair should only be made where the circuit is not critical.

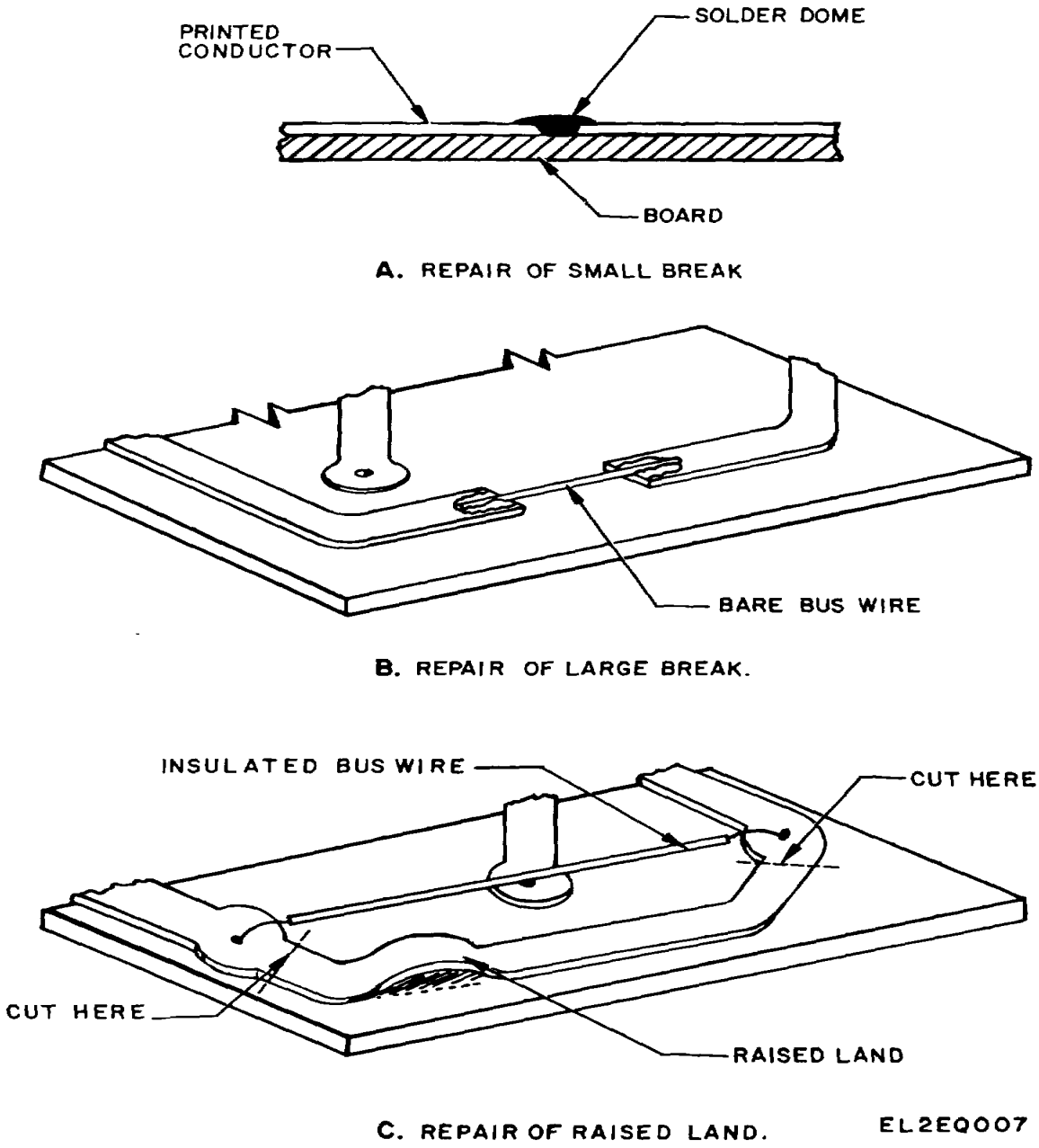


Figure 3-6. Printed

3-9. Repair of Probe

General support repair of the waveguide probe is accomplished through replacement of either the crystal or the disc resistor as indicated below. Refer to figure 3-7.

a. Crystal Replacement.

(1) Loosen the locking ring, and lift the crystal holder from the probe body.

(2) Unscrew the BNC connector from the holder. (A male connector may be used to loosen the BNC female.)

(3) Free the crystal by pushing on the end of the probe tip, where it protrudes from the holder.

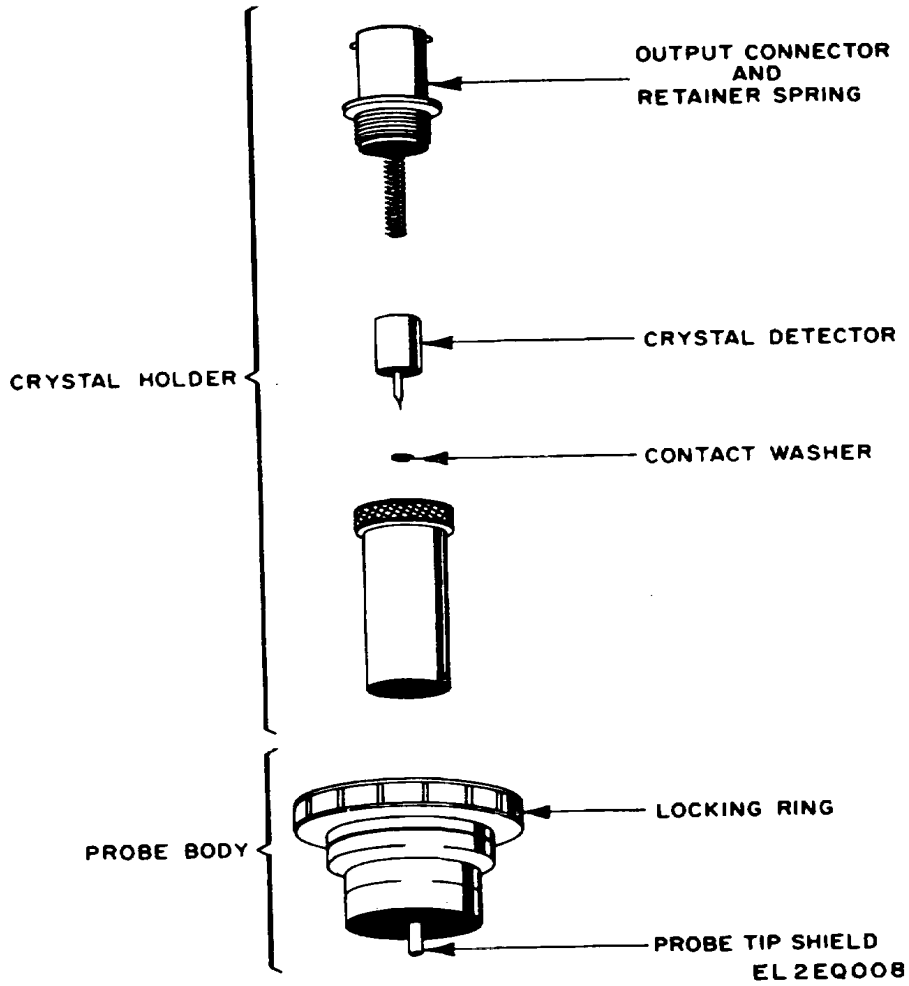
(4) Install a new crystal by reversing the above procedure.

