TM 11-5820-919-40-1

TECHNICAL MANUAL

GENERAL SUPPORT MAINTENANCE MANUAL

RADIO SET AN/PRC-104(A)

(NSN 5820-01-141-7953)

HEADQUARTERS, DEPARTMENT OF THE ARMY
15 JANUARY 1986

5 SAFETY STEPS TO FOLLOW IF SOMEONE IS THE VICTIM OF ELECTRICAL SHOCK

1 DO NOT TRY TO PULL OR GRAB THE INDIVIDUAL

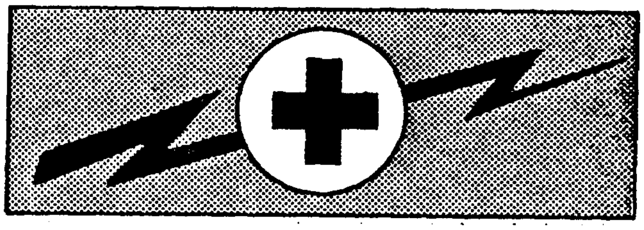
2 IF POSSIBLE , TURN OFF THE ELECTRICAL POWER

3 IF YOU CANNOT TURN OFF THE ELECTRICAL POWER, PULL, PUSH, OR LIFT THE PERSON TO SAFETY USING A WOODEN POLE OR A ROPE OR SOME OTHER INSULATING MATERIAL

4 SEND FOR HELP AS SOON AS POSSIBLE

5 AFTER THE INJURED PERSON IS FREE OF CONTACT WITH THE SOURCE OF ELECTRICAL SHOCK, MOVE THE PERSON A SHORT DISTANCE AWAY AND IMMEDIATELY START ARTIFICIAL RESUSCITATION

WARNING



HIGH VOLTAGE

is used in the operation of this equipment

DEATH ON CONTACT

may result if personnel fail to observe safety precautions

Never work on electronic equipment unless there is another person nearby who is familiar with the operation and hazards of the equipment and who is competent in administering first aid. When the technician is aided by operators, he must warn them about dangerous areas.

Whenever possible, the power supply to the equipment must be shut off before beginning work on the equipment. Take particular care to ground every capacitor likely to hold a dangerous potential. When working inside the equipment, after the power has been turned off, always ground every part before touching it.

Be careful not to contact high-voltage connections or 115 volt ac input connections when installing or operating this equipment.

Whenever the nature of the operation permits, keep one hand away from the equipment to reduce the hazard of current flowing through the body.

Warning: Do not be misled by the term "low voltage." Potentials as low as 50 volts may cause death under adverse conditions.

For Artificial Respiration, refer to FM 21-11.

SAFETY SUMMARY

The following are general safety precautions that are not related to any specific procedures and therefore do not appear elsewhere in this publication . These are recommended precautions that personnel must understand and apply during many phasesof operation and maintenance.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must at all times observe all safety regulations. Unless specifically directed in this manual, do not replace components or make adjustments inside the equipment with any power supply turned on. Under certain conditions, dangerous potentials may exist in the power supplies when the power control is in the off position. To avoid casualties, always remove power and discharge and ground a circuit before touching it.

DO NOT SERVICE OR ADJUST ALONE

Under no circumstances should any person reach into or enter the enclosure for the purpose of servicing or adjusting the equipment except in the presence of someone who is capable of rendering aid.

RESUSCITATION

FIRST AID

Each person engaged in electrical operations will be trained in first aid, particularly in the technique of mouth to mouth resuscitation and closed chest heart massage (FM 21-11).

The following warnings appear in this volume, and are repeated here for emphasis.

WARNING

A 3-wire (line, neutral, and safety ground) AC line power connections is required when operating the equipment. If a 3-wire safety grounded AC power receptacle is not available, a separate ground wire must be installed from the chassis ground to an earth ground. Without an adequate ground, the equipment chassis and frame will float to a dangerously high potential.

WARNING

Lethal voltage is used in the operational checkout of this unit. Death on contact may result if personnel fail to observe the following safety precautions. Remove watches and rings and exercise extreme caution when working inside the equipment throughout the remainder of this procedure.

WARNING

Prior to performing the folowing functions all electrical power is to be removed from the system. External power disconnected and a “MAINTENANCE IN PROGRESS” tag attached or power switches will be locked out to prevent inadvertent energizing of the system.

WARNING

Lifting heavy equipment incorrectly can cause serious injury. Do not try to lift more than 35 pounds by yourself. Get a helper. Bend legs while lifting. Don’t support heavy weight with your back.

WARNING

Adequate ventilation should be provided while using TRICHLOROTRIFLUOROETHANE. Prolonged breathing of vapor should be avoided. The solvent should not be used near heat or open flame, the products of decomposition are toxic and irritating. Since TRICHLOROTRIFLUOROETHANE dissolves natural oils, prolonged contact with skin should be avoided. When necessary use gloves which the solvent cannot penetrate. If the solvent is taken internally, consult a physician.

Compressed air shall not be used for cleaning purposes except where reduced to less than 29 psi and then only with effective chip guarding and personnel protective equipment. Do not use compressed air to dry parts when TRICHLOROTRIFLUOROETHANE has been used. Compressed air is dangerous and can cause serious bodily harm if protective means or methods are not observed to prevent chip or particle (of whatever size) from being blown into the eyes or unbroken skin of the operator or other personnel.

SAFETY SUMMARY

The following warnings and cautions appear within the text or illustrations of this manual. The warnings or cautions include a paragraph, figure, or table reference to where they appear in text or illustrations.

WARNING

Vapors emitted during certain circuit card repair procedures may be irritating to personnel. Always perform circuit card repair procedures in a well ventilated area. (3-17)

WARNING

Isopropyl alcohol is flammable. Keep away from heat and open flame. Vapors may be harmful. Use with adequate ventilation. Avoid prolonged or repeated breathing of vapor. Avoid eye contact. Do not take internally. (3-22, 3-23, 3-39)

WARNING

Adhesives are irritating to the skin and eyes upon contact, and may emit harmful vapor. Use only with adequate ventilation or respirator as specified by the Bioenvironmental Engineer. Avoid all skin and eye contact. Use protective clothing such as rubber gloves, apron and eye protection. Wash off immediately any accidentally contaminated skin area. Hand washing facilities and eye wash fountain should be provided. Do not take internally. (3-22, 3-24, 3-35, 3-36, 3-37, 3-38)

WARNING

Handling hot items presents a serious injury potential. Asbestos gloves are required. (3-22, 3-24, 3-33, 3-34, 3-35, 3-36, 3-38)

WARNING

Polyurethane contains flammable solvents and toxic diisocyanates. Keep away from heat and open flame. Vapors or mists are harmful. Complete body protection, including entire head, is required to prevent skin or eye irritation from contact with the paint or its vapors or mists. Respirator protection is required, usually an air-supplied hood, during mixing, curing, and application. Use this paint only with the protection requirements specified by the Bioenvironmental Engineer. Suitable flushing facilities must be provided for immediate clean water flushing of any accidental skin or eye contact. Do not take internally. (3-22)

SAFETY SUMMARY (Continued)

WARNING

Drilling operations create metal chips which may enter the eyes and cause serious injury. Eye protection is required. (3-23)

WARNING

Toluene is flammable. Keep away from heat and open flame. Vapors are harmful. Use only with adequate ventilation or respirator as specified by the Bioenvironmental Engineer. Avoid prolonged or repeated breathing of vapor. Avoid contact with skin and eyes. Do not take internally. Comply with air pollution control rules concerning photochemically reactive solvents. (3-24)

CAUTION

Never apply excessive pressure against a circuit card. (3-25)

WARNING

Solvents used in this procedure are flammable and must be kept from open flame, heat, and sparks. Keep containers tightly closed and store them in a cool place when not being used. The solvent must be used only in an adequately ventilated environment. Avoid breathing vapors and repeated contact with skin. Clean hands thoroughly before smoking, eating, or drinking. (3-33)

WARNING

Use Freon with good ventilation. Avoid prolonged or repeated breathing of vapor. Avoid contact with skin and eyes. Do not take internally. (3-35, 3-37, 3-38)

CAUTION

The areas to be soldered must be heated until the solder flows. Overheating can damage the board or nearby components. The wires being soldered must not be allowed to move in relation to one another until the solder has completely solidified. (3-36, 3-37)

CAUTION

Do not cut down into the circuit card pad when trimming the wire. (3-39)

SAFETY SUMMARY (Continued)

WARNING

When using a compressed airjet, use eyeshields. (3-43)

WARNING

When using solvents, provide proper ventilation, avoid prolonged contact, and do not smoke. Solvents must meet all pertinent specifications regarding toxicity, flammability, and allergenic effects. (3-43)

CAUTION

Compressed air must be clean, dry, and at a maximum pressure of 28 psi. Do not overlook the force of the airjet when cleaning delicate parts. (3-43)

CAUTION

Certain solvents will damage insulation. Do not use solvents chemically similar to “Chlorothene” or "Glyptal” to clean module connectors. Use only denatured alcohol for this purpose. (3-43)

CAUTION

When removing modules (except for power supply), pull straight up. Do not rock. (5-6)

CAUTION

Improper removal of power supply may cause damage to multipin connector. (5-10)

CAUTION

Do not place control panel so that it will fall out when captive screws are loosened. Flexible cable to housing could be damaged. (5-11)

CAUTION

When control panel is disattached from radio, care should be taken to prevent static discharge. (5-11)

SAFETY SUMMARY (Continued)

CAUTION

Use extreme care when removing or replacing ribbon cables. Creasing or severe bending will damage ribbon cables internally. (5-12, 5-15, 6-9, 6-22)

CAUTION

Use only moderate force to tighten screws that hold down modules, covers, etc. (5-16)

CAUTION

When replacing modules do not pinch rf cables between housing and module. (5-18)

CAUTION

Insertion of miniature coax connectors must be made carefully without forcing. (5-18)

CAUTION

To avoid damage to the bench test cable radio protection circuits, apply power as follows:

1. Connect bench test cable to radio.

2. Turn on power supply and check output level.

3. Then connect bench test cable to power supply. (F6-3)

Technical Manual

No. 11-5820-919-40-1

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 15 January 1986

GENERAL SUPPORT MAINTENANCE MANUAL

RADIO SET AN/PRC-104A (NSN 5820-01-141-7953)

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: AMSEL-ME-MP, Fort Monmouth, NJ 07703-5007. A reply will be furnished to you.

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GENERAL

0-1. SCOPE. This manual covers general support maintenance for Radio Set AN/PRC-104(A). This manual provides instructions for general support maintenance repair personnel. Throughout this manual AN/PRC-104 should be AN/PRC-104(A).

0-2. CONSOLIDATED INDEX OF ARMY PUBLICATIONS AND BLANK FORMS. Refer to the latest issue of DA Pam 310-1 to determine whether there are new editions, changes or additional publications pertaining to the equipment.

0-3. MAINTENANCE FORMS, RECORDS, AND REPORTS

a. Reports of Maintenance and Unsatisfactory Equipment. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA Pam 738-750 as contained in Maintenance Management Update.

b. Report of Packaging and Handling Deficiencies. Fill out and forward SF 364 (Report of Discrepancy (ROD)) as prescribed in AR 735-11-2/DLAR 4140.55 /NAVMATINST 4355.74A/AFR-400-54/MC0 4430.3F.

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38 /NAVSUPINST 4610.33C/AFR 75-18/MCO P4610.19/DLAR 4500.15.

0-4. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR). If your Radio Set AN/PRC-104(A) needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us why you don’t like the design. Put it on an SF 368 (Quality Deficiency Report). Mail it to Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: AMSEL-ME-MP, Fort Monmouth, New Jersey 07703-5007. We’ll send you a reply.

0-5. ADMINISTRATIVE STORAGE. Administrative Storage of equipment issued to and used by Army activities will have preventive maintenance performed in accordance with the PMCS charts before storing. When removing the equipment from administrative storage the PMCS should be performed to assure operational readiness. Disassembly and repacking of equipment for shipment or limited storage are covered in TM 740-90-1.

0-6. DESTRUCTION OF ARMY ELECTRONICS MATERIEL. Destruction of Army electronics materiel to prevent enemy use shall be in accordance with TM 750-244-2.

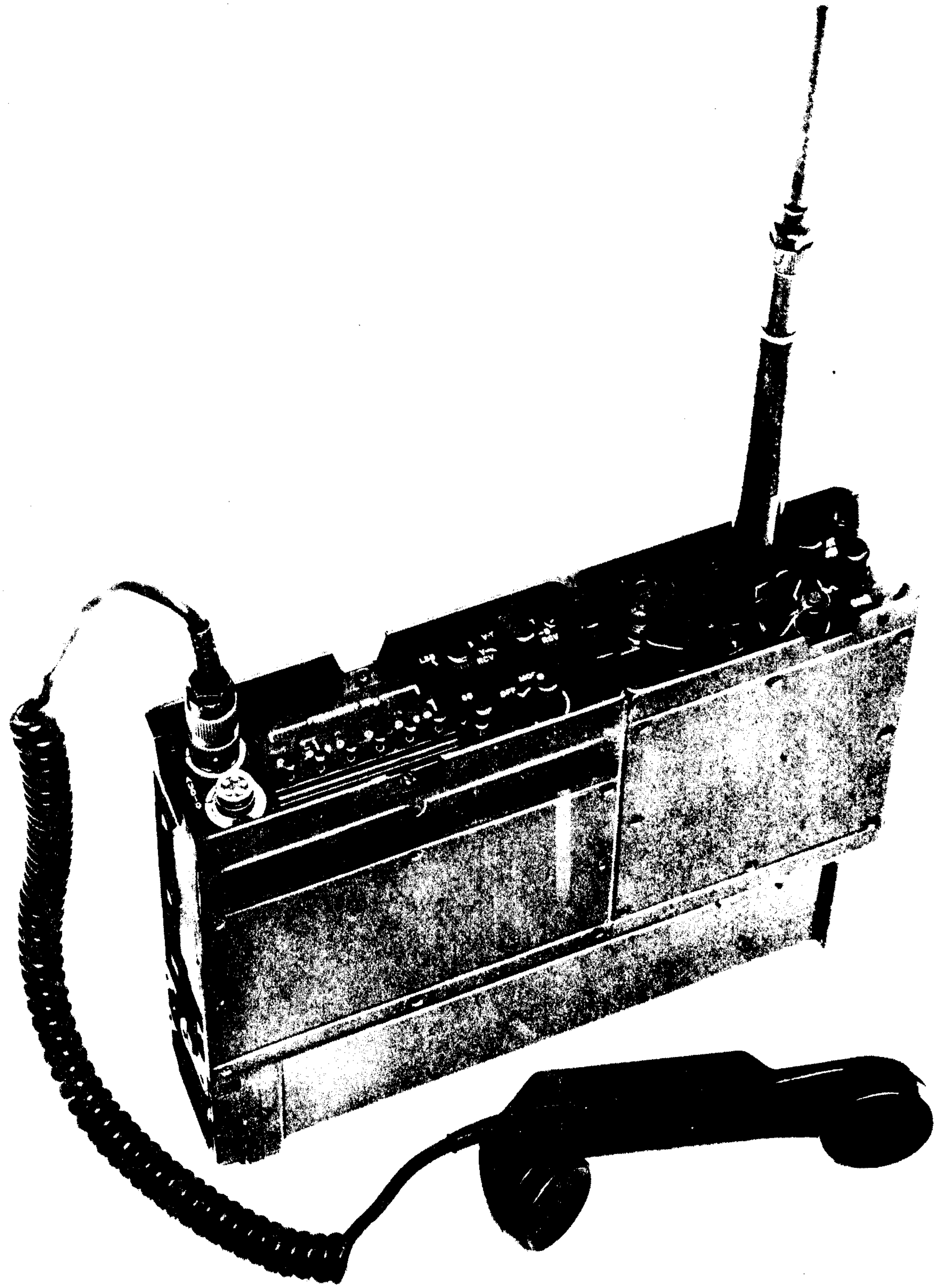

Figure 1-0. Radio Set AN/PRC-104

CHAPTER 1

GENERAL INFORMATION

1-1. SCOPE OF THE TECHNICAL MANUAL

1-2. This technical manual provides field maintenance information covering Radio Set AN/PRC-104 (radio set), and two of its units: Receiver-Transmitter RT-1209/URC (receiver/exciter) and Radio Frequency Amplifier AM-6874/PRC-104 (amplifier/coupler). The third unit, Battery Case CY-7541/PRC-104 (battery pack) is maintained entirely at the organizational level and is covered in Operator's and Organizational Maintenance Manual TM 11-5820-919-12.

1-3. The field maintenance information includes reference data, theory of operation and disassembly and reassembly for the complete radio set. It also provides test troubleshooting, alignment and repair data for the radio set and the receiver/exciter and amplifier/coupler units necessary to replace unit components and modules. Maintenance information for the individual modules is contained in General Support Maintenance Manual TM 11-5820-919-40-2. Depot-unique information is coveredin Rebuild Standards RS-07748A-50/4. For parts ordering data refer to Repair Parts and Special Tools List TM 11-5820-919-24P.

NOTE

Air Force maintenance philosophy limits maintenance to removal and replacement of modules. Repair beyond that level must be performed at depot only.

1-4. Chapter 1 of this technical manual provides information on the physical aspects and performance characteristics of the radio set and its support equipme nt, and provides general reference data.

1-5. Chapter 2 contains system, overall and detailed functional theory of operation of the radio set, with supporting functional block diagrams.

1-6. Chapter 3 provides general maintenance data that is applicable to all the assemblies, including the modules in the General Support Maintenance Manual. It includes circuit card assembly (module) repair procedures; cleaning and examination; fabrication of test cables, adapters and fixtures; and instruction for use of the maintenance diagrams for performance test and troubleshooting. It also contains maintenance data and drawings for the following accessory equipments:

1. Bench Test Cable (Electrical Power Cable Assembly CX-13030/PRC-104)
2. Battery Extender Cable (Electrical Power Cable Assembly CX-13031/PRC-104)
3. Antenna Base (Antenna Base AB-1241/PRC-104)
4. Telegraph Key (Telegraph Key KY-872/PRC-104)
5. Transit Case (Radio Set Case CY-7542/PRC-104)

1-7. Chapters 4 thru 6 provide the maintenance information necessary to test, troubleshoot and repair the radio set and the receiver/exciter and amplifier/coupler units. It is sectionalized in the following sequence: (1) support equipment and materials, (2) disassembly and reassembly, (3) cleaning and examination, (4) performance test and troubleshooting, (5) repair and replacement, (6) component location and parts list, and (7) maintenance diagrams.

1-8. REFERENCE DATA.

1-9. The following paragraphs provide the reference data required for planning maintenance of the radio set and related equipment.

1-10. TECHNICAL CHARACTERISTICS. Technical characteristics for the radio set are listed in table 1-1.

1-11. EQUIPMENT SUPPLIED. The radio set and accessory equipment that is supplied in the transit case are listed in table 1-2.

1-12. EQUIPMENT NOT SUPPLIED. Table 1-3 lists the equipment used with the radio set that is not supplied in the transit case.

1-13. SUPPORT EQUIPVENT. The test equipment required to perform field maintenance of the radio set is listed in table 1-4. Equivalent test equipment may be used.

NOTE

Use only test equipment that is properly calibrated. Failure to do so may provide erroneous and misleading performance or fault indications.

1-14. The special tools, materials, fabricated test cables and fixtures required for field maintenance of the radio set are listed in table 1-5.

1-15. SPECIAL MAINTENANCE FACILITY REQUIREMENTS. There are no, special maintenance facility requirements for the radio set.

1-16. LIST OF PUBLICATIONS. Table 1-6 lists the current publications applicable to the radio set.

TABLE 1-1. TECHNICAL CHARACTERISTICS

Characteristic	Description
	RADIO SET AN/PRC-104 (Radio Set)
Frequency Range	2.0000 to 29.9999 MHz in 0.0001 MHz (100 Hz) increments (280,000 possible frequency settings)
Frequency Accuracy	±1 ppm for -51°F (-46°C) to ±160°F (+71°C) (*2 to 30 Hz of setting) from 2 to 30 MHz, respectively
Operating Modes	Single Sideband (selectable USB or LSB) Voice/cw (Morse or burst cw at 300 wpm) Data (FSK or DPSK Up to 2,400 bps), compatible with 75 baud military teletype Receive only (inhibits transmit operation)
Audio Input Impedance and Level	150 ohms, -56 dbm (voice), or 6 mv rms 600 ohms, 0 dbm (data), or 0.77 vrms

TABLE 1-1. TECHNICAL CHARACTERISTICS (Continued)

Characteristic	Description
RF Output Power	20w (PEP), 0.25w (PEP) exciter output
RF Output Impedance	50 ohms, unbalanced. Output protected to infinite VSWR due to antenna short or open
Antenna Tuning	Automatic to 1.5:1 VSWR (3 seconds tuning time, typical)
Power Requirements	20.0 to 32.0 vdc with input at 3.5 amp (24 vdc) for transmit (typical); 200 ma for receive (typical)
Operating Temperature Range	-51°F (-46°C) to +160°F (+71°c)
Environmental	Meets applicable provisions of MIL-STD-810B
Mean Time Between Failure (MTBF)	2500 hours (demonstrated per MIL-STD-785)
Mean Time to Repair (MTTR)	15 minutes (module replacement)
Dimensions	12 1/2" x 10 1/2" x 2 5/8" (31.75 cm x 26.67 cm x 6.66 cm) Dx W XH
Weight	14 pounds (6.36 kg), including 4.8 AH silver-zinc battery.(without accessories)
	RECEIVER
Sensitivity SSB, CW, FSK	0.7 μv for 10 db SINAD (-110 dbm voice, -70 dbm data)
Selectivity SSB, CW, FSK	2.5 kHz Bandwidth at -3 db 6.0 kHz Bandwidth at -60 db
Image Rejection	70 db
I.F. Rejection	60 db
Audio Output	25 mw into 500 ohms (nominal)
Audio Distortion	5 percent at 5 mw, 350 to 3000 Hz
Desensitization (signal to degrade SINAD 3 db)	± 2.5% to -29 dbm; ± 10% to -15 dbm; ± 50% to +17 dbm

TABLE 1-1. TECHNICAL CHARACTERISTICS (Continued)

Characteristic	Description
	TRANSMITTER
RF Output Power	0.3W (PEP) for RT-1209, 20W (PEP or average) with AM-6874
Intermodulation Distortion (IMD)	-25 db (two equal tones at rated output power)
Harmonic Radiation	-50 db
Carrier Suppression	-42 db
Unwanted Sideband Suppression	-45 db
All Other Spurious	-45 to -60 db
Duty Cycle	1 minute continuous keydown, 9:1 transmit/receive ratio
	BATTERY PACK
Battery	Silver-Zinc (AgZn), rechargeable, 4.8 AH

TABLE 1-2. EQUIPMENT SUPPLIED

Nomenclature	Manufacturer's Part Number	Reference Designator	Common Name	Overall Dimensions	Weight
Case, Radio Set CY-7542/PRC-104	755002A3100	...	transit case	14.5 in. (36.83 cm) wide 15.25 in. (38.74 cm) high 22.0 in. (55.88 cm) long	28.0 lb (12.70 kg)
Radio Set AN/PRC-104	755002A0050	...	radio set	12.5 in. (31.75 cm) wide 10.5 in. (26.67 cm) high 2.62 in. (6.66 cm) deep	14 lb (6.36 kg) (3 units, including battery)
Receiver-Transmitter RT-1209/URC	75502A0150	A1	receiver/exciter	7.25 in. (18.42 cm) wide 7.25 in. (18.42 cm) high 2.62 in. (6.66 cm) deep	5.9 lb (2.68 kg)
Modulator-Demodulator Module	755002A0220	A1A1	modulator/demodulator	...	...
Harmonic Filter Module	755002A0270	A1A2	harmonic filter	...	...
Synthesizer Module	755002A0320	A1A3	synthesizer	...	...
Control Panel Module	755002A0440	A1A4	control panel	...	...
Power Supply Module	755002A0350	A1A5	power supply	...	...

TABLE 1-2. EQUIPMENT SUPPLIED (Continued)

Nomenclature	Manufacturer's Part Number	Reference Designator	Common Name	Overall Dimensions	Weight
Amplifier, Radio Frequency AM-6874/PRC-104	755002A0550	A2	amplifier/coupler	5.25 in. (13.34 cm) wide 7.25 in. (18.42 cm) high 2.62 in. (6.66 cm) deep	4.1 lb (1.86 kg)
Power Amplifier Module	755002A0650	A2A1	power amplifier	...	...
Antenna Tuner Module	755002A0750	A2A2	antenna tuner	...	...
Case, Battery CY-7541/ PRC-104	755002A0850	...	battery pack	12.5 in. (31.75 cm) wide 3.25 in. (8.26 cm) high 3.25 in. (8.26 cm) deep	4.0 lb (1.81 kg) (including battery)
Storage Battery, Silver-Zinc	755002A7043-1	...	battery	...	...
Cable Assembly, Power, Electrical CX-13030/PRC-104	755002A1255	...	bench test cable	48.0 in. (121.92 cm) long	...
Cable Assembly, Power, Electrical CX-13031/PRC-104	755002A1260	...	battery extender cable	48.0 in. (121.92 cm) long	...
Cable Assembly, Power, Electrical CX-13032/PRC-104	755002A1250	...	battery charger cable	48.0 in. (121.92 cm) long	...
Cable Assembly, Radio Frequency CG-3815/U	755002A7114-1	...	antenna base cable	24.0 in. (60.96 cm) long	...

TABLE 1-2. EQUIPMENT SUPPLIED (Continued)

Nomenclature	Manufacturer's Part Number	Reference Designator	Common Name	Overall Dimensions	Weight
Antenna, Spring Section AB-129/PR	SC-D-20938	...	shock mount	...	...
Antenna AT-271A/PRC	SM-D-182392	...	whip antenna	10 ft. (3.048 m) long	0.7 lb (0.32 kg)
Base, Antenna AB-1241/PRC-104	755002A0900	...	antenna base	...	...
Handset H-189/GR	4139440-1	...	handset	...	1.0 lb (0.45 kg)
Key, Telegraph KY-872/PRC-104	755002A1000	...	CW key	...	...
Card, Instruction	755002A0057	...	instruction card	...	...
ALICE (All-Purpose Lighweight Individual Carrying Equipment)		...	backpack	...	4.0 lb (1.81 kg)
Field Pack	4100050-17	...	field pack	...	...
Frame, Shelf, Pack	4100050-18	...	frame shelf	...	...
Strap, Frame Assembly	4100050-16	...	frame strap	...	...
Strap, Webbing	4100050-19	...	webbing strap	...	...

TABLE 1-3. EQUIPMENT NOT SUPPLIED

Nomenclature	Common Name	Purpose
Antenna, AS-2259/GR	NVIS antenna	Alternate antenna

TABLE 1-4. TEST EQUIPMENT

NOTES: 1. * denotes test equipment not required for Air Force intermediate maintenance.

2. Equivalent test equipment may be used.

3. Use only test equipment that is properly calibrated. Failure to do so may provide erroneous or misleading performance or fault indications.

4. If adequate wattmeter is not available, substitute vtvm terminated with dummy load, $P = E^2/R$ where R = 50 ohms.

5. Before using spectrum analyzer, RF section HP-8553B perform preliminary checks contained in the HP-8553B Operating Manual.

Name	Designation	Item Parameters	Quantity
Radio Set	AN/PRC-104	100% functional, test bed	1
Frequency Counter*	AN/CP-843P/U	50 Hz - 5 MHz readings in 1.0 Hz increments at 5 MHz	1*
Audio Oscillator	SG-1152/U	± 2% accuracy, 0.5 - 6 kHz	1
VTVM	AN/USM-116	ac voltage measurable at 1 kHz, high input impedance	1
Signal Generator, RF	AN/USM-323	2-30 MHz, -110 to +20 db	1
Oscilloscope, Storage*	Hewlett Packard HP-1741A	bandwidth extending to 50 MHz, 10 mv sensitivity	1*
Digital Multimeter	AN/USM-341	High impedance (ohmmeter), ac and dc, 0-30v, ± 0.1%	1
Attenuator	CN-1128/U	10-db steps, 0.5w, 50 ohm	1
Dummy Load	DA-553( )/4	30w rein, 50 ohm, 20 db	1
Watt Meter, RF		2 - 95 MHz, 1 - 31 mw	
- Power Meter	Hewlett Packard HP-435A		1

TABLE 1-4. TEST EQUIPMENT (Continued)

Name	Designation	Item Parameters	Quantity
- Thermocoupler Power Sensor	Hewlett Packard HP-8482A		1
Spectrum Analyzer*	Hewlett Packard HP-141-T	2-110 MHz sweep capability	1*
- High Resolution IF Section*	Hewlett Packard HP-8552B	bandwidth resolution 100 Hz to 300 kHz	1*
- RF Section*	Hewlett Packard HP-8553B	bandwidth resolution 10 Hz to 300 kHz	1*
- Tracking Generator*	Hewlett Packard HP-8443A	track analyzer and counter functions counter display 7 digits with 1 digit over range. Reads to ±10 Hz increments ±1 Hz 50Ω/1 MEGΩ	1*
- High Impedance Probe*	Hewlett Packard HP-1121A	±0.5 db, ±2% from 0.1 to 110 MHz	1*
Distortion Analyzer*	Hewlett Packard HP-334A	± .5%, 1 kHz	1*
Power Supply, Current Limited*	Hewlett Packard HP-6215A	0-15v, 0400 ma current limited	1*
Power Supply, DC	Hewlett Packard HP-6439B	0-30v, 7 amp max	1
Attenuator, Coaxial	Narda 765-20	20 db, 30w min, 50 ohm	1
Multimeter*	Simpson 260-6P	ammeter function, ±1%	1*
150 Ohm Resistor*	..0	±20%, 0.25w	1*
500 Ohm Resistor*	l..	±20%, 0.25w	1*

TABLE 1-5. SPECIAL TOOLS, MATERIALS, AND FABRICATED CABLES

NOTES: 1. * denotes equipment not required for Air Force intermediate maintenance.

2. Referenced figures are in Chapter 3.

3. ** denotes equipment authorized for Army use.

Description	Part Number	Reference
Kit, Tool, Electronic	TK-100/G	None
Bench Repair Center	Pace PRC-350C	None
Maintenance Kit, Printed Circuit	MK-984/A	None
Conformal Coating	MIL-I-46048, Type UR	None
Modulator/Demodulator Test Extender Cable*	...	Figure 3-10A
Antenna Tuner Test Extender Cable*	...	Figure 3-10B
Synthesizer Test Extender Cable*	...	Figure 3-10C
Harmonic Filter and Power Amplifier Test Extender Cable*	...	Figure 3-10D
RF Coax Cable (2 each)*	...	Figure 3-11A
RF Extender Cable (4 each)*	...	Figure 3-11B
Audio Input/Keying Adapter	...	Figure 3-11C
Whip Adapter	...	Figure 3-11D
100 Ohm Load*	...	Figure 3-11E
130 Ohm Load*	...	Figure 3-11F
Frequency Converter A1A1A1, A1A1A2, A1A1A3 Test Beds*	...	Figure 3-12
Maintenance Kit 0A-9161/GRC-213 **	**(NSN 5820-01-159-1646)**	**None**

TABLE 1-6. LIST OF PUBLICATIONS

Title	Publication Number
Radio Set AN/PRC-104(A)	
Operator's and Organizational Maintenance Manual	TM 11-5820-919-12
General Support Maintenance Manual	TM 11-5820-919-40-1
General Support Maintenance Manual	TM 11-5820-919-40-2
Rebuild Standards	RS-07748A-50/4
Repair Parts and Special Tools List	TM 11-5820-919-24P
Antenna AS-2259/GR and Antenna-to-Antenna Base Adapter MX-9313/GR	TM 5985-379-14&P

CHAPTER 2

THEORY OF OPERATION

2-1. INTRODUCTION.

2-2. This chapter describes the radio from a functional viewpoint. First, a system viewpoint is discussed. This first section reviews rf mixing principles and automatic impedance-matching as they apply to the radio set. Next, an overall or major unit viewpoint is discussed. This second section examines the primary functional role of the modules within each major unit. Finally, a detailed description of each module is presented. This third section can be used in two ways: (1) by following the block diagram accompanying the text, and (2) by referring to the schematic diagram of the module found in the General Support Maintenance Manual TM 11-5820-919-40-2 as a supplement. The schematic diagrams shouldbe used when performing troubleshooting procedures on a module.

SECTION I

SYSTEM FUNCTIONAL DESCRIPTION

2-3. GENERAL.

2-4. This section describes the frequency conversion and impedance-matching functions of the radio set. Frequency conversion is discussed in transmit operation (audio frequency to radio frequency) and in receive operation (radio frequency to audio frequency). Impedance-matching is discussed in terms of standing wave ratio (swr) and the automatic procedure which the radio set uses.

2-5. TRANSMIT OPERATION (Figure 2-1).

2-6. For ease of explanation, assume the voice signal (Xmt Audio) from the microphone is 1 kHz. The Xmt Audio from the microphone is routed through the audio filter which suppresses spurious rf noise signals picked up at the microphone.

2-7. The Xmt Audio is then mixed with the 5-MHz local oscillator (LO) signal from the synthesizer. The mixer produces two signals: (1) 5MHz + Xmt Audio, and (2) 5 MHz - Xmt Audio.* The 5-MHz crystal filter passes the 5 MHz - Xmt Audio (4.999 MHz) and suppresses the 5 MHz + Xmt Audio signal.

2-8. The output of the 5-MHz crystal filter is then, mixed with 70 MHz if upper sideband (USB) is selected on the control panel, or with 80 MHz if lower sideband (LSB) is selected. The mixer also produces the following signals:

1. Upper sideband selected

   a. 70 MHz + 5 MHz - Xmt Audio (74.999 MHz)*

   b. 70 MHz - 5 MHz - Xmt Audio (64.999 MHz)

2. Lower sideband selected

   a. 80 MHz - 5 MHz - Xmt Audio (75.001 MHz)*

*Indicates the desired signal

b. 80 MHz + 5 MHz - Xmt Audio (84.999 MHz)

The 75-MHz crystal filter passes 74.999 MHz (USB) or 75.001 MHz (LSB).

2-9. The automatic level control (ALC) circuits maintain the signal level required to produce the 20-watt output power for the radio set. The ALC circuits receive feedback from the power amplifier or antenna tuner.

2-10. The output of the 75-MHz crystal filter is mixed with 77-105 MHz LO from the synthesizer. The generation of the 77-105 MHz LO signal is controlled by the frequency selector switch settings on the control panel. For example, if the frequency selector is set to 2 MHz, 77 MHz is generated and mixed. If 3 MHz is selected, 78 MHz is generated; if 29.999 MHz is selected, 104.999 MHz is generated. If 2 MHz is selected, the mixer produces the following:

1. Upper sideband selected

   a. 77 MHz + 74.999 MHz (151.999 MHz)

   b. 77 MHz - 74.999 MHz (2.001 MHz)*

2. Lower sideband selected

   a. 77 MHz + 75.001 MHz (152.001 MHz)

   b. 77 MHz - 75.001 MHz (1.999 MHz)*

2-11. The 0.3 to 1 watt (PEP) amplifier in the first frequency converter rejects the 151.999 MHz or 152.001 MHz. The 2.001-MHz signal (USB), or 1.999-MHz signal (LSB), is amplified up to 0.25 watt, then amplified again to 20 watts by the 20-watt amplifier.

2-12. The 1.999- or 2.001-MHz 20-watt signal (Xmt RF) is routed through the harmonic filter for further filtering and through the L-C network of the antenna.

*Indicates the desired signal

2-13. **RECEIVE OPERATION** (Figure 2-1).

2-14. Assume that the receive rf (Rcv RF) signal is 2 MHz with a 1-kHz voice signal. The 2-MHz Rcv RF signal is routed from the antenna, through the L-C network and harmonic filter to the mixer. The 2 MHz (2.001 MHz USB, 1.999 MHz LSB) is mixed with 77 MHz LO to produce 74.999 MHz (USB) or 75.001 MHz (LSB). The output of the mixer is routed through the 75-MHz crystal filter and the 75-MHz amplifier, and mixed with 70 MHz (USB) or 80 MHz (LSB). The resulting mixer outputs, 4.999 MHz (USB) or 5.001 MHz (LSB), is routed through the 5-MHz crystal filter, through the automatic gain control (agc) circuits, and mixed with the 5 MHz LO. The mixer produces the 1-kHz (Rcv) Audio which is routed through the audio filter to the earphones.

2-15. **AUTOMATIC IMPEDANCE MATCHING.**

2-16. The antenna tuner module automatically matches the characteristic impedance of the selected antenna to that of the radio set (50 ohms). Note that the impedance of the antenna varies with frequency, because its impedance has both reactive and resistive components. Instead of selecting a different antenna each time frequency is changed, the antenna’s electrical characteristics are changed. The electrical characteristics of the antenna are changed in the antenna tuner module by adding different inductors and capacitors between the power amplifier and antenna. Each time an inductor or capacitor is added, the standing wave ratio (vswr) and/or impedance is checked. When the vswr drops below 1.5:1, this indicates that: (1) the antenna tuner module has added the correct capacitor and inductor, and (2) the antenna’s electrical characteristics are matched to the applied frequency. Once this match has been accomplished, the required inductor and capacitor will remain switched into the network until retuning is required.

2-17. The inductors and capacitors are added to an L-C network similar to the one shown in figure 2-1, detail A. Note that the relays are arranged so that the inductors are added in series and the capacitors are added in parallel. For example, if relays KL4, KL2, and KL1 are open and KL3 is closed, the inductors are added as if they were the binary digits 1011:

$$\text{total inductance} = (1)2^3L + (0)2^2L + (1)2^1L + (1)2^0L$$
$$= 8L + 0L + 2L + 1L$$
$$= 11\ L$$

where L is the value of the smallest inductor.

The capacitive elements are added in a like manner. Both inductors and capacitors are added in an ascending count in order of increasing inductance or capacitance (0001, 0010, 0011, 0100, etc). The inductors are added until the impedance drops to 100 ohms. Then the capacitors are added until the swr is 1.5:1.

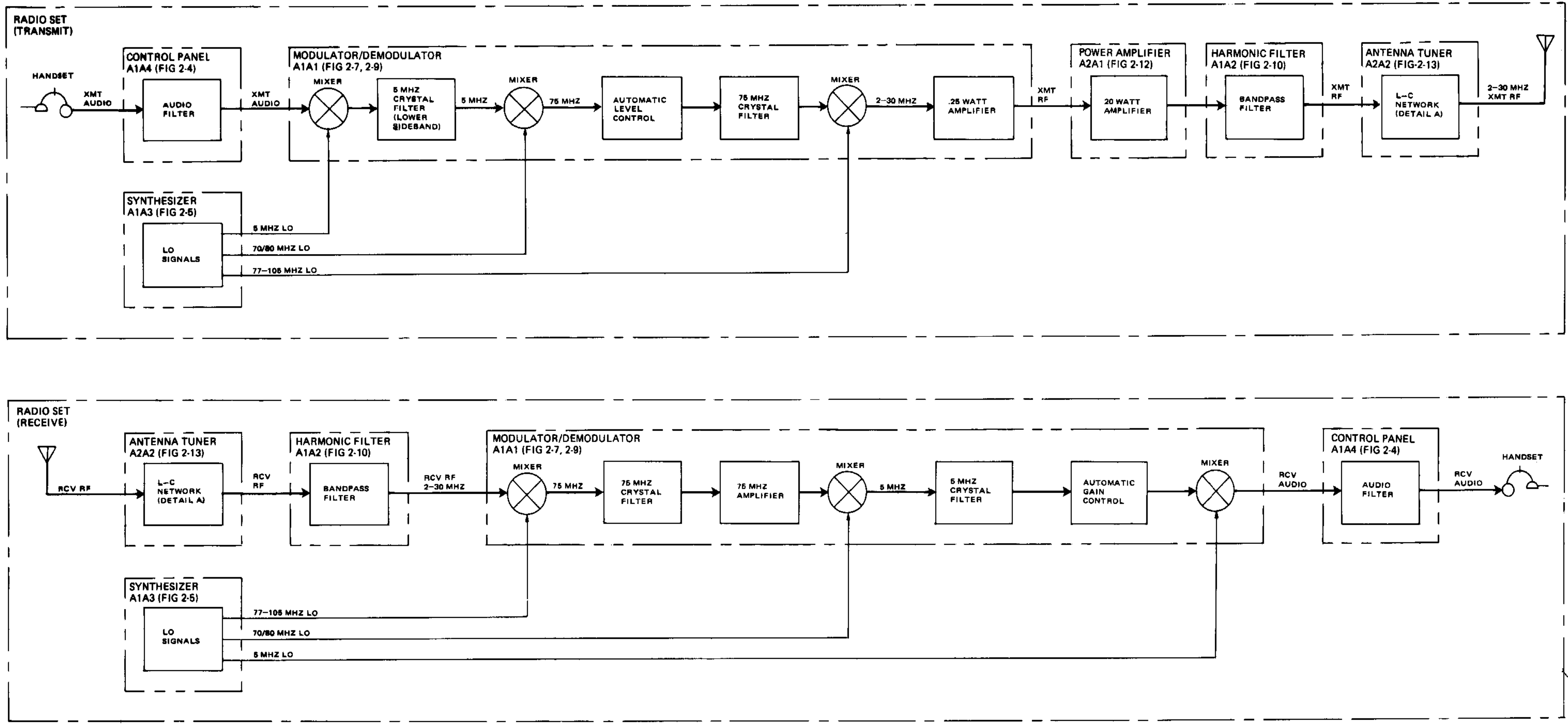

Figure 2-1. System Block Diagram

SECTION II

OVERALL FUNCTIONAL DESCRIPTION

2-18. GENERAL.

2-19. RADIO SET. The radio set consists of three major assemblies:

1. Receiver/exciter (A1)
2. Amplifier/coupler (A2)
3. Battery pack

The receiver/exciter contains five modules: (1) control panel, (2) synthesizer, (3) modulator/demodulator, (4) harmonic filter, and (5) the power supply. The amplifier/coupler contains the power amplifier and antenna tuner modules. The battery pack provides the radio set with the +28v (nominal) dc power.

2-20. RECEIVER/EXCITER (Figure 2-2).

2-21. CONTROL PANEL. The control panel provides operational control of the radio set and couples transmit/receive audio signals between the audio devices in use by the operator and the radio set. The control panel contains the FREQUENCY KHZ (frequency select) switches, MODE select switch, SB (sideband) select switch, VOLUME control, LIGHT switch, and audio connectors.

2-22. Frequency Selection. The FREQUENCY KHZ switches select the operating frequency of the radio set (2,000 thru 29,999 kHz). The frequency select switches send Frequency Select signals (logic data) to the synthesizer for use in determining the frequency of the 77-105 MHz LO signal. The Frequency Select signals are also used by the antenna tuner during impedance matching. The Filter Select signal from the frequency select switches is used by the harmonic filter to select the bandpass filter corresponding to the selected frequency.

2-23. Mode Selection. The MODE switch selects either voice transmit (V-TR), voice receive (V-RCV), data transmit (D-TR), or data receive (D-RCV). The Mode Select signals are used by the modulator/demodulator to control the processing of the transmit/receive radio frequency (Xmt/Rcv RF). In the voice mode, the microphone input impedance is 150 ohms and the VOLUME control adjusts the level of the Rcv Audio. In the data mode, the input impedance is changed to 600 ohms, which is compatible with standard data systems. The VOLUME control is also disabled so that a constant receive level is maintained. In addition, the receiver agc release time constant is shortened to reduce the receive response time to incoming data.

2-24. Sideband Selection. The SB switch selects either upper sideband (USB) or lower sideband (LSB) of the radio frequency. The Sideband Select signals are sent to the synthesizer. The synthesizer sends either 70 MHz to the modulator/demodulator if USB is selected or 80 MHz if LSB is selected.

2-25. Volume Control. The VOLUME control is used to control the Rcv Audio level from the modulator/demodulator.

2-26. SYNTHESIZER. The synthesizer generates the 5 MHz, 70 (USB) or 80 (LSB) MHz, and 77–105 MHz LO signals. The exact frequency of the 77–105 MHz LO is 75 MHz plus the control panel frequency. The LO signals are used by the modulator/demodulator in the processing of transmit/receive signals. The synthesizer also generates a 1-kHz tone which is used by the modulator/demodulator to develop a cw key tone.

2-27. MODULATOR/DEMODULATOR. In transmit operation the modulator/demodulator converts the Xmt Audio into two successive intermediate frequencies and then into the Xmt RF. During receive operation, the same circuits reverse the operation, extracting the Rcv Audio from the rf input signal.

2-28. HARMONIC FILTER. The harmonic filter removes spurious received signals and suppresses transmitter harmonics using six bandpass filters. The Filter Select signals from the control panel determine the choice of filter. In transmit mode, Xmt RF is routed from the power amplifier through the filter and to the antenna tuner. In receive mode, the rf flow is reversed,

2-29. POWER SUPPLY. The power supply converts the +28v to 6.5v and 12.5v.

2-30. AMPLIFIER/COUPLER.

2-31. POWER AMPLIFIER. The Xmt RF from the modulator/demodulator is amplified by the power amplifier during transmit operation to provide 20 watts of power. The power amplifier is bypassed during receive operation.

2-32. ANTENNA TUNER. In transmit operation, the filtered Xmt RF from the harmonic filter is routed through the antenna tuner to the selected antenna. The antenna tuner automatically matches the antenna impedance to the radio set. In receive operation, the rf flow is reversed. The antenna tuner is bypassed if the antenna select switch (ANT SEL) is in the 50-OHM position.

2-33. BATTERY PACK.

2-34, DESCRIPTION. The battery pack consists of 16 silver-zinc cells which are connected in series. Each cell has a nominal voltage of 1.86v. The rated capacity for the battery pack is 4.8 ampere-hours. Later versions of the battery pack may use different battery cells, such as nickel-cadmium or lithium fluoride.

2-35. POWER DISTRIBUTION SYSTEM (Figure 2-3).

2-36. DESCRIPTION. The +28v Battery (power input) from the battery pack is routed through the amplifier/coupler to the power amplifier module and a fuse and to the control panel module, located in the receiver/exciter unit.

2-37. In the control panel, the +28v Battery is routed through a fuse and through the VOLUME switch where it is redesignated as +28v On. The +28v On is routed to the following modules: power amplifier (amplifier/coupler unit), modulator/demodulator, synthesizer, harmonic filter, and power supply.

2-38. The power supply converts the +28v on to +6.5v and +12.5v. The +12.5v is routed to the control panel, synthesizer, and modulator/demodulator. The +6.5v is routed to the synthesizer, modulator/demodulator, power amplifier and antenna tuner. The synthesizer filters out any ripple in the +6.5v by converting the +6.5v to +6v. The +6v is routed to the modulator/demodulator.

2-39. The power amplifier supplies +16v Regulated to the relays of the antenna tuner during the tune mode. This voltage will vary from +14 ± 2v depending on the ambient temperature.

SECTION II

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2-27. MODULATOR/DEMODULATOR . In transmit operation the modulator/demodulator converts the Xmt Audio into two successive intermediate frequencies and then into the Xmt RF. During receive operation, the same circuits reverse the operation, extracting the Rcv Audio from the rf input signal.

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2-29. POWER SUPPLY, The power supply converts the +28v to 6.5v and 12.5v.

2-30. AMPLIFIER/COUPLER.

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2-38. The power supply converts the +28v On to +6.5v and +12.5v. The +12.5v is routed to the control panel, synthesizer, and modulator/demodulator. The +6.5v is routed to the synthesizer, modulator/demodulator, power amplifier and antenna tuner. The synthesizer filters out any ripple in the +6.5v by converting the +6.5v to +6v. The +6v is routed to the modulator/demodulator.

2-39. The power amplifier supplies +16v Regulated to the relays of the antenna tuner during the tune mode. This voltage will vary from +14 ± 2v depending on the ambient temperature.

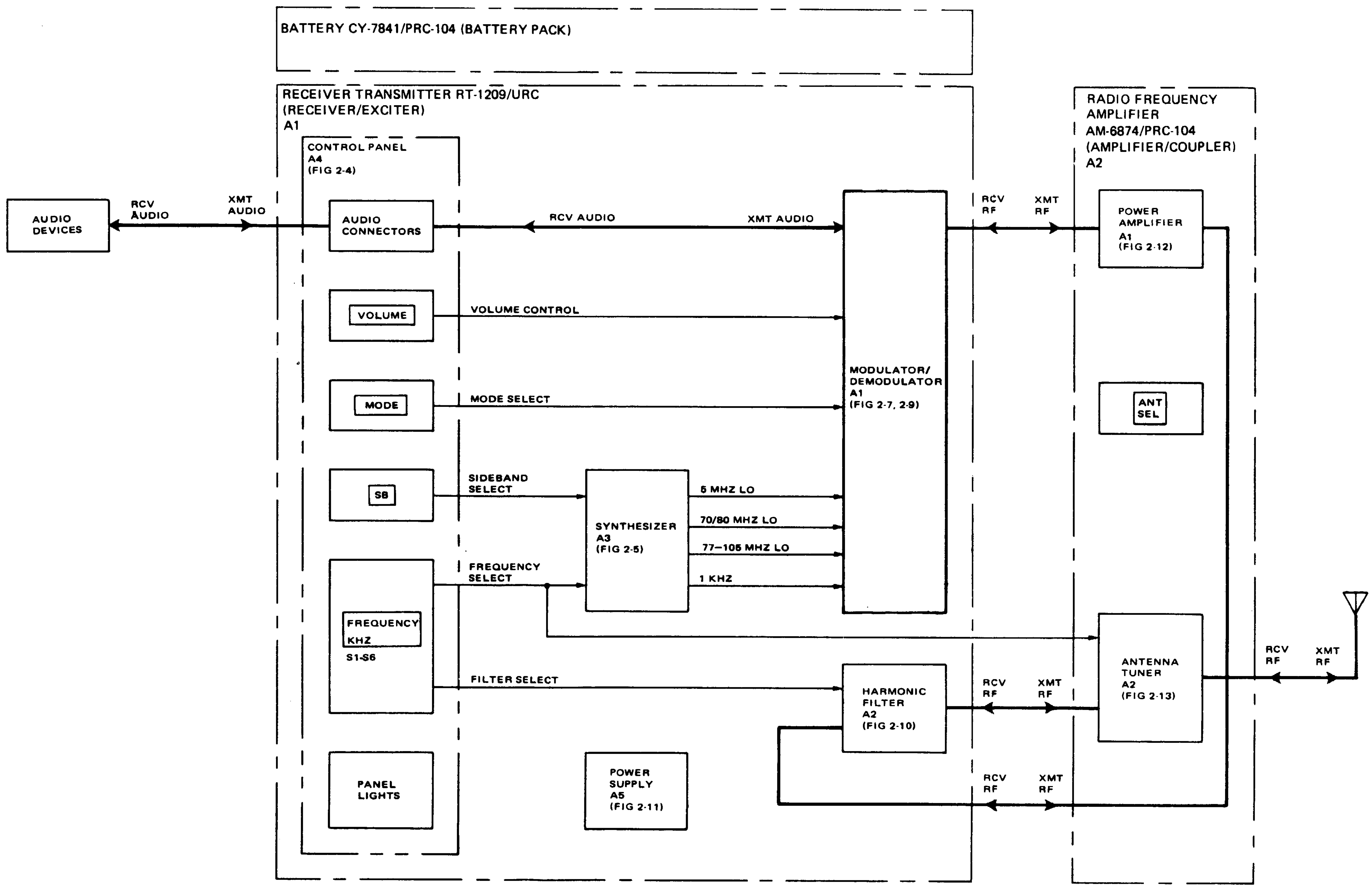


Figure 2-2. Radio Set Overall Block Diagram

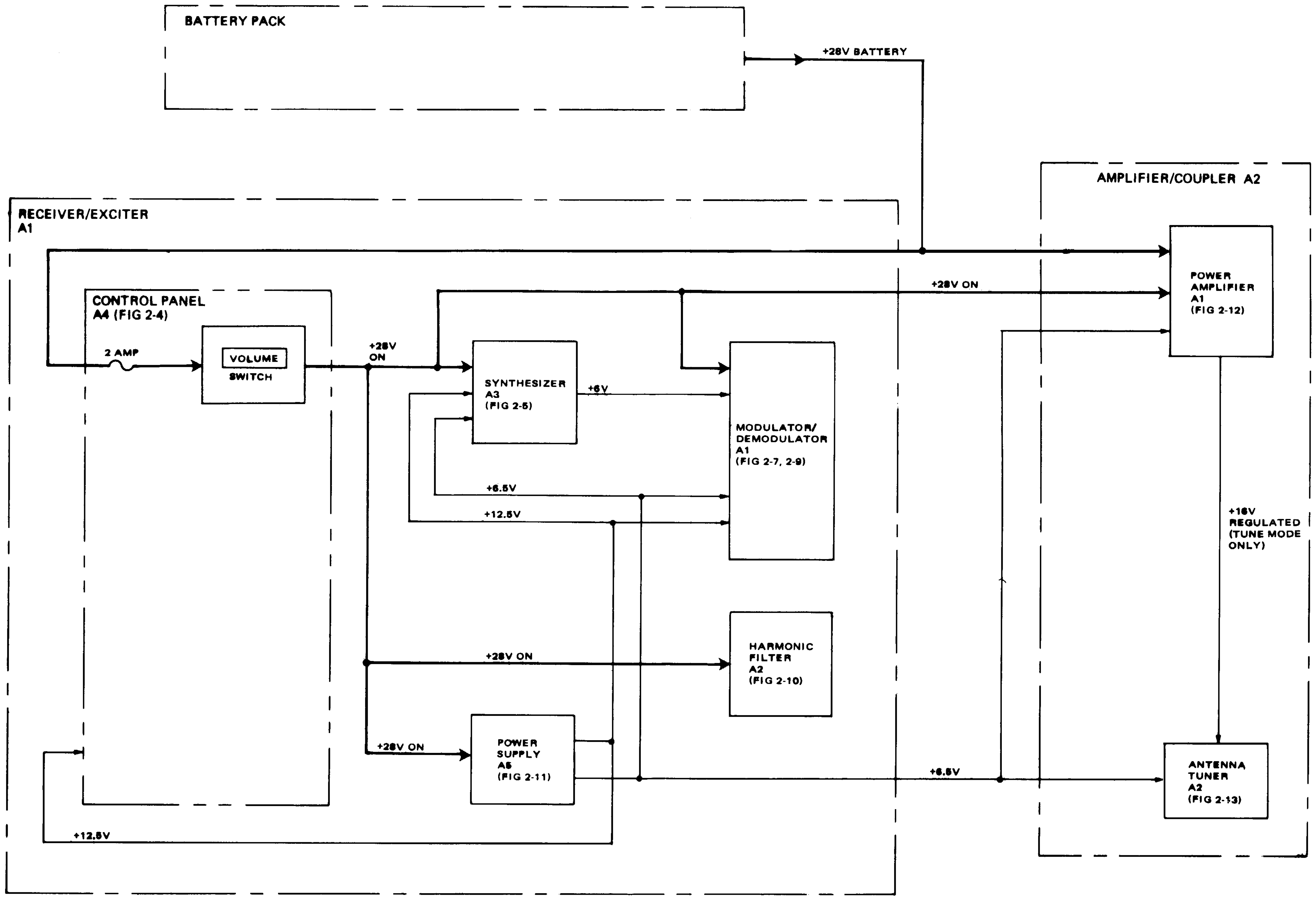


Figure 2-3. Power Distribution System

SECTION III

DETAILED FUNCTIONAL DESCRIPTION

2-40. RECEIVER/EXCITER.

2-41. CONTROL PANEL (Figure 2-4).

2-42. General. The control panel contains the operational controls of the radio set. Audio input/output connectors J1 and J2 are also provided to permit connecting audio devices selected by the operator. The control panel provides the following controls.

2-43. FREQUENCY KHZ Switches (right half of figure). The FREQUENCY KHZ switches S1 thru S6 produce a binary-coded-decimal (bed) output which controls the radio set operating frequency. Bcd is a 4-digit binary code, where 0000=0, 0001=1, 0010=2, ..., 1001=9. Frequency Select signals are sent to the synthesizer to determine the frequency of the 75-105 MHz LO signal. Filter Select signals are applied to the harmonic filters to select the proper band-pass filter for the operating frequency. A frequency change (AF) signal is generated each time a new operating frequency is selected. The AF signal indicates to the modulator/demodulator that a new frequency has been selected, initiating a tune start to the antenna tuner and the synthesizer.

2-44. Frequency Select Signals. Frequency Select signals for 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz, and 10 MHz are routed from the frequency select switches to the synthesizer. The 1- and 10-MHZ signals are also routed to the antenna tuner which uses them in the automatic impedance-matching process. Tables 2-1 and 2-2 list the bed logic for FREQUENCY KHZ switches S1 and S2 thru S6, respectively.

TABLE 2-1. FREQUENCY KHZ SWITCH S1 BCD LOGIC

Dial Setting	Output Pin					
	2	1	x	A	B	c
0	0	0	-	0	nc	1
1	0	1	-	1	nc	1
2	1	0	-	1	nc	0

1 = +12V

0 = gnd

- = normally open; momentarily gnd when switch is changed

TABLE 2-2. FREQUENCY KHZ SWITCHES S2 THRU S6 BCD LOGIC

Dial Setting	Output Pin 8	4	2	1	X
0	0	0	0	0	
1	0	0	0	1	
2	0	0	1	0	
3	0	0	1	1	
4	0	1	0	0	
5	0	1	0	1	
6	0	1	1	0	
7	0	1	1	1	
8	1	0	0	0	
9	1	0	0	1	

1 = +12V

0 = gnd

= normally open; momentarily gnd when switch is changed

2-45. Harmonic Filter Select Signals. Filter Select signals for the 2-3 MHz, 3-5 MHz, 5-8 MHz, 8-12 MHz, 12-20 MHz and 20-30 MHz Bands are developed by frequency select switches S1 and S2 and selector decoder multiplexer U1 and U2. The selector decoder logic for U1 is described in table 2-3, and for U2 in table 2-4.

2-46. The emitters (E) of the 2-3 MHz, 3-5 MHz, and 5-8 MHz band switches Q1, Q2 and Q3 are controlled by 2-7 MHZ Band Switch Enable from frequency select switch S1. When a frequency of 2 to 7 MHz has been selected on the control panel, the 2-7 MHz Band Switch Enable (grid) is applied to the emitters (E) of band switches Q1 thru Q3. The 2 MHz thru 7 MHz Select signal corresponding to the selected dial setting is applied to the appropriate band switch base (B). This sets the desired band control line on the collector (C) to ground. The emitters (E) of the 8-12 MHz and 12-20 MHz band switches, Q4 and Q5, are tied to ground and will apply a ground on their band control line whenever an 8-11 MHz or 12-19 MHz Select signal (1=+12v) is applied to their base.

2-47. Table 2-5 lists the operating frequency of the radio set, and-lists the selected band switch and filter select output for each frequency.

Figure 2-4. Control Panel A1A4 Functional Block Diagram

TABLE 2-3. SELECTOR DECODER U1 LOGIC

Input Pin				Output Pin							
11	10	9	6	13	14	15	12	1	5	24	
0	0	0	0	1	0	0	0	0	0	0	0
1	0	0	0	0	1	0	0	0	0	0	0
0	1	0	0	0	0	1	0	0	0	0	0
1	1	0	0	0	0	0	1	0	0	0	0
0	0	1	0	0	0	0	0	1	0	0	0
1	0	1	0	0	0	0	0	0	1	0	0
0	1	1	0	0	0	0	0	0	0	1	0
1	1	1	0	0	0	0	0	0	0	0	1
X	X	X	1	0	0	0	0	0	0	0	0

1 = +12v

0 = gnd

X = no effect

TABLE 2-4. SELECTOR DECODER U2 LOGIC

Inputs					outputs	
1	4	2	6	5	7 (when tied to 15)	9
0	0	0	x		0	0
0	0	1	X		1	0
1	0	X	0		0	1
1	0	X	1		1	0
0	1	X	X		0	0
1	1	X	X		0	0

1 = +12v

0 = gnd

X = no effect

TABLE 2-5. FILTER SELECT LOGIC

Operating Frequency (MHz)	S1 Dial Setting	S2 Dial Setting	Band Switch Selected	Control Line output
0	0	0		
1	0	1		
2	0	2	Q1	2-3 MHz Band
3	0	3	Q2	3-5 MHz Band
4	0	4	Q2	3-5 MHz Band
5	0	5	Q3	5-8 MHz Band
6	0	6	Q3	5-8 MHz Band
7	0	7	Q3	5-8 MHz Band
8	0	8	Q4	8-12 MHz Band
9	0	9	Q4	8-12 MHz Band
10	1	0	Q4	8-12 MHz Band
11	1	1	Q4	8-12 MHz Band
12	1	2	Q5	12-20 MHz Band
13	1	3	Q5	12-20 MHz Band
14	1	4	Q5	12-20 MHz Band
15	1	5	Q5	12-20 MHz Band
16	1	6	Q5	12-20 MHz Band
17	1	7	Q5	12-20 MHz Band
18	1	8	Q5	12-20 MHz Band
19	1	9	Q5	12-20 MHz Band
20	2	0		20-30 MHz Band
21	2	1		20-30 MHz Band
22	2	2		20-30 MHz Band
23	2	3		20-30 MHz Band
24	2	4		20-30 MHz Band
25	2	5		20-30 MHz Band
26	2	6		20-30 MHz Band
27	2	7		20-30 MHz Band
28	2	8		20-30 MHz Band
29	2	9		20-30 MHz Band

Note 1: No output is selected for a frequency of less than 2 MHz.
Note 2: The 20-30 MHz Band is a direct output of S1.

2-48. Frequency Change. The frequency change (ΔF) signal is generated each time a new operating frequency is selected. The AF signal is momentary 0 (grid) during each change in setting of the frequency select switches S1 thru S5. AF is not generated by S6. The AF signal indicates to the modulator/demodulator that a new frequency has been selected.

2-49. Volume off/max (left half of figure). The VOLUME OFF/MAX S9 is a conventional on/off switch and potentiometer. The switch, when closed, applies +28v On power from the battery pack to the MODE, SB, and LIGHT switches on the control panel, and to all radio set circuits. The potentiometer R1 controls the level of Rcv Audio developed by the modulator demodulator by tapping off a portion of the audio (from the VOLUME control) back to the modulator/demodulator.

2-50. Mode. The MODE (mode select) switch S8 provides both a +28v Xmt Enable and/or a Data Enable signal to the modulator/demodulator. The Xmt Enable signal (V-TR and D-TR) permits Xmt RF to be generated by the modulator/demodulator when the modulator is keyed. The Data Enable signal (D–TR) indicates to the modulator/demodulator that a data transmission has been selected. The modulator/demodulator will cause the receiver agc time constant to be shortened. When a voice receive (V-RCV) or data receive (D-RCV) has been selected, the +28v Xmt Enable signal is inhibited, preventing transmission (receive operation only).

2-51. Sideband Select. The SB (sideband select) switch S7 applies either an upper (USB-open) or lower (LSB +28v) Sideband Select signal to the synthesizer. The signal is used to switch the 70/80 MHz LO to provide either upper or lower single sideband operation.

2-52. Light The LIGHT switch S10 is a press-and-hold switch which applies +28v On to panel lights DS1 thru DS6. When the LIGHT switch is released, the panel lights extinguish.

2-53. Audio Input/Output Connectors. The audio connectors J1 and J2 enable the operator to connect a handset or headset and microphone combination to the radio set. A CW telegrapher’s key can be substituted for the microphone for code operation.

2-54. Handset or Headset and Microphone Operation. When a handset or headset and microphone are used in conjunction with the radio set, they are connected to the control panel by audio input/output connectors J1 and J2. The push-to-talk (PTT) signal and the Xmt Audio are routed through the low-pass L-C filter networks contained in the audio filter to the modulator/demodulator. The audio filter rejects any rf which is picked up by the cables leading to the radio set from the microphone or handset. The PTT is used by the modulator/demodulator to key the modulator for transmit operation. Rcv Audio from the modulator/demodulator is also routed through the audio filter to the handset or headset.

2-55. CW Key. A cw telegrapher’s key is normally used in conjunction with a headset, but can be used with a handset. The cw telegrapher’s key outputs a CW Key signal which is filtered and routed to the modulator/demodulator. The CW Key signal is used by the modulator/demodulator to activate the keyline circuits and internal 1-kHz modulation tone circuits.

2-56. SYNTHESIZER MODULE (Figure 2-5).

2-57. General. The synthesizer provides input to the modulator/demodulator in the form of three high frequency LO signals and one audible tone. The high frequency LO signals are 5 MHz, 70/80 MHz, and 77-105 MHz. The 70-MHz LO signal is outputted if USB is selected and the 80 MHz is outputted if LSB is selected. The frequency of the 77-105 MHz LO signal is 75 MHz above the frequency selected at the control panel. The audible tone (1 kHz) is used in the modulator/demodulator for alarm signals, timing functions, and CW Key operation.

2-58. Transmit/Receive. The module functions identically in either transmit or receive.

2-59. 5-MHz LO. The 5-MHz temperature-compensated crystal oscillator (TCXO) U1 generates the 5-MHz LO signal. The 5-MHz LO is routed to the multiplier U8 and the frequency divider U9 (via amplifier Q3). The 5-MHz LO is also routed to the modulator/demodulator at J3. A11 other frequencies are referenced to the output of this oscillator.

2-60. 70/80-MHz LO. The 5-MHz output of the crystal. oscillator U1 is applied to multiplier U8 where 70-80 MHz harmonics are generated. Narrow bandpass filters FL2A and FL3B pass 70 and 80 MHz, respectively. The peak amplitudes are adjusted in limiter U7 and outputted to three filters (FL2C, FL3A and FL2B). When the LSB +28v select line is at +0v, filter FL2C receives 70 MHz LO. When the LSB +28v is +28v, filter FL3A receives 80 MHz LO. Filter FL2B receives the 70 MHz (whether LSB +28v is on or off) which is used in the 77-105 MHz voltage-controlled oscillator (vCo). The 70 or 80 MHz is routed through power splitting transformer, T2, and impedance matching transformer, T1, to the modulator/demodulator.

2-61. 77-105 MHz LO. The 77-105 MHz LO is discussed in paragraphs 2-62 thru 2-69.

2-62. VCO. The exact frequency of the 77-105 MHz LO can be determined by adding 75,000 kHz to the control panel frequency. This frequency is generated by the VCO U3. The oscillation frequency of the VCO U3 is controlled by the VCO tune voltage (2.6 to 9v). The voltage is linearly proportional to frequency. At 2.6v the VCO output is about 77 MHz, and at 9v it is about 105 MHz. The VCO tune voltage changes when a new frequency is selected at the control panel. The tune voltage is part of a phase-locked loop (PLL) and will stabilize when the VCO oscillates at the selected frequency. For example, at 16 MHz (which is halfway between 2 and 30 MHz), the VCO tune voltage is +5.8v and the LO frequency is 91 MHz.

2-63. Low Frequency PLL. The low frequency reference of the PLL begins with the 5-MHz TCXO. Frequency divider U9 generates two frequency standards, 1 and 10 kHz, from the 5-MHz input. The 1-kHz Standard and the Frequency Select Logic are applied to the low frequency phase lock U5. The low frequency phase lock generates a signal that is between 0.0900 and 0.0999 MHz (0.09XY, where X and Y correspond to 1-kHz and O.1-kHz control panel digits). Table 2-6 lists a few examples. The 0.09XY MHz signal mixes with 70.00 MHz from filter FL2B to produce 70.09XY MHz and 69.91xY MHz. The 69.91xY MHz is filtered out at filter FL1A, leaving the 70.09XY MHz to be amplified at amplifier AR3 and refiltered at filter FL1B. The 70.09XY MHz is then applied to the VCO.

2-64. High Frequency PLL. The 70.09XY MHz enters the VCO U3 where it mixes with the output of the voltage-controlled oscillator (between 77 and 105 MHz). The upper sideband product of the mixing (77-105 + 70.09XY MHz) is filtered out at the band-pass filter L3-7, C18-22. The frequency passing through is 6.91-34.90 MHz. This is approximately 4.91 MHz above the control panel frequency.

2-65. 10-kHz Standard. The 6.91-34.90 MHz signal is routed through prescaler U4 to high frequency loop filter U2. These two circuits work together to divide the 6.91-34.90 MHz input between 691 and 3490 times. After the division, the 6.91-34.90 MHz signal is about 10 kHz, which is phase and frequency-compared against the .10-kHz Standard. Any difference will cause the VCO tune voltage to change.

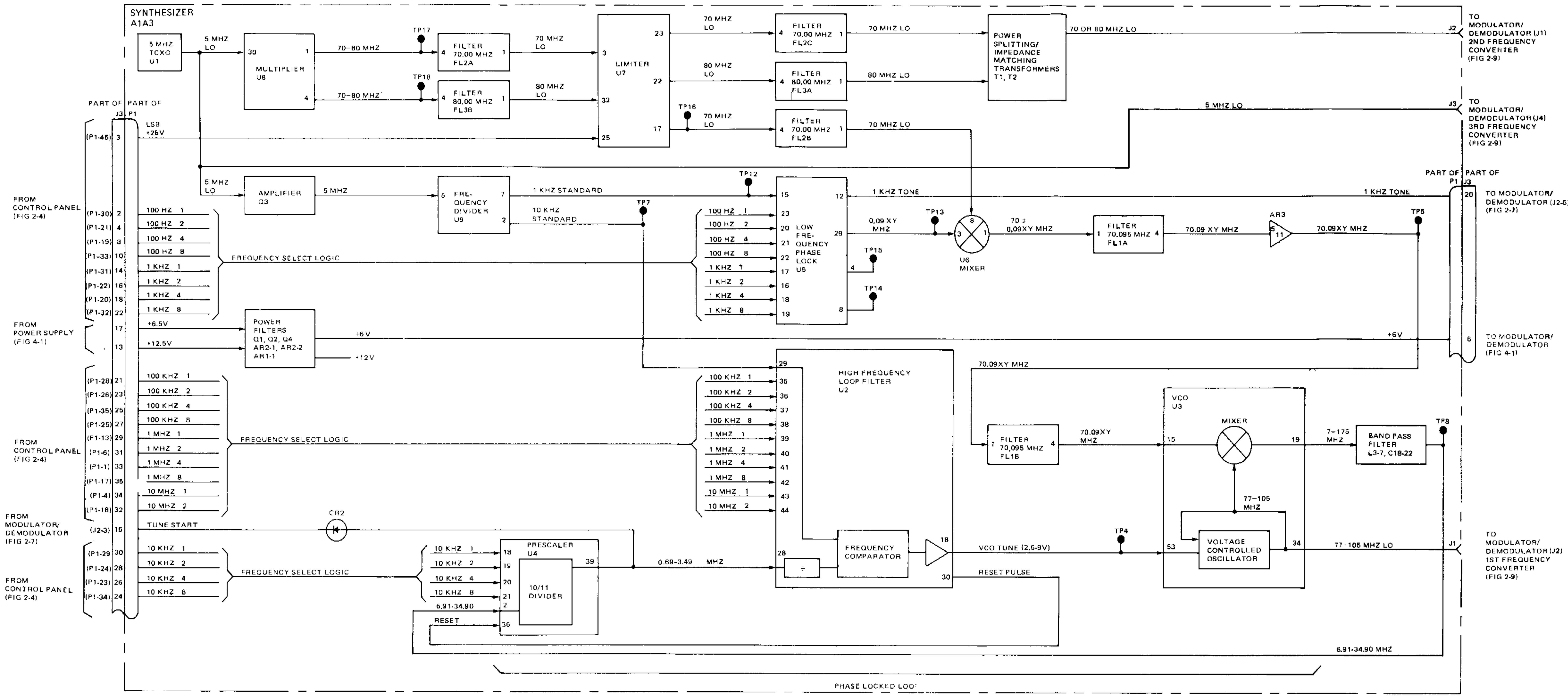


Figure 2-5. Synthesizer A1A3 Functional Block Diagram

TABLE 2-6. LOW FREQUENCY PHASE LOCK (U5)

Input Pin								Control Panel Frequency kHz	output 0.09XY MHz
19	18	16	17	22	21	20	23		
								X.Y	0.090XY
0	0	0	0	0	0	0	0	0.0	0.0900
0	0	0	0	0	0	0	1	0.1	0.0901
0	0	0	0	0	0	1	0	0.2	0.0902
0	0	0	0	1	0	0	1	0.9	0.0909
0	0	0	1	1	0	0	1	1.9	0.0919
0	0	1	0	0	1	0	1	2.5	0.0925
1	0	0	1	1	0	0	1	9.9	0.0999

0 = gnd

1 = open (+12v pullup)

X is the l-kHz digit and Y is the 100-HZ digit on the control panel.

2-66. Prescaler. The effect of the prescaler U4 is to divide the 6.91-34.90 MHz signal by ten and to cancel out the 10-kHz digit setting from the LO. To cancel out the 10-kHz digit setting, prescaler U4 divides by either 10 or 11; that is, it pulses out once for every 10 or 11 pulses in. Table 2-7 summarizes the input and output. For example, If the bcd Frequency Selection Logic is 0011 (correspondeng to 30 kHz on the control panel), prescaler U4 pulses 1:11 four times and by 1:10 for the rest of the frequency input. It pulses 1:11 again four times when it receives a Reset Pulse from the high frequency loop filter U2. The system-level effect of the 10 versus 11 divisions is explained in paragraph 2–68.

TABLE 2-7. PRESCALER DIVISION CODE

Input : Pin				10–KHZ Digit on Control Panel	No. of 1:11 Pulse Ratios. The Remaining Pulse Ratios are all 1:10
21	20	19	18		
0	0	0	0	0	1
0	0	0	1	1	2
0	0	1	0	2	3
0	0	1	1	3	4
0	1	0	0	4	5
0	1	0	1	5	6
0	1	1	0	6	7
0	1	1	1	7	8
1	0	0	0	8	9
1	0	0	1	9	10

1 = open (+12v pullup)

0 = gnd

2-67. High Frequency Loop Filter. High frequency loop filter U2 divides the 0.69-3.49 MHz from the prescaler according to the code on the bcd frequency select pins. Table 2-8 gives a few examples, After the high frequency loop filter U2 has completes its divisions, it sends a Reset Pulse back to prescaler U4. If the VCO is tuned, the 0.69-3.49 MHz signal should be divided to exactly 10 kHz. The divided signal will agree with the 10-kHz Standard and the VCO tune voltage will remain constant. If the divided frequency is below the 10-kHz Standard, it will cause the VCO tune voltage to increase. If the divided frequency is above the 10-kHz Standard, it will cause the VCO tune voltage to decrease.

TABLE 2-8. HIGH FREQUENCY LOOP DIVISION CODE

Input Pin										Control Panel Frequency kHz	No. Divisions
44	43	42	41	40	39	38	37	36	35		
-	-			-	-	-	-	-	-		S1(100) +S2(10) + S 3 + 4 9
0	0	0	0	1	0	0	0	0	0	2,000	69 (20 + 49)
0	1	0	0	0	0	0	0	0	0	10,000	149 (100 + 49)
0	1	0	1	0	1	0	0	0	1	15,100	200 (151 +49)
0	1	0	1	1	0	0	0	0	0	16,000	209 (160 + 49)
1	0	1	0	0	1	1	0	0	1	29,900	348 (299 + 49)

0 = ground — S1 is 10-MHZ digit, S2 is 1-MHz digit, and

1 = open (+12v pullup) — S3 is 100-kHz digit on the control panel

2-68. Example - Steady State Operation of 77-105 MHz LO With FREQUENCY KHZ Set to 15,184.3. This example summarizes the operation of the 77-105 MHz LO. Table 2-9 lists the equations from which any FREQUENCY KHZ setting can be figured.

1. The output of the LO is 75,000.0 kHz above the FREQUENCY KHZ setting. This is 15,184.3 kHz plus 75,000.0 kHz or 90,184.3 kHz.

2. The output of the low frequency phase lock is 90.0 kHz above the XY (4.3 kHz digits). This is 90.0 plus 4.3 kHz or 94.3 kHz.

3. The output of the mixer U6 is 70,000 kHz plus or minus 94.3 kHz. The filtered product which reaches the VCO at pin 15 is 70,000 kHz plus 94.3 kHz or 70,094.3 kHz.

4. The output of the mixer within the VCO U3 is 90,184.3 kHz (the LO) plus or minus the 70,094.3 kHz from the mixer U6). The minus product reaches the prescaler U4 at 0,090.0 kHz. Note that the XY (4.3) kHz digits have been mixed out by the correct LO output. In addition, the prescaler input is always 4.91 MHz above the FREQUENCY KHZ setting. So 2.000 MHz

plus 4.91 MHz is 6.91 MHz, and 29.9999 MHz plus 4.91 MHz is 34.90 MHz.

5. Table 2-7 indicates that the prescaler will pulse at a 1:11 ratio nine times and then pulse at a 1:10 ratio the remaining times before it is reset. The high frequency loop filter will send one reset pulse back to the prescaler for every 200 pulses (see table 2-8, number of divisions) it receives from the prescaler. This means that the prescaler will pulse 1:11 nine times and 1:10 191 times. So, for the first 2009 pulses which enter the prescaler, 200 pulses will reach the high frequency loop filter. This is repeated for the remainder of the 20,090,000 pulses (corresponding to 20,090,0 kHz) until 2,000,000 pulses reach the high frequency loop filter.

6. Table 2-8 indicates that the divide counter inside the high frequency loop filter will divide by 200. The 2,000,000 pulses will be divided to 10,000 pulses, which corresponds to 10 kHz. This will match the 10-kHz Standard and the VCO tune voltage will remain constant.

7. The approximate VCO tune voltage can be determined from the slope formula

$$g = mP+b$$

where

g = the VCO tune voltage

m = 6.4/28.,000
· 2.29×10^{-4}

P = frequency kHz = 15,184.3

b = +2.13v

In this case, the VCO tune voltage is +5.6v.

8. Since the VCO tune voltage is constant, the voltage controlled oscillator will continue to oscillate at 15,164.3 kHz, which is the LO output.

TABLE 2-9. EQUATION SUMMARY

Component	Pin	Formula
1. VCO, U3, LO	34	P kHz + 75,000 kHz = a
2. Low Frequency Phase Lock, U5	29	S6 (.1) kHz + S5 kHz + 90.0 kHz = b
3. Mixer U6	1	b kHz + 70,000 = C
4. VCO, U3, mixer	19	a kHz - C kHz = d kHz = P MHz + 4.91 MHz
5. Prescaler, U4	39	(d kHZ - (S4 + 1) 10 kHz)/10
6. High Frequency Loop Filter U2, divide number	...	(S1 (100) + S2 (10) + S3) + 49
7. High Frequency Loop Filter U2, VCO tune voltage	18	g = mP + b = VCO tune voltage b = +2.13 m = 2.29×10^{-4}

Where
P is the control panel frequency in kHz.
S1 is the 10-MHZ digit (1)
S2 is the 1-MHz digit (5)
S3 is the 100-kHz digit (1)
S4 is the 10-kHz digit (8)
S5 is the 1-kHz digit (4)
S6 is the 100-HZ, digit (3)

2–69. Tune Start. The Tune Start signal form the modulator/demodulator momentarily grounds the 0.69-3.49 MHz Line. The divided frequency at the high frequency loop no longer equals 10,000 Hz. The VCO tune voltage increases, causing the LO output to shift. Eventually, a new steady-state LO frequency is reached.

2-70. 1-kHz Tone. The 1–kHz Standard developed at the frequency divider U9 is routed to low frequency phase lock U5. The low frequency phase lock U5 filters the 1-kHz Standard, and routes the 1-kHz Standard to the modulator/demodulator.

2-71. Power Filters. The +12.5 and +6.5v from the power supply is given additional filtering at power regulator AR2-1, AR2–2, Q1 and Q2. The +12.0 and +6.Ov are distributed within the synthesizer. The +6.Ov is also applied to the modulator/demodulator. The chip supply voltage for operational amplifiers AR2-1 and AR2-2 is provided by transistor Q4, which is controlled by operational amplifier AR1-1.

2-72. MODULATOR/DEMODULATOR (Figure 2-6).

2-73. General. The modulator/demodulator performs audio-to-radio frequency conversion. It also coordinates other functions, such as level control, gain controls, fault signals and tuning initialization. The modulator/demodulator contains the frequency converters and the audio control hybrid. The frequency converters are controlled by the audio control hybrid. The Keyline signal from the audio control hybrid, and the +28v Xmt Enable from the control panel, determine whether the radio set is in transmit or receive operation.

2-74. Transmit Operation. In transmit operation, the Keyline signal and +28v Xmt Enable are routed to the frequency converters, enabling the transmit circuits. The Xmt Audio is then processed by the audio control hybrid and sent to the frequency converters. The frequency conversers translate the Xmt Audio freuency into two intermediate frequencies (if.) and then into Xmt RF. The Xmt RF is then routed to the power amplifier for further amplification.

2-75. Receive Operation. In receive operation, the absence of the Keyline signal places the frequency converters into receive mode. During receive operation, the frequency converters extract the Rcv Audio frequency from the incoming RF Signal (demodulation). The audio control hybrid processes the Rcv Audio and routes it to the control panel.

2-76. Audio Control Hybrid (Figure 2-7).

NOTE

The audio control hybrid is not repairable but the block diagram (figure 2-7) is necessary to understand the function. Therefore, no circuit designators are given.

2-77. General. The audio control hybrid contains the control circuits required by the modulator/demodulator to control and process the Xmt and Rcv Audio. The hybrid also generates Tune Start, Power Amplifier (PA) On/Off (not used in PRC-104; used with AM-6879/URC) and Keyline signals.

2-78. Transmit Operation. Xmt Audio is received from the control panel and routed through the microphone/data attenuator switch to the transmit audio amplifier. When in voice mode, the Xmt Audio is not attenuated. In data mode, the data Xmt Audio is attenuated by the microphone/data attenuator switch. The transmit audio amplifier is a three-stage differential amplifier with an agc feedback loop consisting of the transmit output level adjust and a gain control amplifier. The gain control amplifier tries to maintain a constant output with a varying input. The output of the transmit audio amplifier is routed to the third frequency converter for further processing and to the sidetone level adjust for use in sidetone operation.

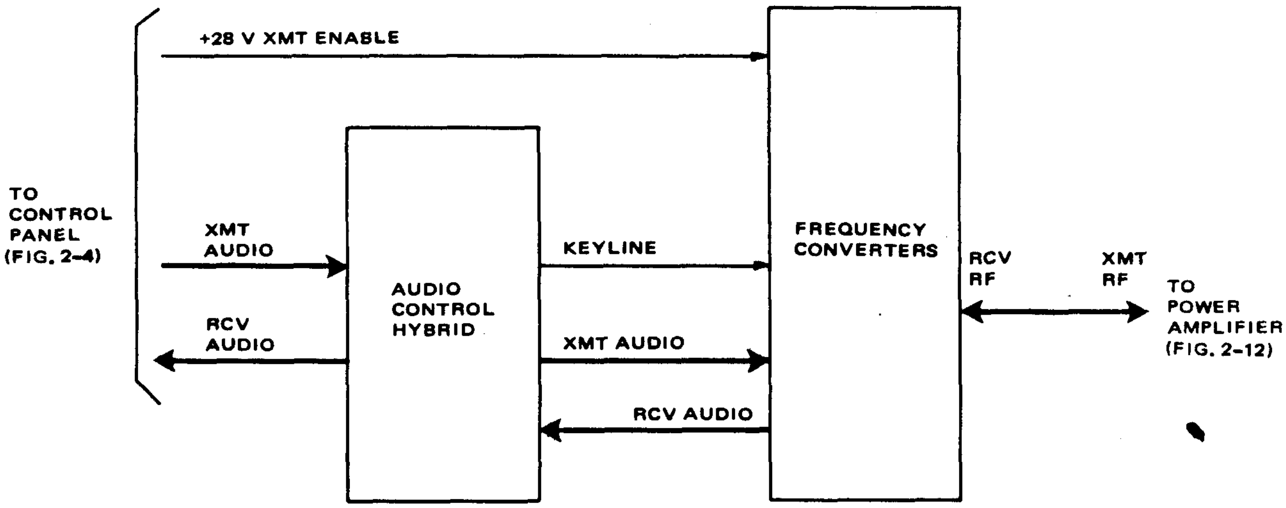


Figure 2-6. Modulator/Demodulator A1A1 Functional Block Diagram

Figure 2-7. Audio Control Hybrid A1A1A4 Functional Block Diagram

2-79. Voice Transmission. When voice transmission (V-TR) has been selected on the control panel and a handset (or headset) is used, the Xmt Audio is routed through the collector to the emitter of the microphone switch and to the transmit audio amplifier. No attenuation takes place.

2-80. CW Key Transmission. When V-TR has been selected on the control panel and a telegrapher's key is used, the transmit audio amplifier is bypassed. The 1-kHz tone is received from the synthesizer and routed through the 1-kHz tone level adjust and applied to the 1-kHz electronic switch. When the CW Key signal is applied to the 1-kHz electronic switch from the control panel, the 1-kHz tone is routed through the electronic switch to the third frequency converter and to the sidetone level adjust. The 1-kHz tone is present whenever the telegrapher's key is pressed (CW Key 0). The 1-kHz electronic switch operates in the same manner during Tune In Progress to generate the Tune In Progress tone. Table 2-9A describes the logic for the 1-kHz electronic switch.

TABLE 2-9A. 1-KHZ ELECTRONIC SWITCH LOGIC

Input		1-kHz Switch Results
CW	Tune In Progress	
1	1	Open
0	1	Closed
1	0	Closed
0	0	Closed

0 = gnd

1 = open

2-81. Data Transmission. When data transmission (D-TR) has been selected on the control panel, Data Enable enables the microphone attenuator control, and the Xmt Audio is routed through the attenuator of the microphone attenuator switch. The Xmt Audio is attenuated to -36 dbm when the input is 0 dbm. Refer to table 2-10 for microphone/data attenuator switch logic.

TABLE 2-10. MICROPHONE/DATA ATTENUATOR SWITCH LOGIC

Input Data Enable	Transmit Audio
0	Not attenuated
1	Attenuated

2-82. Receive Operation. Rcv Audio iS received from the third frequency converter and routed to the agc buffer and the receive audio amplifier. The Rcv Audio input level is controlled by Rcv Audio level adjust R12. The output of the agc buffer (a voltage follower) is routed to the agc generator in the third frequency converter. The Rcv Audio is routed through the receive audio amplifier to the control panel. The level of the Rcv Audio output of the receive audio amplifier is controlled by the level of the signals which are routed through one of the following switches: audio-electronic switch, data electronic switch, and sidetone electronic switch.

2-83. Voice and CW Operation. During voice or cw operation, the audio electronic switch is closed, routing the audio From Vol control Wiper to one of the differential inputs of the first stage of the receive audio amplifier. This signal controls the level of Rcv Audio frequency. Table 2-11 describes the audio electronic switch logic.

TABLE 2-11. AUDIO ELECTRONIC SWITCH LOGIC

Input Data Enable	Voice Switch
0	Closed
1	Open

2-84. Data Operation. During data operation, Data Enable from the control panel opens the audio electronic switch and closes the data electronic switch. The To Vol Control signal is routed through the data level adjust to the input stage of the receive audio amplifier. This signal controls the level of Rcv Audio. Refer to table 2-12 for data electronic switch logic.

TABLE 2-12. DATA ELECTRONIC SWITCH LOGIC

Input Data Enable	Data Switch Results
0	Open
1	Closed

2-85. Sidetone Operation. During transmit operation, the Xmt Audio is routed through the sidetone level adjust to the sidetone electronic switch. Sidetone Enable from the power amplifier closes the sidetone electronic switch, and a portion of the Xmt, Audio is routed to the receive audio amplifier. Table 2-13 describes the sidetone electronic switch logic.

TABLE 2-13. SIDETONE ELECTRONIC SWITCH CONTROL

Input Sidetone Enable	Sidetone Switch Results
1	Open
0	Closed

2-86. Tune Start (ΔF). The tune start logic is enabled:

1. When the radio is first turned on.
2. When the FREQUENCY KHZ settings (except for 100 Hz) are changed on the control panel.
3. By the +28v Xmt Enable signal when the mode switch is reset to voice transmit or data transmit.

The output of the tune start logic is applied to the tune start control which causes tune start switch Q1 to close, routing the Tune Start signal to the power amplifier, antenna tuner, and the synthesizer. The Tune Start signal will be on (a ground) for a period of 65 milliseconds.

2-87. Tune Fault/Low Voltage Fault. The tune fault generator generates a Tune Fault signal (repetitive beep) when a Tune Fault signal is received from the antenna tuner. The low voltage fault generator generates a Low Voltage Fault tone (repetitive click) when the +28v On from the control panel drops below +20v. The outputs of the tune and low voltage fault generators are routed through the receive audio amplifier to the control panel and then to the handset.

2-88. Keyline. The Keyline logic signal is generated by:

1. +28v Xmt Enable signal (MODE switch on control panel set to V-TR or D-TR) and PTT signal from the handset or headset.
2. +28v Xmt Enable signal and CW Key signal from telegrapher's key.

The keyline logic is inhibited by the Tune Fault signal. If not inhibited, the keyline logic signal from the Keyline Control causes Keyline Switch Q4, Q5 to switch, routing the keyline signal to the first, second, and third frequency converters and the power amplifier.

2-89. 100 μF Switch. When Data Enable is received from the control panel, the 100 μF switch switches a 100-microfarad capacitor out of the third converter circuits. The frequency converter uses the 100-microfarad capacitor for agc release time constant. In voice mode, the agc release time is about 1 second and in data mode it is 0.1 second.