b. Resistor Replacement. The disc resistor is permanently mounted in the end of the crystal holder. Therefore the crystal holder must be replaced when a defective resistor is indicated.

(1) Remove the crystal holder and crystal as described in a, 1-3 above.

(2) Install the crystal in a new crystal holder.

(3) Screw the BNC connector onto the new crystal holder and replace the holder in the probe body.



3-10. Repair of Cables

Check the continuity of the test leads and power cable with Multimeter TS-352B/U. If a short is indicated repair as directed below.

a. Jacket Repair. Worn or frayed insulation may be repaired with plastic electrical tape, provided the underlying conductor has not been damaged.

NOTE

This is the only repair that should be performed on the power cable. Procedures in b and c refer to test leads only.

b. Connector Replacement.

(1) Unscrew the connector sleeve and slide it back onto the cable.

(2) Disconnect the braided shielding from the connector back shell.

(3) Cut and remove the sleeving over the center conductor.

(4) Unsolder the conductor from the center pin and remove the connector.

(5) Remove the connector sleeve from the cable and slide on the sleeve from the replacement connector.

(6) Install the replacement connector by reversing the procedures in steps (1) through (4).

c. Cable Replacement. Cable defects that cannot be repaired with tape as in a, above, necessitate replacement of the entire cable. Proceed as indicated below.

(1) Remove the connectors as described in b, (1) through (5) above.

(2) Cut a section of cable the same length as the section being replaced.

(3) Reinstall the connectors as described in b above.

3-11. Adjustments

If the troubleshooting procedures in section III indicate maladjustment of the areas specified below, or if components have been removed and replaced on the printed circuit board, perform adjustments as-indicated.

a. Bias Power Supply. To adjust the bias supply current and voltage levels to the INPUT connector (for use with bolometers and biased crystal detectors) proceed as follows:

(1) Remove left side panel (facing front of meter).

(2) Connect a 200-ohm +1% resistor (wired to a UG-88 connector) to the INPUT connector of the SWR Indicator.

(3) Set the POWER switch on the SWR Indicator to LINE ON and the INPUT SELECTOR to BOLO/8. 7mA.

(4) Connect Voltmeter ME-202/U across the 200-ohm test resistor. The ME-202/U should read between 1.80 and 1.68 Vdc. If necessary, adjust variable resistor R354 (fig. 3-5).

NOTE

The ME-202/U common lead should be connected to the black terminal of the AMPLIFIER OUTPUT connector (instrument ground) on the rear panel.

(5) Set INPUT SELECTOR switch to BOLO/4.5 ma. The ME-202/U should read between 0.93 and 0.87Vdc. If necessary, adjust variable resistor R354.

(6) Disconnect the 200 ohm test resistor from INPUT connector and replace with a 1000 ohm +1 % resistor. Set INPUT SELECTOR switch to XTAL BIASED position. The ME-202/U should read between 1.03 and 0.97V. If necessary, adjust variable resistor R354.

NOTE

Since one adjustment sets the bias level for all three bias power supplies, steps (4), (5) and (6) must be repeated after any adjustment is performed.

(7) Disconnect the ME-202/U from the SWR Indicator INPUT connector and remove the top and right side plates from the IM-157E/U.

(8) Use Multimeter TS-352B/U to measure the dc potential at the positive battery terminal (J301 pin 2, marked BT1 +). This dc potential should read between + 12 and + 14 volts dc.

b. Bandwidth Stability. To adjust the IM-157E/U so that a change in bandwidth will cause no more than a 0.1-db error in any meter reading, proceed as follows:

(1) Set the SWR Indicator front panel controls to the following positions:

(a) POWER switch to LINE ON.

(b) INPUT SELECTOR to XTAL HIGH.

(c) RANGE DB switch to 0 db.

(d) RANGE EXPAND switch to NORM.

(e) COARSE and FINE GAIN controls fully clockwise.

(f) BANDWIDTH control fully clockwise.

(g) FREQ control about mid-range.

(2) With Signal Generator AN/USM-205 connected to the IM-157E/U INPUT connector, adjust the output frequency and amplitude to obtain a reading on the SWR Indicator meter near full scale.

(3) To insure that meter is tuned to the center frequency of the input signal, adjust FREQ control to obtain maximum meter needle deflection (to the right).

(4) Change EXPAND switch setting to 0.

(5) Adjust COARSE GAIN control to set meter needle to 1 on the 0-2 DB scale.

(6) Turn BANDWIDTH control fully counterclockwise and repeat step (3). The change in the meter reading should be no more than 0.1 db.

NOTE

If the change is greater than 0.1 db adjust R329 (see fig. 3-5) and repeat step (6) until the change in meter reading is less than 0.1 dB.

c. Expand Scale. To adjust the offset current supply to meter M1 (which supplies the EXPAND scale zero reference signal), proceed as follows:

(1) Connect test equipment as shown in figure 3-10.

(2) Set the SWR Indicator front panel controls to the following positions:

(a) POWER switch to LINE ON.

(b) INPUT SELECTOR to XTAL LOW.

(c) RANGE DB switch to 0.

(d) EXPAND switch to 0.

(e) FINE and COARSE GAIN controls fully counterclockwise.

(3) Set Attenuator CN-970/U to 0 db and Attenuator CN-1128/U to 10 db.

(4) Adjust AN/USM-205 output and SWR Indicator FINE GAIN control to obtain a meter reading of 0 db on the 0-2 DB scale.

(5) Change CN-970/U setting from 0 to 4 db in 1-db steps. The SWR Indicator meter readings should be as shown below:

CN-.970/Settings	SWR Indicator Readings
1 db	0.5 -0.02 db
2 db	1.0 t0.02 db
3 db	1.5+*0.02 db
4 db	2.0 -0.02 db

(6) If meter tracking error is greater than +0.02 db, adjust R357 (see fig. 3-5) and repeat procedure until meter tracking error is less than +0.02 db.

3-12. Reassembly

To reassemble the SWR Indicator, replace the cover plates and securely fasten the brackets holding the folding stand to the bottom plate.

Section V. GENERAL SUPPORT TESTING PROCEDURES

3-13. General

a. The following testing procedures are prepared for use by general support maintenance shops and service organizations responsible for general support maintenance of electronic equipment to determine the acceptability of repaired electronic equipment. These procedures set forth specific requirements that repaired electronic equipment must meet before it is returned to the using organization.

b. Comply with the instructions preceding the body of each chart before proceeding to the chart. Perform each test in sequence. Do not vary the sequence. For each step, perform all the actions required in the control settings column; then perform each specific test procedure and verify it against its performance standard.

3-14. Physical Tests and Inspection

a. Test Equipment and Material. None.

b. Test Connections and Conditions. Remove indicator from transit case.

c. Procedures. Proceed as indicated in table 3-2.

Table 3-2. Physical Tests and Inspection.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	N/A	N/A	Inspect all exterior surfaces for damage.	No damage evident.
2	N/A	N/A	Check the tightness of connectors.	All connectors tightly fitted.
3	N/A	N/A	Operate controls through all positions.	Action of each control is smooth and free of external or internal binding and there is no excessive looseness.
4	N/A	N/A	Inspect cords, cables, and wires for chafed, cracked or frayed insulation.	Cords, cables, and wires are free of chafes, cracks, or frays.
5	N/A	N/A	Check for missing or loose hardware.	AU hardware present and tight.
6	N/A	N/A	Check seating of pluckout items.	Pluckout items securely seated.
7	N/A	N/A	Inspect terminal blocks for loose connections and cracked or broken insulation.	All connections are secure and no damage evident.
8	N/A	N/A	Check resistors and capacitors for	Resistors and capacitors are free of defects. cracks, blistering, and other defects.

3-15. Frequency Response Test

a. Test Equipment and Materials.

(1) Signal Generator AN/USM-205.

(2) Electronic Digital Readout Counter AN/USM - 207.

(3) Attenuator CN-970/U.

(4) 50 ohm feed-through termination.

b. Test Connections and Conditions. Connect the equipment as shown in figure 3-8. Allow sufficient time for the equipment to warm up and stabilize.

c. Procedures. Follow the procedures in table 3-3.

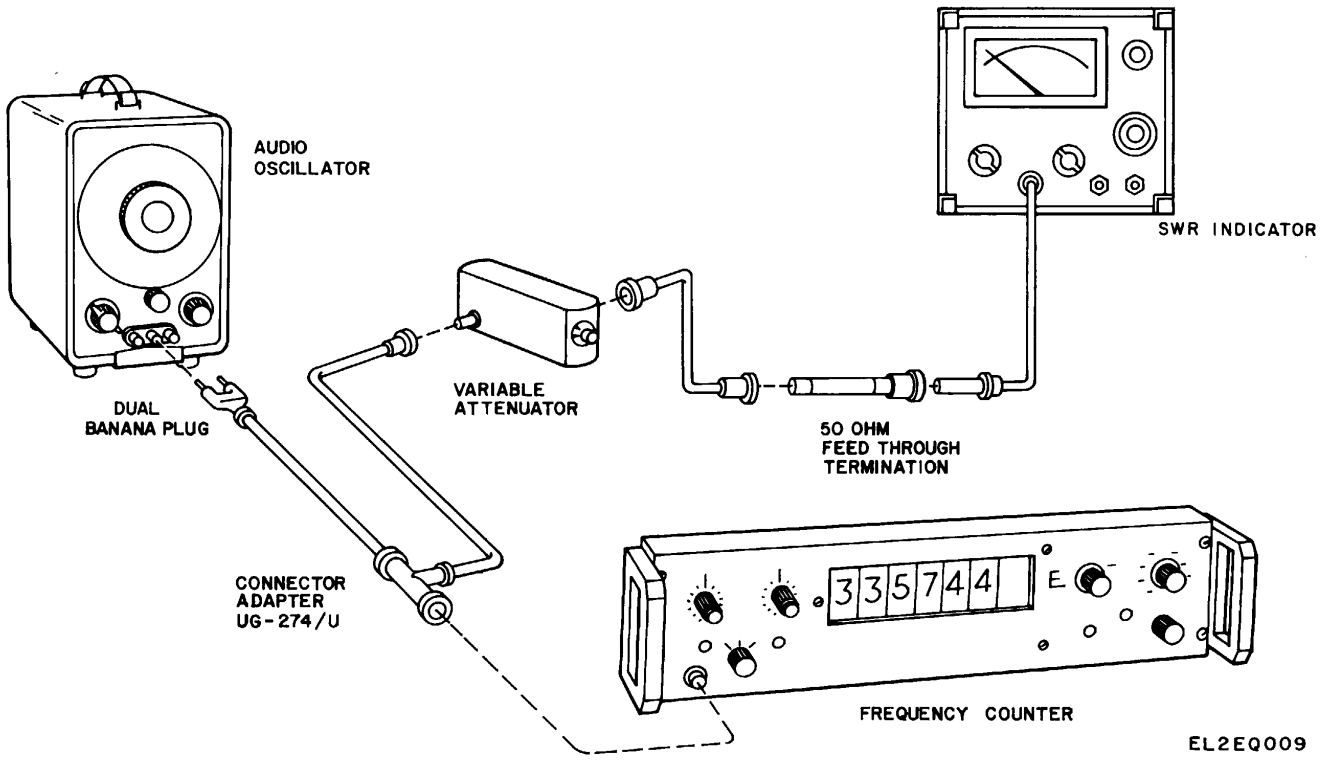


Figure 3-8. Frequency response and bandwidth test setup.