2-90. ALC Feedback (Figure 2-8). The ALC In signal is routed from both the power amplifier and antenna tuner. The power amplifier samples the VFWD from the harmonic filter and compares it against a +14.5v reference. The +14.5v corresponds to a 20-watt radio output. When the VFWD exceeds the +14.5v reference, the ALC voltage rises. The audio control hybrid reduces the output of the second converter at a rate of 8 db/v ALC In. The maximum ALC voltage is +6v, which corresponds to more than a 40-db reduction of the second converters's output power. The antenna tuner samples the radio set output in the tune mode (via the rf sensor bridge) and compares it against a +2.74v reference. The +2.74v indicates a 2-watt radio output from the rf sensor bridge. The audio control hybrid reduces the gain as above.

2-91. ALC In (Figure 2-7). In the audio control hybrid A4, the ALC In is routed to the ALC Off/On. The reference voltage from the ALC offset adjust determines the threshold at the ALC amplifier. The time constant of the ALC amplifier output is adjusted by the ALC time constant switch. This occurs when the antenna tuner applies a Tune In Progress signal to the ALC time constant switch.

2-92. PA OFF/ON Control. Table 2-14 describes the PA OFF/ON control logic. The PA OFF/ON control is used with other configurations of the receiver/ exciter, but not the AN/PRC-104.

TABLE 2-14. PA OFF/ON CONTROL LOGIC

Input +6.5v Transmit Enable	PA OFF/ON Control Result
1	ON - (3.5 ma)
0	OFF - (0 ma)

2-93. Frequent y Converters (Figure 2-9).

2-94. Third Converter A3. In transmit operation, relays K1 and K2 are energized by the +28v Xmt Enable and by the Keyline ground signal. This permits the Xmt Audio to be mixed with the 5-MHz LO (amplified by Q1) at mixer U4 via the energized contacts (3-2) of K2. The 5-MHz mixing product goes to the sideband filter FL2 via the energized contacts (7-8) of relay K2 and contacts (7-8) of relay K1. The energized contacts (2-3) of relay K1 also route +12.5v to the first converter. The +12.5v Xmt also turns switch Q6 on, which causes +6.5v Xmt to be applied to the second converter A2 and the audio control hybrid, A4. In receive operation, the relays are not energized so the 5-MHz if. goes through amplifiers U1 and U2 and +12.5v is applied to Zener diode VR1 (which breaks down at +6.5v). The gain of the 5-MHz if. is controlled at U2 and U1 by the agc voltage from the agc generator U3. This agc voltage is also applied to the second frequency converter via FET Q7; FET Q7 conducts when the +12.5v Xmt enable is absent at the gate (G). The agc generator, in turn, is controlled by the Rcv agc receive audio signal from the audio hybrid. A portion of the agc Receive Audio becomes the To Vol Control signal which is fed back to the audio control hybrid to control the output of the receive audio amplifier. In data mode, a 100-microfarad capacitor is switched out, which shortens the time constant on the agc generator output. Finally, the 5-MHz if. mixes with the 5-MHz LO to create the audio frequency and upper sideband mixing product at mixer U4.

2-95. Sideband Filter FL2. The crystal filter functions identically in receive and transmit operation. The filter rejects frequencies other than 4.9970 to 409997 MHz.

2-96. Second Converter. In transmit operation, relay K1 is energized by the +28v Xmt Enable and by the Keyline signal. The 5-MHz if. goes through matching transformer T1 and to amplifier U2; the level (amplitude) of the entire modulator/demodulator transmit output is controlled at this amplifier by the ALC signal from the audio control hybrid A4 and by the presence of the +6.5 Xmt Enable signal. The 5-MHz if. is applied to mixer U4 where it mixes with the 70/80 MHz LO. (The 70/80-MHz Lo has

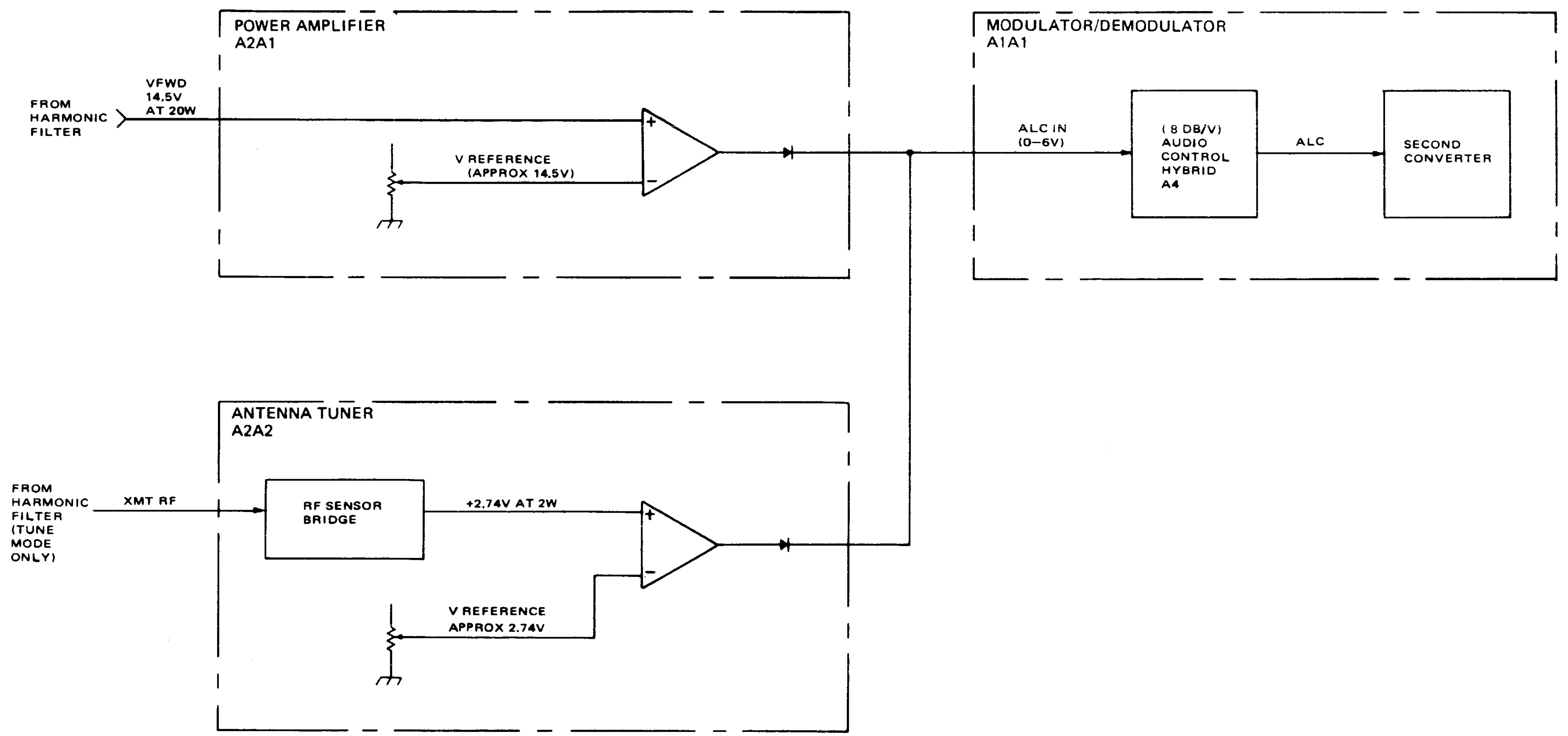


Figure 2-8. ALC Feedback Diagram

Figure 2-9. Frequency Converter A1A1A1, A1A1A2, A1A1A3, Functional Block Diagram

been previously amplified at amplifier U1.) This results in a 75-MHz mixing product (either 75 plus 65 MHz or 75 plus 85 MHz). The 75-MHz mixing product is routed through energized contacts 8-7 of relay K1, through amplifier Q1, T3 and back through energized contacts 3-2. The 75-MHz mixing product is routed to bandpass filter FL1. In receive mode, the 75-MHz if. passes through deenergized contacts (2-4-7) of relay K1, through amplifier Q1 and back through contacts 3-6-8. The 75-MHz if. mixes with the 70/80-MHz LO at mixer U4. The 5-MHz mixing product goes through amplifier Q2, T4 and isolation transformer T5. The FET Q3 and amplifier U3 control the gain of the 5-MHz mixing product. The control signal is applied from the agc generator U3 in the third converter. Finally the 5-MHz mixing product is routed to pin 29 to the sideband filter FL2.

2-97. Bandpass Filter FL1. The filter functions identically in receive and transmit operation. The filter rejects frequencies other than 75 MHz, ±]15 kHz.

2-98. First Converter. In transmit operation, relay K1 is energized by the +28v Xmt Enable and by the Keyline ground signal. The 75-MHz if. goes to mixer U2 where it mixes with the 77-105 MHz LO. (The 77-105 MHz LO has been previously amplified at amplifier U1.) This results in the rf mixing product (2-30 MHz and 152-180 MHz). The rf mixing product is routed through energized contacts 8 and 7 of relay K1 Lo the 2-30 MHz amplifier Q1 thru Q3, T1 thru T6 where it is boosted to 0.25 watt. The frequency component above 30 MHz is not amplified. The +12.5v Transmit from the third converter powers this amplifier. The rf mixing product goes through energized contacts 3 and 2 of relay K1 to the output jack, J3. In receive operation, the 2-30 MHz rf is routed through contacts 2, 4, 6 and 8 of relay K1 to mixer U4. The 2-30 MHz rf mixes with the 77-105. MHz LO to produce a 75-MHz mixing product.

2-99. HARMONIC FILTER (Figure 2-10).

2-100. <u>General Transmit Operation</u>. The harmonic filter suppresses transmitter harmonics and noise levels outside of the selected frequency band.

2-101. <u>Bandpass Filter Selection</u>. The selection of one of six bandpass filters, FL1 thru FL6, is controlled by the filter select Band signals from the control panel. The filter select signal (grid) is applied directly to the relays of the selected bandpass filter to provide a return path for the relay solenoid. The following chart lists the filter select Band signal and the filter selected by the signal. For example, the 2-3 MHz Band Select signal selects FL6 between 2,000 kHz and 2,999 kHz.

Filter Select Signal	Selected Filter
20-30 MHz Band	FL1
10-20 MHz Band	FL2
8-12 MHz Band	FL3
5-8 MHz Band	FL4
3-5 MHz Band	FL5
2-3 MHz Band	FL6

2-102. Transmit/Receive RF Processing. Xmt RF from the power amplifier is routed through the energized contacts of relay K1 of the selected filter via the filter network and through the rf low pass filter and the rf detector to the antenna tuner. The rf low pass filter is an L-C filter network which improves the high frequency suppression (above 30 MHz) of the selected bandpass filter. The rf detector generates dc voltages proportional to the forward power (VFWD) and the reflected power (VREFL).

2-103. Receive Operation. Receive operation is in the reverse direction: from the antenna tuner through the rf detector and rf low pass filter, and through the energized contacts of the selected filter to the power amplifier.

2-104. POWER SUPPLY (Figure 2-11).

2-105. General. This module converts +28v from the battery (via the control panel) to +6.5v and +12.5v for use by the other modules.

2-106. Down Switching. The actual conversion from +28v to +12.5v/+6.5v is performed by the down switchers U3 and U4 shown in the detail of figure 2-11. A transistor switch (Q) is driven on and off at a switching frequency of approximately 77 kHz. When the switch (Q) is closed, current flows through the inductor (L) and charges the capacitor (c). When the switch opens, the energy stored in the inductor (L) is transferred into the capacitor (C) via the diode (D). The voltage on the capacitor (C) is determined by the ratio of closed to open time of the switch (Q). The switch (Q) and diode (D) are integrated parts of switching regulators U3 or U4. The other elements are discrete.

2-107. Switching Frequency. The voltage feedback from the +12.5v or +6.5v output modulates the on/off periods of timers U1 and U2, respectively. That is, if the load is small, the capacitor will charge easily and cut the slave timer off. Conversely, if the load is large, the slave timers U1 and U2 will stay on (low) for a longer interval.

2-108. Overload Latch. The overload latch circuit Q1, Q2 will shut the slave timers U1 and U2 off if an abnormally large load should appear. The large current flow through R3 will turn Q1 on which will then turn Q2 on, which then causes Q1 to latch on. A large voltage then appears on the Voltage Feedback line and turn U1 and U2 off. The power supply remains off until the +28v input is removed momentarily by switching the radio off and then back on:

2-109. AMPLIFIER/COUPLER UNIT.

2-110. POWER AMPLIFIER (Figure 2-12).

2-111. General. The power amplifier boosts the 0.25-watt (nominal) output from the modulator/demodulator to provide 20 watts (nominal) rf power at the antenna. The module also contains temperature compensation and overpower protection circuits which prevent damage in the event of a malfunction. In addition, the regulated power supply for the antenna tuner relays is in this module.

2-112. Transmit/Receive Operation. In transmit operation, relays K1 and K2 are energized by the Keyline signal from the modulator/demodulator. These relays switch the amplifiers into the rf path in the transmit mode. They also cause +28v Battery to be switched into the system as +28v Battery Xmt. When +28v Battery Xmt is present, switch Q13 conducts and applies +6v Transmit to various circuits. In receive operation, the relays are deenergized and the rf bypasses the amplifiers.

2-113. RF Preamplification. The driver stage (T1, Q3, Q6, T2) amplifies the 0.25-watt Xmt RF to about 2 watts using a push-pull amplifier configuration (basically two transistors Q3, Q6 with input and output transformers T1, T2). This stage is powered by +28v Battery. The amplification of this

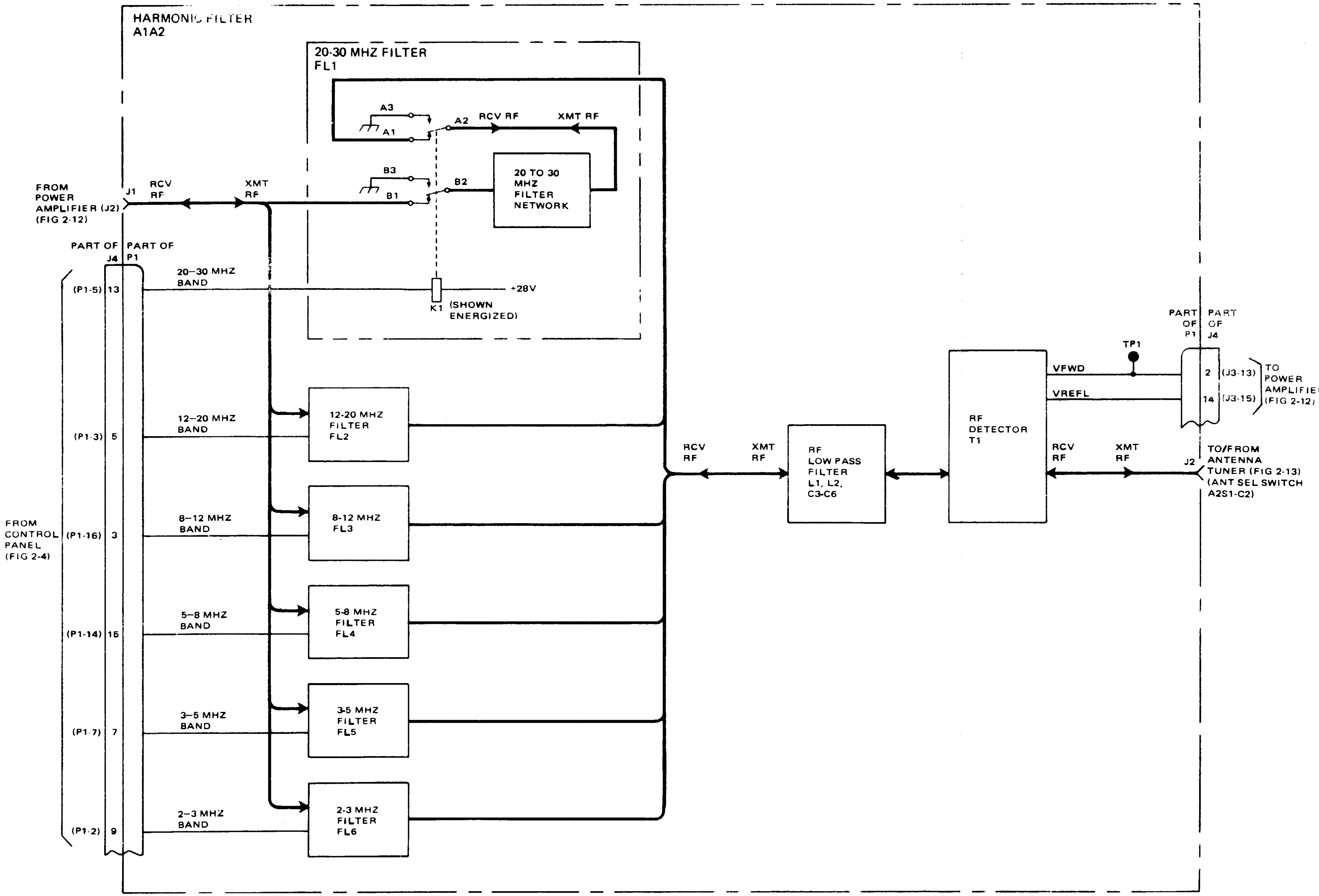


Figure 2-10. Harmonic Filter A1A2 Functional Block Diagram

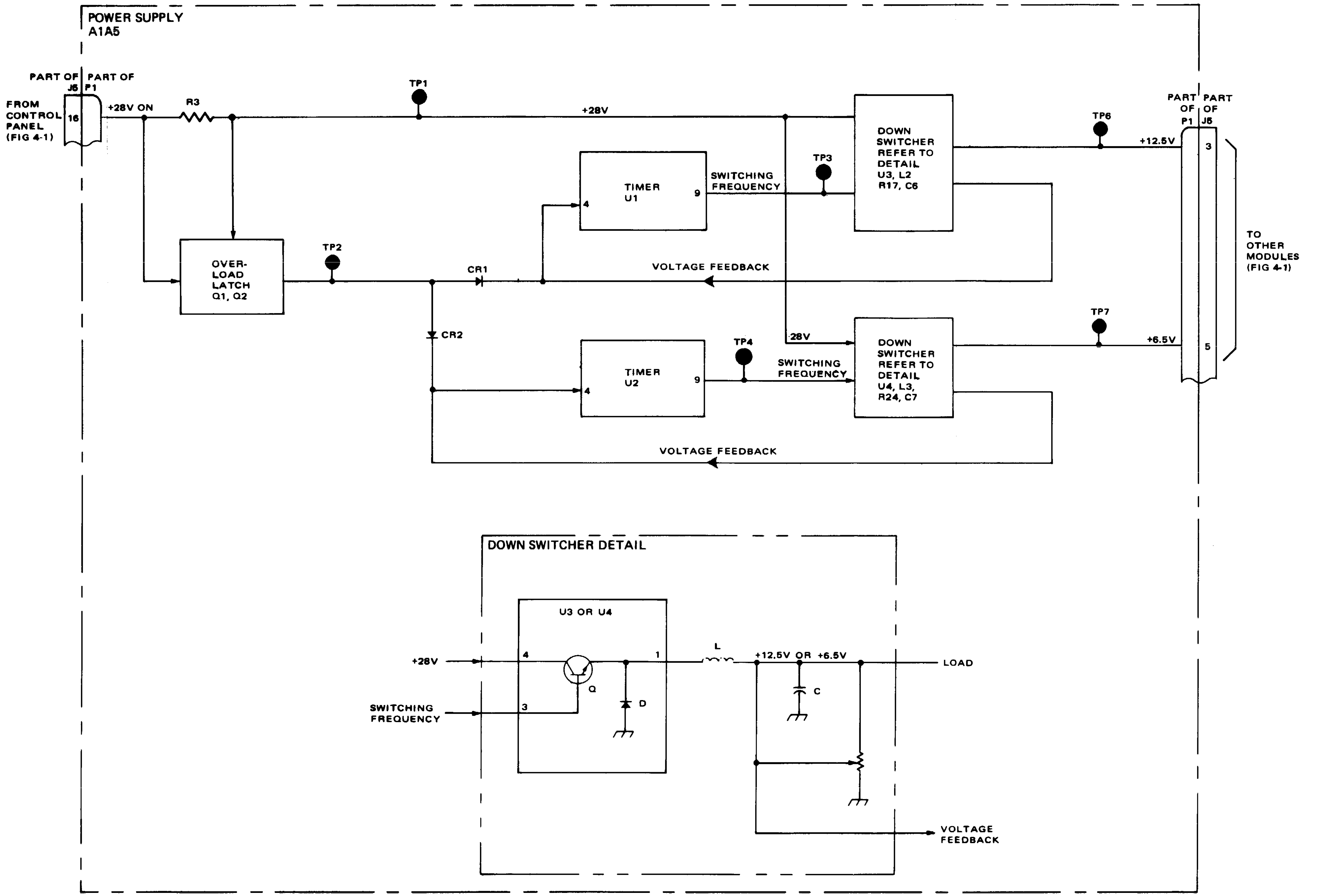


Figure 2-11. Power Supply A1A5 Functional Block Diagram

Figure 2-12. Power Amplifier A2A1 Functional Block Diagram

stage can be retarded by the PA disable switches Q4, Q5. These two switches are normally enabled (conducting) by the overshoot control (AR4-2, AR3-2). If the enabling voltage is reduced, Q4 and Q5 will decrease conduction and reduce the rf amplification.

2-114. RF Output Amplification. Next, the rf is amplified to about 20 watts by the output stage (T3, Q10, Q11, T4, T5). This amplification is also done using a pushpull configuration, using T3 as an input transformer and T4-T5 as output transformers. This stage is powered by +31v from the DC-DC converter.

2-115. Temperature Compensation. Both the driver stage (T1, Q3, Q6, T2) and the output stage (T3, Q10, Q11, T4, T5) use temperature-compensating bias circuits; (1) Q1, Q2 and (2) Q7, Q8, and Q9, respectively. These circuits reduce the tendency for the gain of the push-pull amplifiers to increase as the temperature rises. Both bias circuits use the +6.5v transmit for input voltage.

2-116. Overpower Detector AR4-1. The overpower detector receives Xmt RF input via isolation transformer T6. Any large excess in the power reflecting back at the power amplifier will cause a voltage to be applied to the overshoot control and ALC circuits.

2-117. Overshoot Control AR4-2, AR3-2. The overshoot control acts on information regarding antenna match in the form of buffered VFWD and VREFL inputs from the harmonic filter, or input from the overpower detector AR4-1. VFWD is a measure of the energy going to the antenna and VREFL is a measure of the energy that is reflecting back at the harmonic filter. VFWD and VREFL are summed, amplified, and compared against a reference value. If the power reflection condition is momentarily high, the overpower detector will cease to apply an enabling voltage to the PA disable switch. The rf amplification will be reduced and power will be reduced to a safe level.

2-118. ALC AR3-1. The ALC amplifier processes the same information as the overshoot control (buffered VFWD and VREFL) but the reference voltage is lower. In addition, the ALC affects the Xmt RF at the modulator/demodulator module and the reaction time is slower. Refer to the ALC paragraph in the modulator/demodulator (paragraph 2-90). As a result of the longer reaction time (typically 5 milliseconds), the overshoot control acts to dampen the initial peak of the Xmt RF until the ALC reduces the Xmt RF at the modulator/demodulator.

2-119. Sidetone Enable AR2-1, Q15. This circuit determines whether the power output is adequate for transmit communication (about 6 watts). If SO, audio feedback is provided to the operator. Again, the buffered VFWD and VREFL voltages are compared against reference values. The difference is that the output of AR2-1 passes through switch Q15. Q15 is enabled by both the Keyline signal (grid) from the modulator/demodulator and an adequate power level. The activated state (Q15 conducting) of the Sidetone Enable is +1.4v or less. The Tune In Progress signal provides Sidetone Enable by passing ground through diode CR24 during the automatic tuning process. When Tune In Progress is present, the operator hears a 1-kHz tone.

2-120. Tune Check Enable AR2-2, Q16. If, while transmitting, the antenna should become detuned, the Tune Check Enable will be applied to the antenna tuner. Buffered VFWD and VREFL are sampled and compared against a reference value at AR2-2. If the vswr is worse than 1.6:1, the Tune Check Enable will cause retuning the next time PTT is pressed. Q16 ensures that the radio is in transmit mode and the Keyline is grounded. In the active state, this line is about +6v. Tune In Progress will prevent a false Tune Check Enable from being generated during the tuning process.

2-121. Tuner DC Source TR1, Q1, Q2, Q3, Q11. This circuit provides a regulated power supply (+16v) for the relays in the antenna tuner module. The circuit compensates for changes in temperature and battery voltage; it is activated by grounds from Tune In Progress or Tune Start lines which turn on switch Q11. As temperature increases, the voltage needed to drive the antenna tuner relays will increase. Conversely, if the temperature decreases, the relay voltage will decrease. The temperature-dependent voltage range is from about +12v to +18v. The mechanism of temperature regulation is thermistor TR1; as the temperature increases, its resistance decreases. A Zener diode, VR1, is connected so that a constant +18v is applied to the thermistor. Transistors Q1, Q2, Q3 buffer the thermistor output to provide a low impedance dc source.

2-1’22. DC-DC Converter. This network converts +28v to +31v which is used in the output stage (T3, Q10, Q11, T4, T5). It works in the following way:

1. Switch Q10 closes. Current flows through coil L2, storing energy.

2. When Q10 opens, the energy stored in L2 is transferred to C32 via diode CR5.

3. The current flowing in C32 charges it to 31v.

4. The energy stored in L2 (which determines the charge of C32) is proportional to the on and off time of switch Q10. Oscillator U1 sets the frequency to 50 kHz. Differential amplifier Q5, Q6 determines the on to off ratio (duty cycle) via feedback applied through Q9. Driver Q7, Q8 provides the base current to drive switch Q10.

2-123. ANTENNA TUNER MODULE (Figure 2-13).

2-124. General. The antenna tuner automatically matches impedances between the radio set (50 ohms resistive) and the selected antenna (reactive/resistive). The module systematically switches inductors and capacitors into the L-C coupling network KL1-KL11, KC1-KC8, until the resulting impedance matches the impedance of the radio set.

2-125. Tune Start. A Tune Start signal is generated whenever any of the following occur:

1. The radio is turned on.

2. The mode switch is changed from V/RCV or D/RCV to V/TR or D/TR.

3. The frequency is changed by 1 kHz or more.

The Tune Start signal turns the +16v relay supply (located at the power amplifier module) on momentarily, and causes removal of the impedance-matching elements from the rf pathway.

2-126. Tune-Check Enable. A Tune-Check Enable signal is sent from the PA module to the antenna tuner hybrid if a high vswr condition (vswr is the detection of swr) occurs during a normal transmission. The antenna tuner will perform a tune-check the next time Keyline goes low (PTT or CW Key).

2-127. Tune-Check. Without disturbing the L-C values set into the tuning network, the antenna tuner hybrid closes transfer relay and measures the antenna tuner vswr. If the vswr is less than 1.6:1, transfer relay opens and normal operation is resumed. If the vswr is greater than 1.6:1, the impedance-matching elements are removed from the rf pathway when the Keyline goes low (PTT or CW Key). At this time, the module begins the tuning cycle.

2-128. Element Switching. Each inductive and capacitive element (L1-L11 and C1-C8) is switched into and out of the rf pathway by a relay (K1-K11 and K1-K8). The element and relay are grouped together as KL1-KL11 and KC1-KC8. To switch an inductive element out of the rf pathway, the following must happen.

Figure 2-13. Antenna Tuner A2A2 Functional Block Diagram

1. The antenna tuner hybrid A1 pulses the set driver transistor with +0.8v.

2. The output of the set driver transistor changes from +16v to ground.

3. The relay closes and short circuits the inductive element (a coil) connected in parallel.

To switch an inductive element into the rf pathway, the reset driver must be pulsed. The capacitive element (KC1-KC8) is connected in series with the relay. When the reset driver is pulsed, the relay opens and switches the element out of the rf pathway. When the set driver is pulsed, the relay closes and switches the element into the rf pathway.

2-129. Tuning Cycle. The tuning cycle consists of the following:

1. When the Keyline is grounded after a Tune Start or Tune Check Enable has occurred, a Tune In Progress signal (active state is +0.7v or less) is routed to the power amplifier and the transfer relay. This causes +16v regulated to be applied to the relays KL1-KL11 and KC1-KC8, and the rf is routed through the energized contacts of transfer relay to the rf sensor bridge (R6-25, T2). The rf sensor bridge outputs Z (impedance), vswr, and ALC analog voltages.

2. The antenna tuner hybrid A1 places the inductors KL1-KL11 in a binary count in the rf path by opening the associated relay. The hybrid samples the analog Z voltage and compares the Z voltage to a reference at a comparator.

3. The inductance is incrementally added in a binary count. The inductance of KL2 is twice KL1; KL3 is twice KL2; KL4 is twice KL3, etc. (For example, on the fifth binary count - binary number 101 - KL3 is in, KL2 is out, KL1 is in.) The L-C clock determines the count timebase.

4. The count continues until the Z drops to indicate 100 ohms or less. At that time, the Z comparator digital output changes state and signals the control logic.

5. The control logic places capacitors KC1-KC8 between the rf path and ground in a binary count. The hybrid samples the vswr voltage and compares it to a reference at a comparator.

6. Capacitance is incrementally added until the vswr reaches 1.5:1. The comparator changes state and signals the control logic. If the 1.5:1 vswr is not reached when all the capacitors are added, they are reset. Another inductor is added and the capacitor count begins again.

7. When the vswr is 1.5:1, satisfactory impedance match has been achieved. The control logic discontinues the ground on the Tune In Progress line. The transfer relay is deenergized and the rf sensor bridge (R6-25, T2) ceases to sample the rf. The supply voltage to the relays KL1-KL11, KC1-KC8 is removed. The relays are held in place by magnetic latching.

2-130. Frequency Select Logic. The Frequency Select Logic signals from the control panel are applied to the control logic in the antenna tuner hybrid. The control logic selects which inductors and capacitors will be used at a particular frequency band. This is shown in table 2-15. For example, at 2,000 kHz, inductors KL1, KL2, and KL3 are bypassed in the binary count. KL4 becomes the least significant bit.

2-131. The average tuning time is approximately 3 seconds, but may run as long as 12 seconds. If the tuning has

TABLE 2-15. INDUCTORS AND CAPACITORS USED AT DIFFERENT FREQUENCY BANDS

Frequency MHz	'L' Bank, 759 Board										
	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11
2.0 → 2.9999				2^0	2^1	2^2	2^3	2^4	2^5	2^6	2^7
3.0 → 7.9999			2^0	2^1	2^2	2^3	2^4	2^5	2^6	2^7	2^8
8.0 → 11.9999		2^0	2^1	2^2	2^3	2^4	2^5	2^6	2^7	2^8	2^9
12.0 → 29.9999	2^0	2^1	2^2	2^3	2^4	2^5	2^6	2^7	2^8	2^9	2^{10}

	'C' Bank, 760 Board										
	K1	K2	K3	K4	K5	K6	K7	K8			
2.0 → 4.9999				2^0	2^1	2^2	2^3	2^4			
5.0 → 7.9999			2^0	2^1	2^2	2^3	2^4				
8.0 → 11.9999		2^0	2^1	2^2	2^3	2^4					
12.0 → 19.999		2^0	2^1	2^2	2^3						
20.0 → 29.9999	2^0	2^1	2^2	2^3							

L1 = .08 µH	C1 = 7.5 pF
L2 = .16 µH	C2 = 15.0 pF
L3 = .33 µH	C3 = 30.0 pF
L4 = .66 µH	C4 = 62.0 pF
L5 = 1.30 µH	C5 = 120.0 pF
L6 = 2.60 µH	C6 = 240.0 pF
L7 = 5.20 µH	C7 = 470.0 pF
L8 = 10.50 µH	C8 = 910.0 pF
L9 = 21.00 µH	
L10 = 42.00 µH	
L11 = 85.00 µH	

not taken place within 12 seconds, the antenna tuner hybrid A1 will output an open on the No-Tune line to the tune fault logic U1, Q3. This will cause the Tune Fault signal to become +6v and the modulator/demodulator to generate a beeping signal to the user. If an illegal frequency has been selected (under 2 MHz), then the Frequency Select Logic inputs from the control panel will all be at ground, and the Tune Fault line will again become +6v.

2-132. In routine operation (after the tuning cycle), the Xmt RF is not sampled by the rf sensor bridge. The +16v regulated supply from the power amplifier is off.

2-133. ALC. The ALC voltage from the rf sensor bridge is compared with a reference voltage at a differential hybrid. The output is routed to the modulator/demodulator. Refer to the ALC paragraph in the modulator/demodulator (paragraph 2-90). Note that this is used during tune-up only.

2-134. Receive Operation. During receive operation, the Rcv RF travels through the L-C coupling network to the modulator/demodulator. No tuning takes place while receiving. However, if a tune start is initiated, all capacitors and inductors will be removed from the rf pathway. To initiate a tune-up, the PTT or CW KEY must be pressed.

2-135. Antenna Select Switch S1. The antenna select switch S1 has three positions:

1. 50Ω
2. BNC antenna
3. Whip antenna

In the 50Ω position, the Xmt RF and Rcv RF bypasses the antenna tuner module, and the rf goes in and out of the BNC connector. In the BNC and Whip positions, the rf is routed through the tuner to the BNC connector or Whip socket, depending on which has been selected.

CHAPTER 3

GENERAL MAINTENANCE DATA

3-1. GENERAL.

3-2. This chapter provides general maintenance information that is applicable to the maintenance and repair of the radio set and units covered in maintenance chapter 4 thru 6, and the modules covered in General Support Maintenance Manual TM 11-5820-919-40-1. Applicable parts of each maintenance chapter and maintenance manual identify and reference the appropriate maintenance information contained in this chapter. The maintenance information is presented as follows:

Section I. Circuit Card Assembly Repair Procedures.

Contains description and definition of standards to be observed, followed by procedures to be performed, for repair of circuit cards and replacement of components.

Section II. Cleaning and Examination.

Contains general information for the cleaning and inspection of the radio set, units and modules.

Section III. Fabrication of Special Support Equipment.

Contains information and drawings for fabrication of special cables, adapters, and fixtures required to perform the test, troubleshooting and alignment procedures for the radio set, units and modules.

Section IV. Performance Test and Troubleshooting.

Contains description of the use of the performance test and troubleshooting flowcharts, in conjunction with other supporting data and maintenance diagrams.

Section V. Maintenance Data for Accessories.

Contains fabrication drawings and parts identification for the radio set accessories that are unique to the AN/PRC-104.

SECTION I

CIRCUIT CARD ASSEMBLY REPAIR PROCEDURES

3-3. GENERAL.

3-4. This section contains description and definitions of standards to be ohserved followed by procedures to be performed for repair of circuit cards and replacement of components. Read the procedures in this section before attempting card repair.

3-5. STANDARDS.

3-6. SOLDERING STANDARDS FOR CIRCUIT CARDS . The following paragraphs contain standards to be observed when soldering circuit cards.

3-7. Soldering Voids. A void (fig 3-1) is area which is not filled with solder, the extent of which is completely visible. For cards with eyelets or plated-through holes, voids in the circuit side of a solder joint are permissible, provided that they are not deeper than half of the hole depth and do not extend over more than a quarter of the hole area. If no" circuit is connected to the pad on the side of the void, the void may extend over the entire hole area if the outline of the lead is visible. Voids in unsupported holes may extend through the hole but should not extend over more than a fifth of the hole area.

3-8. Soldering Pinholes. A pinhole is a hole in the surface of the solder which indicates the absence of solder beneath the surface, the extent of which is not visible. Pinholes (fig 3-2) should not be permitted adjacent to the component lead or wire.

3-9. Pad Area. Solder is not required to cover the entire pad area. Voids and pinholes in these areas are acceptable.

3-10. Excessive Solder. Solder that flows beyond the bend radius of a component lead is not acceptable, except for small diameter components (for example, glass diodes). The maximum solder height, including component lead, on the bottom of the board is 0.062 inch (fig 3-3). Solder spikes should not exceed 0.062 inch.

3-11. Insufficient Solder. Except for permissible voids and pinholes, the solder must fill the hole to the point where the solder covers the entire inner surface of the hole. For eyelet holes or standoff terminals with circuit connections, the solder should flow between the eyelet and the pad for at least four-ifths of the circumference.

3-12. Cold Solder Joints. Cold solder joints (fig 3-4) where the solder balls at the point of contact with a pad or lead are not acceptable.

3-13. Preferred Solder Connections. All components may be soldered by either flow soldering or by hand soldering. The completed joint must have a clear, smooth appearance which indicates proper soldering. Examples of preferred solder connections are shown in figure 3-5.

3-14. CIRCUIT CARD BASE MATERIAL STANDARDS. Cracks, chips, or gouges in the base material should not exceed the following:

1. Cracks or chips should not exceed back from the edge of the hole more than 0.040 inch.

2. Cracks, chips, and gouges at the edge of the board should not exceed 1/3 of the board thickness or extend back more than 0.12 inch from the edge.

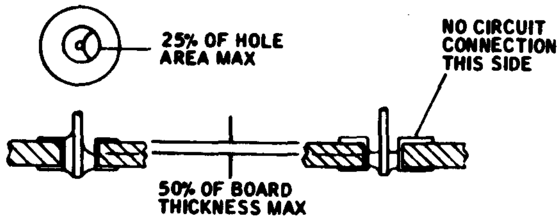


Figure 3-1. Void Standards

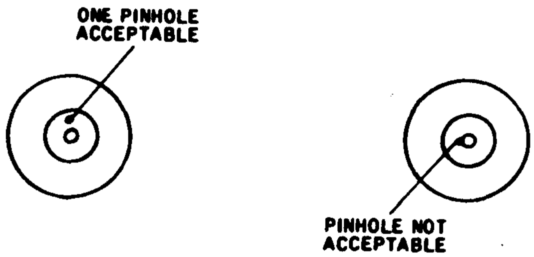


Figure 3-2. Pinhole Standards

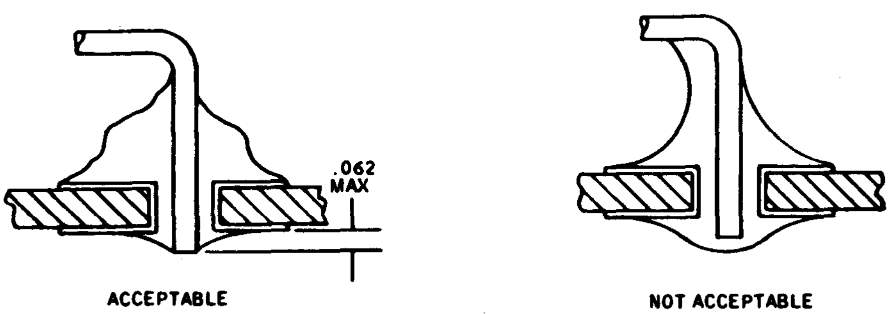


Figure 3-3. Solder Height Standards

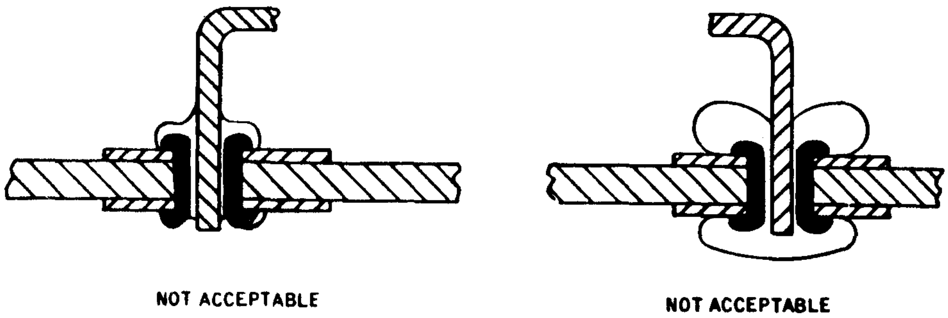


Figure 3-4. Cold Solder Joints (Not Acceptable)

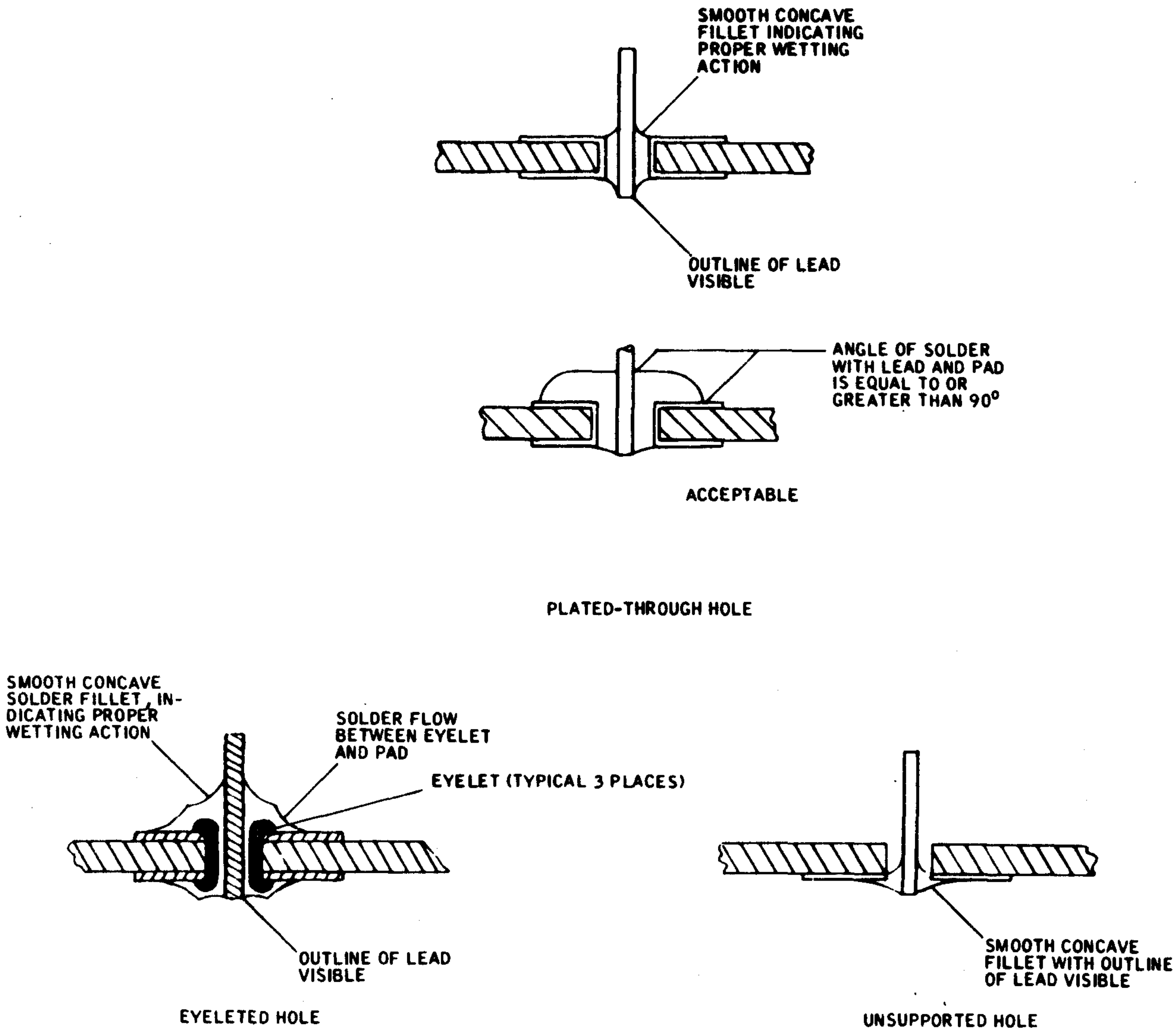


Figure 3-5. Preferred Solder Connections

3. Cracks, chips, and gouges are not acceptable on the contact strip edge of the board.

4. Cracks or chips should not extend from one conductor to another conductor.

5. Delamination of the base material is not acceptable.

3-15. CIRCUIT CARD ETCH STANDARDS. Circuit card etch standards are as follows :

1. Cracks, pits, or voids in the contact strip area are not acceptable.

2. Scratches which expose the copper are not acceptable.

3. Cracks , pits, or voids in any etch which reduce the conductor by more than 20 percent are not acceptable. No defect should reduce the conductor to less than 0.010 inch.

4. Lifting of a conductor above the surface of the board is not acceptable.

5. Reduction in the area of any pad in excess of 25 percent is not acceptable. Cracks, pits, or voids should not extend to a plated-through hole.

3-16. STORAGE AND HANDLING OF CIRCUIT CARDS . When stored, circuit cards should be wrapped individually in polyethylene bags, or equivalent, and stacked in storage pans. Other objects should not be placed in the storage pans with circuit cards. Avoid touching the circuit card surface with bare hands or fingers. Handle the circuit card by its edges.

3-17. <u>CIRCUIT CARD REPAIR PROCEDURES</u>.

WARNING

Vapors emitted during certain circuit card repair procedures may be irritating to personnel. Always perform circuit card repair procedures in a well ventilated area.

3-18. The repair of circuit cards requires proper tools and careful work habits. Excessive heat when soldering, or undue force applied to components or to the circuit card, can seriously damage the assembly. In general, the following precautions should be observed:

1. Never try to save a component part at the possible expense of damaging a circuit card. Most component parts can be clipped from the circuit card. When clipping the defective part, be careful to protect the printed circuit conductor (etch) and other component parts.