Table 3-3. Frequency Response Check.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	CN-970/U Set to 10 db.	POWER switch to LINE ON. INPUT SELECTOR TO XTAL LOW. RANGE DB to O. FINE and COARSE GAIN controls fully clockwise. FREQ adjust fully clockwise. BANDWIDTH adjust fully counterclockwise. EXPAND to NORMAL.	Tune ANIUSM-205 for a peak deflection on SWR Indicator meter. Note frequency on ANIUSM-207 and record.	Frequency must be above 1, 000 Hz.
		2FREQ adjust fully counterclockwise.	Tune ANIUSM-205 for a peak deflection on SWR Indicator meter. Note frequency on AN/USM-207 and record.	Frequency must be below 1, 000 Hz.
			3N/ASubtract frequency reading of step 2 from reading of step 1.	Frequencyspread must be at least 70 Hz.

3-16. Bandwidth Test.

a. Test Equipment and Materials.

(1) Signal Generator AN/USM-205.

(2) Electronic Digital ReadoutCounter AN/USM -207.

(3) Attenuator CN-970/U.

(4) 50 ohm feed through termination.

b. Test Connections and Conditions. Refer to figure 3-8 for test connections.

c. Procedures. Follow the procedures in table 3-4.

Table 3-4 Bandwidth Check.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test Procedure	Performance standard
1	('CN-970/ U Set to 10 db. AN/USM 205 Adjust to 1, 000 Hz	POWER switch to LINE ON. INPUT SELECTOR to XTALLOW RANGE DB to 0. FINE and COARSE GA I N controls about /4 clockwise. BANDWIDTH adjust fully counterclockwise.	Set SWR Indicator FREQ adjust for peak deflection on meter (to the right). Then adjust GAIN controls for a 0 reading on lower DB scale of meter.	NIA
2			Increase ANIUSM-205 frequency for a 1.5 reading on lower DB scale of SWR Indicator Meter Note frequency on AN/ULSM 207 and record	N/A
3			Decrease ANIUSM -205 frequency for a 1.5 reading on lower DB scale of SWR Indicator meter Note frequency on AN/USM 207 and record	N/A
4			Subtract frequency reading of step 3 from reading of Step2.	frequency spread, must be 15 Hz. or less. (This Is the minimum bandwidth.)

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test Procedure	Performance standard
5		BANDWIDTH adjust fully clockwise.	Tune AN/USM-205 for peak deflection on SWR Indicator meter. Then adjust GAIN controls for a 0 reading on lower DB scale of meter.	N/A.
			Increase AN/USM-205 frequency for a 1.5 reading on lower DB scale of SWR Indicator meter. Note frequency on AN:USM-207 and record.	N/A
			Decrease AN'USM-205 frequency for a 1.5 reading on lower DB scale of SWR Indicator meter. Note frequency on AN'USM-207 and record.	N/A
			Subtract frequency reading of step 7 from reading of step 6.	Frequency spread must be 130 Hz or more. (This is the maximum bandwidth.)

3-17. Sensitivity and Noise Test

a. Test Equipment and Materials.

(1) Signal Generator AN/USM-205.

(2) Electronic Digital Readout Counter AN/USM - 207.

(3) Attenuator CN-970/U.

(4) 50 ohm feed-through termination.

(5) Voltmeter ME-264/U.

(6) 100 ohm + 1%, low noise resistor.

(7) 5000 ohm * 1%, low noise resistor.

b. Test Connections and Conditions. Connect the equipment as shown in figure 3-9. Allow sufficient time for equipment to warm up and stabilize.

c. Procedures. Follow the steps in table 3-5.

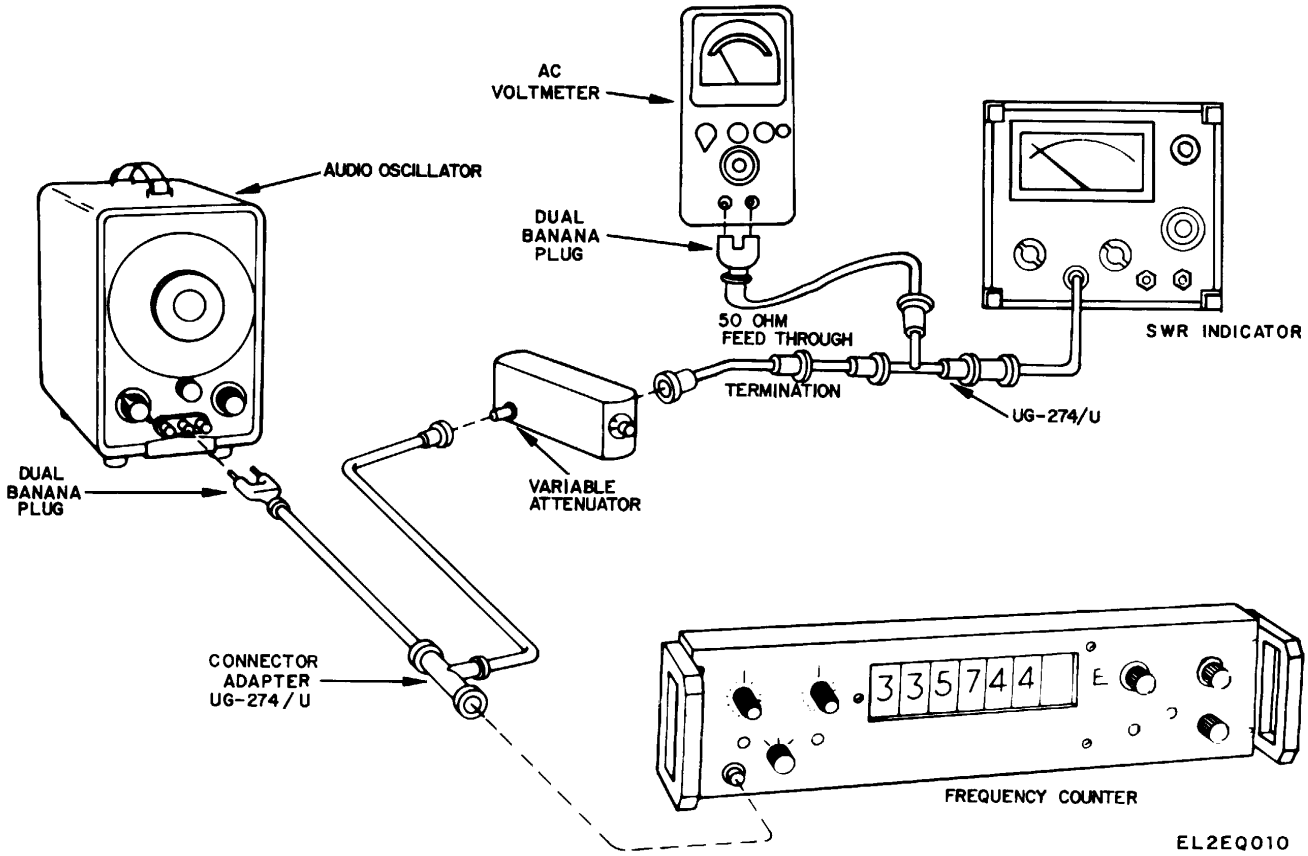


Figure 3-9. Sensitivity and noise test setup.

Table3.-5. Sensitivity and Noise ('heck.

Step No.	Control settings		Test Procedure	Performance standard
	Test equipment	Equipment under test		
1	AN/USM-205 Adjust to 1, 000 Hz	POWER switch to LINE ON. INPUT SELECTOR to XTAL LOW. RANGE DB switch to 0. EXPAND switch to NORM. FINE AND COARSE GAIN controls fully clockwise. BANDWIDTH adjust fully clockwise.	Set FREQ adjust on SWR Indicator for a peak deflection on meter. Use AN/USM-205 output control to maintain an on-scale indication.	N/A
2			Adjust CN-970/U and AN/USM-205 for a 0 dB reading on SWR Indicator meter.	ME-264/U must indicate a maximum of 0.1 5V rms.
3			Adjust CN-970/U and AN/USM-205 to exactly 0.15V rms on ME-264/U.	N/A
4			Adjust GAIN controls on SWR Indicator for a 0 db reading on meter.	N/A
5			Disconnect the CN-970/UN/A from the SWR Indicator and connect a 100 ohm + 1%, low-noise resistor to INPUT connector.	
6		RANGE DB switch to 60.	N/A	Meter on SWR Indicator must read 7.5 db (or greater) down from 0 on 0-10 DB Scale.
7		RANGE DB switch to 0.	Remove the resistor and reconnect the CN-970/U to the INPUT connector.	N/A
8		INPUT selector to XTAL HIGH.	Adjust CN-970/U and AN/USM-205 for a indication of 0 db on SWR Indicator meter.	ME-264/U must indicate a maximum of 1.OV rms.
9			Adjust CN-970/U and AN/USM-205 for a 1.0 Vrms reading on ME-264/U.	N/A
10			Adjust GAIN controls on SWR Indicator for a 0 db reading on meter.	
11			Disconnect the CN-970/U from the SWR Indicator and connect a 5, 000 ohm + 1%, low-noise resistor to INPUT connector.	
12		RANGE DB switch to 60.	N/A	Meter on SWR Indicator must read 7.5 db (or greater) down from 0 on 0-10 DB scale.

3-18. Range Tracking Test.

a. Test Equipment and Materials.

(1) Signal Generator AN/USM-205.
(2) Attenuator CN-970/U.
(3) Attenuator CN-1128/U.
(4) 50 ohm feed through termination

b. Test Connections and Conditions. Connect the equipment as shown in figure 3-10. Allow sufficient time for equipment to warm up and stabilize.

c. Procedures. Follow the procedures in table 3-6.