2. A vacuum resoldering unit should be used, if available, to remove the leads of a clipped part. The technical manual for the vacuum resoldering unit contains operating procedures for the unit. Basically, the vacuum resoldering unit operates as follows: a high flow hole, across the pads and around the leads to remove the solder and cool down these areas to prevent resweating of the lead. At the same time, the temperature-controlled resoldering tip, which initially provided the heat to melt the solder, is cooled rapidly by the air flow to prevent further heat from being applied to the workpiece. Once the air flow is stopped, the tip heats up rapidly for continued vacuum resoldering. The coaxial, in-line design of the handpiece allows molten solder and clipped leads to be drawn into the heat-resistant chamber where solder is solidified.

3. Exercise care when using a soldering iron to remove the leads of a clipped part, to connect a new part, or to service the circuit card itself. Circuit cards are easily damaged by heat. Prolonged application of heat will destroy the adhesive quality of the bonding agent that holds the printed etch to the circuit card. Use the recommended soldering iron, or equivalent.

4. Use solder sparingly. Excess solder should be removed with the recommended solder-removing tool, or equivalent.

5. Clean and tin the leads of a component before soldering the component to the board.

6. Check the work. Be certain that the solder joint is firm and clean.

3-19. CIRCUIT CARD REPAIR TOOLS AND MATERIALS. For repair to the circuit cards, the tools listed in table 3-1 and the materials listed in table 3-2 are recommended.

TABLE 3-1. RECOMMENDED TOOLS

Tool	Manufacturer	Part Number
Bench repair center	Pace Inc.	PRC-350C
Kit, tool , electronic	...	TK-100/G
Maintenance kit, printed circuit	...	MK 984/A
Clamps, small	...	...
Coining tool	Erem	5174
Oven capable of maintaining 150 ±10 °F	...	...
Parallel gap welding machine:		
Power supply	...	MCW 550
Welding head	...	VTA66

TABLE 3-2. RECOMMENDED MATERIALS

Material	Manufacturer	Type
Acetone solvent (acetone)	...	...
Epoxy compound (Epon packaged in a plastic syringe, DTA catalyst in a glass vial)	Frey Engineering	MIL-I-16923
Epoxy adhesive	Narmco	3135A and B kit
Epoxy adhesive kit, flexible, frozen pre-mix (Narmco adhesive kit)	Narmco	3135

TABLE 3-2. RECOMMENDED MATERIALS (Continued)

Material	Manufacturer	Type
Epoxy adhesive kit, flexible, 18 gram (Narmco adhesive kit)	Narmco	3135-MRO 40-0965
Epoxy adhesive kit, flexible, 1 pint (Narmco adhesive kit)	Narmco	3135-MRO 40-0962
Glass beads, 0.003-inch diameter	Superbrite	...
Hook-up wire and cable, 26 gage, insulated electrical (copper jumper wire)	...	4297780-49, LW-C-26-1-J-9
Isopropyl alcohol	...	...
Masking tape	...	...
Polyurethane conformal coating compound	Conap, Inc.	MIL-I-46058, Type UR
Sandpaper, 80 to 180 grit	...	...
Soldering flux	Kester	197
Solder, rosin-cored, 1/32 inch	Kester	44
Solder-wick	Solder Removal Co.	-3-500
Solvent	Conap, Inc.	MIL-I-46058, Type UR
Solvent, TMC (Freon TMC solvent)	Freon	MRO 55
Thermally conductive adhesive	Wakefield	Delta Bond 152
Tin-coated wire, 34 gage, uninsulated, electrical	...	4297869-25
Toluene solvent (toluene)	...	...

3-20. ETCH REPAIR. The solder-plated copper or gold-plated copper conductors (etch) bonded to the surface of the circuit cards can be damaged when mishandled or when a component failure causes current flow that exceeds the current-carrying limits of the etch. Certain types of damage to the etch can be repaired by using the appropriate repair techniques. Scratches or gouges on the etch can be repaired by soldering. Soldering is also used to repair voids or pinholes in the etch. Breaks or cuts in the etch can be repaired by bridging the defect with a new section of etch. Lifted, raised, or unbended etch can be repaired by pressing the etch against the card surface and encapsulating the defect with epoxy adhesive. Damaged plated-through holes or eyelets are repaired by inserting and soldering an eyelet. To repair damaged etch, perform the procedures of the following paragraphs that apply to the type of damage to be repaired.

3-21. Repair of Scratched, Gouged, Voided, or Pinholed Etch. Scratched, gouged, voided, or pinholed etch faults can be repaired by performing the following steps:

1. With an X-acto knife, scrape the polyurethane coating from the area of the circuit card to be repaired. Be careful not to cause further damage to the etch.

2. Flatten any burrs that exist on the defective area of the etch by using the back of the recommended diagonal cutting pliers, or equivalent.

3. Use a brush to apply soldering flux to the etch where defect exists.

4. Use the soldering iron to apply solder to the defect. Use solder sparingly.

5. Inspect the repair to be certain that the damaged area has been bridged by the solder.

6. Encapsulate the worked area by the method described in paragraph 3-33.

3-22. Repair of Broken Gold-Plated Copper Etch. Broken or cut gold-plated copper etch can be repaired by performing the following steps:

1. With an X-acto knife, scrape the polyurethane coating from the area of the circuit card to be repaired. Be careful not to cause further damage to the etch.

2. Cut out a section approximately 1/2 inch longer than the area to be repaired from a strip of gold-plated copper ribbon (etch material).

3. Tin the new piece of etch material; use solder sparingly.

4. Position the new etch material over the damaged area so that it overlaps by 1/8 inch and hold it in place with an orange stick.

5. Touch the soldering iron to one end of the new etch material until the solder flows to the damaged etch at that end.

6. Use an orange stick to smooth out the new etch material, work toward the unsoldered end; hold the new etch material firmly in place with the orange stick, cut off the surplus, and allow approximately 1/8 inch for overlap.

7. Touch the soldering iron to the free end of the new etch material until the solder flows to the damaged etch at that end.

WARNING

Isopropyl alcohol is flammable. Keep away from heat and open flame. Vapors may be harmful. Use with adequate ventilation. Avoid prolonged or repeated breathing of vapor. Avoid eye contact. Do not take internally.

8. Remove excess soldering flux with isopropyl alcohol.

9. Apply masking tape around the repaired area. Allow approximately l/16-inch gap between the circuit and tape on both sides and 1/8 inch at the ends.

WARNING

Adhesives are irritating to the skin and eyes upon contact, and may emit harmful vapor. Use only with adequate ventilation. Avoid all skin and eye contact. Use protective clothing such as rubber gloves, apron and eye protection. Wash off immediately any accidentally contaminated skin area. Hand washing facilities and eye wash fountain should be provided. Do not take internally.

10. Mix a small quantity of epoxy adhesive in equal parts on a smooth piece of glass or hard plastic; mix the two components thoroughly.

11. Seal the repaired area by applying a thin, smooth bead of the mixed adhesive over and around the edges of the circuit in a neat and workmanlike manner.

12. Allow the adhesive to set 1 hour at room temperature.

13. Remove masking tape and remove surplus adhesive by scraping lightly.

WARNING

Handling hot items presents a serious injury potential. Asbestos gloves are required.

14. Cure the repair in an oven for 1 hour at 150 ±10 °F or allow it to stand at room temperature for 24 hours.

WARNING

Polyurethane contains flammable solvents and toxic diisocyanates. Keep away from heat and open flame. Vapors or mists are harmful! Complete body protection, including entire head, is required to prevent skin or eye irritation from contact with the paint or its vapors or mists. Respirator protection is required, usually an air-supplied hood, during mixing, curing, and application. Use this paint only with the protection requirements as specified above. Suitable flushing facilities must be provided for immediate clean water flushing or any accidental skin or eye contact. Do not take internally.

15. Encapsulate the worked area with polyurethane coating by the method described in paragraph 3-33.

3-23. Repair of Raised or Unbended Gold-Plated Copper Etch. Raised or unbended gold-plated copper etch can be repaired by performing the following steps:

1. Determine the hole diameter required for the new eyelet and select an eyelet of similar size.

WARNING

Drilling operations create metal chips which may enter the eyes and cause serious injury. Eye protection is required.

2. If the hole is plated-through, drill the hole to accommodate the new eyelet. Be careful not to raise the etch while drilling. If the hole has an eyelet, remove the defective eyelet.

3. Use the eyelet press and dies to insert and form the new eyelet; allow approximately 0.01 inch of etch to extend beyond the eyelet rim. Allow clearance under both of the formed heads so that solder flow under and around the formed heads will not be impaired.

4. Insert a round toothpick, or equivalent, in the eyelet hole to prevent solder from entering the hole.

5. Apply soldering flux with a brush to the eyelet and surrounding etch.

6. Use a soldering iron to apply solder to the eyelet and to the surrounding etch on both sides of the circuit card.

WARNING

Isopropyl alcohol is flammable. Keep away from heat and open flame. Vapors may be harmful. Use with adequate ventilation. Avoid prolonged or repeated breathing of vapor. Avoid eye contact. Do not take internally.

7. Remove the soldering flux and clean the circuit card with isopropyl alcohol.

3-24. REPLACEMENT OF A LIFTED PAD. Lifted pads (circular etch surrounding either eyelets or plated-through holes that have raised from the board) can be replaced by performing the following steps:

1. Remove the lifted pad. If the hole has an eyelet, remove the eyelet first.

WARNING

Toluene is flammable. Keep away from heat and open flame. Vapors are harmful. Use only with adequate ventilation. Avoid prolonged or repeated breathing of vapor. Avoid contact with skin and eyes. Do not take internally. Comply with air pollution control rules concerning photochemically reactive solvents.

2. Clean the area from which the defective pad was removed with a clean cloth moistened with toluene.

WARNING

Adhesives are irritating to the skin and eyes upon contact, and may emit harmful vapor. Use only with adequate ventilation. Avoid all skin and eye contact. Use protective clothing such as rubber gloves, apron and eye protection. Wash off immediately any accidentally contaminated skin area. Hand washing facilities and eye wash fountain should be provided. Do not take internally.

3. Apply a thin, smooth coat of clear epoxy adhesive to the area from which the defective pad was removed.

4. Place the new pad, as nearly as possible, in the exact position of the defective pad. Insert a round, pointed toothpick in the hole to help in alignment. Press the pad firmly in place with an orange stick while gently removing the toothpick from the hole.

5. Allow the epoxy adhesive to set for 1 hour at room temperature.

6. Carefully remove surplus adhesive by using a clean cloth dipped in toluene or other suitable solvent.

WARNING

Handling hot items presents a serious injury potential. Asbestos gloves are required.

7. Cure the repaired pad in an oven ±10 °F or let it stand at room temperature for 24 hours.

8. If the repair appears wet and well bonded, install and solder an eyelet as described in steps 3 thru 7 of paragraph 3-23.

3-25. REMOVAL OF BONDED PARTS. A part that has been bonded to a circuit card (with an epoxy adhesive or similar compound) can be removed after the leads have been clipped or unsoldered by breaking the defective part or by applying heat to the bonding compound. The method to be used depends on the type of part and its location. If a defective part cannot be removed by heat, cut or break the part away from the bonding compound. In some cases, the part to be replaced is so closely positioned between other parts that one lead must be cut close to the body of the defective part to permit the application of a prying tool. Wherever possible, cut the defective part with diagonal cutting pliers.

CAUTION

Never apply excessive pressure against a circuit card.

3-26. Regardless of the tool employed (round-pointed or spade type), great care must be exercised in its use to prevent the circuit card or other parts from being damaged or broken. Apply the point of the tool against the bonding compound and between the part and the circuit card. Use the tool so that it works away the bonding compound from the part to be broken until enough has been removed for the tool to exert pressure against the part. Keep the leverage surface area of the tool flat against the surface of the circuit card to prevent the tool from gouging or breaking the board.

3-27. REMOVAL OF SOLDERED COMPONENTS HAVING AXIAL LEADS. Components with axial leads that are soldered in place on the circuit card may be removed by performing the following steps:

1. Use diagonal cutting pliers to cut the leads of the component part close to the component. Carefully straighten the end that extends through each hole so that the lead may be easily withdrawn.

2. Use a vacuum resoldering unit, if available, to remove the solder from each lead on the component. If a vacuum resoldering unit is not available, exert a slight pressure and apply the tip of the soldering iron to the tip of the lead. Keep the soldering iron away from the circuit etch. As the lead end absorbs heat, the solder will melt and the lead will break away from its junction with the circuit etch. Remove the soldering iron immediately and quickly pull the lead free. Use the solder-removing tool to remove excess solder. Do not force or twist the load to remove it from the circuit card.

3. Remove the component from the circuit card.

3-28. REMOVAL OF SOLDERED COMPONENTS HAVING RADIAL LEADS. Components with radial leads that are soldered in place on the circuit card may be removed by the procedure described in paragraph 3-29 if the leads are accessible on the component side of the circuit card. If the leads of the component are not accessible on the component side of the circuit board, the component may be removed by performing the following steps:

1. Use a vacuum resoldering unit, if available, to remove the solder from each lead on the component. If a vacuum resoldering unit is not available, exert a slight pressure and apply the tip of the soldering iron to the tip of the lead. Keep the soldering iron away from the circuit etch. As the lead absorbs heat, the solder will melt. When the solder has melted, in and around the lead hold, quickly remove the solder with the solder-removing tool. Repeat this procedure for each lead associated with the component to be removed.

2. Remove the component from the circuit card.

3-29. REMOVAL OF TRANSISTORS. The transistor connection points in a given circuit may not be keyed. Therefore, when replacing a transistor, it is possible to insert the replacement transistor backwards to reversing the emitter and collector leads. For this reason, before the transistor is unsoldered from the circuit, identify the emitter and collector terminals in the circuit. Mark the emitter terminal connection point in the circuit with a pencil, a piece of chalk, or a crayon before removing the transistor. The transistor may then be removed.

3-30. SOLDERED COMPONENT REPLACEMENT. Horizontally mounted components rated at less than 1 watt and with pigtail leads which are inserted in plated-through eyelets or in unsupported holes should be mounted flush with the board surface. Components rated at 1 watt or more should be mounted with 1/16-inch clearance between the component and the surface of the board.

3-31. COMPONENT REPLACEMENT IN EYELETS. Components may be replaced in circuit cards which have eyelets by performing the following steps:

NOTE

See paragraph 3-30 for component clearance requirements.

1. Make certain that all the polyurethane coating has been removed from the pads on both sides of the circuit card.

2. Apply the well-tinned tip of the soldering iron as close as possible to the eyelet-component lead intersection.

3. Feed rosin-cored solder to the pad-eyelet junction. When the solder flows, follow the flow around the eyelet with the solder until the entire joint is covered. Remove the iron immediately. Use as small an amount of solder as is practical and still cover the entire joint.

4. Allow the soldered joint to cool at least 5 seconds without disturbing the joint, as any disturbance during solidification may cause a fracture or a cold-solder joint.

5. On the reverse side of the circuit card, trim the lead as flush as possible.

6. Repeat steps 2 thru 4 for each lead on the component.

7. Encapsulate the component using the method described in paragraph 3-33.

3-32. COMPONENT REPLACEMENT IN PLATED-THROUGH HOLES. Components may be replaced in plated-through holes by performing the following steps.

NOTE

See paragraph 3-30 for component clearance requirements.

1. Make certain that all the polyurethane coating has been removed from the pads on both sides of the circuit card.

9 Apply the well-tinned tip of the soldering iron as close as possible to the component lead-pad junction.

3. Feed rosin-cored solder to the component lead-pad junction opposite the soldering tip. When the solder flows, follow the flow around the component lead-pad junction with the solder until the entire joint is covered. Remove the iron immediately. Use as small an amount as is practical and still cover the entire joint.

4. On the reverse side of the board, trim the lead as flush as possible.

5. The opposite side of the board need not be soldered if the entire inner surface of the hole has been soldered.

6. Repeat steps 2 thru 5 for each lead on the component.

7. Encapsulate the component by the method described in paragraph 3-33.

3-33. REPAIR OF POLYURETHANE CONFORMAL COATING. The polyurethane conformal coating seals (encapsulates) the circuit card and components from moisture and dust. The coating should not be relied upon to impart mechanical strength for handling. Discontinuities in the polyurethane conformal coating, such as holes caused by test probes, areas scraped for component replacement or etch repair, burned areas caused by the soldering iron, and discontinuities caused by an uncoated replacement component itself may be repaired by performing the following steps.

WARNING

Solvents used in this procedure are flammable and must be kept from open flame, heat, and sparks. Keep containers tightly closed and store them in a cool place when not being used. The solvent must be used only in an adequately ventilated environment. Avoid breathing vapors and repeated contact with skin. Clean hands thoroughly before smoking, eating, or drinking.

1. Prepare a mixture of polyurethane conformal coating by following the manufacturer’s instructions. Solvent may be added as required.

2. Apply a thin, smooth, uniform coating with a small brush (1/2 inch) to all areas requiring coverage.

WARNING

Handling hot items presents a serious injury potential. Asbestos gloves are required.

3. Cure the coating in an oven set at 165 °F for 1-1/2 hours or by letting the coating stand at room temperature for 24 hours.

3-34. REPAIR OF DAMAGED FIBERGLASS EPOXY PARTS. Damaged fiber glass parts may be repaired by performing the following steps.

NOTE

For parts other than circuit boards, no more than 10 percent of the surface area shall be repaired.

NOTE

For circuit boards, the area to be repaired shall not exceed 1 square inch; the maximum depth of repair shall not exceed 50 percent of the original laminate thickness; misdrilled holes which do not interfere with the function of the circuit board shall remain unrepaired; and minor cracks which do not go through the entire thickness of the laminate may be repaired according to the following procedure.

1. Sand or scrape the area to be repaired using 80 to 180 grit sandpaper or a scraper to remove all traces of burned or charred laminates. In the case of a minor crack, scrape to the entire depth of the crack.

2. Wipe the surface at least twice with a clean cloth wet with acetone and allow to dry thoroughly.

3. Using epoxy compound, empty the glass vial of catalyst and the syringe of Epon into the aluminum cup and mix to a complete homogeneous condition.

NOTE

The pot life of the epoxy mixture is approximately 30 minutes. All material not used within 30 minutes must be discarded.

4. Immediately apply the epoxy mixture to the damaged area making sure to thoroughly wet the area to be repaired.

5. Apply sufficient material to cover the entire area to be repaired. Add a small “crown” of material to allow for shrinkage.

WARNING

Handling hot items presents a serious injury potential. Asbestos gloves are required.

6. Allow the repaired area to air cure for 16 hours minimum or heat cure in an oven for 1 hour at 150 ±10 °F.

7. Sand or scrape the crown of the repair until the repair is relatively smooth and even with the original laminate.

3-35. MODIFICATION OF SOLDER-PLATED PRINTED WIRING CIRCUIT CARDS. Solder-plated printed wiring circuit cards may be modified by brazing gold-plated copper wire to solder-plated copper conductors. The procedural steps are as follows.

NOTE

No more than two modification jumper wires are allowed to be brazed on one printed wiring pad. Joints are not allowed on printed circuit conductors that are less than the width of the coined (flattened) jumper wire end.

NOTE

This procedure may be performed only by personnel qualified as parallel gap welding operators.

1. Technical personnel familiar with the function of the circuit must determine the two points to which the jumper wire must be attached.

2. Bend a 30-gage insulated gold-plated solid-copper jumper wire to the designated tabs. Cut to required length.

3. Remove the insulation for a distance between 6 and 7 millimeters (1/4 and 5/16 inch) from each end of the wire.

4. With the coining tool, coin (flatten) the gold-plated copper wire ends to approximately 0.13 millimeter (0.005 inch) thickness by 2.54 millimeters (0.100 inch) long by 0.38 millimeter (0.015 inch) wide (fig 3-6).

5. Braze the coined (flattened) wire to the printed circuit conductor pad using the parallel gap welding machine according to the following schedule. Single wires (fig 3-7) or double wires (fig 3-8) can be brazed to one circuit pad.

6. Encapsulate the jumper wire as described in steps 7 thru 10.

	SINGLE WIRE	DOUBLE WIRE
Weld duration	8 - 10 ms	8 - 10 ms
Weld voltage	0.63 - 0.66V	0.66 - 0.68v
Weld force	1.3 - 2.3 kg (3-5 lb)	1.3 - 2.3 kg (0-5 lb)
Electrode gap	0.38 - 0.50 mm (0.015 - 0.020 in.)	0.38 - 0.50 mm (0.015 - 0.020 in.)

WARNING

Use Freon with good ventilation. Avoid prolonged or repeated breathing of vapor. Avoid contact with skin and eyes. Do not take internally.

7. Clean the area to be encapsulated, using Freon TMC solvent.

WARNING

Adhesives are irritating to the skin and eyes upon contact, and may emit harmful vapor. Use only with adequate ventilation. Avoid all skin and eye contact. Use protective clothing such as rubber gloves, apron and eye protection. Wash off immediately any accidentally contaminated skin area. Hand washing facilities and eye wash fountain should be provided. Do not take internally.

8. Use any one of Narmco Epoxy Adhesive Kits No. 3135 listed in table 3-2. If the frozen premix kit is used, allow it to thaw to room temperature prior to use. If either of the two-part kits is used, mix approximately equal quantities of Part A and Part B, using a disposable aluminum cup for mixing. Mix thoroughly.

9. Bond the jumper wire to the printed wiring board by applying a spot of adhesive (prepared in step 8) to a minimum diameter of 6.35 millimeters (1/4 inch) at intervals of 5 centimeters (2 inches). It is not necessary to encapsulate the brazed joint. Avoid applying adhesive to any area that may be subsequently soldered.

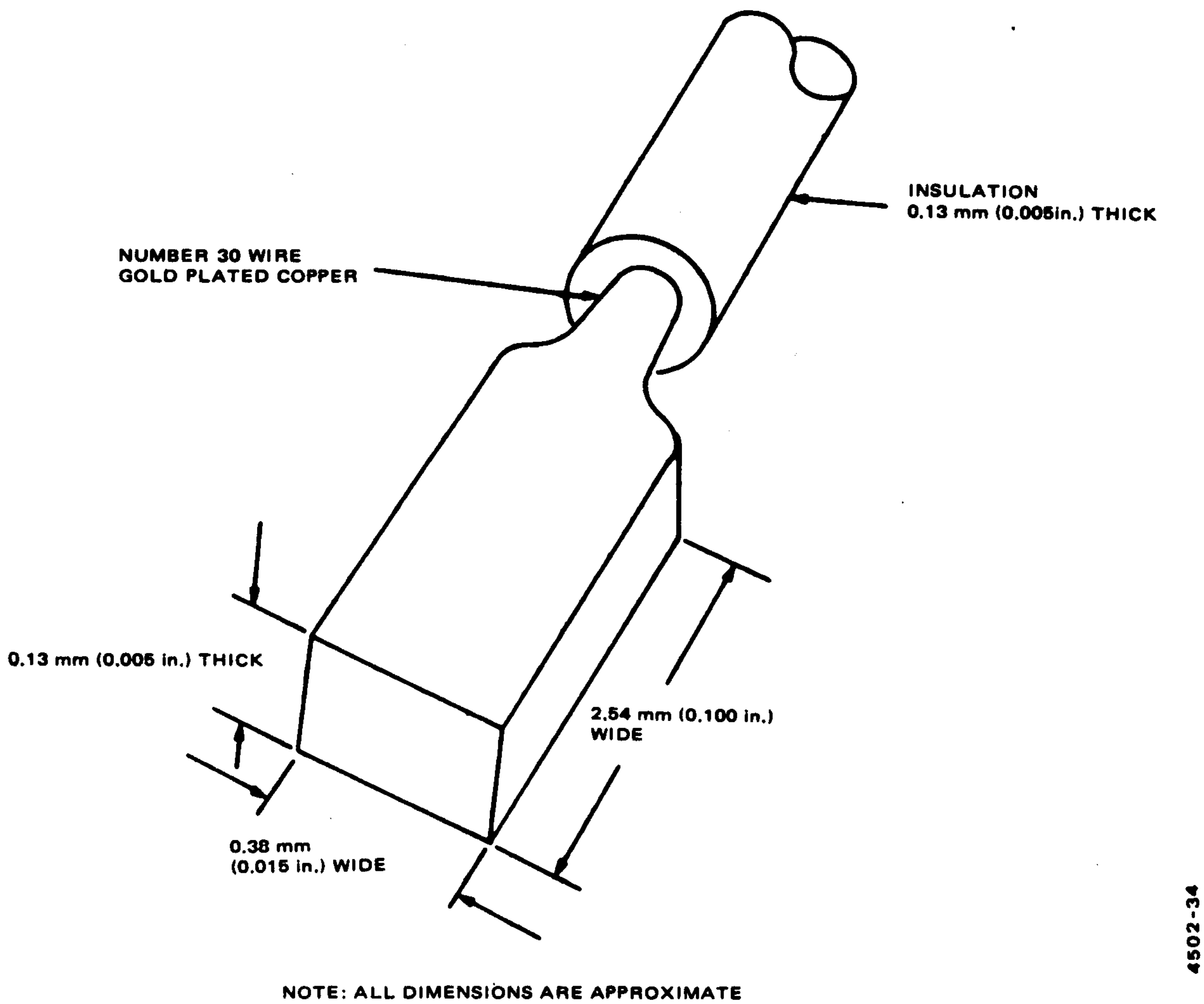


Figure 3-6. Coined 30-Gage Wire End

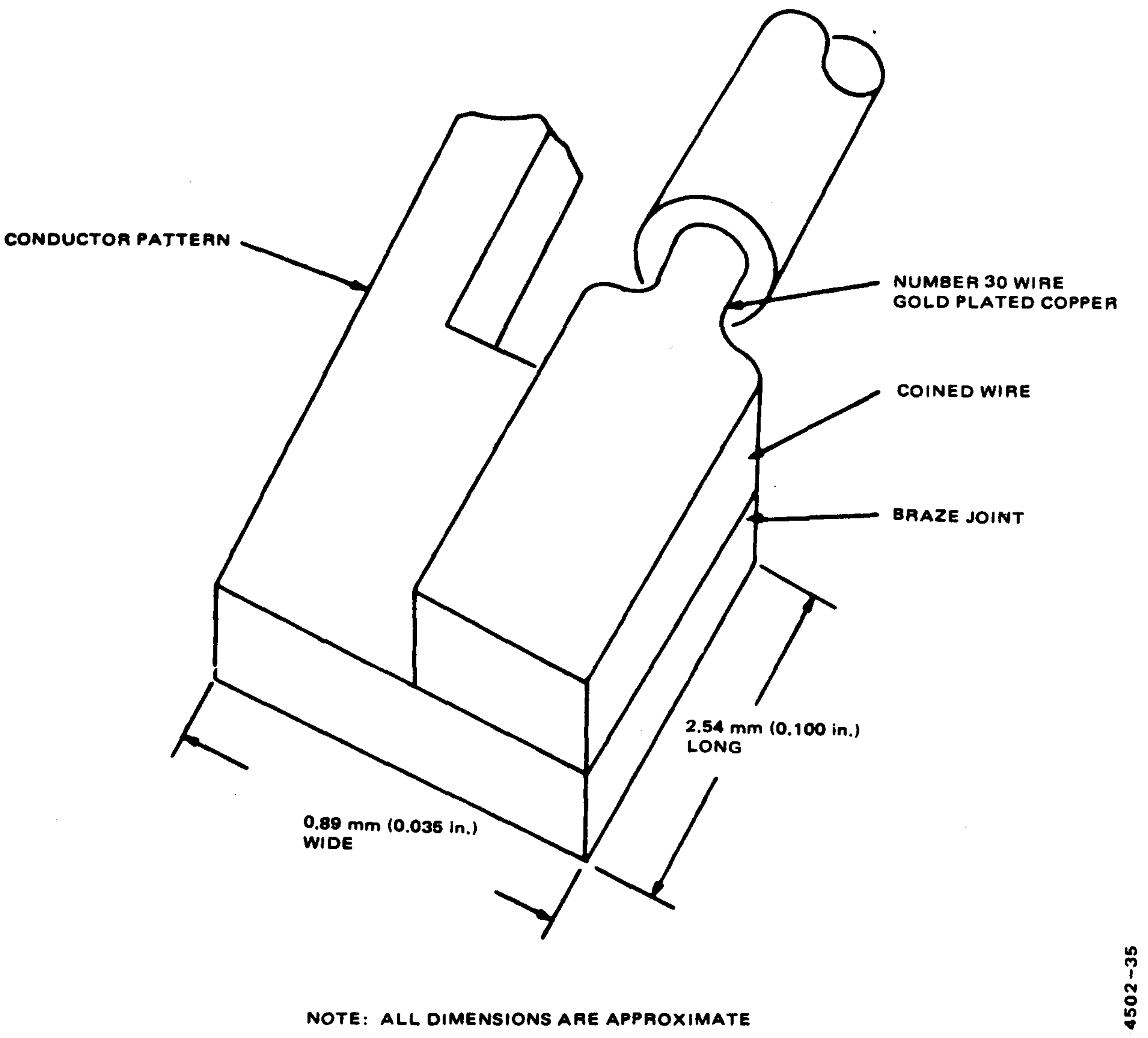
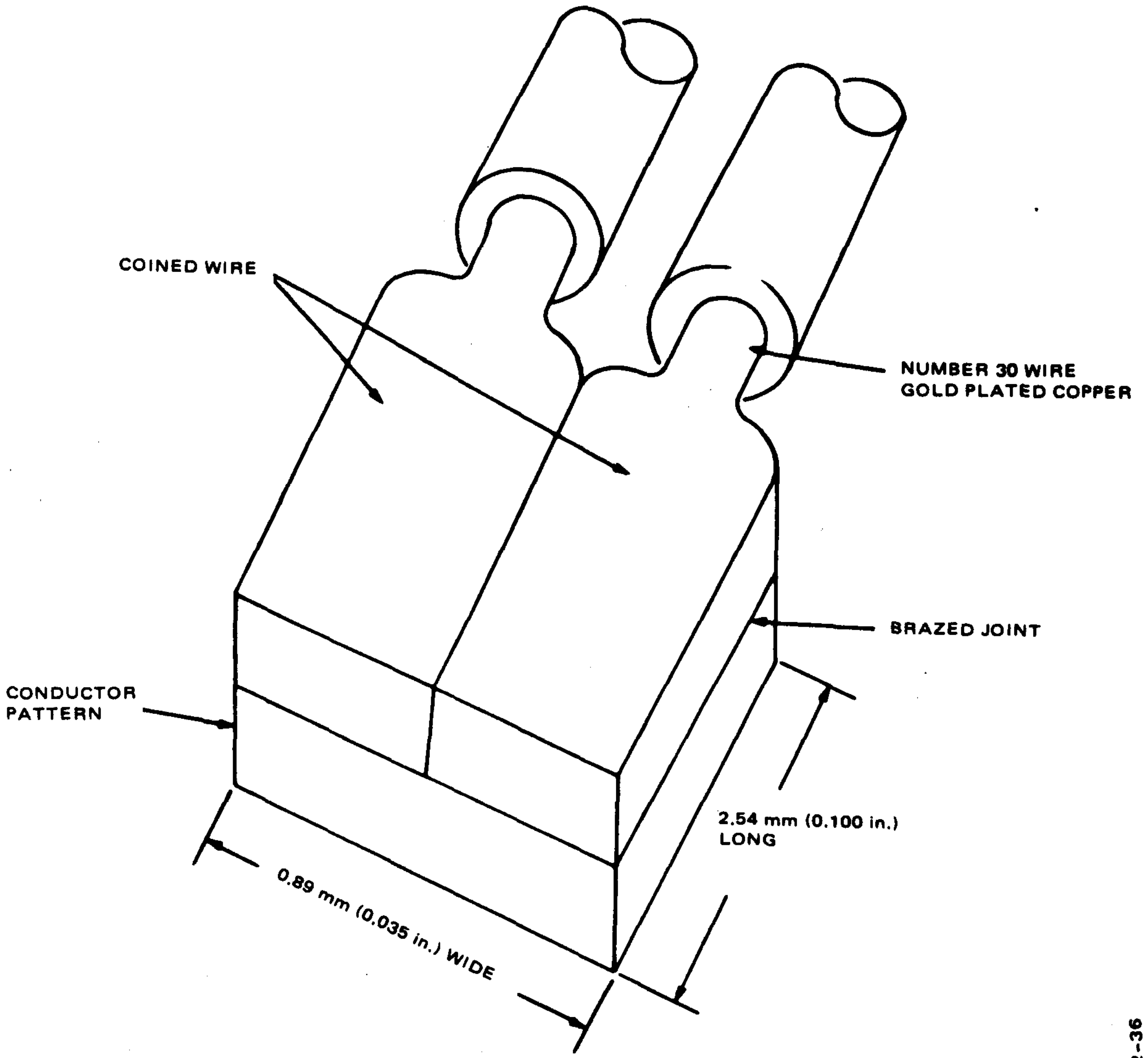


Figure 3-7. Single-Wire Attachment to Printed Circuit Pad



NOTE: ALL DIMENSIONS ARE APPROXIMATE

Figure 3-8. Double-Wire Attachment to Printed Circuit Pad

WARNING

Handling hot items presents a serious injury potential. Asbestos gloves are required.

10. Allow the adhesive to gel for a minimum of 1 hour at room temperature and then bake for 1 hour minimum at a temperature of 150 ±10 °F, or allow adhesive to air dry at room temperature for 24 hours. If adhesive is oven cured, allow it to cool at room temperature after removal from the oven.

3-36. REPAIR OF BROKEN THERMAL MOUNTING PLATE POWER OR GROUND TABS. Broken thermal mounting plate power or ground tabs may be repaired using copper jumper wire by performing 'the following steps:

1. Technical personnel familiar with the function of the circuit must determine the two points to which the copper jumper wire is to be attached.

2. Form the 26-gage insulated copper jumper wire to the designated points and cut to the required length (fig 3-9).

3. Strip a distance of 1/4 to 5/16 inch from the wire ends.

CAUTION

The areas to be soldered must be heated until the solder flows. Overheating can damage the board or nearby components. The wires being soldered must not be allowed to move in relation to one another until the solder has completely solidified.

4. Solder each end of the jumper wire to the selected pads.

5. Encapsulate the jumper wire as described in steps 6 thru 8.

WARNING

Adhesives are irritating to the skin and eyes upon contact, and may emit harmful vapor. Use only with adequate ventilation.. Avoid all skin and eye contact. Use protective clothing such as rubber gloves, apron and eye protection. Wash off immediately any accidentally contaminated skin area. Hand washing facilities and eye wash fountain should be provided. Do not take internally.

6. Use any one of the Narmco Epoxy Adhesive Kits No. 3135 listed in table 3-2. If the frozen premix kit is used, allow it to thaw to room temperature prior to use. If either of the two-part kits is used, mix small, approximately equal, quantities of Part A and Part B, using a disposable aluminum cup for mixing. Mix thoroughly.

7. Bond the jumper by applying a uniform coat of adhesive over the entire length of the jumper wire. Do not use more adhesive than necessary to completely cover the jumper wire.

WARNING

Handling hot items presents a serious injury potential. Asbestos gloves are required.

8. Allow the adhesive to gel for 1 hour minimum at room temperature and then bake for 1 hour minimum at temperature of 150 ± 10 *F or allow adhesive to air dry at room temperature for 24 hours minimum. If adhesive is oven cured, allow it to cool at room temperature after removal from the oven.

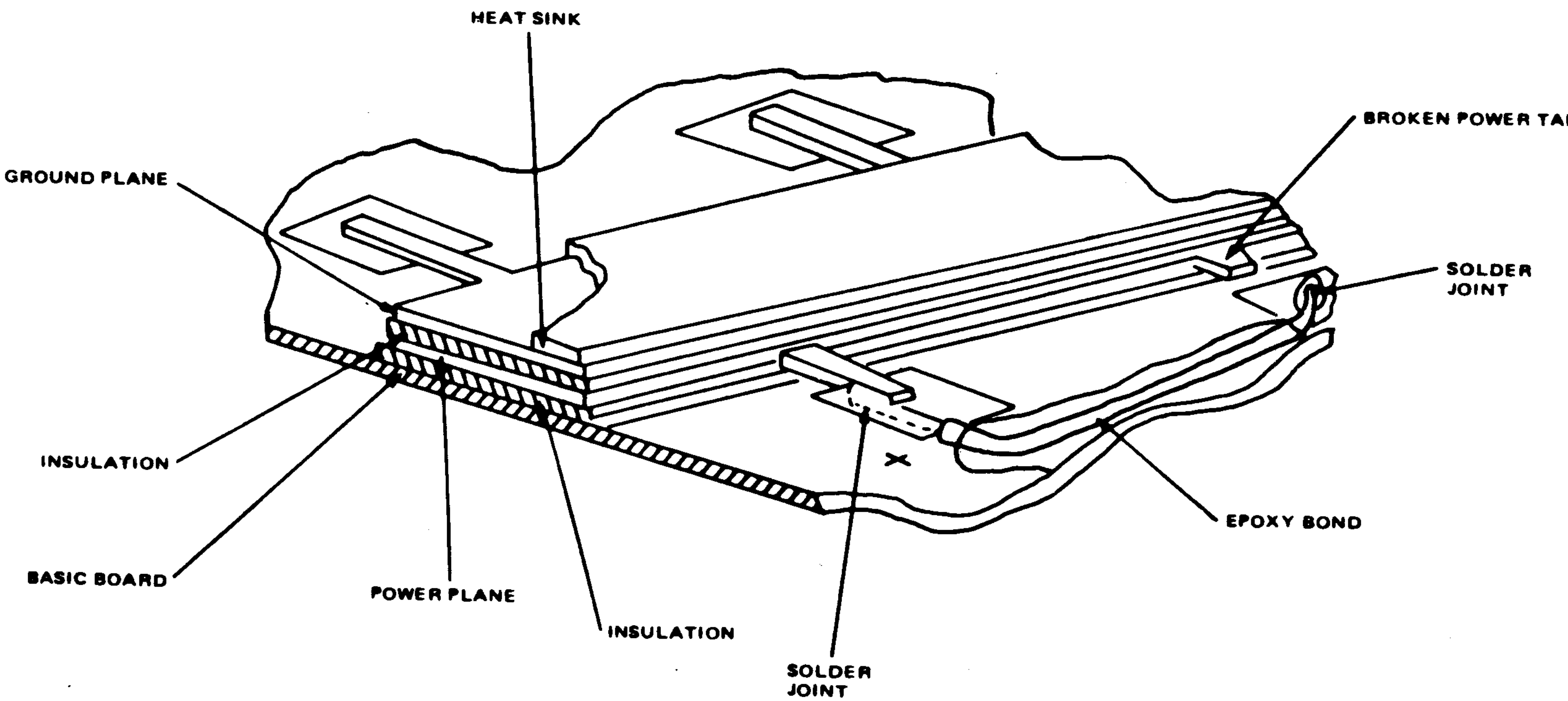


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Figure 3-9. Repair of Broken Thermal Mounting Plate Power or Ground Tabs

3-37. REPAIR OF CONCEALED SHORT CIRCUITS IN PRINTED WIRING ASSEMBLIES. Concealed short circuits in printed wiring assemblies may be repaired by performing the following steps.

NOTE

Jumper wires shall be installed on the rear side of the assembly whenever possible, but if necessary, jumper wires may be installed on the component side provided they do not cross over the top of a component.

NOTE

The repair of concealed short circuits involves three steps: (1) isolation of the shorted area, (2) cutting the conductors at each side of the short, and (3) restoring the continuity by the installation of jumper wires.

1. Technical personnel familiar with the function of the circuit must determine the area of the short circuit, the conductors to be cut, and the jumper wires to be installed.

2. Cut and remove a bit of circuitry 1/8 inch long in each shorted conductor on each side of the short.

3. Form 26-gage insulated copper jumper wires between the designated points on each side of the short circuit area.

4. Strip the ends of each jumper wire a distance of 1/4 to 5/16 inch.

CAUTION

The areas to be soldered must be heated until the solder flows. Overheating can damage the board or nearby components.

NOTE

If there is an eyelet or plated-through hole not being used for a component termination, it may be used as a jumper wire termination.

5. If the end of any one of the jumper wires is to be attached to an etched conductor, plate the stripped end of the wire on the conductor in a direction parallel to the etched conductor and solder in place. Then solder the ends of the other jumper wires in place.

6. Encapsulate each of the jumper wires as described in steps 7 thru 10.

WARNING

Use Freon with good ventilation. Avoid prolonged or repeated breathing of vapor. Avoid contact with skin and eyes. Do not take internally.

7. Clean the areas to be encapsulated using Freon TMC solvent. Be sure that all traces of rosin flux are removed.

WARNING

Adhesives are irritating to the skin and eyes upon contact, and may emit harmful vapor. Use only with adequate ventilation. Avoid all skin and eye contact. Use protective clothing such as rubber gloves, apron and eye protection. Wash off immediately any accidentally contaminated skin areas. Hand washing facilities and eye washing fountain should be provided. Do not take internally.

8. Use any one of the Narmco Epoxy Adhesive Kits No. 3135 listed in

table 3-2. If the frozen premix kit is used, allow it to thaw at room temperature prior to use. If either of the two-part kits is used, mix approximately equal quantities of Part A and Part B, using a disposable aluminum cup for mixing. Mix thoroughly.

9. Bond the jumper wires to the circuit board by applying a uniform coating of adhesive over the entire length of each jumper wire. Do not use more adhesive than necessary to completely cover the jumper wires.

10. Allow the adhesive to gel for 1 hour minimum at room temperature. Then bake for 1 hour minimum at a temperature of 150 ±10 °F, or allow the adhesive to dry at room temperature for 24 hours minimum. If adhesive is oven cured, allow it to cool at room temperature after removal from the oven.

3-38. REPAIR OF THERMAL MOUNTING PLATE ON HIGH-DENSITY PRINTED WIRING BOARDS. Thermal mounting plate on high-density printed wiring boards may be repaired by performing the following steps:

1. Carefully clean out all the loose adhesive from the area between the lifted thermal mounting pad and the printed wiring board using an orange stick, or equivalent hand tool.

WARNING

Use Freon with good ventilation. Avoid prolonged or repeated breathing of vapor. Avoid contact with skin and eyes. Do not take internally.

2. Clean the area to be repaired with Freon TMC solvent to remove residual surface contaminants.

WARNING

Adhesives are irritating to the skin and eyes upon contact, and may emit harmful vapors. Use only with adequate ventilation. Avoid all skin and eye contact. Use protective clothing such as rubber gloves, apron and eye protection. Wash off immediately any accidentally contaminated skin area. Hand washing facilities and eye wash fountain should be provided. Do not take internally.

3. Any one of the Narmco Epoxy Adhesive Kits No. 3135 listed in table 3-2 may be used as the repair adhesive. If the frozen premix kit is used, allow it to thaw at room temperature prior to use. If either of the two-part kits is used , mix small, approximately equal, quantities of Part A and Part B, using a disposable aluminum cup for mixing. Mix thoroughly.

4. Carefully apply a thin smooth coat of adhesive under the thermal mounting pad. Do not use more” adhesive than necessary.

5. Carefully clamp the thermal mounting plate to the board.

6. Allow the adhesive to gel for at least 1 hour at room temperature.

WARNING

Handling hot items presents a serious injury potential. Asbestos gloves are required.

7. Bake the board in an oven at 150 ±10 °F, for at least 1 hour.

8. Remove the board from the oven and allow it to cool to room temperature. Remove the clamp(s).

3-39. REPAIR OF DEFECTIVE PLATED-THROUGH HOLE. Defective plated-through holes can be repaired by performing the following steps.

NOTE

If there should be a component placed in such a manner as to interfere with the performance of this repair, remove that component according to the procedure contained in paragraph 3-27 or paragraph 3-28. Handle this removed component with care because it may be reinstalled upon the completion of this repair.

1. Cut a length of 34-gage uninsulated tin-coated wire from 50 to 100 millimeters (2 to 4 inches) long and pass it through the defective plated-through. hole. If the wire will not pass through the hole, due to solder build-up, the hole may be cleared with the use of a vacuum resoldering unit.

2. Hold one end of the wire against one side of the circuit card and pull the other end taut and down against the other side of the circuit card, being careful to avoid aligning the wire with any circuit traces emerging from the pad.

3. Turn the circuit card over and repeat step 2 for the opposite side.

4. Using solder, the soldering iron, and the flux, carefully solder the wire to the pad using a minimum amount of solder.

5. Turn the circuit card over and repeat step 4 as required.

CAUTION

Do not cut down into the circuit card pad when trimming the wire.

6. Using an X-acto knife, very carefully cut down into the wire just at, or ahead of, the point where it emerges from the solder.

NOTE

The wire shall not extend past the periphery of the pad to which it is soldered.

7. Grasp the free end of the wire and lift it slowly so that it separates at the cut produced in step 6.

8. Turn the circuit card over and repeat steps 6 and 7 for the other side of the repair.

9. Apply a small amount of soldering flux to each side of the repair, and using the soldering iron touch up the solder joints to cover any of the copper wire exposed by the trimming of the leads.

WARNING

Isopropyl alcohol is flammable. Keep away from heat and open flame. Vapors may be harmful. Use with adequate ventilation. Avoid prolonged or repeated breathing of vapor. Avoid eye contact. Do not take internally.

10. Clean the repaired area with isopropyl alcohol.

11. If a component has been removed in order to accomplish this repair, and if it is visually and mechanically sound, replace that component according to the procedure in paragraphs 3-30, 3-31, or 3-32. If the component is defective, replace it with an identical new component.

SECTION II

CLEANING AND EXAMINATION

3-40. GENERAL.

3-41. This section contains general information for the cleaning and inspection of the AN/PRC-104 equipment. The term "cleaning" means all those processes by which dirt or contaminants are removed from the equipment without causing damage to the equipment or hazard to the health of personnel. The term "examination" means all those processes by which the equipment is compared or measured against an acceptable standard for cleanliness, mechanical and electrical (electronic) condition, serviceability, and performance capability.

3-42. CLEANING.

3-43. The general cleaning procedures contained in this section are applicable for field and depot maintenance and rebuild.

WARNING

When using a compressed airjet, use eyeshields.

WARNING

When using solvents, provide proper ventilation, avoid prolonged contact, and do not smoke. Solvents must meet all pertinent specifications regarding toxicity, flammability, and allergenic effect.

CAUTION

Compressed air must be clean, drv, and at a maximum pressure of 28 psi. Do not overlook the force of the airjet when cleaning delicate parts.

CAUTION

Certain solvents will damage insulation. Do not use solvents chemically similar to "Chlorothene" or "Glyptal" to clean module connectors. Use only denatured alcohol for this purpose.

3-44. EXTERNAL. Clean the exterior of the radio set by using an airjet. If accumulated dirt cannot be removed by the airjet alone, use a medium-stiff camel's hair or similar brush to aid the airjet action.

3-45. An approved solvent or detergent may be used to remove grease, oil, or other contaminants, provided that it is not allowed to run into the insulated sleeving of cable assemblies and wiring. All solvents and detergents tend to cause binding if allowed to seep Into shaft bearings,or other moving parts.

3-46. INTERNAL. The interior of the receiver/exciter and amplifier/coupler and separate disassembled parts may be cleaned by using one or more of the following methods:

1. Clean, dry, lint-free cloth.

2. Airjet and brush.

3. Flushing and dipping of separate mechanical parts using an approved solvent or detergent.

4. Flushing and dipping of separate nonmetallic parts in denatured alcohol only.

3-47. CORROSION CONTROL. The following periodic checks and services are required for prevention and control of corrosion and fungus of the radio set.

1. Inspect the exterior of each unit for corrosion and fungus (particularly, around the controls, connectors, and latches).

2. Remove all corrosion and fungus with a cloth and/or brush moistened in cleaning solvent.

3. Repaint all treated areas immediately upon removal of corrosion to alleviate the re-occurrence of corrosion buildup.

3-48. EXAMINATION.

3-49. The general examination procedures contained in this section are applicable for field and depot maintenance and rebuild. It is expected that the majority of examination for field maintenance will take place during troubleshooting, and that examination will simply consist of ensuring that the replaced component is installed correctly, and the equipment passes the performance test.

3-50. GENERAL. The term "examination" is best defined by describing the intent and scope of the inspection work areas, since there are no procedures in this manual which can be separately called "inspection procedures." The intent and scope of the inspection work areas (which have been given arbitrary names) are described under the pertinent subheadings which follow.

3-51. FIRST EXAMINATION. The first, incoming, or receiving examination consists of sorting out the units and modules of the AN/PRC-104 for disposal according to the following criteria:

NOTE

The action required by 1. thru 3. following may not necessarily take place at depot level.

1. Salvage of undamaged parts.

2. Write-off of heavily damaged or missing assemblies.

3. Replacement of written-off assemblies.

4. Scheduling and routing of the units and modules or the complete AN/PRC-104, as applicable, for rebuild processing.

3-52. IN-PROCESS EXAMINATION. In-process examination covers a wide over all inspection work area which may be broken down into smaller work areas as follows:

1. Mechanical and Visual Inspection. The intent is to quickly determine the obvious aspects of the overall maintenance and rebuild requirement. For example," some damaged connector pins in the receiver/exciter would not necessarily involve a complete disassembly, but a damaged receiver/exciter housing would involve an extensive mechanical disassembly.

2. Troubleshooting Inspection. The objective of troubleshooting is to locate the site of a malfunction, after which repair can be carried out. Thus, troubleshooting is an inspection process which determines how a malfunctioning item of equipment can be made serviceable. However, in many cases, this process may require disassembly (refer to 3. following), and the repair may actually be carried out during troubleshooting (to prove the correctness of the troubleshooting diagnosis). In this way, troubleshooting inspection also identifies the replacement item.

3. Disassembly Inspection. This visual inspection is concerned with the following objectives.

   a. To detect frayed, burnt, shorting, or broken cables, wiring, and dry-jointed, shorted, or grounded solder connections.

   b. To detect blackened, overheated, broken, or missing electrical/electronic components and parts.

   c. To detect missing or broken hardware, loose mountings, and missing mechanical parts.

   d. To detect mechanical binding, sticking, looseness, and excessive wear of moving parts.

   e. To record any action required by a. thru d. above including identification of replacement items for repair.

4. Reassembly Inspection. The objective of this inspection is to avoid malfunction or rework after reassembly. The inspection areas are as follows:

   a. observance of critical positioning or adjustment of all mechanical and electrical/electronic parts.

   b. All required hardware is used and correct.

   c. All required parts are used and correct.

   d. All required wiring, soldering, and sleeving is correct. This includes correct “dressing’” arrangement of wire harnesses and cables, etc.

   e. Liquid staking used where required.

   f. Correct lubrication used where required .

   g. There is no binding, sticking, or looseness of moving mechanical parts.

   h. All electrical/electronic parts are correctly orientated for clearances and lead shortness. Printed circuit boards are not under strain due to Incorrect mounting.

   i. No short-circuits or grounds are caused by module case or cover.

3-53. FINAL INSPECTION. The final inspection may be divided into six work areas as follows:

1. Final mechanical and visual inspection of each module following reassembly.

2. Final performance test for each module assembly.

3. Final mechanical and visual inspection of units and modules following reassembly.

4. Final performance test for each unit.

5. Final performance tests for radio set.

6. Documentation, packaging, and shipping inspection for the complete AN/PRC-104, as applicable.

SECTION III

FABRICATION OF SPECIAL SUPPORT EQUIPMENT

3-54. GENERAL.

3-55. This section contains drawings for fabrication of test cables, adapters and fixtures required to perform test, troubleshooting and alignment of the radio set, units and modules. Fabrication data is provided for the following items of special support equipment:

1. Modulator/Demodulator Test Extender Cable (fig 3-10A)
2. Antenna Tuner Test Extender Cable (fig 3-10B)
3. Synthesizer Extender Cable (fig 3-10C)
4. Harmonic Filter/Power Amplifier Test Extender Cable (fig 3-10D)
5. RF Coax Cable (fig 3-11A)
6. RF Extender Cable (fig 3-11B)
7. Audio Input/Keying Adapter (fig 3-11C)
8. Whip Adapter (fig 3-11D)
9. 100 ohm Load (fig 3-11E)
10. 130 ohm Load (fig 3-11F)
11. Frequency Converter Test Bed (fig 3-12)

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Figure 3-10. Fabricated Test Extender Cables

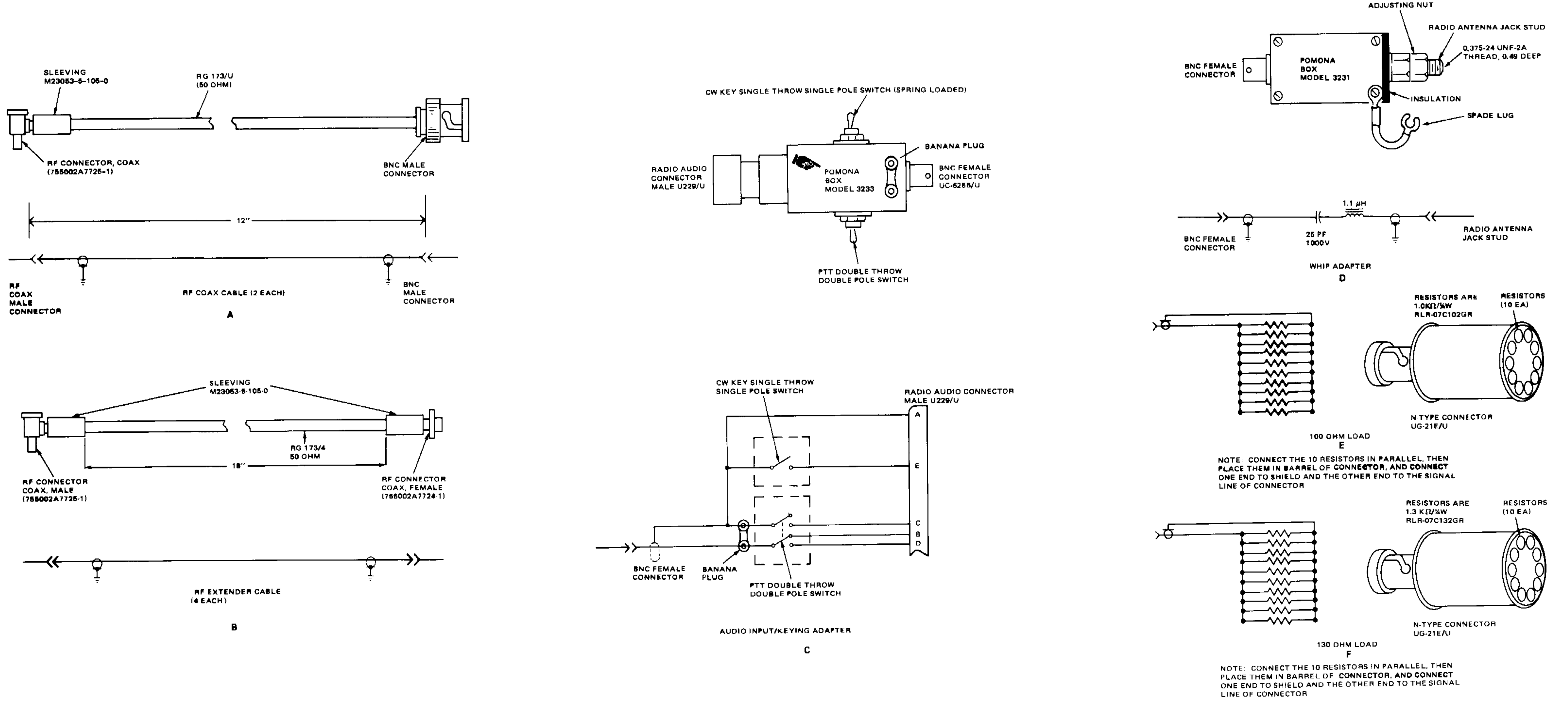


Figure 3-11. Fabricated Test Cables and Adapters

FABRICATION INFORMATION

Troubleshooting of the three frequency converter submodules is best accomplished using three separate frequency converter test beds. Each test bed is a complete and functional modulator/demodulator, with the exception of the test bed extension for either the first, second, or third converter respectively. The frequency converter under test is plugged into the sockets of the extension (although if a pin is misshaped, a jumper must be inserted).

Fabrication of the test bed extension may be accomplished as outlined below:

NOTE

Any equivalent methods or materials may be used. Refer to the Stock List manual for identification of piece parts required.

1. Cut a bare modulator/demodulator printed wiring board out around the first, second, and third converter positions.

2. Insert the amplifier 50864 sockets into the holes for the pins.

3. Remove the appropriate frequency converter submodule from the modulator/demodulator that is to be used as the test module.

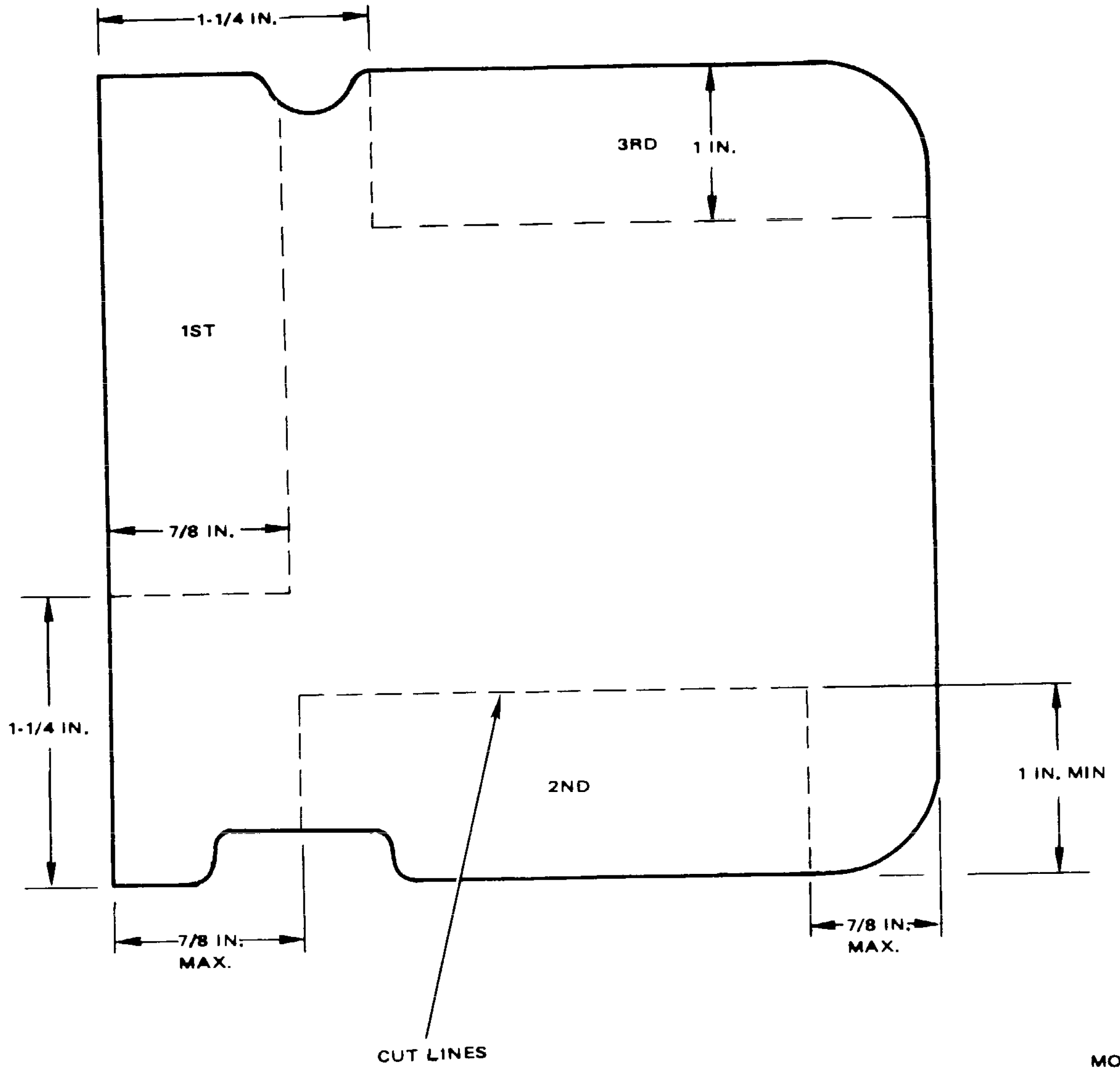
4. Drill 4 holes in the test module for the extender pillars. Be extremely careful to avoid damaging any printed wiring in this four-layer PC board.

5. Drill 4 corresponding holes in the cut out printed wiring board.

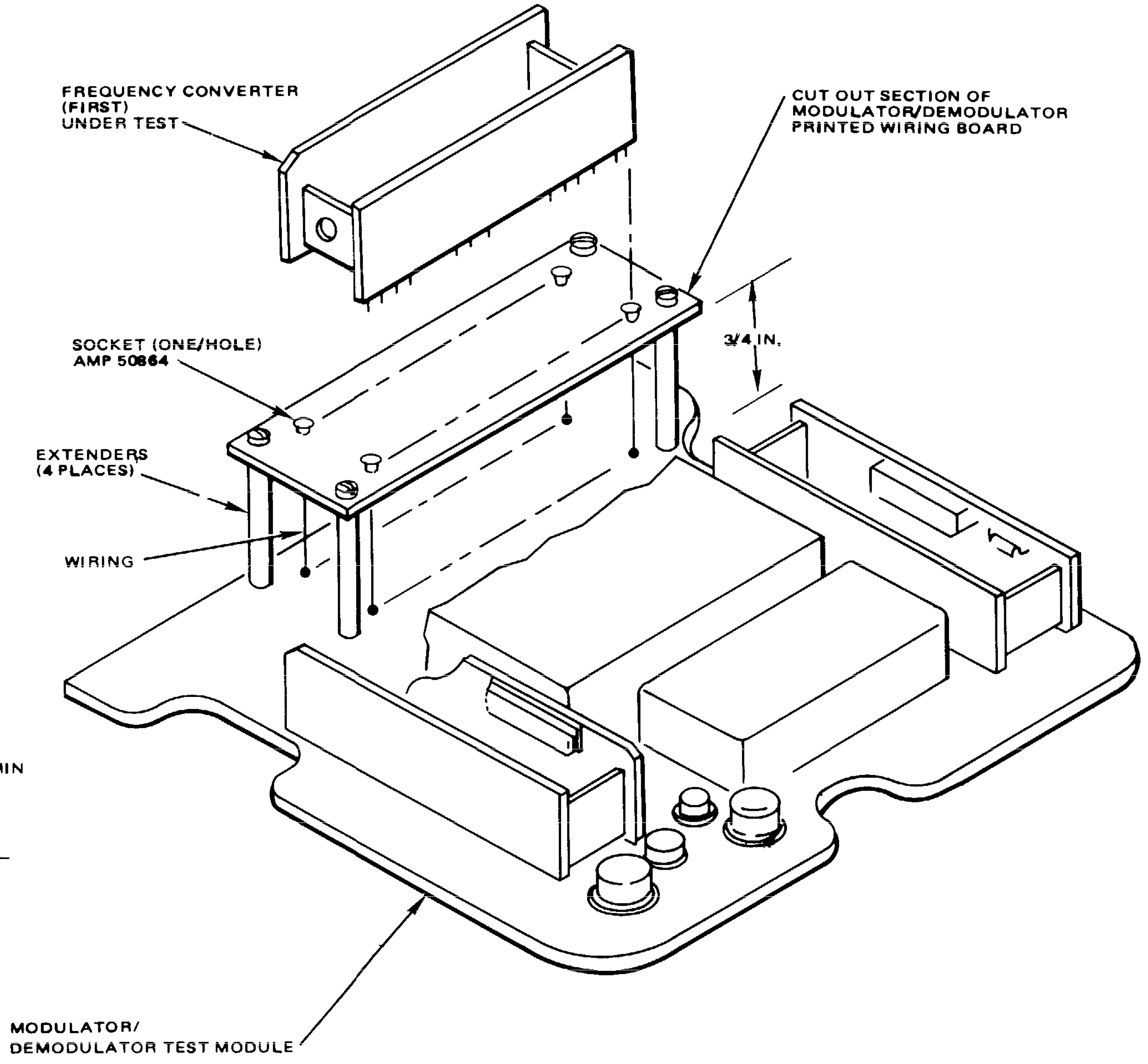
6. Mount the extender pillars onto the cut out printed wiring board.

7. Connect a shielded wire from each socket to the corresponding hole in the test module.

8. Mount the test bed extension onto the test module.



PRINTED WIRING BOARD TO BE CUT OUT



TEST BED EXTENSION IS SIMILAR FOR FIRST CONVERTER, SECOND CONVERTER, THIRD CONVERTER

Figure 3–12. Fabricated Frequency Converter A1A1A1, A1A1A2, A1A1A3 Test Beds

SECTION IV

PERFORMANCE TEST AND TROUBLESHOOTING

3-56. GENERAL.

3-57. Performance tests and trouble–shooting of the radio set units and modules requires a known good radio set as a test bed. The unit (or module) under test (UUT) replaces the known good unit or module of the test bed radio set, and is connected to the test bed by fabricated test cables.

3-58. PERFORMANCE TEST AND TROUBLESHOOTING.

3-59. The performance test flowcharts provide the necessary procedures and information to completely test the radio, a unit or a module (unit under test). The flowcharts also provide troubleshooting procedures as an aid in fault isolating to a group of components if the UUT does not pass a performance test.

3-60. USE OF FLOWCHARTS (Figure 3-13). The performance test procedure path on the flowcharts is indicated by a heavy flow line. The procedure begins at the bubble symbol that reads "Unit Under Test.” Next, the initial setup block references applicable removal disassembly and reassembly instructions, a test setup diagram, and provides initial switch settings required for the test. The initial setup block is followed by a series of procedural blocks, which contain actions required to produce a result, and decision blocks, which asks whether the desired result occurred. If the desired result has occurred, the “yes” pathway is followed; if the desired result did not occur, the "no" pathway is followed for the troubleshooting procedure. The performance test is successfully completed when the “Test Passed” bubble symbol is reached. The troubleshooting procedure is completed when a fault-indication block is reached. Once the fault is corrected, the performance test is resumed at the point where first fault indication occurred. If a flowchart is extended to another sheet, the continuation symbol is used. Caution and warning notes appear to alert the user to potential equipment or human hazards.

3-61. TEST AND TROUBLESHOOTING REFERENCE DATA. The performance test flowcharts are used in conjunction with the supporting data below. Figure 3-14 depicts the arrangement of maintenance information contained in each maintenance chapter.

1. Disassembly and Reassembly Procedures. These procedures provide the information necessary to remove and replace a “Unit Under Test.”

2. Performance Test Setup Diagrams. The test setup diagrams show what test equipment is required for the performance test and troubleshooting, and how to connect the test equipment to the “Unit Under Test.”

3. Alignment Procedures. The alignment procedures are performed when specified in the troubleshooting procedures. They are usually required during troubleshooting to ensure the “Unit Under Test” is properly aligned before determining faulty components.

4. Functional Block Diagrams. The functional block diagrams may be used as an aid to troubleshooting in conjunction with the flowcharts.

5. Schematic Diagram. The schematics for the, "Unit Under Test” are used to aid in’ identifying suspected faulty components. For example, if the fault block on the troubleshooting flowcharts calls out

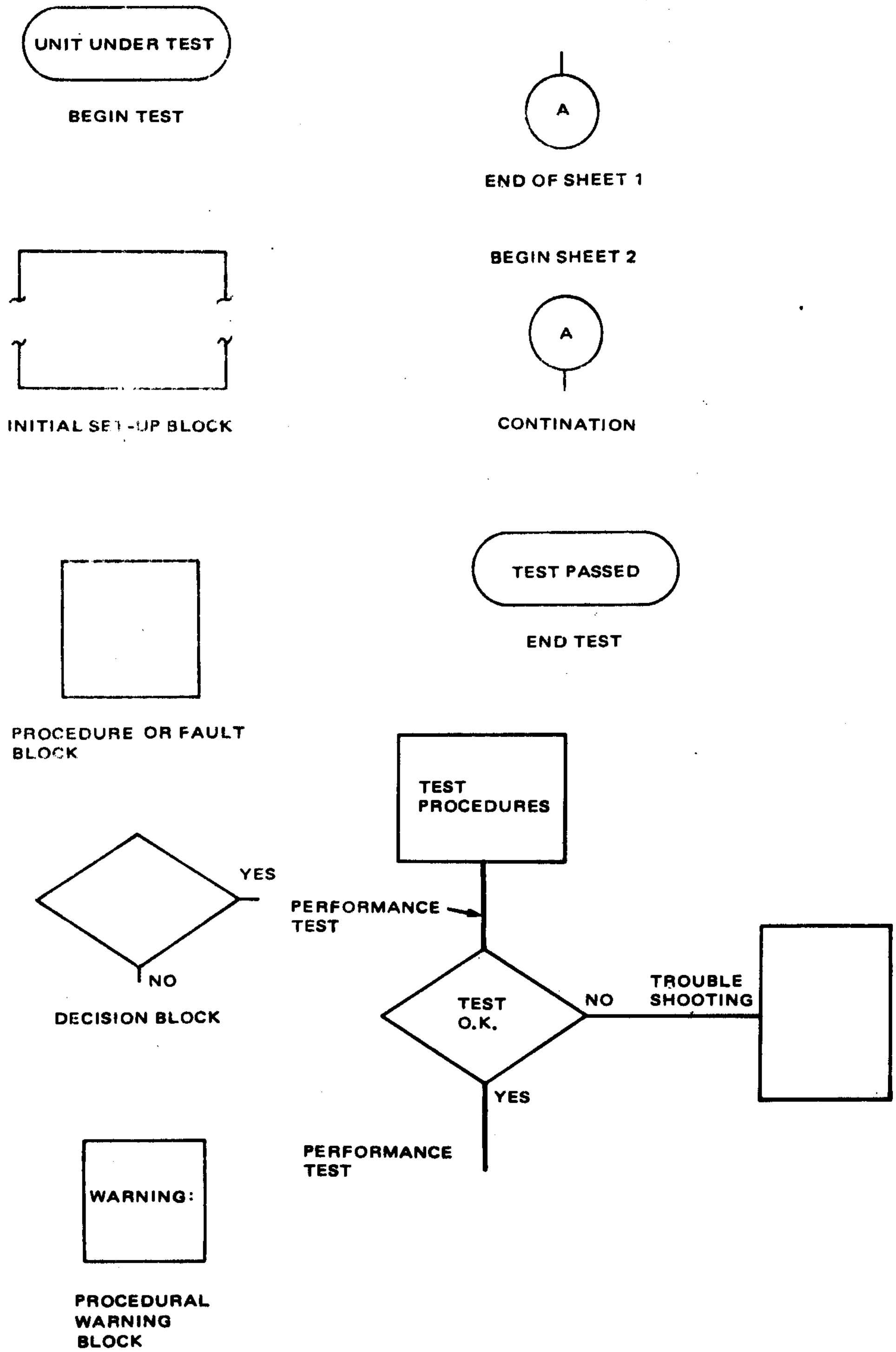


Figure 3-13. Flowchart Symbols

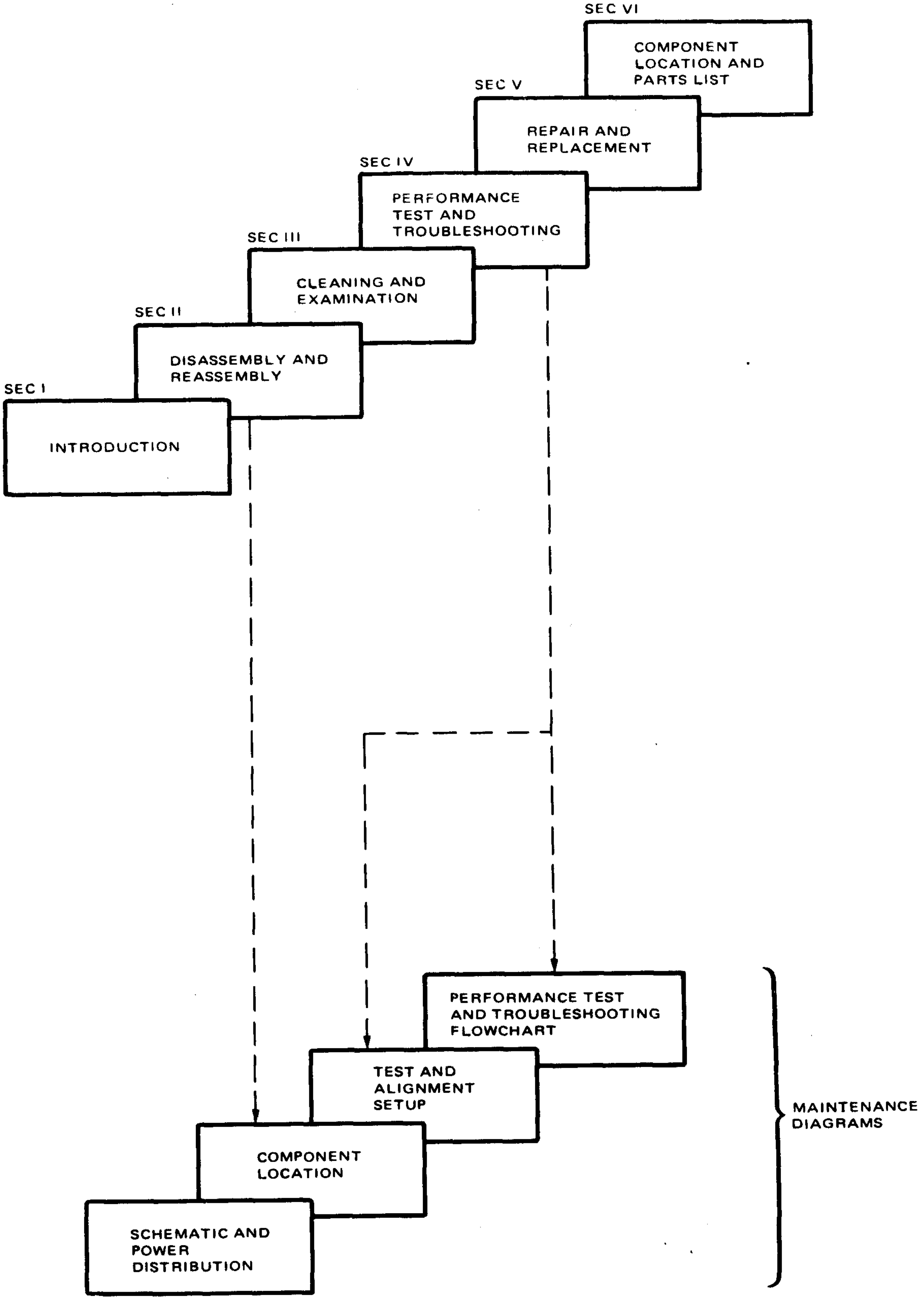


Figure 3-14. Maintenance Chapter Construction

"Switch Q1 Fault," the schematic is used to identify the components associated with Q1 (ie, capacitors, resistors, inductors, etc). The schematics contain pertinent voltage and waveform data to aid in fault isolation.

6. Component Location Diagrqms. The component location diagrams for each "Unit Under Test" are used for three purposes:

a. To identify the location of all components in disassembly and reassembly procedures.

b. To identify the location of the test points and pins required to monitor waveforms and voltages in the performance test and troubleshooting flowcharts. The numbers printed on the backs of the modules correspond to the test points shown on schematics.

c. To identify the location of every replaceable component.

3-62. DESCRIPTION OF COMPONENT LOCATION DIAGRAMS. The component location diagrams provide physical identification of all replaceable piece parts in the radio set. The component location diagrams provide component location information only; for ordering of piece parts refer to the Repair Parts and Special Tools List TM 11-5820-919-24P. There isaseparate diagram for the radio set, each unit, each module, and the cable assemblies. Each component location diagram is supported bya repair parts and special tools list with three columns of data, as follows:

1. ITEM column. Item numbers assigned in numerical sequence, starting with 1 , which correspond to the item numbers shown on the component location diagram for each component. Numbers are assigned clockwise, starting at the top of the illustration. For circuit card assemblies, the actual reference designator is used instead of a sequence number; the sequence is again clockwise, starting at the top.

2. DESCRIPTION column. Contains short name or description of each component. May also contain reference designator number where necessary.

SECTION V

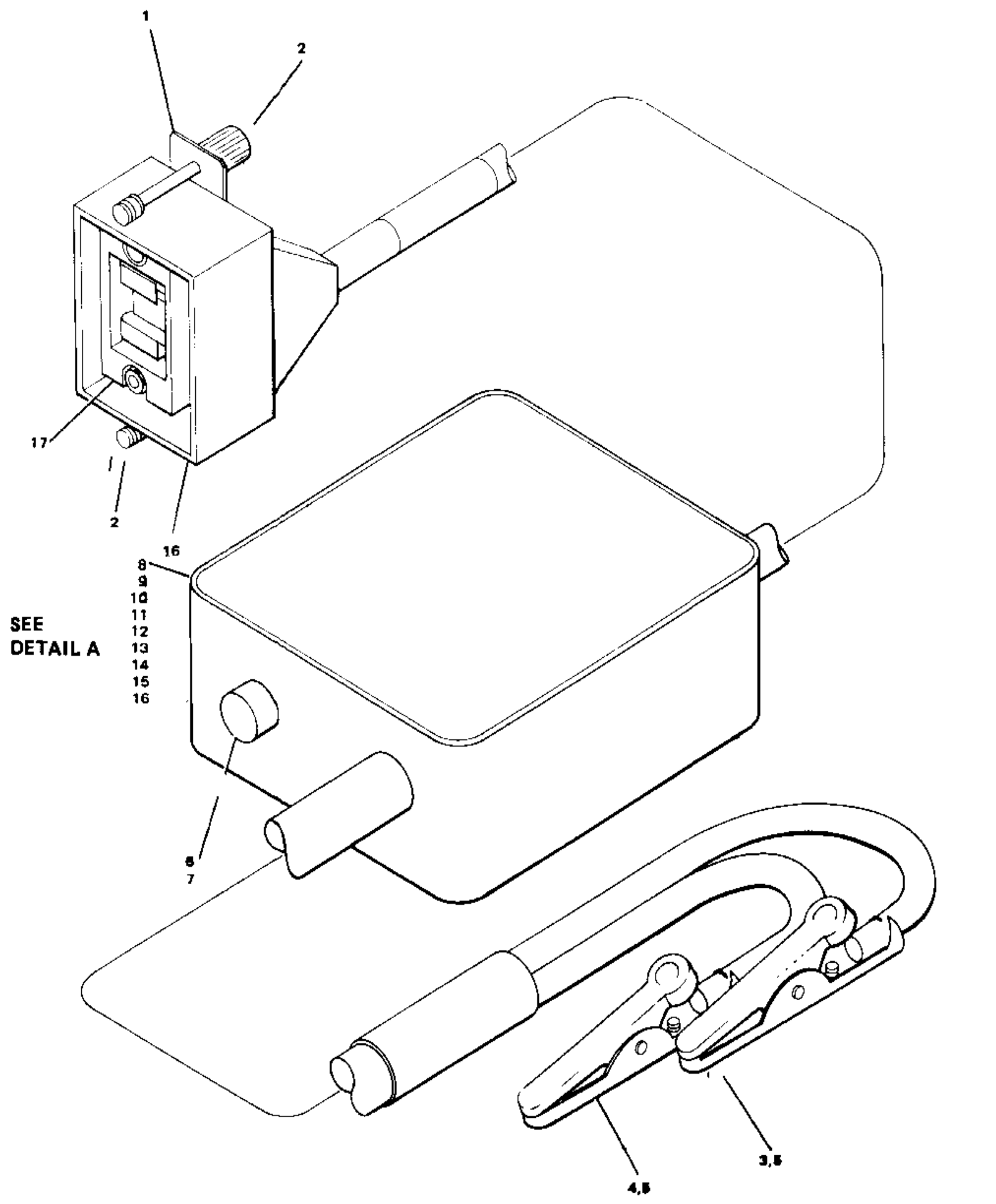
MAINTENANCE DATA FOR ACCESSORIES

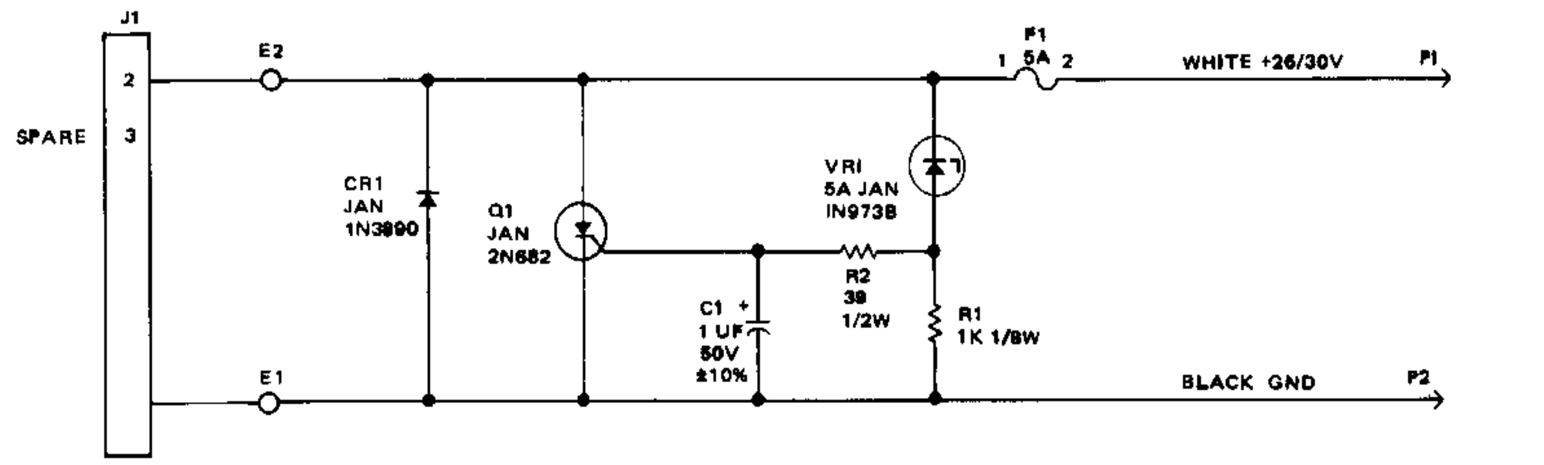
3-63. GENERAL.

3-64. This section contains maintenance information for those radio set accessory equipments that are unique to the AN/PRC-104 application. The maintenance information is provided on maintenance drawings which include schematics, component location and fabrication data, as applicable. Maintenance drawings are provided for the following accessory equipments (refer to table 1-2 for military nomenclature):

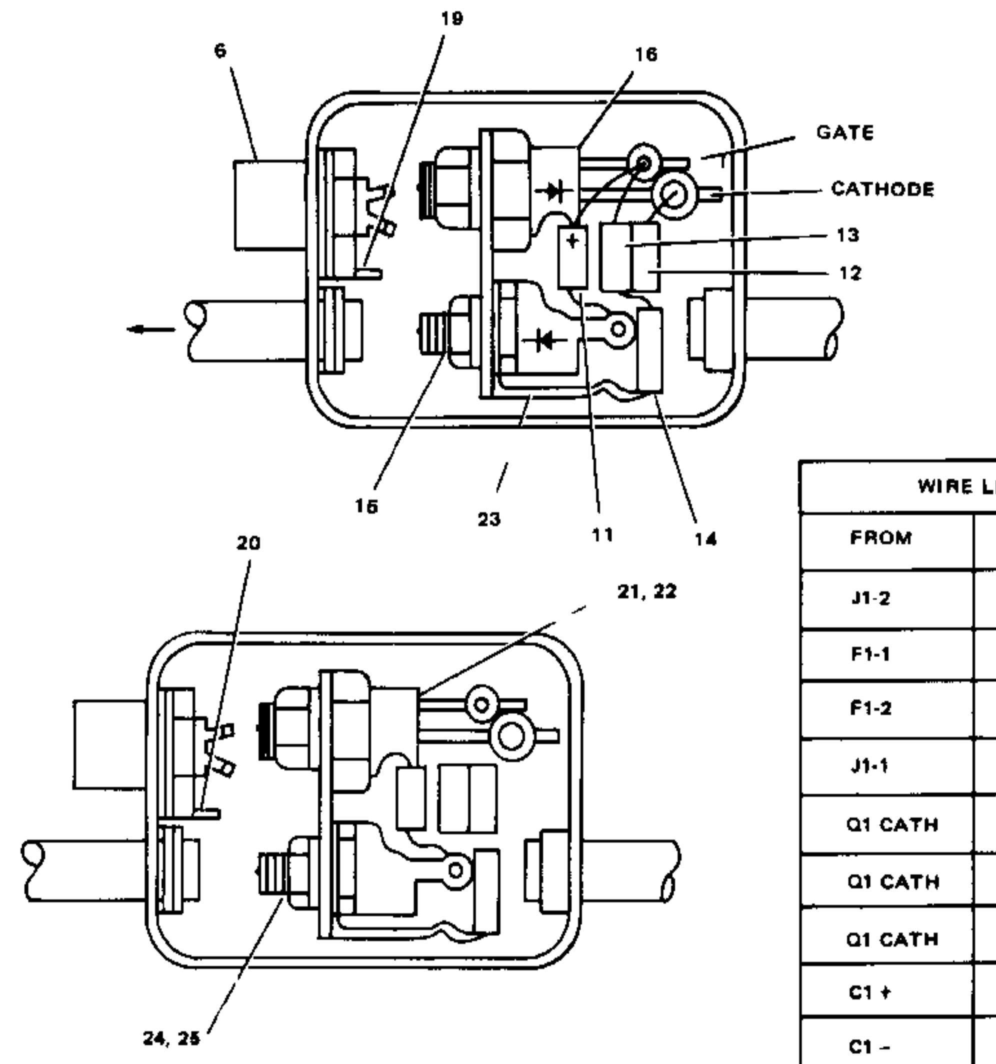
1. Bench Test Cable (fig 3-15)
2. Battery Extender Cable (fig 3-16)
3. Antenna Base (fig 3-17)
4. Telegraph Key (fig 3-18)
5. Transit Case (fig 3-19)

ITEM	DESCRIPTION
1	Strap, Cover
2	Thumb Screw
3	Insulator, Red
4	Insulator, Black
5	Clip, Electrical
6	Fuse
7	Fuse Holder
8	Housing, Prot. Ckt.
9	Junction Box
10	Bracket, Xstr Mounting
11	Capacitor
12	Resistor, R1
13	Resistor, R2
14	Semiconductor, VR1
15	Semiconductor, CR1
16	Thyristor, Q1
17	Cover, Connector
18	Connector, Battery
19	Terminal lug, E1
20	Washer, lock
21	Nut, hexagon
22	Washer, lock
23	Terminal lug, E2
24	Nut, Hexagon
25	Washer, lock





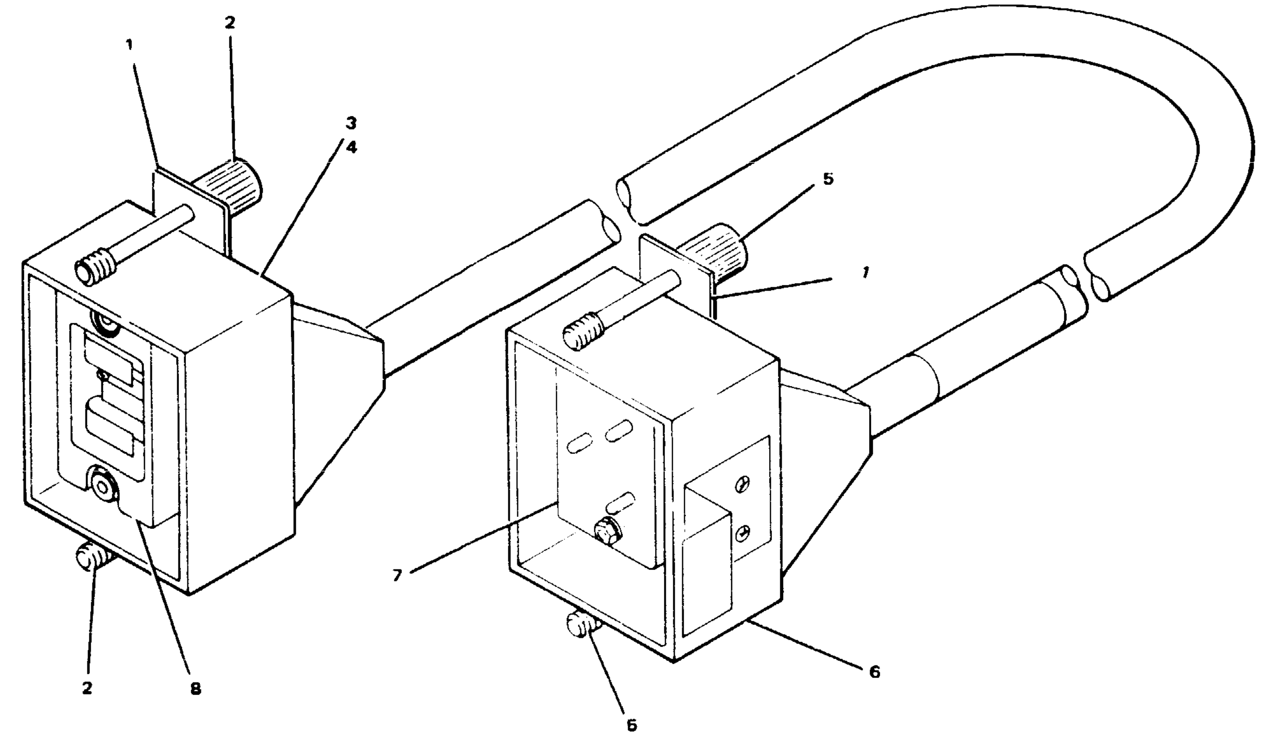
SCHEMATIC DIAGRAM



DETAIL A

WIRE LIST	
FROM	TO
J1-2	F1-1
F1-1	E2
F1-2	P1
J1-1	Q1 CATH
Q1 CATH	P2
Q1 CATH	E1
Q1 CATH	CR1 ANODE
C1 +	Q1 GATE
C1 -	CR1 ANODE
R1	Q1 CATH
R1	VR1 ANODE
R2	VR1 ANODE
R2	Q1 GATE
VR1 CATH	E2