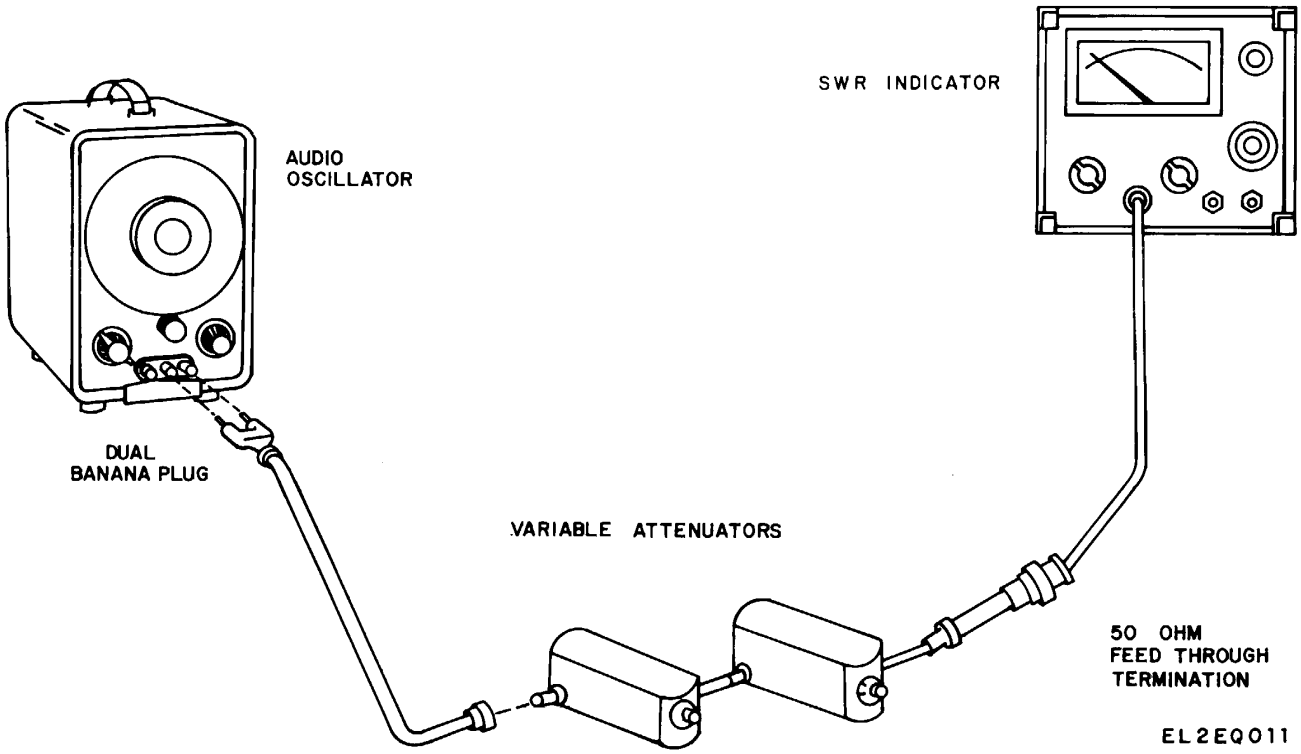


Figure 3-10. Range and expanded range accuracy test setup.

Table,3-6. Range Tracking Check

Step No.	Control settings		Test Procedure	Performance standard
	Test equipment	Equipment under test		
1	CN-970/U Set to 5 db. Adjust frequency for a maximum deflection on SWR Indicator meter.	POWER switch to LINE ON. INPUT SELECTOR TO XTAL LOW. RANGE DB switch to 0. EXPAND switch to 0. Gain controls fully counterclockwise.	Adjust AN/USM-205 and SWR Indicator FINE GAIN control for a reading of I db on 0-2 db scale.	N/A
2	CN-1128/U	RANGE DB switch to 10.	N/A	Indicator on SWR Indicator meter must be 1.0+ 0.05 db.
3	CN-112&/U	RANGE DB switch to 20.	N/A	Indication on SWR Indicator meter must be 1.0+ 0.1 db.
4 SWR	CrN-1 128/U Set to 60 db. Indicatormeter	RANGE DB switch to 30.	N/A	Indication on must be 1.0+ 0.1 db.
5		FINE and COARSE GAINN/A controls full counterclockwise.	N/A	
6	CN-1128/UN/A Set to 40 db.	Adjust AN/USM-205 output	N/A for a reading of 1.0db on SWR Indicator meter.	
7 SWR	CN-1128/U Set to 60 db. Indication meter	RANGE DB switch to 40.	N/A	Indication on must be 1.0+ 0.05 db.
8 SWR	CN-1128/U Set to 80 db.	RANGE DB switch to 50.	N/A	Indication on Indication meter must be 1.0+ 0.1 db.
9 SWR	CN-1128/U Set to 100 db.	RANGE DB switch to 60.	N/A	Indication on Indicator meter must be 1.0+ 0.1 db.

3-19. Expanded Range Tracking Test.

a. Test Equipment and Materials.

(1) Signal Generator AN/USM-205.

(2) Attenuator CN-970/U.

(3) Attenuator CN-1128/U.

(4) 50 ohm feed through termination.

b. Test Connections and Conditions. Refer to figure 3-10 for test connections.

c. Procedures. Follow the steps outlined in table 3-7.

Table 3-7. Expanded Range Tracking Check.

Step No.	Control settings		Test Procedure	Performance standard
	Test equipment	Equipment under test		
1	CN-970/U Set to 0 db. CN-1128/U Set to 10 db.	POWER switch to LINE ON. INPUT SELECTOR TO XTAL LOW. RANGE DB switch to 0. EXPAND switch to 0. FINE and COARSE GAIN controls fully counterclockwise.	Adjust AN/USM-205 output and SWR Indicator FINE GAIN control for a reading of 0 db on 0-2 DB scale.	N/A
2	CN-970/U a. Set to 1db. b. Set to 2 db. c. Set to 3 db. d. Set to 4 db.	N/A	Note indication on meter of SWR Indicator for steps a through d in the control settings columns.	Meter must indicate as shown for corresponding attenuator setting. a. 0.5+0.02 db. b. 1.0+0.02db. c. 1.5+ 0.02 db. d. 2.0+ $^{0.02}$ db.
3	CN-970/U Set to 0 db.	N/A	Adjust AN/USM-205 for a reading of 1.0 db on 0.2 DB scale of SWR Indicator meter.	N/A
4	CN-970/U Set to 4 db.	EXPAND switch to 2.	Note indication on meter of SWR Indicator.	Meter of SWR Indicator must read1.0+0.05! dbon0-2DB scale.
5	CN-970/U Set to 8 db.	EXPAND switch to 4.	Note indication on meter of SWR Indicator.	Same as step 4.
6	CN-970/U Set to 2 db. CN-1128/U Set to 20 db.	EXPAND switch to 6.	Note indication on meter of SWR Indicator.	Same as step 4.
7	CN-970/U Set to 6 db.	EXPAND switch to 8.	Note indication on meter of SWR Indicator	Same as step 4.

3-20. Crystal Detector Accuracy Test

a. Test Equipment and Materials.