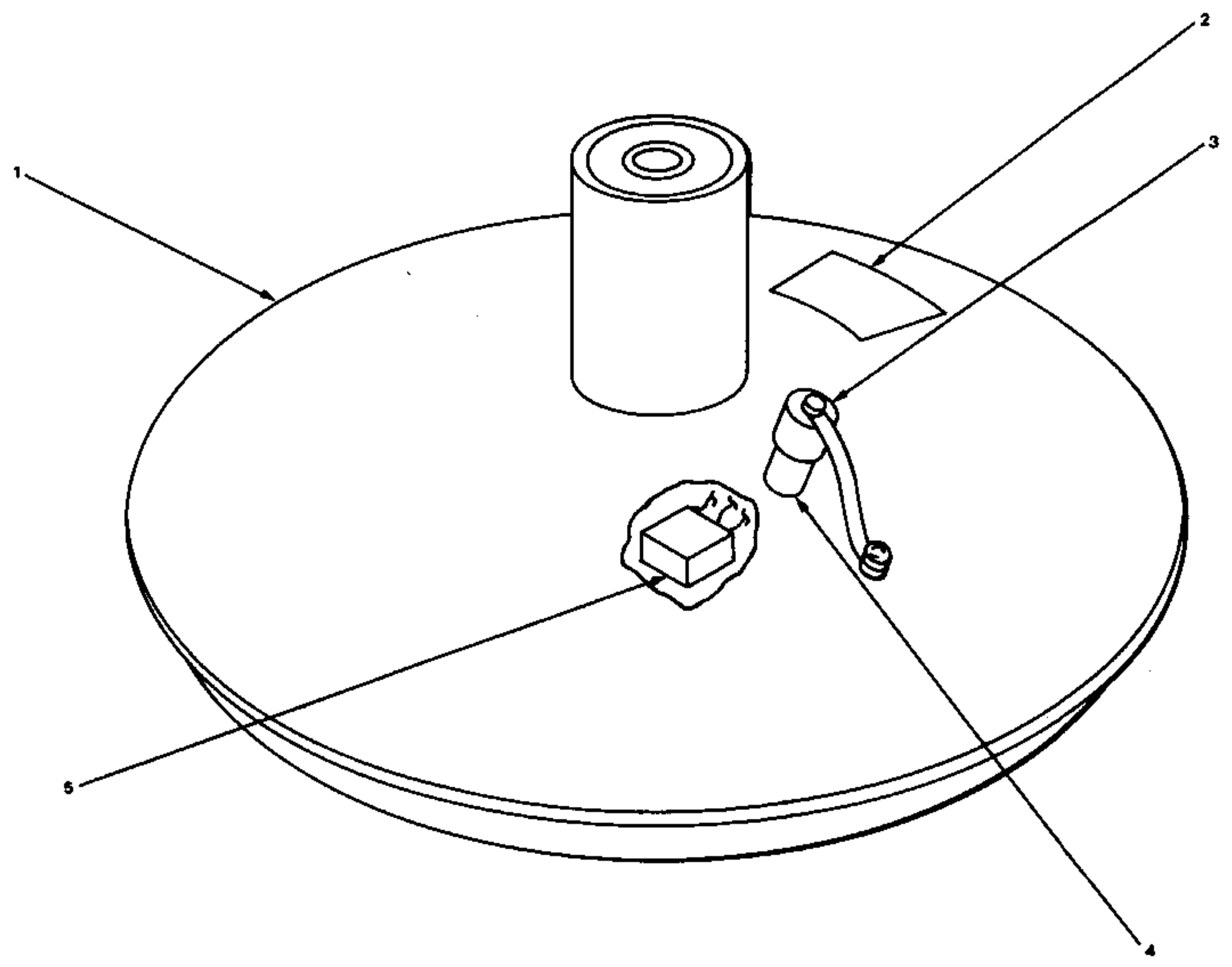
Figure 3-15. Bench Test Cable



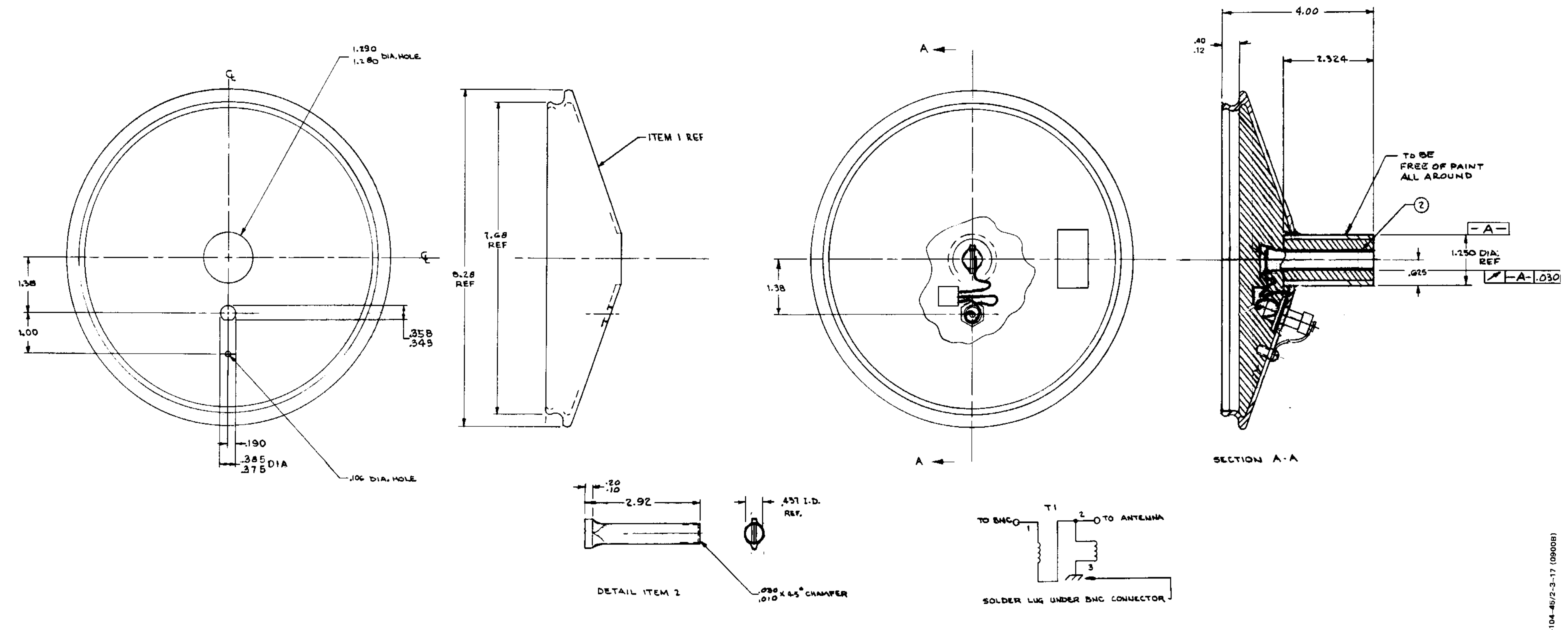
ITEM	DESCRIPTION
1	Strap, Cover
2	Thumb Screw
3	Cover, Connector
4	Cover, Junction Box
5	Thumb Screw
6	Cover, Connector
7	Connector
8	Connector, Battery

Figure 3-16. Battery Extender Cable

ITEM	DESCRIPTION
1	Antenna Base
2	ID Plate
3	Connector, Coaxial
4	Connector, Receptacle
5	Transformer, R.F.

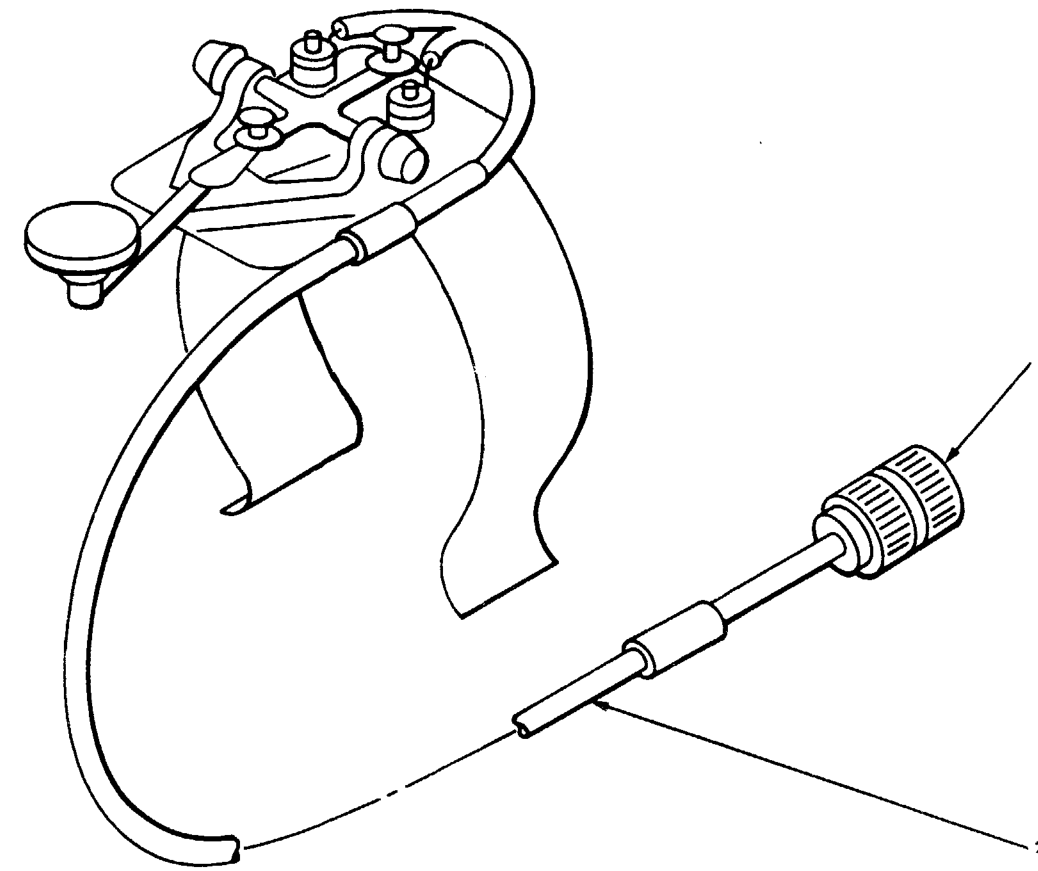


A. COMPONENT LOCATION



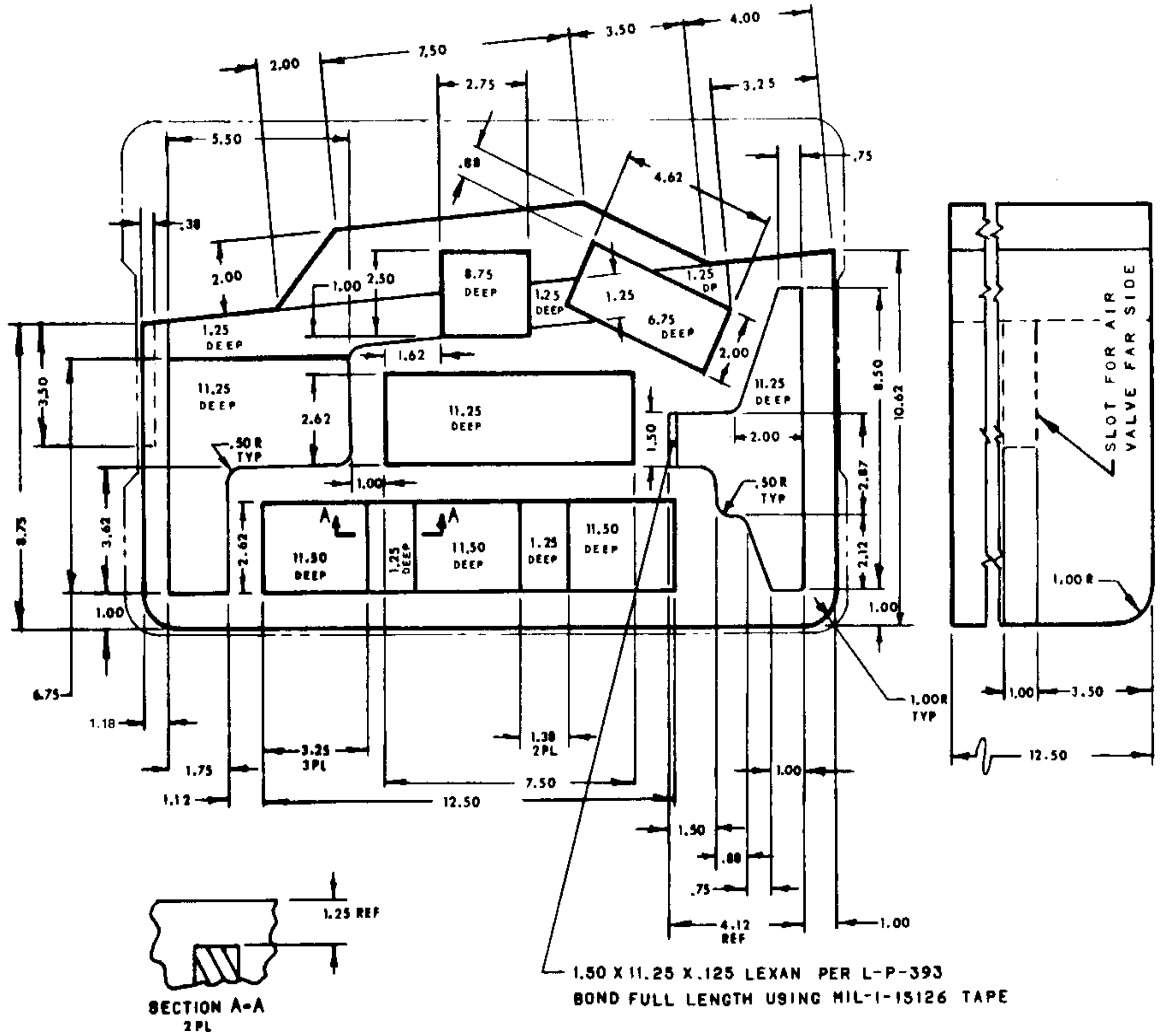
B. FABRICATION

Figure 3-17. Antenna Base

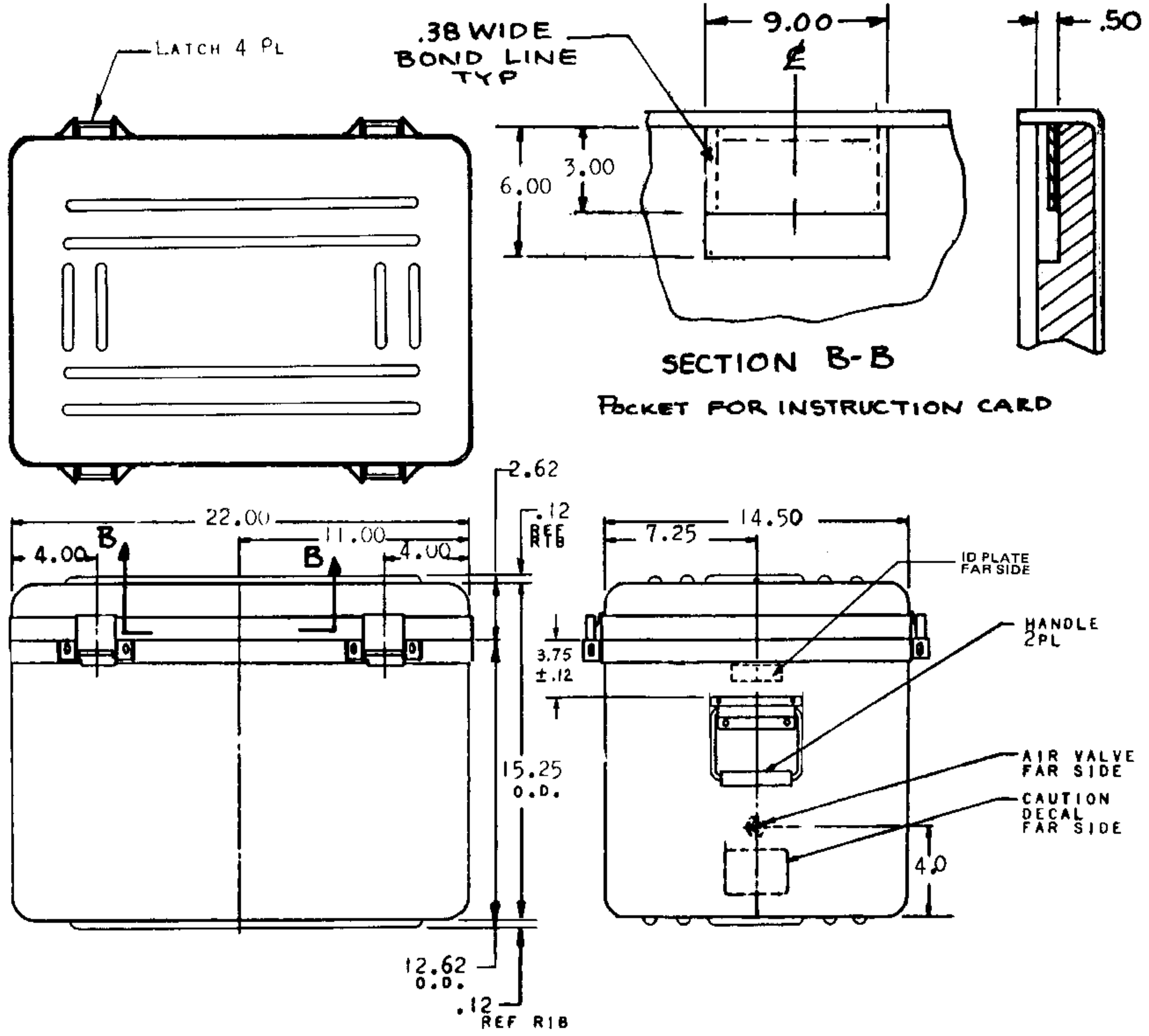


ITEM	DESCRIPTION
1	Connector
2	Cable Assembly

Figure 3-18. Telegraph Key



EQUIPMENT PROTECTION PAD



PRC-104-45/2-3-19(31008)

Figure 3-19. Transit Case

CHAPTER 4

RADIO SET

SECTION I

INTRODUCTION

4-1. INTRODUCTION.

4-2. This chapter provides the necessary information to maintain Radio Set AN/PRC-104 (radio set). The performance test and troubleshooting flowchart checks out the complete radio set, and aids the maintenance technician in isolating a fault to a unit. Disassembly and reassembly procedures are provided to separate the three units (receiver/exciter, amplifier/coupler, and battery pack). Maintenance information for the radio set Is presented as follows:

1. Support Equipment and Materials
2. Disassembly and Reassembly
3. Cleaning and Examination
4. Performance Test and troubleshooting
5. Repair and Replacement
6. Component Location and Parts List
7. Maintenance Diagrams (power distribution (fig 4-1), rf cabling (fig 4-2), component location (fig 4-3), test setup (fig 4-4), performance test and troubleshooting (fig 4-5))

4-3. The special tools, materials, and fabricated test cables and fixtures required for maintenance of the radio set are listed in table 4-1.

4-4. Table 4-2 lists the test equipment required to test the amplifier/coupler. Equivalent test equipment may be used.

TABLE 4-1. SPECIAL TOOLS, MATERIALS, AND FABRICATED TEST CABLES AND FIXTURES

Description	Part Number	Reference
Audio Input/Keying Adapter	...	Figure 3-11C
Whip Adapter	...	Figure 3-11D
Kit, Tool, Electronic	TK-100/G	None
Bench Repair Center	Pace PRC-350C	None
Maintenance Kit, Printed Circuit	MK-984/A	None

TABLE 4-2. TEST EQUIPMENT

NOTES:
1. * Denotes test equipment not required for Air Force intermediate maintenance.
2. Equivalent test equipment may be used.
3. Use only test equipment that is properly calibrated. Failure to do so may provide erroneous or misleading performance or fault indications.
4. If adequate watt meter is not available, substitute VTVM terminated with dummy load, $P = E^2/R$ where $R = 50$ ohms.
5. Before using spectrum analyzer, rf section HP-8553B, perform preliminary checks contained in the HP-8553B operating manual.

Name	Number	Quantity
Audio Oscillator	AN/URM-127	1
VTVM	AN/USM-116	1
Signal Generator, RF	AN/USM-323	1
Digital Multimeter (DVM, ohmmeter function)	AN/USM-341	1
Attenuator, Step 10-db steps, 0.5w, 50 ohm	CN-128/U	1
Dummy Load	DA-553( )/4	1
Watt Meter, RF		
- Power Meter	Hewlett Packard HP-435A	1
- Thermocouple Power Sensor	Hewlett Packard HP-8482A	1
Spectrum Analyzer*	Hewlett Packard HP-141-T	1*
- High Resolution IF Section*	Hewlett Packard HP-8552B	1*
- RF Section*	Hewlett Packard HP-8553B	1*
- Tracking Generator*	Hewlett Packard HP-8443A	1*
Power Supply, D.C.	Hewlett Packard HP-6439B	1
Attenuator, Coaxial 20 db, 30w min., 50 ohm	Narda 765-20	1

SECTION II

DISASSEMBLY AND REASSEMBLY

4-5. DISASSEMBLY.

4-6. Disassembly of the radio set consists of removing (separating) the three units: receiver/exciter, amplifier/coupler, and battery pack.

4-7. ASSEMBLY REMOVAL (Figure 4-3).

4-8. Assembly removal is accomplished as follows:

1. Remove the antenna or antenna cable as required.

2. Unfasten the 2 latches securing the battery pack to the receiver/exciter and amplifier/coupler combination and remove the battery pack.

3. Lay the receiver/exciter and amplifier/coupler combination on a suitable surface.

4. Unfasten the top latch and then the bottom latch securing the receiver/exciter and amplifier/coupler together.

5. Carefully separate the 2 assemblies to prevent damaging the connector.

4-9. ASSEMBLY REPLACEMENT (Figure 4-3).

4-10. Assembly replacement is accomplished as follows: .

1. Secure the receiver/exciter and amplifier/coupler assemblies together and fasten the latches. Be sure tongue of latch is fully engaged before torquing down.

2. Secure the battery pack to the receiver/exciter and amplifier/coupler combination and fasten the latches.

3. Reconnect the antenna (or cable).

SECTION III

CLEANING AND EXAMINATION

4-11. CLEANING AND EXAMINATION.

4-12. General cleaning and examination information is contained in chapter 3.

SECTION IV

PERFORMANCE TEST AND TROUBLESHOOTING

4-13. INTRODUCTION.

4-14. The performance test and troubleshooting procedures are combined into a single flowchart format (chapter 3). This allows the maintenance technician to check the radio set for normal indications, and to branch off for fault isolation if an abnormal indication exists. The troubleshooting flowchart is an aid for isolation to a probable fault and should be used in conjunction with the functional block diagrams (chapter 2), power distribution diagram figure 4-1 and rf cabling diagram figure 4-2. Once a fault has been isolated and corrected, the performance test must be repeated. Do not skip blocks in the performance test, because succeeding blocks may be predicated on certain faults being eliminated.

4-15. RADIO SET PERFORMANCE TEST.

4-16. The performance test setup is shown in figure 4-4 and the performance test procedure is as shown in figure 4-5.

SECTION V

REPAIR AND REPLACEMENT

4-17. GENERAL .

4-18. Repair and replacement information is contained in the applicable unit chapters 5 and 6.

SECTION VI

COMPONENT LOCATION AND PARTS LIST

4-19. GENERAL.

4-20. This section contains the component location diagram and repair parts list figure 4-3 for the radio set. The repair parts lists for the radio set are included in the unit chapters 5 and 6.

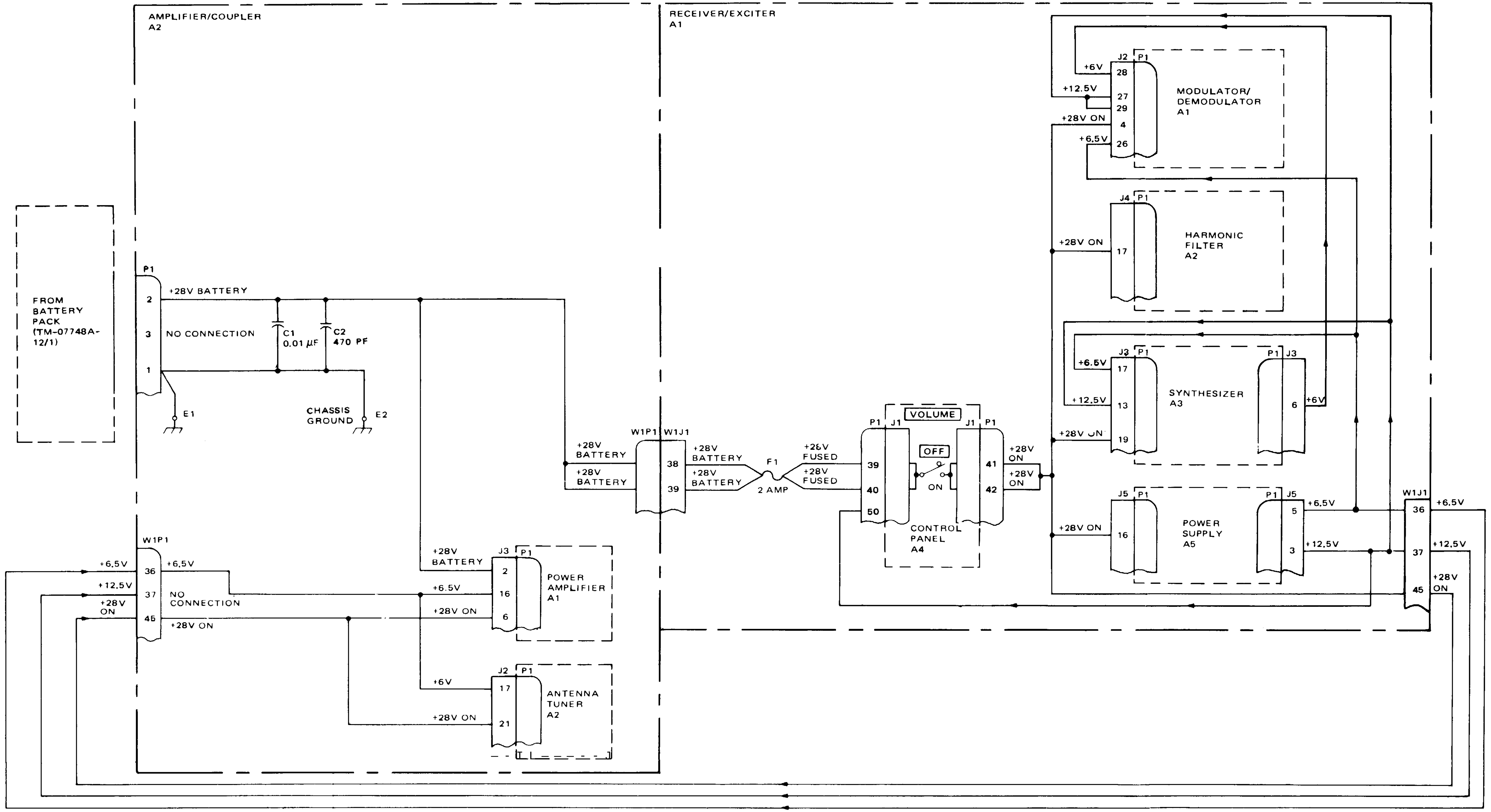


Figure 4-1.Radio Set Power Distribution

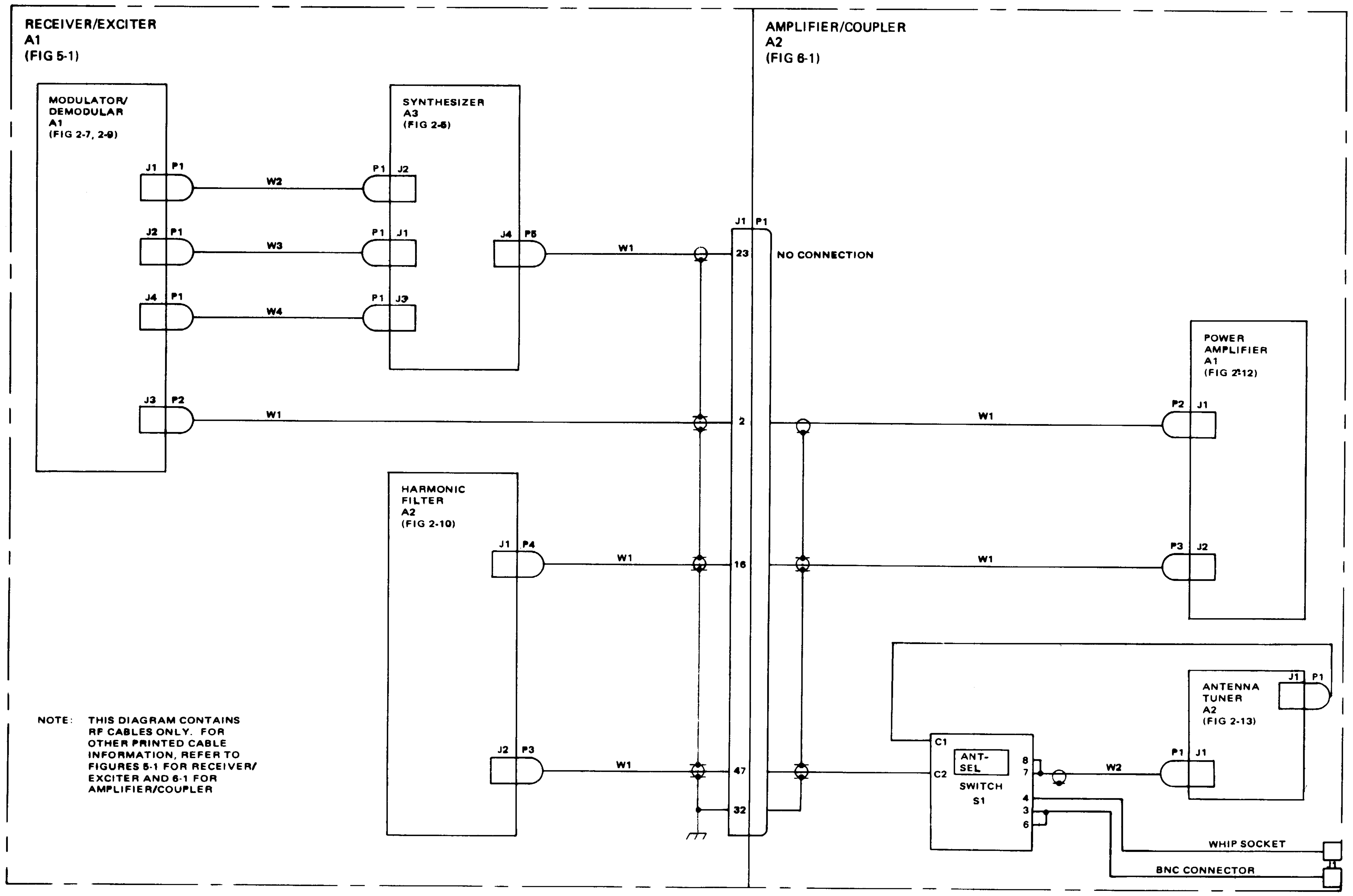


Figure 4-2. Radio Set RF Cabling

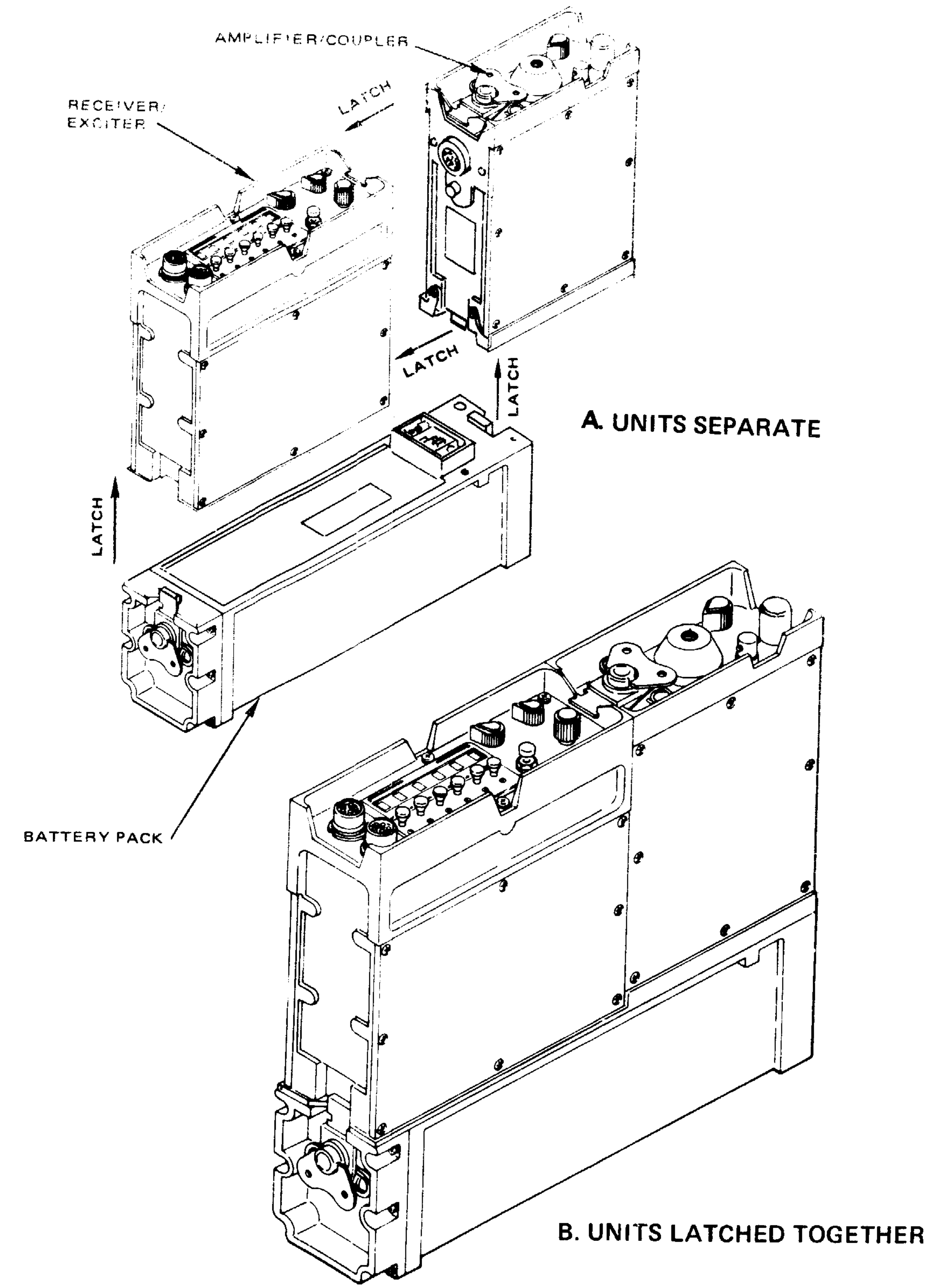


Figure 4-3. Radio Set Component Location

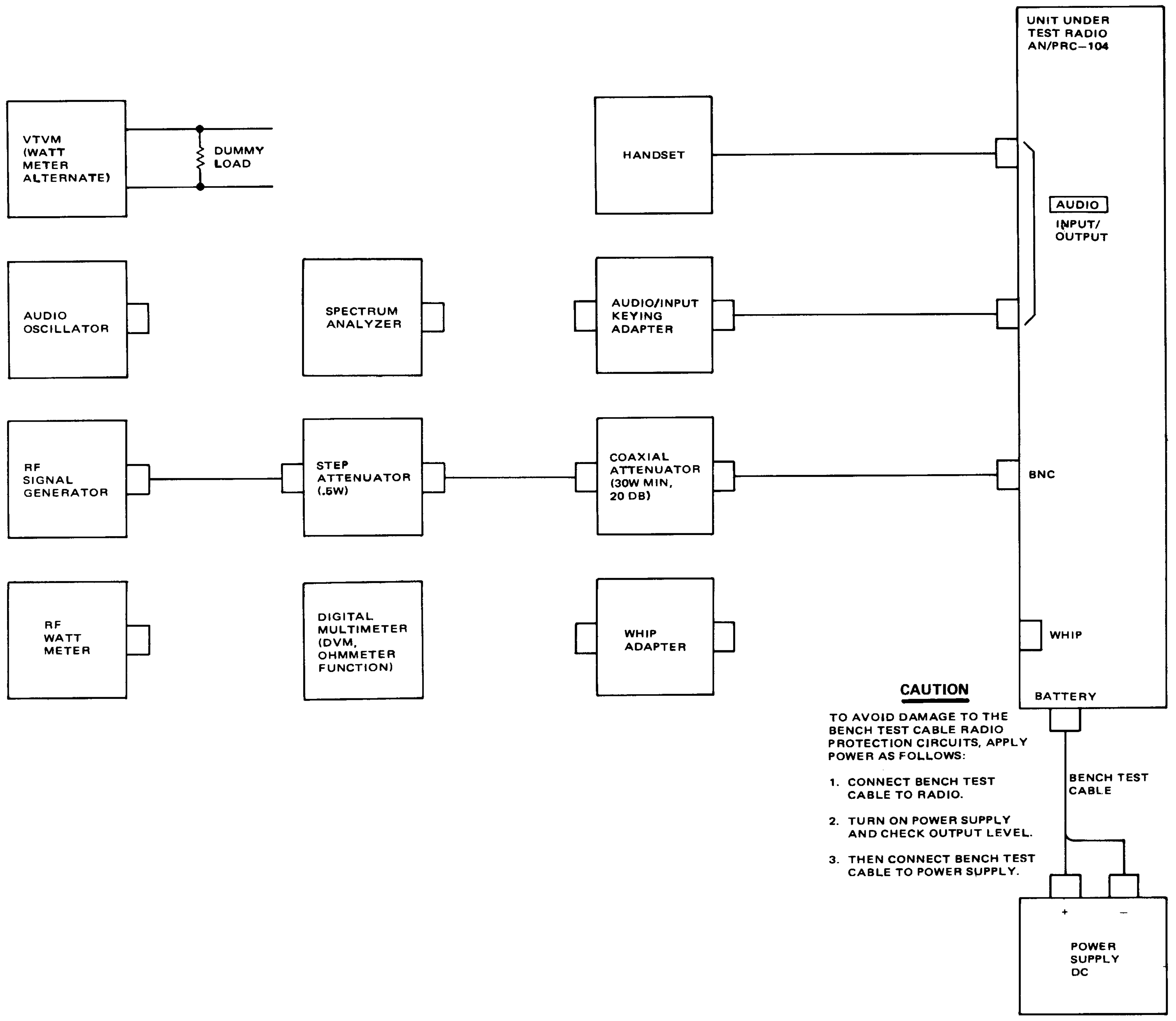


Figure 4-4. Radio Set Performance Test Setup

RADIO SET PERFORMANCE TEST

NOTE 1:

		Radio Set Frequency (kHz)	Sideband	RF Signal Generator Frequency (MHz)
No. 1.	a.	2,221.0	USB	2.2220
	b.	2,221.0	LSB	2.2200
No. 2	a.	3,334.0	USB	3.3350
	b.	3,334.0	LSB	3.3330
No. 3	a.	6,665.0	USB	6.6660
	b.	6,665.0	LSB	6.6640
No. 4	a.	8,889.0	USB	8.8900
	b.	8,889.0	LSB	8.8880
No. 5	a.	15,554.0	USB	15.5550
	b.	15,554.0	LSB	15.5530
No. 6	a.	27,778.0	USB	27.7790
	b.	27,778.0	LSB	27.7770

NOTE 2: Harmonic filter bands are 2-3 MHz, 3-5 MHz, 5-8 MHz, 8-12 MHz, 12-20 MHz, and 20-30 MHz.

NOTE 3: For a thorough test, use all the test frequencies listed in Note 1 on USB only.

NOTE 4: Frequency must be changed each time to cause tune-up tone when PTT is closed.

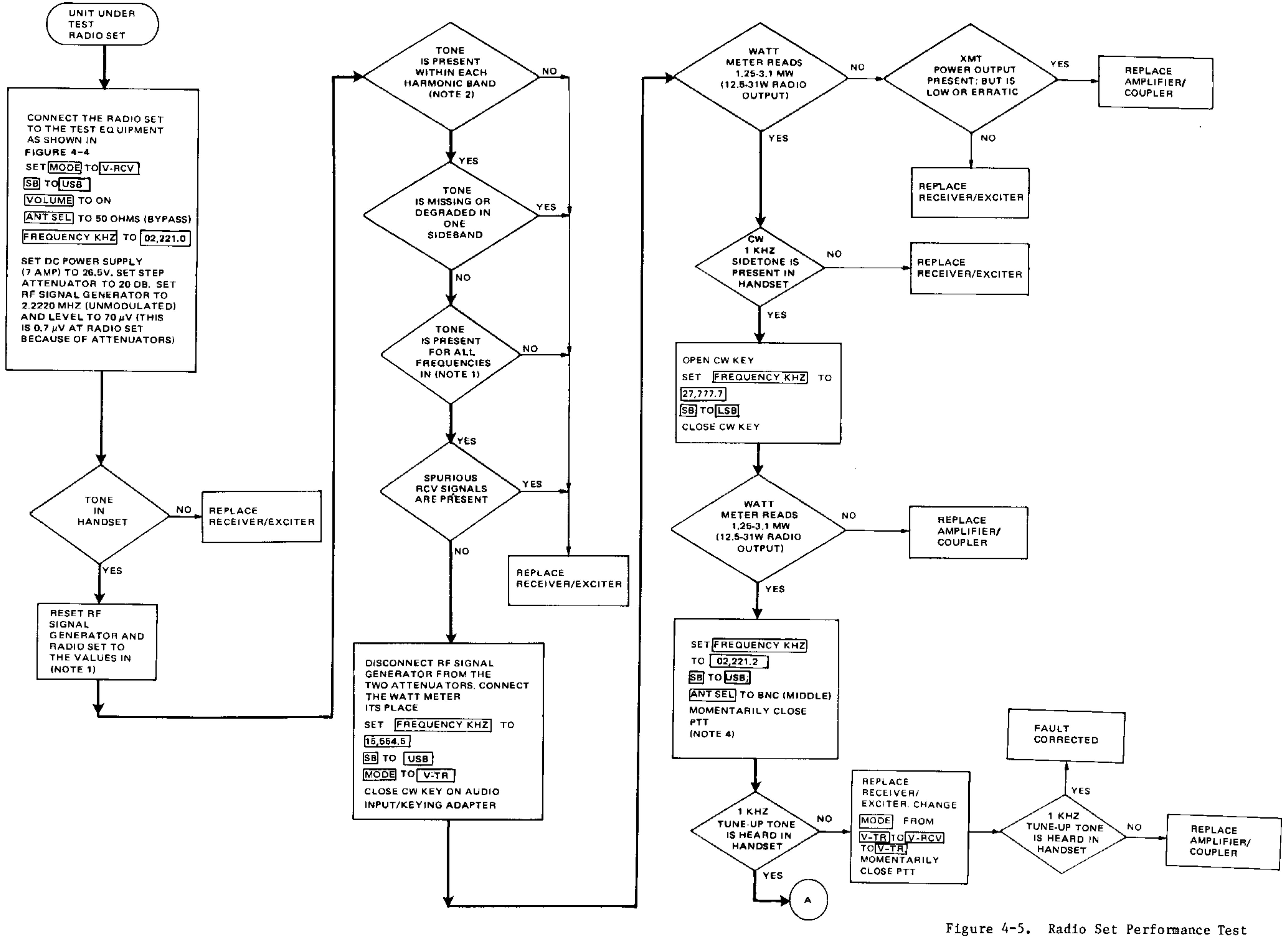


Figure 4-5. Radio Set Performance Test (Sheet 1 of 2)

BANDWIDTH	300 KHZ
SCAN (INNER RED)	PER DIV
INPUT ATTEN	20 DB
RANGE	0–110 MHZ
CENTER FREQ	50 MHZ
VIDEO FILTER	100 HZ
SCAN MODE	SINGLE
10 DB LOG	
SCAN TRIGGER	AUTO
LOG REF	100 DB
LINEAR SENSITIVITY	0
SCAN WIDTH	10 MHZ
SCAN TIME	1 SECOND
STORAGE	STD
INTENSITY	CENTERED

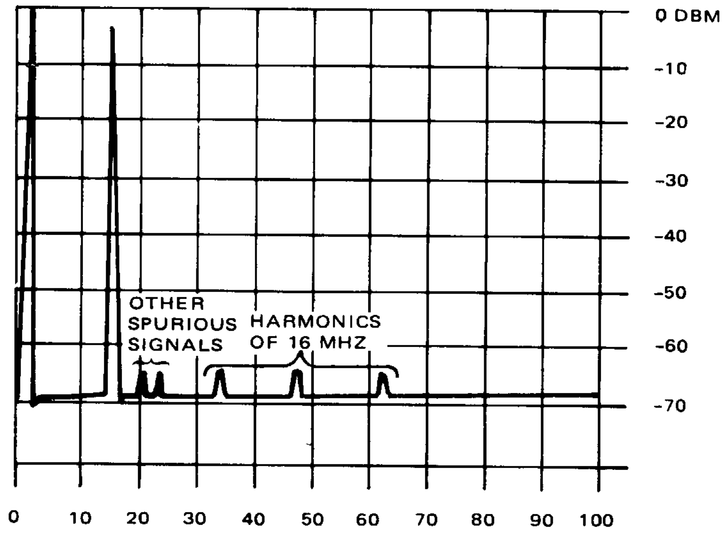


FIG A

BANDWIDTH	0.1 KHZ
SCAN	1 KHZ/DIV
INPUT ATTEN	20 DB
RANGE	0–110 MHZ
CENTER FREQ	16,000 MHZ
VIDEO FILTER	10 HZ
SCAN MODE	SINGLE
10 DB LOG	
SCAN TRIGGER	AUTO
LOG REF	0 DB
LINEAR SENSITIVITY*	-12
SCAN TIME/DIV	2 SECONDS
STORAGE	STD
INTENSITY	CENTERED

*VARY LINEAR SENSITIVITY TO OBTAIN WAVEFORM LEVEL SIMILAR TO FIGURE B

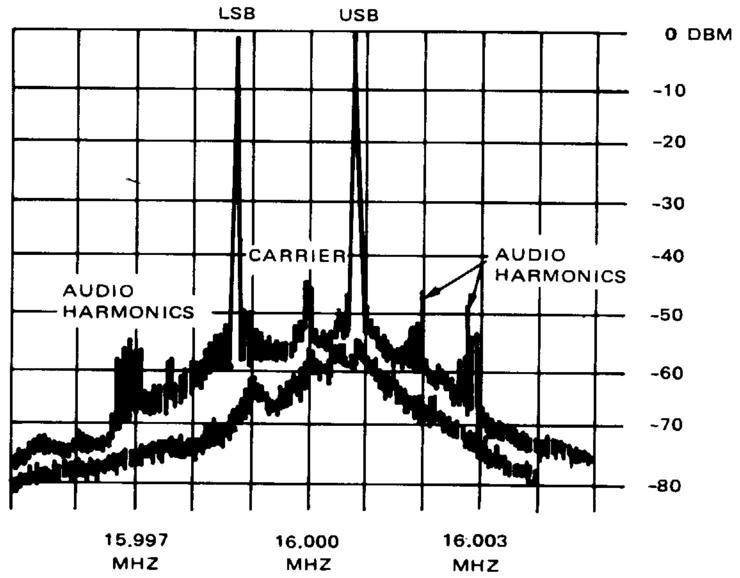


FIG B

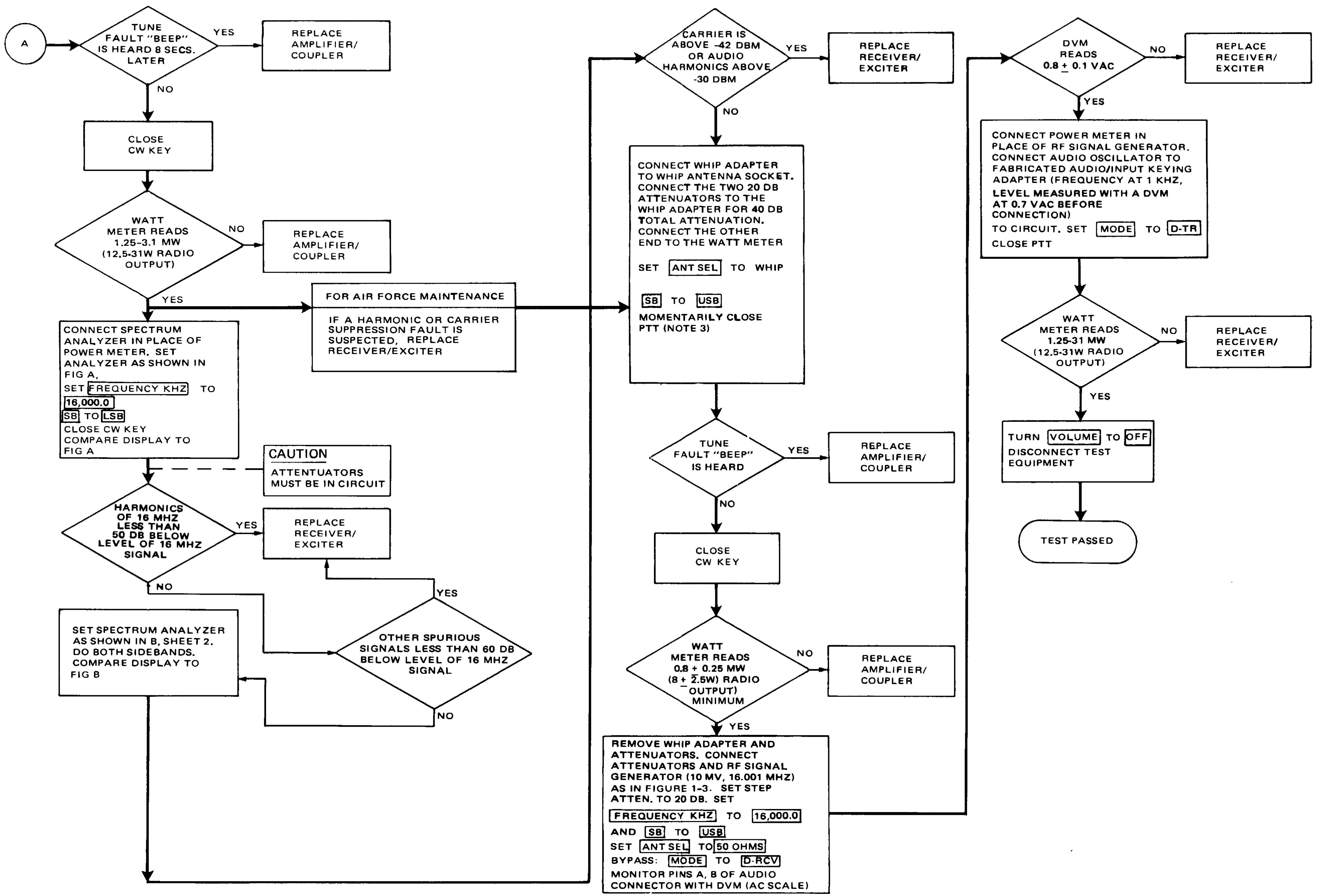


Figure 4-5. Radio Set Performance Test (Sheet 2 of 2)

CHAPTER 5

RECEIVER/EXCITER

SECTION I

INTRODUCTION

5-1. INTRODUCTION.

5-2, This chapter provides the necessary information to maintain Receiver-Transmitter RT-1209/URC (receiver/exciter). Information required for the repair of the receiver/exciter housing and covers is contained in RS-07748A-50/4 . The performance test and troubleshooting flowchart checks out the receiver/exciter and aids the maintenance technician in isolating a fault to a module or a component of the unit. Complete disassembly and reassembly procedures are provided for the receiver/exciter unit (Al), including procedures for the control panel module (A1A4). General SupPort Maintenance Manual TM 11-5820-919-40-2 contains another maintenance data for the five receiver/exciter modules:

1. Modulator/Demodulator A1A1
2. Harmonic Filter A1A2
3. Synthesizer A1A3
4. Control Panel A1A4
5. Power Supply A1A5

Maintenance information for the receiver/exciter is presented as follows:

1. Support Equipment and Materials
2. Disassembly and Reassembly
3. Cleaning and Examination
4. Performance Test and Troubleshooting
5. Repair and Replacement
6. Component Location and Parts List
7. Maintenance Diagrams (schematic (fig .5-1), component location (fig 5-2), test setup (fig 5-3), and performance test (fig 5-4))

5-3. The special tools, materials, and fabricated test cables and fixtures required for maintenance of the receiver/exciter are listed in table 5-1. Materials and tools in tables 3-1 and 3-2 should also be considered when unit repair is required.

TABLE 5-1. SPECIAL TOOLS, MATERIALS, AND FABRICATED TEST CABLES AND FIXTURES

Description	Part Number	Reference
Audio Input/Keying Adapter	...	Figure 3-11C
Whip Adapter	...	Figure 3-11D
Kit, Tool, Electronic	TK-100/G	None
Bench Repair Center	Pace PRC-3500	None
Maintenance Kit, Printed Circuit	MK-984/A	None
O-Ring Lubricant, Barium Base	755002A7551	MIL-R-3065

5-4. Table 5-2 lists the test equipment required to test the receiver/exciter. Equivalent test equipment may be used.

TABLE 5-2. TEST EQUIPMENT

NOTES: 1. * Denotes test equipment not required for Air Force intermediate maintenance.

2. Equivalent test equipment may be used.

3. Use only test equipment that is properly calibrated. Failure to do so may provide erroneous or misleading performance or fault indications.

4. If adequate watt meter is not available, substitute VTVM terminated with dummy load, $P = E^2/R$ where R = 50 ohms.

5. Before using spectrum analyzer, rf section HP-8553B, perform preliminary checks contained in the HP-8553B operating manual.

Name	Number	Quantity
Radio Set, Test Bed	AN/PRC-104	1
Audio Oscillator	AN/URM-127	1
VTVM	AN/USM-116	1
Signal Generator, RF	AN/USM-323	1
Digital Multimeter (DVM, ohmmeter function)	AN/USM-341	1
Attenuator, Step 10-db steps, 0.5w, 50 ohm	CN-128/U	1
Dummy Load	DA-553( )/4	1
Watt Meter, RF		
- Power Meter	Hewlett Packard HP-435A	1
- Thermocouple Power Sensor	Hewlett Packard HP-8482A	1
Spectrum Analyzer*	Hewlett Packard HP-141-T	1*
- High Resolution IF Section*	Hewlett Packard HP-8552B	1*
- RF Section*	Hewlett Packard HP-8553B	1*
- Tracking Generator*	Hewlett Packard HP-8443A	1*
Power Supply, DC	Hewlett Packard HP-6439B	1
Attenuator, Coaxial 20 db, 30w min., 50 ohm	Narda 765-20	1

SECTION II

DISASSEMBLY AND REASSEMBLY

5-5. RECEIVER/EXCITER DISASSEMBLY (Figure 5-2).

5-6. Procedures for disassembly of the receiver/exciter consist of removing the five modules A1A1 thru A1A5 and ribbon cable W1.

CAUTION

If Radio is being disassembled for the first time, apply heat to screws to loosen loctite compound.

CAUTION

When removing modules (except for power supply), pull straight up. Do not rock.

5-7. MODULATOR/DEMODULATOR A1A1 REMOVAL .

1. Place the receiver/exciter so that cover assembly (1) is on top and, when facing the control panel, the control knobs read right side up.

2* Remove the cover assembly (1) by loosening the 8 captive screws (2).

3. Disconnect the color-coded rf cables (17) A1J1, A1J2, A1J3, and A1J4 from the module (18).

4. Loosen the 4 captive screws (19) on the modulator/demodulator module (18).

5. Grasp the wire handle on top of the module (18) and pull gently upward to remove the module from the receiver/ exciter housing (8).

5-8. HARMONIC FILTER A1A2 REMOVAL.

1. Place the receiver/exciter so that access cover is on top and the control panel and the control knobs read right side up.

2. Remove the cover assembly (1) by loosening the 8 captive screws (2).

3. Disconnect the color-coded rf cables (6) A2J1, A2J2 from the harmonic filter module (4).

4. Loosen the 4 captive screws (3) on the harmoic filter module (4).

5. Grasp the wire handle on top of the module (4) and pull gently upward to remove the module.

5-9. SYNTHESIZER A1A3 REMOVAL.

1. Place the radio so that the cover assembly (12) is on top.

2. Remove the cover assembly (12) by loosening the 8 captive screws (13).

3. Disconnect the color-coded rf cables (9) A3J1, A3J2, and A3J3 from the synthesizer module (10).

4. Loosen the 5 screws (11) on the synthesizer module (10).

5. Grasp the wire handle on the module (10) and pull gently upward to remove the module.

5-10. POWER SUPPLY A1A5 REMOVAL.

1. To remove the power supply module (15), the synthesizer module (10) must first be removed. Refer to paragraph 5-9 for removal of synthesizer.

2. Remove the 4 captive screws (14) holding the power supply module (15) and shield to the receiver/exciter housing (8).

CAUTION

Improper removal of power supply may cause damage to multipin connector.

3. Grasp the wire handle and gently ease the module (15) and shield backwards out of the plug before lifting upward.

4. "Loosen the 5 captive screws (not shown) connecting the shield to the power supply.

5. Remove the shield.

5-11. CONTROL PANEL A1A4 REMOVAL.

1. Place the receiver/exciter so that the control panel cover assembly (7) is on top.

CAUTION

Do not place control panel so that it will fall out when captive screws are loosened. Flexible cable to housing could be damaged.

2. Loosen the 6 captive screws (22) on the control panel cover assembly (7).

3. Pull the panel (7) out by grasping the audio connector plugs A1A4J1 and J2 (21).

CAUTION

When control panel is dis-attached from radio, care should be taken to prevent static discharge.

4. Locate the multipin connector (23) and ribbon cable (26).

5. Loosen the 2 captive Allen screws (24).

5. Pull the ribbon cable (26) and multipin connector (23) apart.

5-12. RIBBON CABLE W1 REMOVAL.

NOTE

Perform the procedures in paragraphs 5-7 thru 5-11 before attempting removal of W1.

1. Remove the 2 mounting screws (38) and washers for multipin connector A1A3J3 (37) located on the back side of receiver/exciter housing.

2. Carefully fold back multipin connector A1A3J3 (37).

3. Remove the 2 mounting screws (32) and washers for connector plug A1A2J4 (33). One screw is located under multipin connector A1A2J3 (37) ribbon cable.

4. Remove mounting screws (39) and washers for multipin connector A1A1J2 (40).

5. Remove receptacle connector J1 (29) by removing the two mounting nuts (28) from the connector studs (36) and pull connector (29) backwards, carefully folding, leaving circuit board mounting Allen screws (42) visible.

CAUTION

Use extreme care when removing or replacing ribbon cables. Creasing or severe bending will damage ribbon cables internally.

6. Remove printed circuit board and cable assembly A1W1 (25); pull upward, removing it from the receiver/exciter housing.

5-13. <u>RECEIVER/EXCITER REASSEMBLY</u> (Figure 5-2).

5-14. Procedures for reassembly of the receiver/exciter consist of replacement of five modules A1A1 thru A1A5 and ribbon cable W1 (fig 5-2).

5-15. RIBBON CABLE W1 REPLACEMENT.

CAUTION

Use extreme care when removing or replacing ribbon cables. Creasing or severe bending will damage ribbon cables internally.

1. Align ribbon cable and printed circuit board assembly (25) with receiver/exciter housing (8); place assembly into position.

2. Place circuit board Allen mounting screws (42) into position and tighten.

3. Carefully align multipin connector A1A3J3 (37) and push into place.

Inspect preform packing 0-rings (30 and 35). Replace if worn or cracked. Lubricate (see table 5-1) preform packings (30 and 35).

5. Slide connector J1 (29) into place.

6. Attach mounting nuts (28) to the back side of connector studs (36) and tighten.

7. Using screws and washers, align multipin connectors as follows: screws 38 for A1A3J3 (37), 39 for A1A1J2 (40), 32 for A1A2J4 (33).

8. Tighten mounting screws on multi-pin connectors A1A1J2 (40), A1A3J3 (37), A1A2J4 (33).

5-16. CONTROL PANEL REPLACEMENT.

1. Align the ribbon cable (26) and multipin connector A1A4P1 (23); push them together.

CAUTION

Use only moderate force to tighten screws that hold down modules, covers, etc.

2. Tighten the 2 captive Allen screws (24) using the appropriate Allen wrench.

3. Put the control panel back in the receiver/exciter housing (8). Make sure the gasket (not shown) is in place.

4. Tighten the 6 captive screws (22) on control panel cover assembly (7).

5-17. POWER SUPPLY REPLACEMENT.

1. Replace the shield by tightening the 5 screws (not shown).

2. Place the module so that the multi-pin connector A1A5P1 (16) and the jack on the receiver/exciter housing (8) are aligned. Carefully plug the module into housing.

3. Replace and tighten the 4 captive screws (14) on the power supply module (15), so that the module is fastened to the receiver/exciter housing (8).

5-18. SYNTHESIZER REPLACEMENT.

1. Align the synthesizer module (10) over the receiver/exciter housing (8).

CAUTION

When replacing modules do not pinch rf cables between housing and module.

2. Carefully plug the module into the receiver/exciter housing (8) so that the multipin connector (not shown) and jack fit properly.

3. Tighten the 5 captive screws (11) on the module.

CAUTION

Insertion of miniature coax connectors must be made carefully without forcing.

4. Reconnect the rf cables (9) A3J1, A3J2, and A3J3 to the module according to the color code. Male connector should be perpendicular to module.

5. Lubricate the O-ring in the cover assembly (12) (see table 5-1). Replace the cover assembly (12). Tighten the 8 captive screws (13).

5-19. HARMONIC FILTER REPLACEMENT.

1. Align the harmonic filter module (4) over the receiver/exciter housing (8).

2. Carefully plug the module into the receiver/exciter housing (8), so that the multipin connector A1A2P1 (5) and jack fit properly.

3. Tighten the 4 captive screws (3) on the module.

4. Reconnect the 2 rf cables (6) A2J1 and A2J2 to the module according to the color code.

5. Replace the cover assembly (l). Tighten the 8 captive screws (2).

5-20. MODULATOR/DEMO DULATOR REPLACEMENT.

1. Align the modulator/demodulator module (18) over the receiver/exciter housing (8).

2. Carefully plug the module into the receiver/exciter housing (8) so that the multipin connector A1A1P1 (20) and jack fit properly.

3. Tighten the 4 captive screws (19) on the module.

4. Reconnect the 4 color-coded rf cables (17) A1J1, A1J2, A1J3, and A1J4 to the module according to the color code.

5. Lubricate the O-ring in the cover assembly (1) (see table 5-1). Replace the cover assembly (l). Tighten the 8 screws (2).

5-21. CONTROL PANEL DISASSEMBLY (Figure 5-3).

5-22. Procedures for disassembly of the control panel A1A4 consist of removing the switches.

5-23. FREQUENCY KHZ (S1-S6) SWITCH REMOVAL.

1. Remove control panel (1) from receiver/exciter (para 5-11).

2. Place control panel face down.

3. Locate 12 Allen screws (34) which fasten rotary switches (27 thru 32).

4. Loosen Allen screws (34) using appropriate tool.

5. Locate connectors A1A2J1, J2 (37) and audio filter assembly A1A2 (36).

6. Using appropriate tool, loosen and remove 2 connector rings (2) and 2 connector washers (38).

7. Slowly separate audio filter assembly A1A2 (36) and control panel circuit card assembly (35) from control panel (1) at the same time, and carefully fold back.

8. Unsolder and replace necessary pushbutton rotary switches (27 thru 32).

5-24. SB (S7), MODE (S8) AND VOLUME (S9) SWITCH REMOVAL.

1. Remove control panel from receiver/exciter (para 5-11).

2. Place panel so that the control knob faces upward.

3. Locate SB switch (6) and MODE switch (10) knobs on face of panel (l).

4. Locate the 2 Allen screws (5) on SB switch knob (6).

5. Loosen the setscrews and remove knob.

6. Using appropriate wrench, remove remaining nut (4) and washer (3).

7. Unsolder wires from rear terminals of SB switch (26).

8. Carefully pull out switch from the back of the control panel.

9. Remove MODE switch (24) and VOLUME switch (23) using the same procedures as removing SB switch.

5-25. LIGHT SWITCH (S10) REMOVAL.

1. Remove control panel from the receiver/exciter unit (para 5-11).

2. Place unit so that control knobs face upward; then locate light switch knob (9).

3. Remove light switch knob (9) by loosening Allen screw (8) located on the side of knob (9).

4. Remove threaded retainer (7) from switch shaft.

5. Unsolder wires from terminals located at the rear of the light switch (25).

6. Grasp light switch (25) and remove from control panel (1).

5-26. CONTROL PANEL REASSEMBLY.

5-27. Procedures for reassembly of the control panel A1A4 consist of replacing the switches.

5-28. LIGHT (S10) SWITCH REPLACEMENT.

1. Working from the back side of the control panel, align light switch (25) with the light switch mounting hole and then push the switch in the hole, allowing the switch shaft and threaded portion of the switch to be visible from the front face of the panel.

2. Place threaded retainer (7) over the threaded portion of switch shaft and tighten switch into place.

3. Place light switch knob (9) onto switch shaft.

4. Secure light switch knob (9) by tightening Allen screw (8) on the,side light switch knob.

5. Resolder wires to light switch terminals, located at the rear of light switch (25).

5-29. SB (S7) MODE (S8) AND VOLUME (S9) SWITCH REPLACEMENT.

1. Align SB rotary switch (26) with the back of control panel.

2. Push firmly into place allowing shaft of switch to be visible from the front of the panel.

3. Replace washer (3) and nut (4); then tighten.

4. Resolder wires to terminals at the rear of SB rotary switch (26).

5. Replace SB switch knob (6) and tighten the 2 Allen screws (5).

6. Replacement procedures for MODE switch and VOLUME switch are the same as SB switch.

5-30. FREQUENCY KHZ (S1-S6) SWITCH REPLACEMENT.

1. Carefully fold forward and align audio filter assembly (36) and control panel circuit card assembly (35).

2. Carefully push both units into place.

3. Replace connector washers (38) and connector rings (2) on connectors (28) and tighten.

4. Replace Allen screws (34) in rotary switches (27) and tighten.

5. Replace control panel (para 5-16) on receiver/exciter unit.

SECTION III

CLEANING AND EXAMINATION

5-31. GENERAL.

5-32. Cleaning and examination procedures are contained in chapter 3.

SECTION IV

PERFORMANCE TEST AND TROUBLESHOOTING

5-33. INTRODUCTION.

5-34. The performance test and troubleshooting procedures are combined into a single flowchart scheme (chapter 3). This allows the maintenance technician to check the receiver/exciter (A1) for normal indications, and to branch off for troubleshooting if the indications are abnormal. The troubleshooting is only an aid for isolating to a probable fault. The flowcharts should be used in conjunction with the functional block diagrams (chapter 2), and the schematic figure 5–1. Once a fault has been isolated and corrected, the performance test is repeated. Do not skip blocks in the performance test, because succeeding blocks may be predicated on certain faults being eliminated.

5-35. PERFORMANCE TEST.

5-36. The performance test setup is shown in figure 5-4 and the performance test is shown in figure 5-5.

SECTION V

REPAIR AND REPLACEMENT

5-37. GENERAL.

5-38. Repair and replacement information for the receiver/exciter (A1) is contained in chapter 3 and in section II.

SECTION VI

COMPONENT LOCATION AND PARTS LIST

5-39. GENERAL.

5-40. This section contains the component location and parts list diagrams for the receiver/exciter (A1), figure 5-2, and the control panel (A1A4), figure 5-3. These diagrams support the disassembly and reassembly procedures of section II.

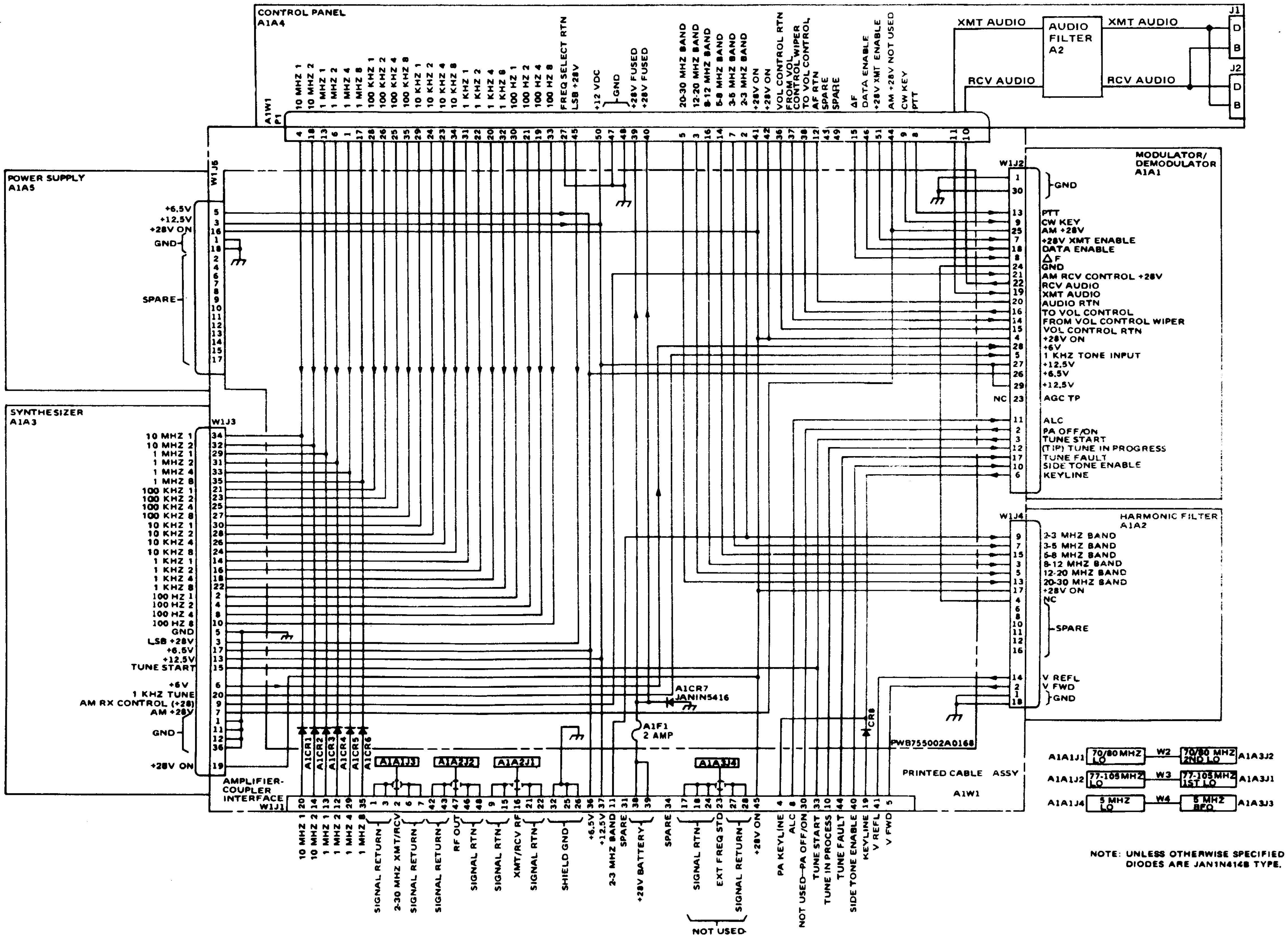


Figure 5-1. Receiver/Exciter A1 Schematic

ITEM	DESCRIPTION
1.	Cover Assembly
2.	Screw, Captive (8 places)
3.	Screw, Captive (4 places)
4.	Harmonic Filter Module A1A2
5.	Multipin Connector (Harmonic Filter Module) A1A2P1
6.	RF Cables A1A2J1(W1P4), A1A2J2(W1P3)
7.	Control Panel cover Assembly (Face) A1A4
8.	Receiver/Exciter A1
9.	RF Cables A1A3J3(W4), A1A3J4(W1P5), A1A3J2(W2), A1A3J1(W3)
10.	Synthesizer Module A1A3
11.	Screw, Captive (5 places)
12.	Cover, Assembly
13.	Screw, Captive (8 places)
14.	Screw, Captive (4 places)
15.	Power Supply Module A1A5
16.	Multipin Connector A1A5P1
17.	RF Cables A1A1J1(W2), A1A1J2(W3), A1A1J3(W1P2), A1A1J4(W4)
18.	Modulator/Demodulator Module A1A1
19.	Screw, Captive (4 places)
20.	Multipin Connector A1A1P1
21.	Audio Connector Plugs A1A4J1, J2
22.	Screw, Captive (6 places)

ITEM	DESCRIPTION
23.	Multipin Connector A1A4P1
24.	Captive Allen Screw (2 places)
25.	Printed Wiring Board
26.	Ribbon Cable Assembly
27.	RF Cables A1A2J2(W1), A1A2J1(W1), A1A2J3(W1), A1A2J4(W1)
28.	Mounting Nut (2 places)
29.	Jack Receptacle Connector A1 J1
30.	Packing, Preform
31.	Connector, Plug (Multipin) A1A4P1
32.	Mounting Screw (2 places)
33.	Multipin, Connector, A1A2J4
34.	Ribbon Cable Assembly A1W1
35.	Packing, Preform
36.	Connector, Stud
37.	Multipin Connector A1A3J3
38.	Mounting Screw (2 places)
39.	Mounting Screw (2 places)
40.	Multipin Connector A1A1J2
41.	Ribbon Cable Assembly A1W1
42.	Circuit Board Mounting Screws, Allen (4 places)

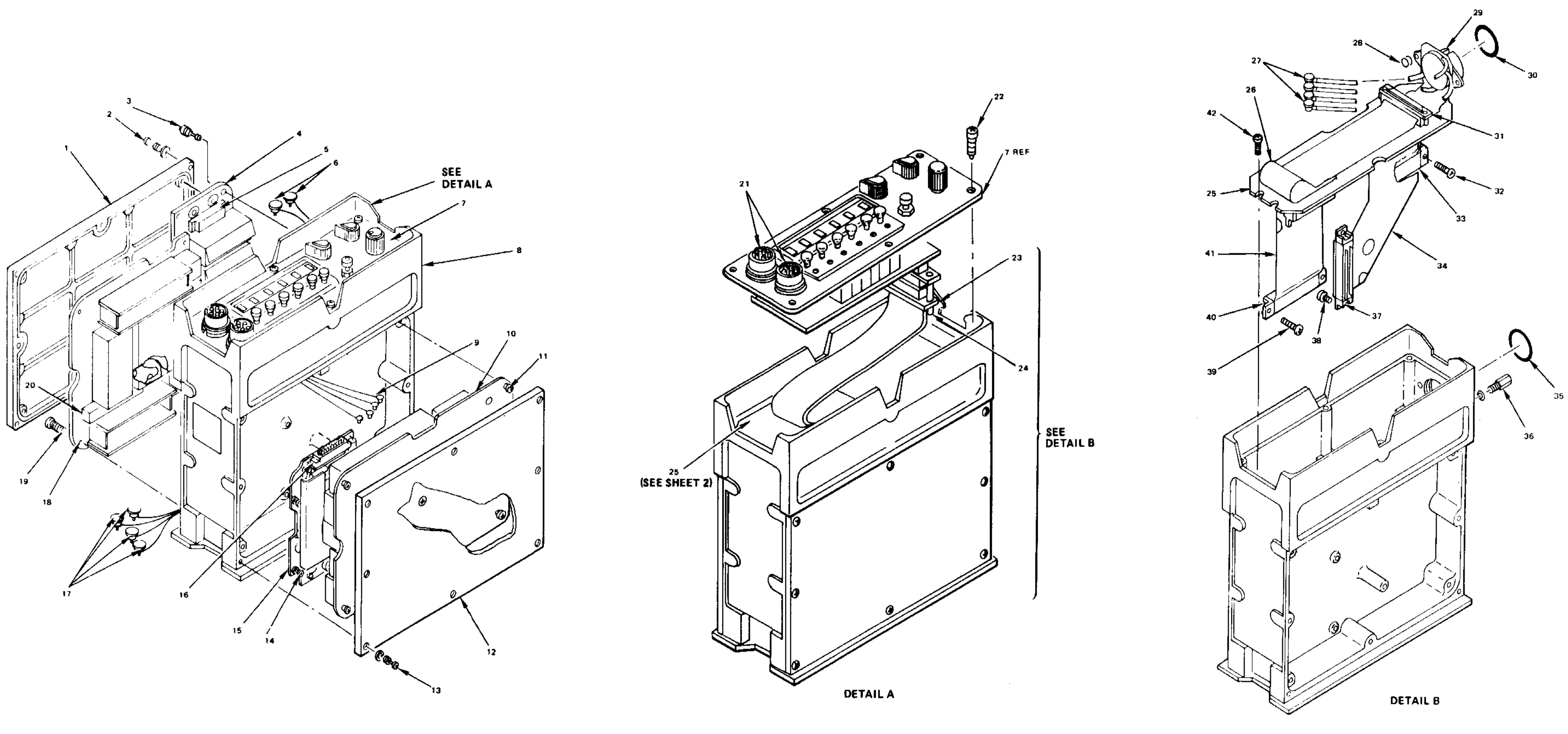


Figure 5-2. Receiver/Exciter A1 Component Location (Sheet 1 of 2)

ITEM	DESCRIPTION
1	Printed Wiring Board
CR7	Diode
2	Lead Socket
3	Fuse, Instr
CR5	Diode
CR6	Diode
CR2	Diode
CR1	Diode
CR8	Diode
CR3	Diode
CR4	Diode
J5	Connector, Receptacle

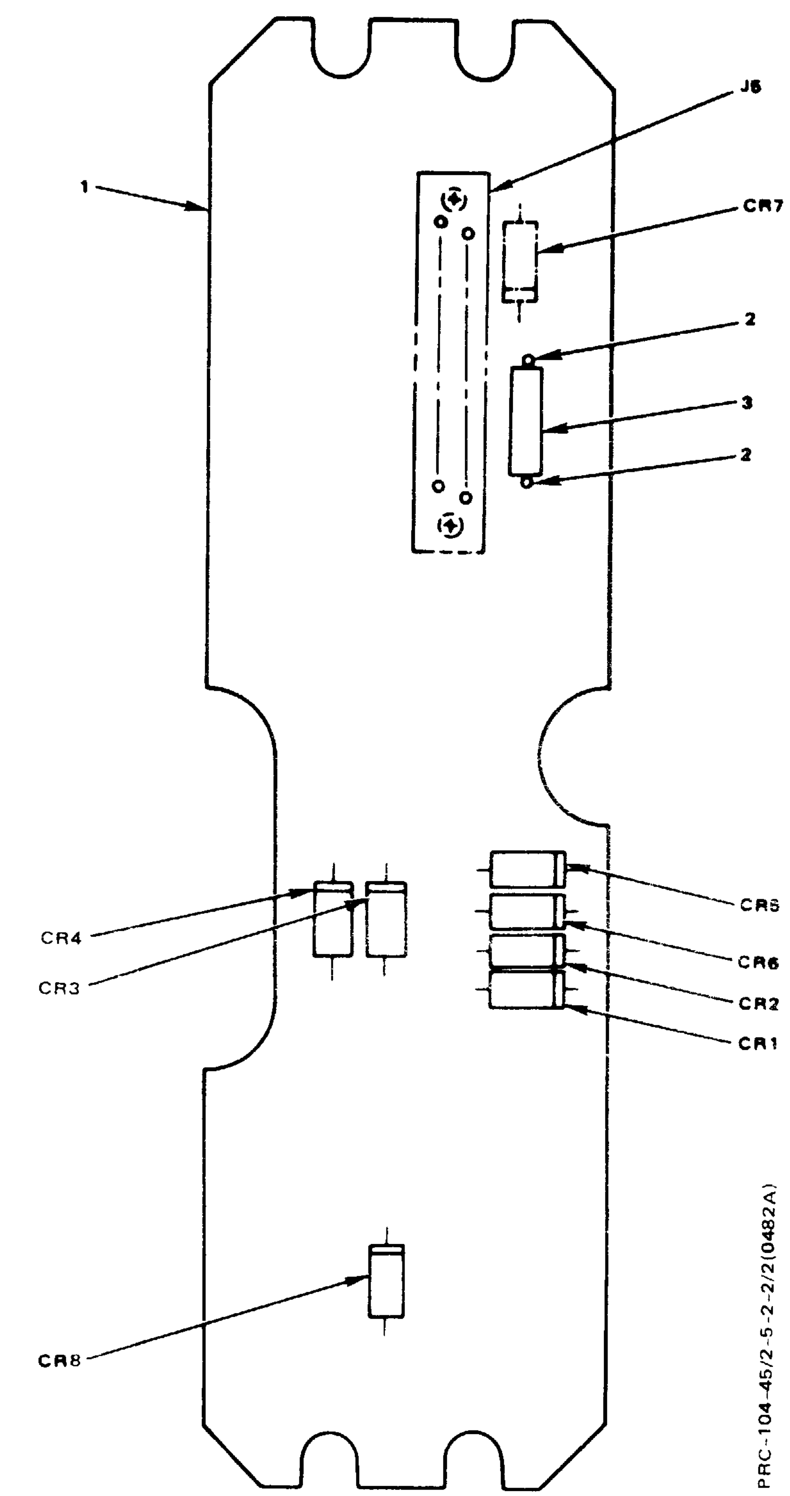


Figure 5-2. Receiver/Exciter A1
Component Location
(Sheet 2 of 2)

ITEM	DESCRIPTION
1.	Panel
2.	Connector Ring (2 places)
3.	Washer
4.	Nut
5.	Allen Screw (2 places)
6.	SB Switch Knob
7.	Retainer (threaded)
8.	Allen Screw
9.	Lightswitch Knob
10.	Mode Switch Knob
11.	Allen Screw (2 places)
12.	Nut
13.	Washer
14.	Volume Knob
15.	Allen Screw (2 places)
16.	Screw, Cap tive (6 places)
17.	Nut
18.	Washer
19.	Gasket
20.	Gasket
21.	Gasket
22.	Gasket
23.	Switch, Volume A4S9
24.	Switch, Mode A4S8
25.	Switch, Light A4S10
26.	Switch, SB A4S7
27.	Switch, 100 Hz A4S6
28.	Switch, 1 kHz A4S5
29.	Switch, 10 kHz A4S4
30.	Switch, 100 kHz A4S3
31.	Switch, MHz A4S2
32.	Switch, 10 MHz S1
33.	Connector, Multipin A1A4J1
34.	Allen Screw (12 places)
35.	Circuit Board Assembly (Control Panel) A1A4A1
36.	Audio Filter Assembly A1A4A2
37.	Connectors A1A4A2J1 A1A4A2J2
38.	Connector Washer (2 places)
39.	Gasket

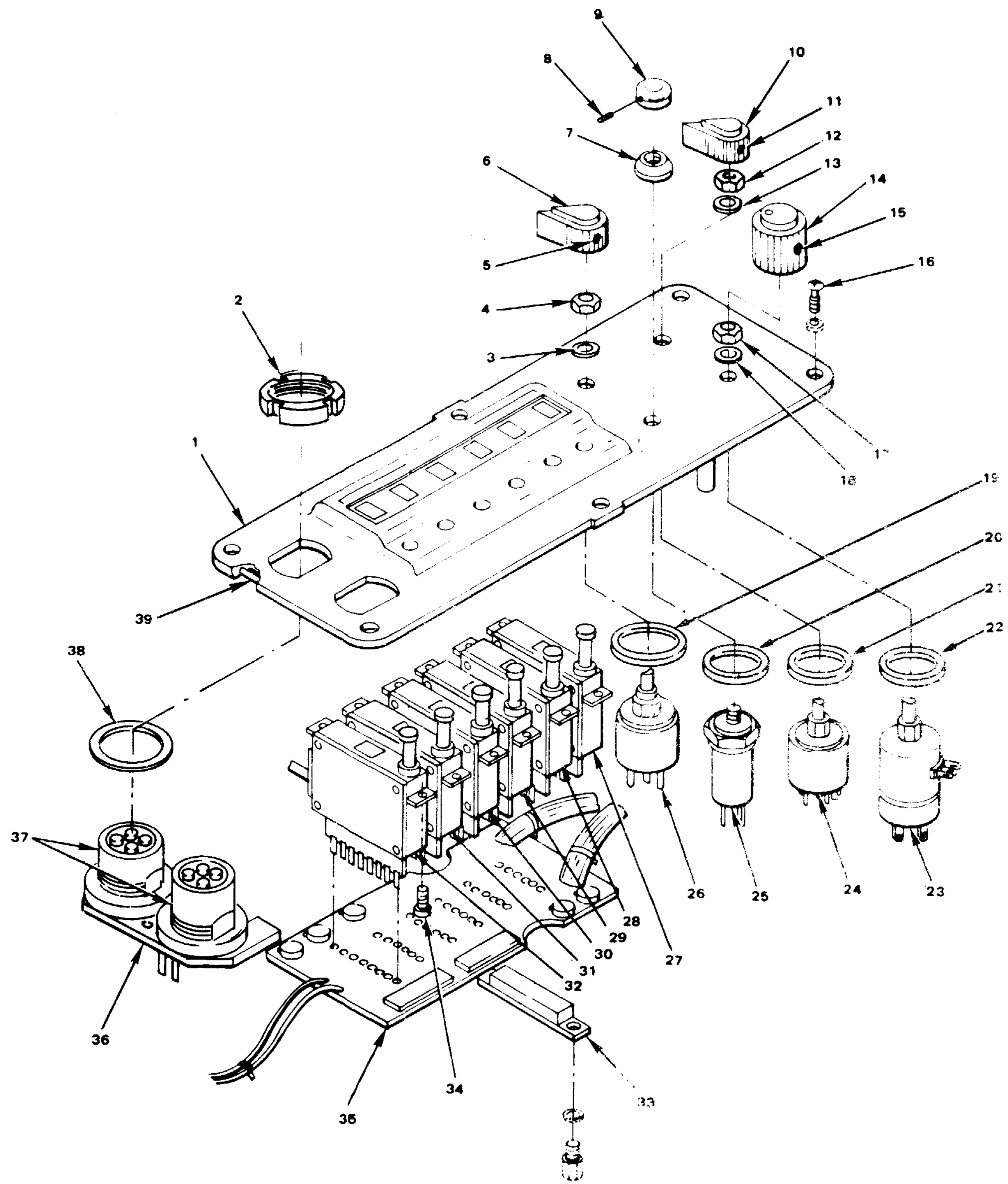


Figure 5-3. Control Panel A1A4 Component Location

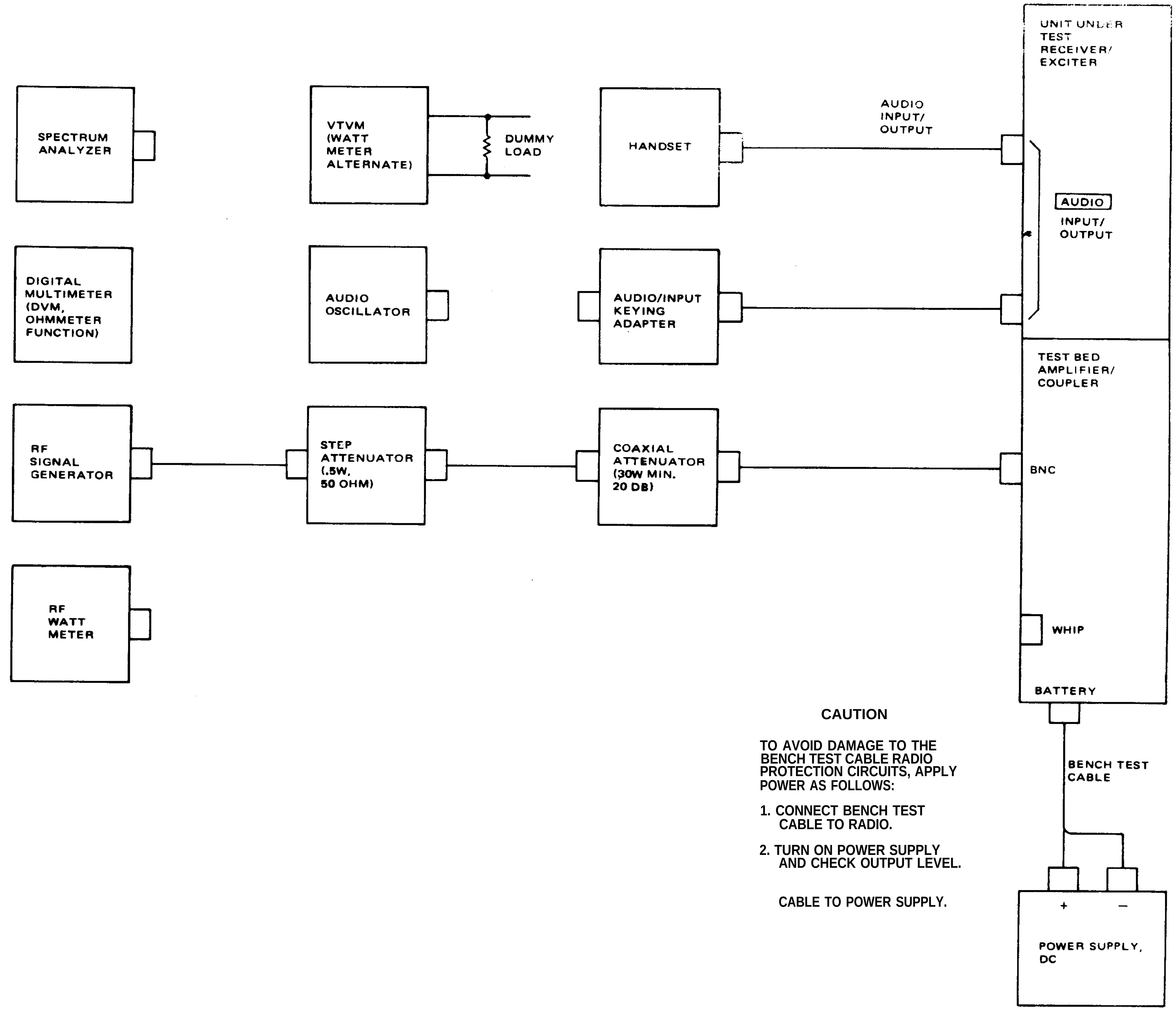


Figure 5-4. Receiver/Exciter A1 Performance Test Setup

RECEIVER/EXCITER PERFORMANCE TEST

NOTE 1:

		Radio Set Frequency (kHz)	Sideband	RF Signal Generator Frequency (MHz)
No. 1.	a.	2,221.0	USB	2.222
	b.	2,221.0	LSB	2.220
No. 2	a.	3,334.0	USB	3.335
	b.	3,334.0	LSB	3.333
No. 3	a.	6,665.0	USB	6.666
	b.	6,665.0	LSB	6.664
No. 4	a.	8,889.0	USB	8.890
	b.	8,889.0	LSB	8.888
No. 5	a.	15,554.0	USB	15.555
	b.	15,554.0	LSB	15.553
No. 6	a.	27,778.0	USB	27.779
	b.	27,778.0	LSB	27.777

NOTE 2: Harmonic bands are 2-3 MHz, 3-5 MHz, 5-8 MHz, 8-12 MHz, 12-20 MHz, and 20-30 MHz.