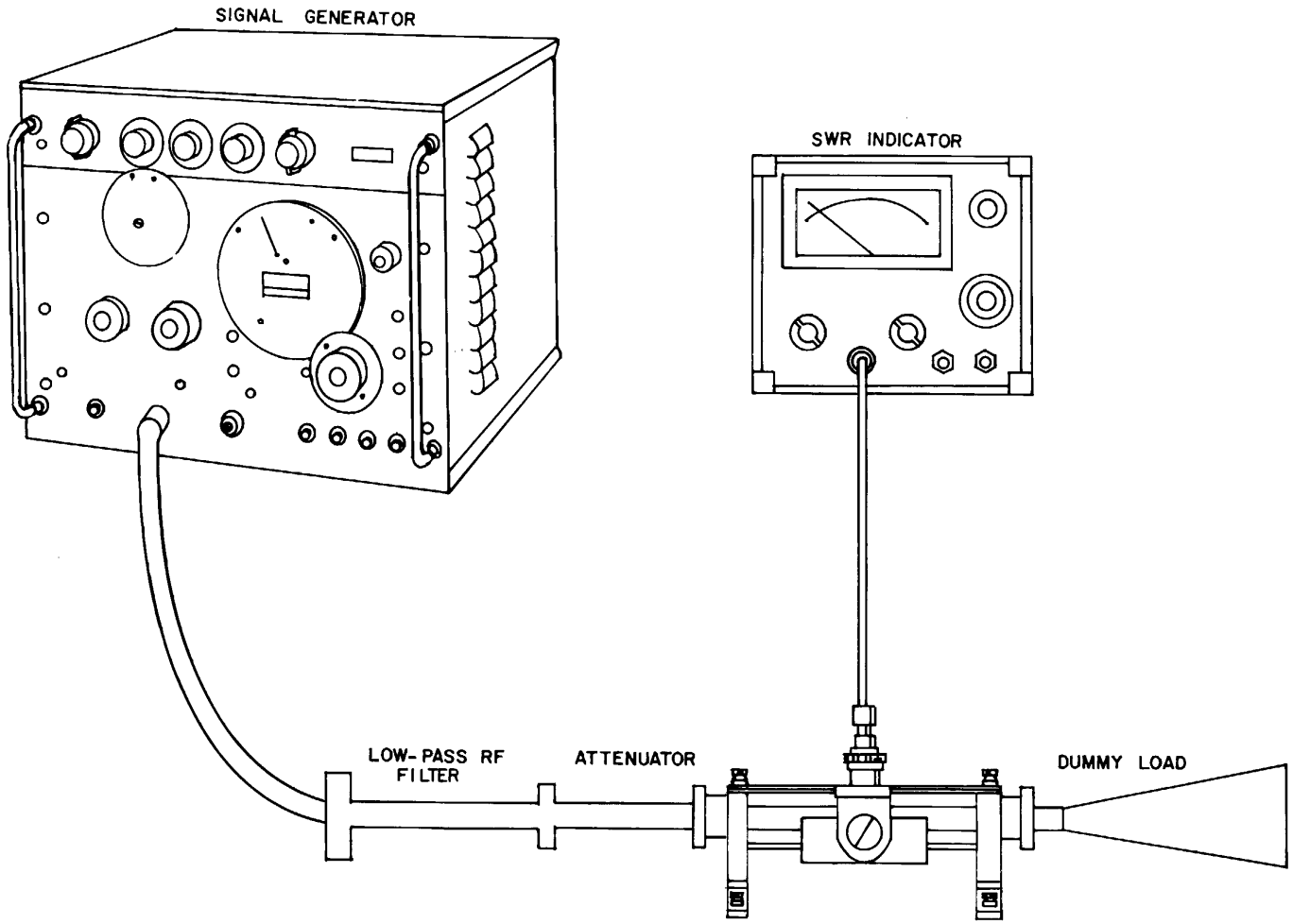
(1) Radio Test Set AN/URM-44A.

(2) Electrical Dummy Load DA-265.

(3) Attenuator.

b. Connections and Conditions. Connect the equipment as illustrated in figure 3-11. Allow sufficient time for the equipment to warm up and stabilize.

c. Procedures. Follow the procedures outlined in table 3-8.



NOTES:
1. USE A LOW-PASS RF FILTER WHEN SOURCE PRODUCES HARMONICS OF DESIRED SIGNAL.
2. USE AN ATTENUATOR TO REDUCE RE-REFLECTIONS FROM SOURCE AND FILTERS.

Figure 3-11. Crystal detector accuracy test setup.

Table 3-a Crystal Detector Accuracy.

Step No.	Control settings		Test Procedure	Performance standard
	Test equipment	Equipment under test		
1	AN/URM-44A Set RF frequency for 8 Ghz, with 1000 Hz square wave modulation.	POWER switch to LINE ON. FINE and COARSE GAIN controls approximately 3/4 maximum. RANGE DB switch to 30. EXPAND switch to NORM. INPUT SELECTOR switch to XTAL HIGH.	Move the probe carriage along the slotted line until a maximum indication (to the right) is evidenced on the SWR Indicator meter. Adjust the COARSE and FINE GAIN controls to keep the meter needle on-scale; keep probe penetration to a minimum.	The SWR Indicator meter must read 0 on 0-10 DB scale.
3	AN/URM-44A Reduce output by exactly 10 dB	RANGE DB switch to 50.	Observe deflection (to the right) of SWR Indicator meter needle.	SWR Indicator meter must read O+ .0.25 nominal on 0-10 DB scale, indicating a decrease of 10 dB.
4	Reduce output by exactly 10dB.	RANGE DB switch to 60.	Observe deflection (to the right) of SWR Indicator meter needle	SWR Indicator meter must read 0 + 0.25 nominal on 0-10 DB scale, indicating a decrease of 10 dB.

APPENDIX A
REFERENCES

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7 , 8, and 9), Supply Bulletins, and Lubrication Orders.
DA Pam 310-7	US Army Equipment Index of Modification Work Orders.
TB 43-0118	Field Instructions for: Painting and Preserving Electronics Command Equipment Including Camouflage Pattern Painting of Electrical Equipment Shelters.
TB 43-180	Calibration Requirements for the Maintenance of Army Materiel.
TM 11-6625-366-10	Operator's Manual for Multimeter TS-352B/U(NSN 6625 -00 -552-0142).
TM 11-6625-369-12-1	Operator and Organizational Maintenance Manual for Measuring Set, Standing Wave Ratio AN/USM-37E (NSN 6625 -00-197-6910).
TM 11-6625-412-15-1	Operator, Organizational, DS, GS, and Depot Maintenance Manual Including Repair Parts and Special Tools List: Radio Test Set AN/URM-44A.
TM 11-6625-537-15	Operator, Organizational, Field and Depot Maintenance Manual: Voltmeter, Electronic ME-202/U.
TM 11-6625-665-15	Operator's Organizational, DS, GS, and Depot Maintenance Manual: Generator Signal AN/USM-205.
TM 11-6625-700-10	Operator's Manual: Digital Readout, Electronic Counter AN/USM-207 (NSN 6625-00-911-6368).
TM 11-6625-2658-14	Operator's Organizational, Direct Support, and General Support Maintenance Manual for Oscilloscope AN/USM-281C (NSN 6625 -00-106 -9622).
TM 38-750	The Army Maintenance Management System (TAMMS).
TM 750-244-2	Procedures for Destruction of Electronics Materiel to Prevent Enemy Use.

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- 11-97 (1)
- 11-117(1)
- 11-500 (AA- AC) (1)
- 32-56(1)
- 32-57(1)

NG: None

USAR: None

For explanation of abbreviations used see, AR 310-50

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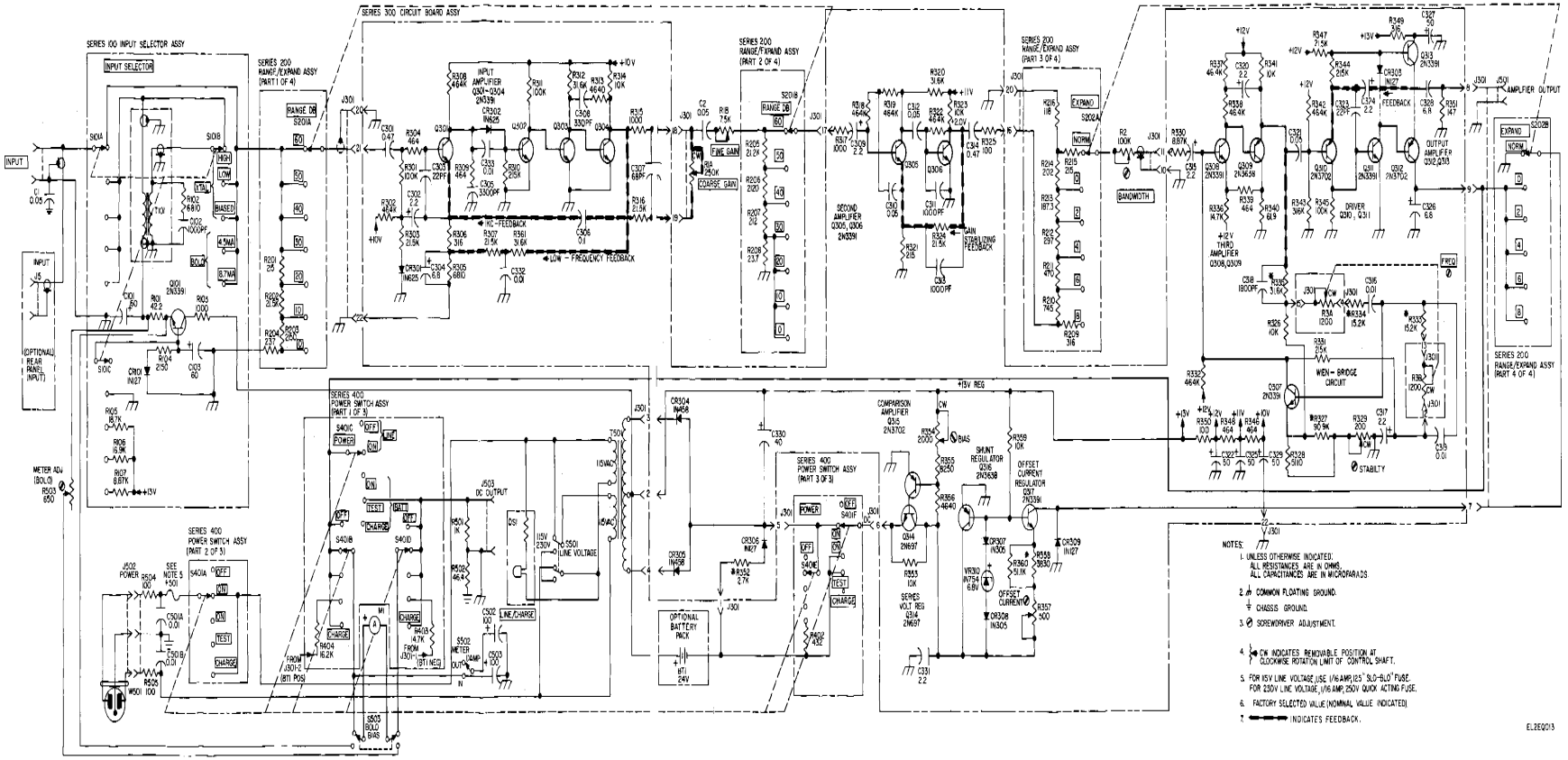
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SERIES 300 CIRCUIT BOARD ASSY
SERIES 200 RANGE/EXPAND ASSY (PART 2 OF 4)
SERIES 200 RANGE/EXPAND ASSY (PART 3 OF 4)
SERIES 200 RANGE/EXPAND ASSY (PART 4 OF 4)
SERIES 400 POWER SWITCH ASSY (PART 1 OF 3)
SERIES 400 POWER SWITCH ASSY (PART 2 OF 3)
SERIES 400 POWER SWITCH ASSY (PART 3 OF 3)
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METER ADJ
AMPLIFIER OUTPUT
OPTIONAL BATTERY PACK
LINE/CHARGE
LOW — FREQUENCY FEEDBACK
HC-FEEDBACK
GAIN STABILIZING FEEDBACK
WIEN-BRIDGE CIRCUIT
BANDWIDTH
STABILITY
FREQ
FINE GAIN
COARSE GAIN
SECOND AMPLIFIER Q305, Q306 2N3391
THIRD AMPLIFIER Q308, Q309
DRIVER Q310, Q311
OUTPUT AMPLIFIER Q312, Q313
COMPARISON AMPLIFIER Q315 2N3702
SHUNT REGULATOR Q316 2N3638
OFFSET CURRENT REGULATOR Q317 2N3391
SERIES VOLT REG Q314 2N3697
+15V REG
NOTES:
1. UNLESS OTHERWISE INDICATED: ALL RESISTANCES ARE IN OHMS. ALL CAPACITANCES ARE IN MICROFARADS.
2. COMMON FLOATING GROUND.
3. SCREWDRIVER ADJUSTMENT.
4. CW INDICATES REMOVABLE POSITION AT CLOCKWISE ROTATION LIMIT OF CONTROL SHAFT.
5. FOR 115V LINE VOLTAGE USE 1/16 AMP, 125" SLO-BLO" FUSE. FOR 230V LINE VOLTAGE 1/16 AMP, 250V QUICK ACTING FUSE.
6. FACTORY SELECTED VALUE (NOMINAL VALUE INDICATED)
7. INDICATES FEEDBACK.
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