NOTE 3: Replace original modules in reverse order (except for the faulty module) and listen for tone in handset. Otherwise, the good modules would be condemned as faulty.

NOTE 4: Frequency must be changed or mode changed each time to cause tune-up tone when PTT is closed. Setting the MODE switch to V-RCV and back to V-TR will generate a tune start pulse. This, in turn, allows a tune cycle to start when PTT is pressed. Changing any frequency digit except 100 Hz or turning the radio set off and back on will also generate a tune start pulse.

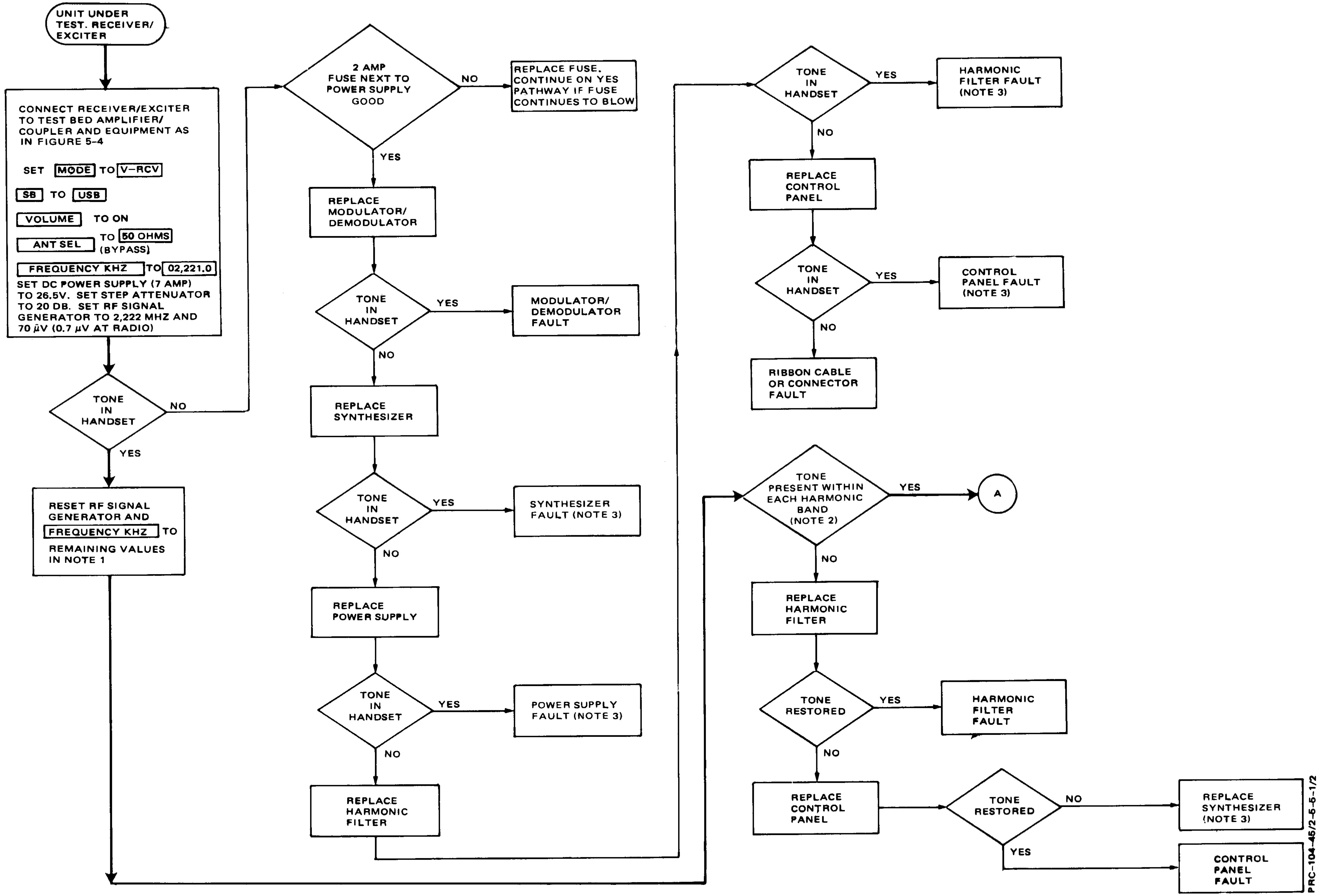


Figure 5-5. Receiver/Exciter A1 Performance Test (Sheet 1 of 2)

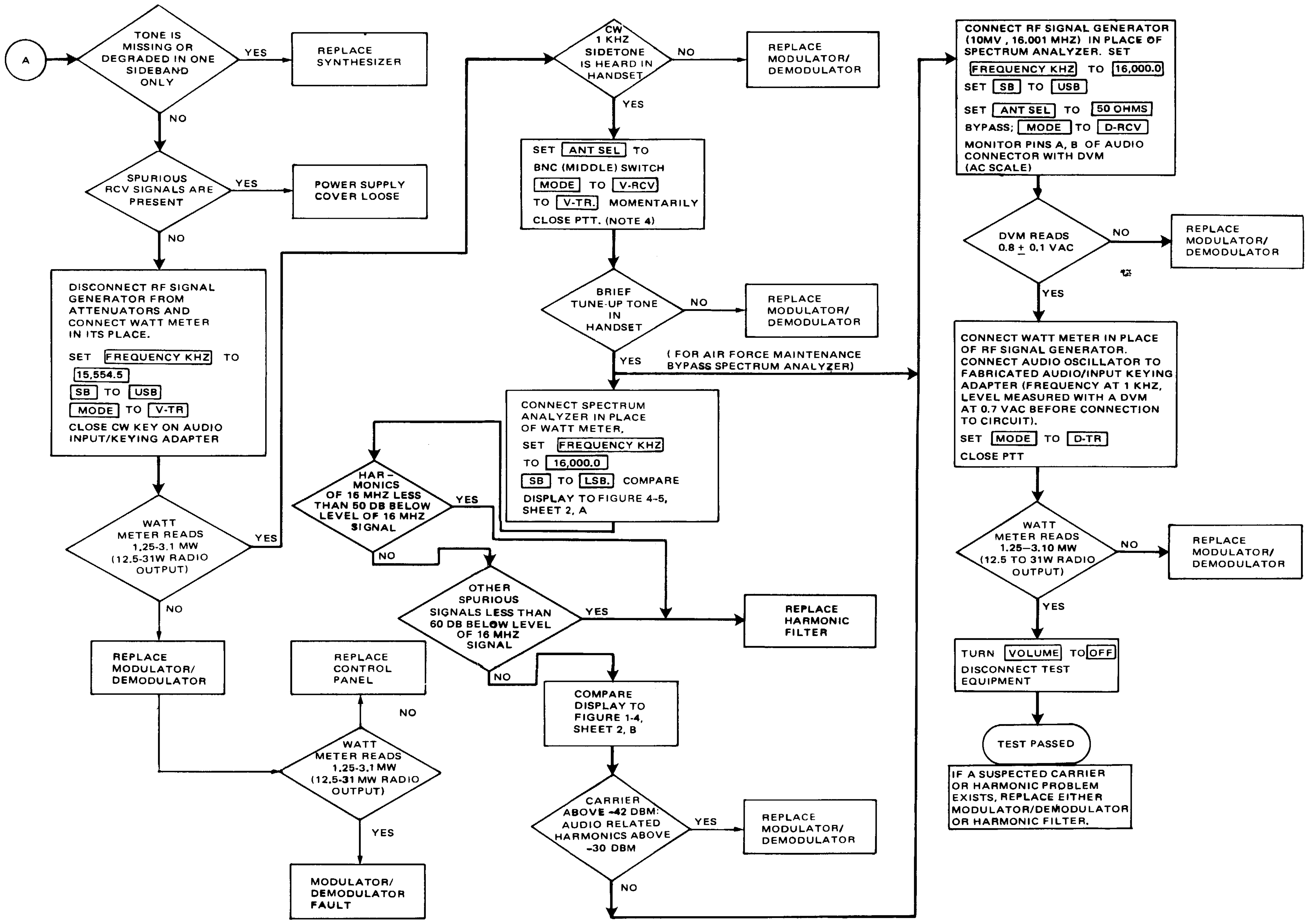


Figure 5-5. Receiver/Exciter A1 Performance Test (Sheet 2 of 2)

CHAPTER 6

AMPLIFIER/COUPLER

SECTION I

INTRODUCTION

6-1. GENERAL.

6-2. This chapter provides the information necessary to maintain Radio Frequency Amplifier AM-6874/PRC-104 (amplifier/coupler). Information required for the repair of the amplifier/coupler housing and covers is contained in RS-07748A-50/4. The performance test and troubleshooting flowchart checks out the amplifier/coupler and aids the maintenance technician in isolating a fault to a module or a component of the unit. Complete disassembly and reassembly procedures are provided for the amplifier/coupler (A2). General Support Maintenance Manual TM 11-5820-919-40-2 contains all maintenance data for the two amplifier/coupler modules:

1. Power Amplifier A2A1
2. Antenna Tuner A2A2

Maintenance procedures for the amplifier/coupler are presented as follows.

1. Support Equipment and Materials
2. Disassembly and Reassembly
3. Cleaning and Examination
4. Performance Test and Troubleshooting
5. Repair and Replacement
6. Component Location and Parts List
7. Maintenance Diagrams (schematic (fig 6-1), component location (fig 6-2), test setup (fig 6-3), and performance test (fig 6-4)).

6-3. The special tools, materials, and fabricated test cables and fixtures required for ‘maintenance of the amplifier/coupler are listed in table 6-1. Tools and materials in tables 3-1 and 3-2 should also be considered when unit repair is required.

TABLE 6-1. SPECIAL TOOLS, MATERIALS, AND FABRICATED TEST CABLES AND FIXTURES

Description	Part Number	Reference
Audio Input/Keying Adapter	...	Figure 3-11C
Whip Adapter	...	Figure 3-11D
Kit, Tool, Electronic	TK-100/G	None
Bench Repair Center	Pace PRC-350C	None
Maintenance Kit, Printed Circuit	MK-984/A	None
O-Ring Lubricant, Barium Base	755002A7551	MIL-R-3065

6-4. Table 6-2 lists the equipment required to test the amplifier/coupler. Equivalent test equipment may be used.

TABLE 6-2. TEST EQUIPMENT

NOTES: 1. Equivalent test equipment may be used.

2. Use only test equipment that is properly calibrated. Failure to do so may provide erroneous or misleading leading performance or faults indications.

3. If adequate watt meter is not available, substitute VTVM terminated with dummy load, $P = E^2/R$ where $R = 50$ ohms.

Name	Number	Quantity
Radio Set, Test Bed	AN/PRC-104	1
VTVM	AN/USM-116	1
Signal Generator, RF	AN/USM-323	1
Attenuator, Step 10-db steps, 0.5w, 50 ohm	CN-128/U	1
Dummy Load	DA-553( )/4	1
Watt Meter, RF		
- Power Meter	Hewlett Packard HP-435A	1
- Thermocouple Power Sensor	Hewlett Packard HP-8482A	1
Power Supply, DC	Hewlett Packard HP-6439B	1
Attenuator, Coaxial 20 db, 30w min., 50 ohm	Narda 765-20	1

SECTION II

DISASSEMBLY AND REASSEMBLY

6-5. AMPLIFIER/COUPLER DISASSEMBLY (Figure 6-2).

6-6. Procedures for disassembly of the amplifier/coupler (A2) consist of removing the two modules, A2A1 and A2A2, ribbon cable A2W1, antenna mount, BNC connector A2J1, and antenna select (ANT SEL) switch A2S1.

6-7. POWER AMPLIFIER A2A1 REMOVAL.

1. Place the amplifier/coupler so that the cover assembly (10) is on top and front face reads up-side down.

2. Remove the cover assembly (10) by loosening the 8 captive screws (9).

3. Disconnect the rf cables A1J1, A1J2 (5) from the power amplifier module assembly (11).

4. Loosen the 4 captive (Phillips head) screws (8) that connect the power amplifier module assembly (11) to the amplifier/coupler housing (4).

5. Grasp the wire handle on the module and pull gently upward so that the module is removed.

6-8. ANTENNA TUNER A2A2 REMOVAL.

1. Place the amplifier/coupler so that the cover assembly (1) is on top.

2. Remove the cover assembly (1) by loosening the 8 captive screws (2).

3. Disconnect the rf cable A2J1 (16) from the antenna tuner module assembly (14).

4. Loosen the 4 captive screws (3) that connect the module to the amplifier/coupler housing (4).

5. Grasp the module and pull gently upward so that the module is removed.

6-9. RIBBON CABLE A2W1 REMOVAL.

NOTE

Remove power amplifier and antenna tuner before attempting removal of ribbon cable A2W1 .

1. Locate connector receptacle A2W1P1 (13) on the side of amplifier/coupler housing (4).

2. Remove the mounting screws of multipin connector A2W1J3 (12) which are located on the opposite side of the amplifier/coupler unit just below multipin connector A2W1J2 (49).

3. Remove screw and nut that mount terminal E1 to amplifier/coupler housing (4) adjacent to multipin connector A2W1J3 (12).

4. Remove the mounting screws (44) for multipin connector A2W1J2 (49), which are located on the opposite side of amplifier/coupler unit, just above multipin connector A2W1J3 (12).

5. Place amplifier/coupler so that the battery connector P1 (37) faces upward and remove the 2 mounting screws (38) with associated washers.

6. Remove screw and nut that mount terminal E1 (48) to amplifier/coupler housing (4) at the base of multipin connector A2W1J2 (19) adjacent to the capacitors (39).

CAUTION

Use extreme care when removing or replacing ribbon cables. Creasing or severe bending will damage ribbon cables internally.

7. Grasp ribbon cable support (45) and ribbon cable assembly (47) and

slowly pull backwards until the notched area of circuit card is separated from the raised portion of the amplifier/coupler housing. Lift circuit card and ribbon cable assembly upward and forward until connector receptacle A2P1 (13) is separated from amplifier/coupler housing (4).

Place amplifier/coupler housing (4) so that multipin connector A2W1J3 (12) faces upward. Slowly lift up and carefully pull back ribbon cable support (45) and ribbon cable assembly (47).

9. Grasp the bottom of battery connector A2P1 (37) and slowly pull ribbon cable assembly outward, separating battery connector from amplifier/coupler housing (4).

10. Unsolder ribbon cable assembly from battery connector A2P1 (37).

11. Grasp ribbon cable support (45) and ribbon cable assembly (47) and remove from the amplifier/coupler housing (4).

6-10. ANTENNA MOUNT REMOVAL.

1. Remove ribbon cable support (45) and ribbon cable assembly (47) as in paragraph 6-9.

2. Loosen and remove nut (36) at the base of whip antenna mount.

3. Remove lockwasher (35) terminal lug E4 (34), and lower antenna mount (33).

4. Grasp upper antenna mount (25), pull upward separating upper antenna and preform packing (27) from the amplifier/coupler housing (4).

6-11. BNC CONNECTOR A2J1 REMOVAL.

1. Unsolder lead from terminal (not shown) of the back side of the BNC connector A2J1 (28), adjacent to upper antenna mount (25).

2. Loosen and remove nut and washer on bottom of BNC connector (28).

3. Grasp BNC connector (28) from the top and pull upward separating connector and preform packing (29) from amplifier/coupler housing (4).

6-12. ANTENNA SELECT SWITCH A2S1 REMOVAL .

1. Working from the back side of antenna select switch A2S1 (32), unsolder terminals 1, 3, 4, 5, and 8.

2. Remove antenna select knob (26) by loosening 2 Allen screws on the side of the knob.

3. Remove the nut and lockwasher from the threaded portion of the antenna select switch (32) shaft.

4. Carefully pull antenna select switch downward, separating and removing switch from amplifier/coupler housing (4).

6-13. GROUND A2E1 REMOVAL.

1. Working from the back side of the ground connector A2E1 (30) (not shown), adjacent to antenna select knob (26), loosen and remove nut and washer.

2. Grasp top of connector ground (30) and pull upward, removing ground from amplifier/coupler housing (4).

6-14. LATCH REMOVAL.

1. Remove latch (21) by loosening and removing 2 Allen screws (22). Use the same procedure for removing bottom latch (43).

6-15. <u>AMPLIFIER/COUPLER REASSEMBLY</u> (Figure 6-2).

6-16. Reassembly of the amplifier/coupler (A2) consists of the replacement of the two modules, A2A1 and A2A2, and the replacement of ribbon cable A2W1, antenna mount, BNC connector A2J1, and antenna select switch A2S1.

6-17. LATCH REPLACEMENT .

1. Place amplifier/coupler housing (4) so that control knobs face upward.

2. Align latch (21) with the raised portion of amplifier/coupler housing (4).

3. Insert the 2 Allen screws (22) and tighten.

4. Use the same procedures for replacing the bottom latch (43).

6-18. GROUND A2E1 REPLACEMENT.

1. Align connector ground A2E1 (30) and place in appropriate hole with the threaded portion extending downward.

2. Attach washer and nut to the threaded portion of the connector ground (30) and tighten.

6-19. ANTENNA SELECT SWITCH A2S1 REPLACEMENT.

1. Align antenna select switch A2S1 (32) with appropriate hole in amplifier/coupler housing (4) and place into position with switch shaft extending upward with threaded portion of shaft visible.

2. Attach lockwasher and the 2 nuts.

3. Solder terminal connections 1, 3, 4, 5, and 8 located at the base of antenna select switch (32).

4. Place antenna select knob (26) on antenna select switch shaft (32) and align with appropriate selection, and tighten 2 Allen screws on the side of the knob.

6-20. BNC CONNECTOR A2J1 REPLACEMENT.

Inspect preform packing O-ring (29). Replace if worn or cracked. Lubricate preform packing (see table 6-1).

2. Align BNC connector A2J1 (28) and preform packing (29) with hole adjacent to antenna mount.

3. Push BNC connector and preform packing into position with connector soldering terminal extending downward.

4. Screw on nut and washer and tighten.

5. Solder teflon wire from antenna select switch A2S1 (32) to BNC connector terminal (28).

6-21. ANTENNA MOUNT REPLACEMENT.

1. Inspect preform packing (27). Replace if worn or cracked. Lubricate preform packing (see table 6-1).

2. Align upper antenna mount (25) and preform packing (27) with the hexagon cut-out on the top of the amplifier/coupler housing. “

3. Push upper antenna mount (25) through the hex cut-out.

4. Align lower antenna mount (33) with the upper antenna mount (25).

5. Push lower antenna mount (33) into hex cut-out.

6. Attach terminal lug E4 (34).

7. Attach lockwasher (35).

8. Attach nut (36) and tighten.

6-22. RIBBON CABLE A2W1 REPLACEMENT.

CAUTION

Use extreme care when removing or replacing ribbon cables. Creasing or severe bending will damage ribbon cables internally.

1. Place ribbon cable assembly (47) and ribbon cable support (45) in amplifier/coupler housing (4) so that the bottom of the ribbon cable extends through connector opening, located at the bottom of the amplifier/coupler housing, allowing for enough space to solder battery connector A2P1 (37) onto ribbon cable (47).

2. Solder battery connector A2P1 (37) onto ribbon cable terminal (48) to amplifier/coupler housing (4) by attaching mounting bracket with screw and nut.

3. Carefully push battery connector A2P1 (37) into place. Attach the connector screws (38) with associated washers and tighten.

4. Grasp ribbon cable support (45) and ribbon cable assembly (47) and straddle amplifier/coupler internal housing. At the same time, work receptacle connector A2W1P1 (13) into position.

5. Push ribbon cable support and ribbon cable assembly into position by carefully pushing circuit card toward connector A2W1P1 (13) opening and then pushing circuit board forward allowing notched portion of circuit board (45) to fit into notched portion of amplifier/coupler housing (4).

6. Align connectors A2W1J2, A2W1J3 on their appropriate mounting studs.

7. Attach connector A2W1J2 (49) using 2 screws, 2 lockwashers, and 2 flat washers. Screws and washers are attached from the back side of the connector. Attach terminal (46) adjacent to A2W1J2 using mounting plate, screw, “and flat washer.

8. Attach connector A2W1J3 (12) using the same procedures for attaching connector A2W1J2.

9. Attach connector A2W1P1 (13) using 2 screws (17), packing (18), and nuts (20).

6-23. ANTENNA TUNER A1A2 REPLACEMENT.

1. Align the module (14) over the amplifier/coupler housing (4) as shown.

2. Carefully plug the module (14) into the amplifier/coupler housing (4) so that the multipin connector A2A2P1 (15) and jack fit properly.

3. Tighten the 4 captive screws (3) on the module.

4. Reconnect the rf cable A2J1 (16) according to the color-code.

5. Lubricate the O-ring in the cover assembly (1) (see table 6-1). Replace the cover assembly. Tighten the 8 captive screws (2).

6-24. POWER AMPLIFIER A1A1 REPLACEMENT.

1. Align the power amplifier module (11) over the amplifier/coupler housing (4) as shown.

2. Carefully plug the module (11) into the housing so that the multipin connector A2W1J3 (12) and jack fit properly. .

3. Tighten the 4 captive’ screws (8) on the module (11).

4. Reconnect the 2 rf cables (5) A1J1 and A1J2 to the module according to the color-code.

5. Lubricate the O-ring in the cover assembly (10) (see table 6-1). Replace the cover assembly. Tighten the 8 captive screws (9).

6-25. <u>POWER AMPLIFIER DISASSEMBLY AND REASSEMBLY.</u>

6-26. There are no special procedures required to disassemble and reassemble the power amplifier (A2A1) with the exception of separating the upper 755002A0667 assembly and the lower 755002A0668 assembly. To do this, loosen and remove the 4 Allen screws on 755002A0667. When reassembling lower and upper assembly, carefully fold the interconnecting ribbon cable into . position.

6-27. <u>ANTENNA TUNER DISASSEMBLY AND REASSEMBLY.</u>

6-28. There are no special procedures required to disassemble and reassemble the antenna tuner (A2A2) with the exception of separating the 755002A0759 upper assembly from the 75502A0760 lower assembly. To do this, loosen and remove 6 Allen screws on 755002A0759 only. Failure to comply with the above will result in improper module clearance when reassembled.

SECTION III

CLEANING AND EXAMINATION

6-29. GENERAL .

6-30. Cleaning and examination procedures are contained in chapter 3.

SECTION IV

PERFORMANCE TEST AND TROUBLESHOOTING

6-31. INTRODUCTION.

6-32. The performance test and troubleshooting procedures are combined into a single flowchart format (chapter 3). This allows the maintenance technician to check the amplifier/coupler (A2) for normal indications, and to branch off for fault isolation if an abnormal indication exists. The troubleshooting flowchart is an aid for isolating to a probable fault and should be used in conjunction with the functional block diagrams (chapter 2) and the schematic figure 6-1. Once a fault has been located and corrected, the performance test is repeated. Do not skip blocks in the performance test, because succeeding blocks may be predicated on certain faults being eliminated.

6-33. PERFORMANCE TEST.

6-34. The performance test setup is shown in figure 6-3. The performance test is contained in figure 6-4.

SECTION V

REPAIR AND REPLACEMENT

6-35. GENERAL.

6-36. Repair and replacement information for the amplifier/coupler (A2) is contained in chapter 3 and in section II.

SECTION VI

COMPONENT LOCATION AND PARTS LIST

6-37. GENERAL.

6-38. This section contains the component location and parts list diagram, figure 6-2, for the amplifier/coupler (A2). This diagram supports the disassembly and reassembly procedures of section II.

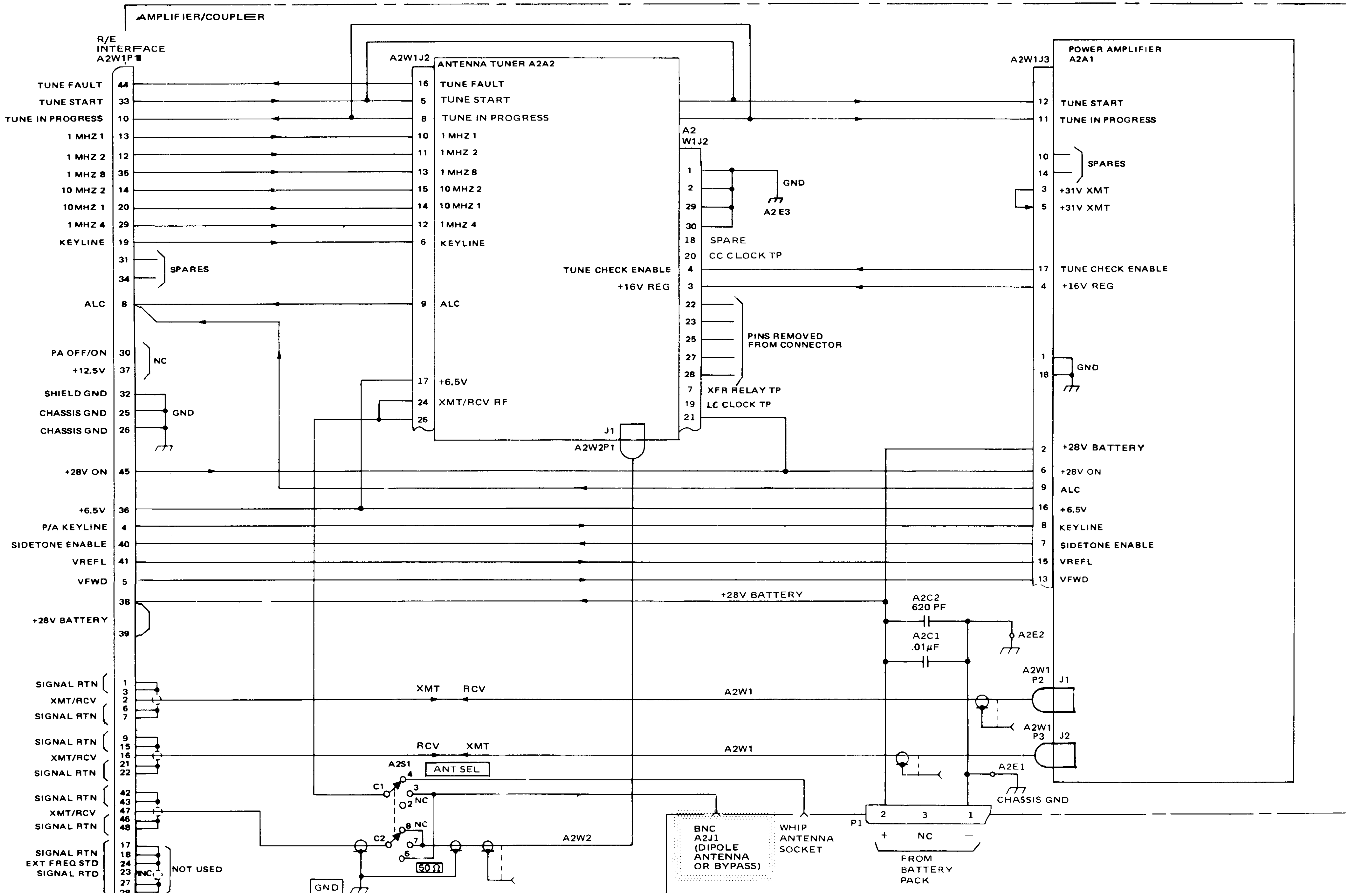


Figure 6-1. Amplifier/Coupler A2 Schematic

ITEM	DESCRIPTION
1.	Cover Assembly
2.	Screw, Captive (8 places)
3.	Screw, Captive (4 places)
4.	Amplifier/Coupler Housing
5.	RF Cables A1J1(W1P2), A1J2(W1P3)
6.	Marker
7.	Marker
8.	Screw, Captive (4 places)
9.	Screw, Captive (8 places)
10.	Cover Assembly
11.	Power Amplifier Module A2A1
12.	Multipin Connection A2W1J3
13.	Connector Receptacle A2W1P1
14.	Antenna Tuner Module Assembly A2A2
15.	Multipin Connector A2A2P1
16.	RF Cable A2J1(W2P1)
17.	Screw (2 places)
18.	Self-Sealing O-Ring, Part of Screw (2 places)
19.	Packing, Preform
20.	Nut (2 places)
21.	Latch
22.	Screw, Allen (2 places)
23.	Connector Cover
24.	Antenna Cover
25.	Antenna Mount, Upper
26.	Knob, Antenna Select
27.	Packing, Preform
28.	Connector, BNC A2J1
29.	Packing, Preform
30.	Post, Ground A2E3
31.	Gasket
32.	Switch, Antenna Select A2S1
33.	Antenna Mount, Lower
34.	Terminal Lug A2E4
35.	Lockwasher
36.	Nut
37.	Connector, Battery A2P1

ITEM	DESCRIPTION
38.	Screw (2 places)
39.	Capacitor (2 places)
40.	Gasket
41.	Gasket
42.	Terminal
43.	Latch
44.	Mounting Screw (2 places)
45.	Ribbon Cable Support
46.	Terminal
47	Ribbon Cable Assembly A2W1
48.	Terminal
49.	Multipin Connector, A2W1J2
50.	**Hex Nut**
51.	**0.02" C Spring Clip (16 places)**

NOTE:

1. Heat screw prior to removal to loosen loctite.

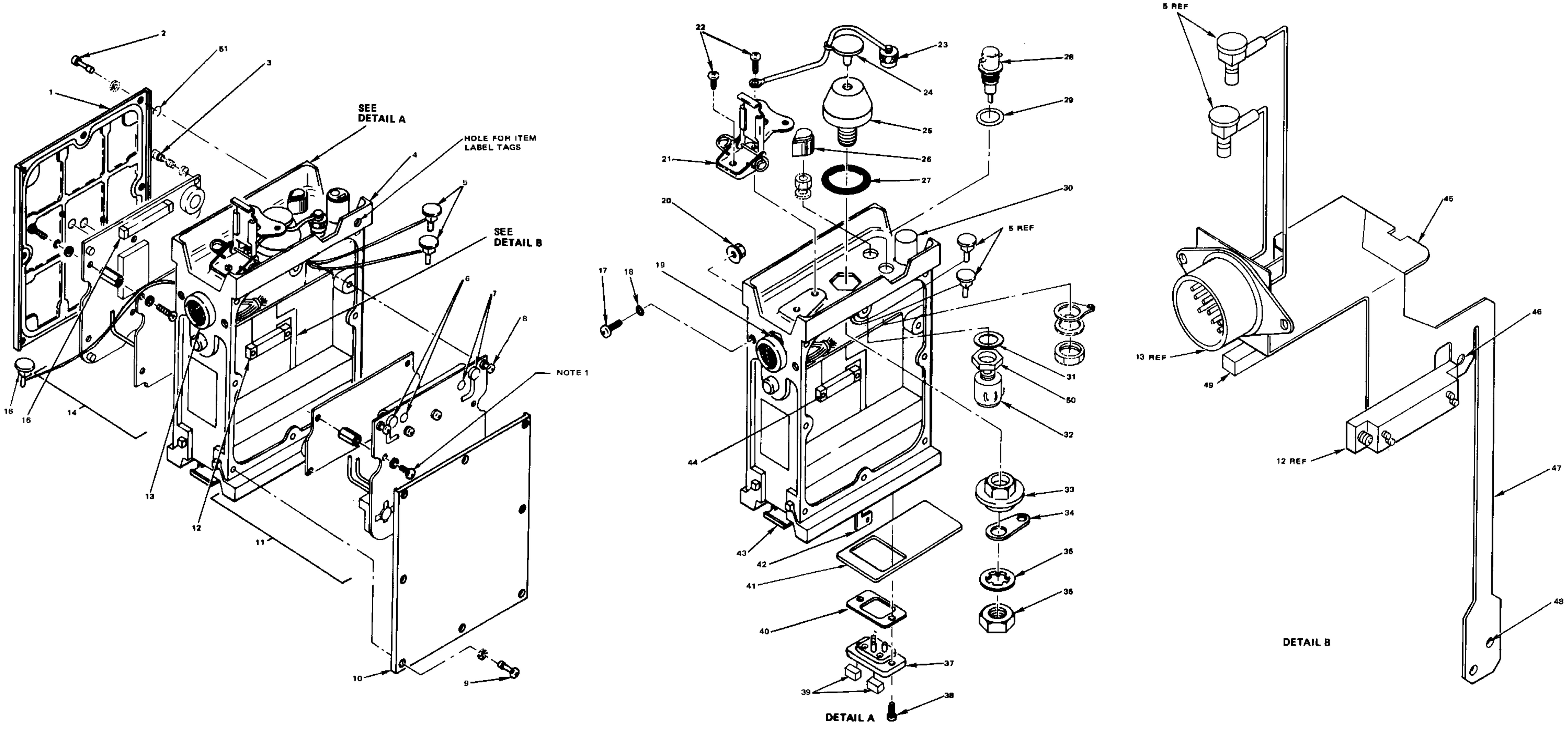


Figure 6-2. Amplifier/Coupler A2 Component Location

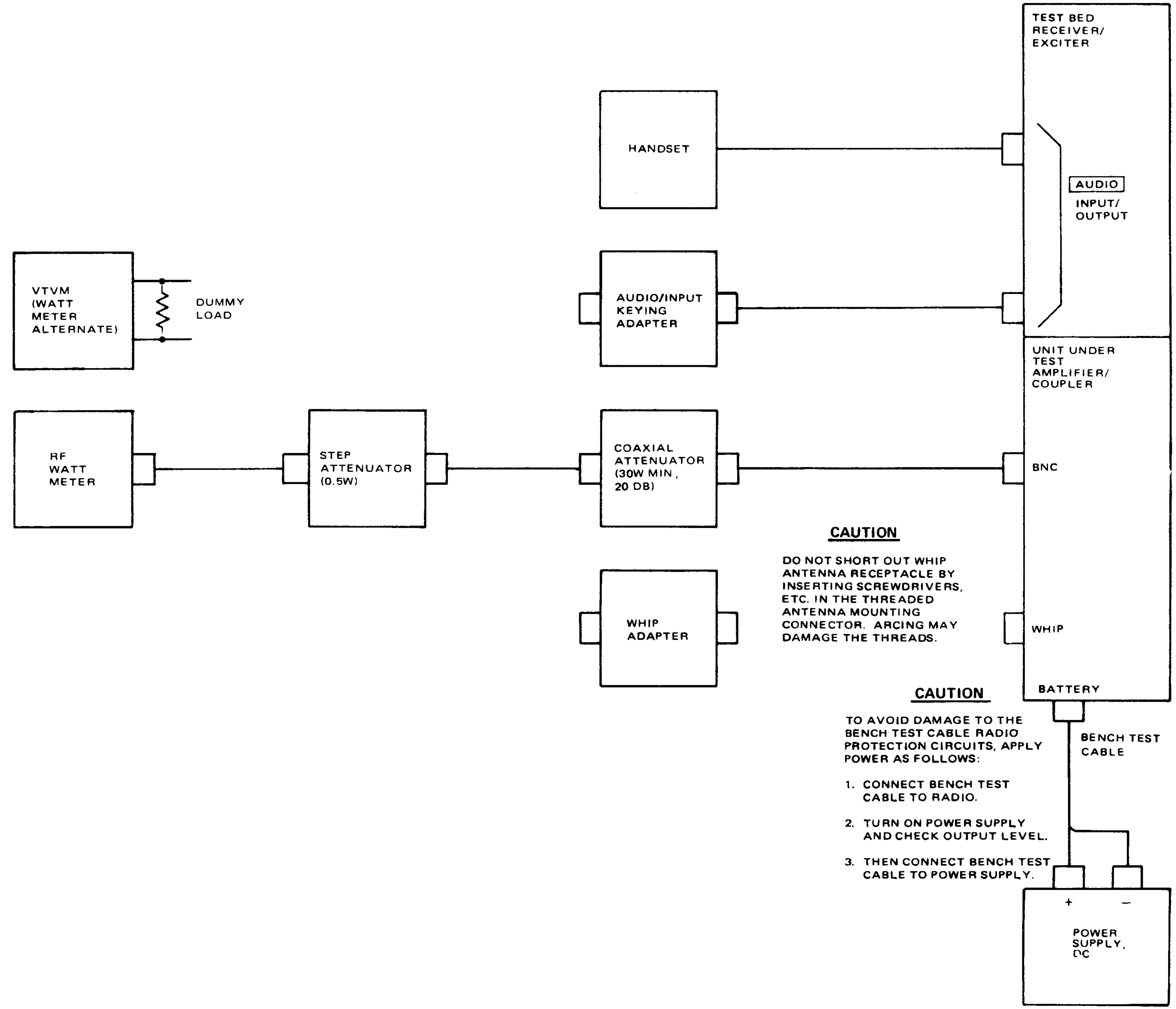


Figure 6-3. Amplifier/Coupler A2 Performance Test Setup

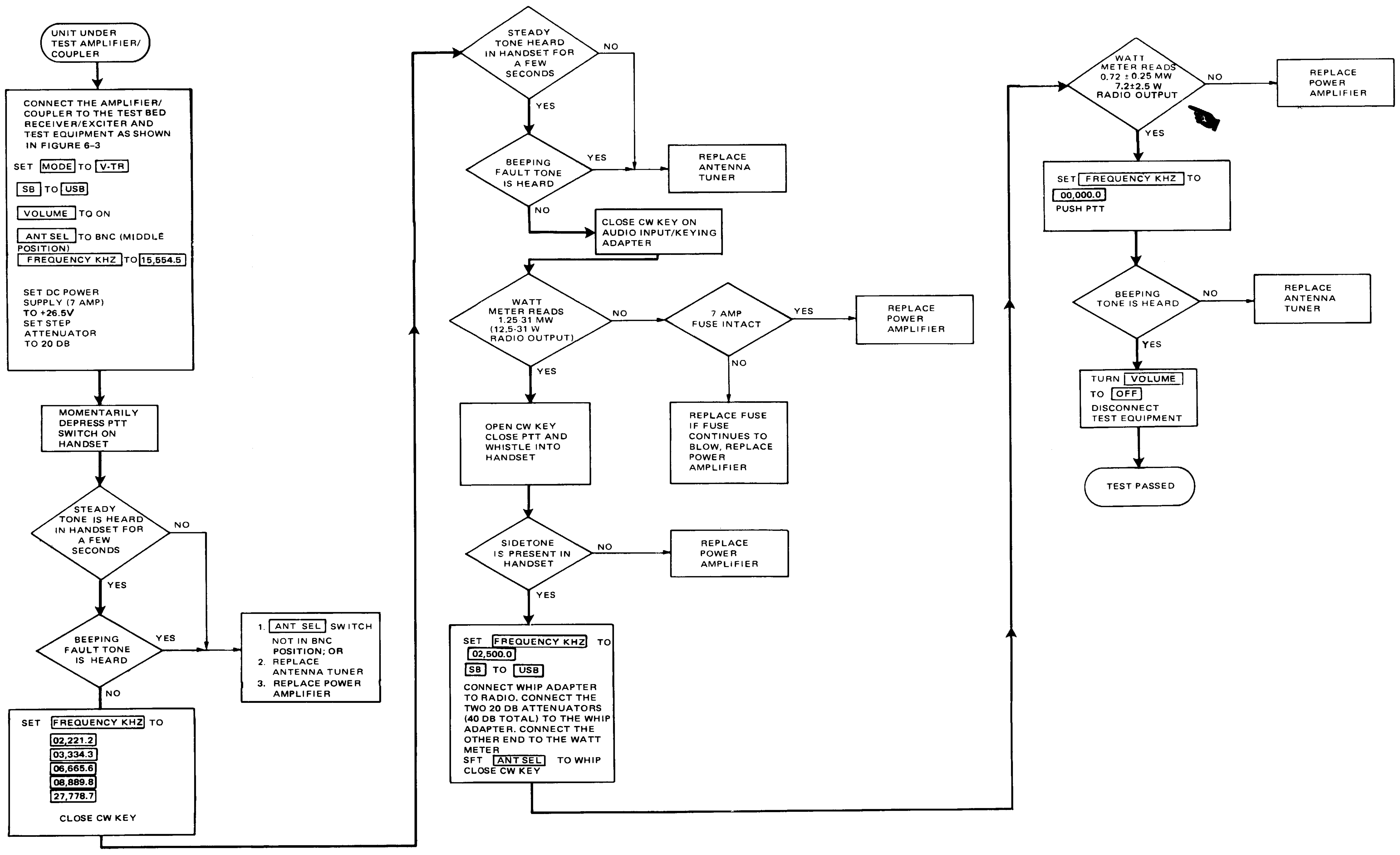


Figure 6-4. Amplifier/Coupler A2 Performance Test

APPENDIX A

REFERENCES

AR 55-38	Reporting of Transportation Discrepancies in Shipments
AR 735-11-2	Reporting of Item and Packaging Discrepancies
AR 755-2	Disposal of Excess, Surplus, Foreign Excess, Captured, and Unwanted Material
DA Pam 310-1	Consolidated Index of Army Publications and Blank Forms
DA Pam 738-750	The Army Maintenance Management System (TAMMS)
SB 11-131	Vehicular Radio Sets and Authorized Installations
SB 38-100	Preservation, Packaging, Packing and Marking Materials, Supplies and Equipment Used by the Army
TB SIG 291	Safety Measures to be Observed When Installing and Using Whip Antenna, Field-type Masts, Towers, Antennas, and Metal Poles that are Used with Communication, Radar, and Direction Finder Equipment
TB 43-0118	Field Instructions for Painting and Preserving Electronics Command Equipment Including Camouflage Pattern Painting of Electrical Equipment Shelters
TM 11-5820-919-12	Operator’s and Organizational Maintenance Manual Radio Set AN/PRC-104A
TM 11-5820-919-24P	Organizational, Direct Support and General Support Maintenance Repair Parts and Special Tools List for Radio Set AN/PRC-104A
TM 11-5820-919-40-2	General Support Maintenance Manual Radio Set AN/PRC-104A
TM 740-90-1	Administrative Storage of Equipment
TM 750-244-2	Procedures for Destruction of Electronic Materiel to Prevent Enemy Use (Electronics Command)

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ALPHABETICAL INDEX (Continued)

ALPHABETICAL INDEX (Continued)

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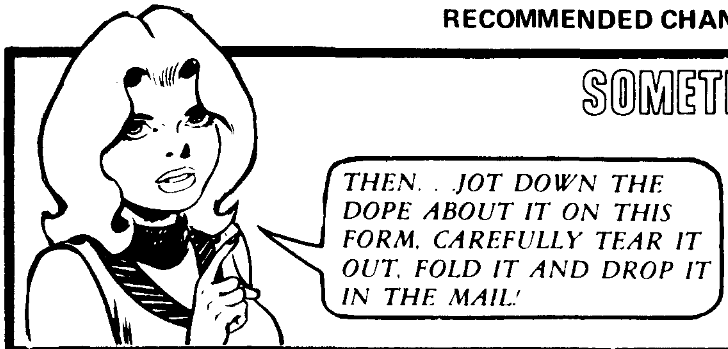

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TM 11-5840-340-12	23 Jan 74	Radar Set AN/PRC-76

BE EXACT. . PIN-POINT WHERE IT IS

PAGE NO	PARA-GRAPH	FIGURE NO	TABLE NO	IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:
2-25	2-28			Recommend that the installation antenna alignment procedure be changed throughout to specify a 2^{o} IFF antenna lag rather than 1^{o}. REASON: Experience has shown that with only a 1^{o} lag, the antenna servo system is too sensitive to wind gusting in excess of 25 knots, and has a tendency to rapidly accelerate and decelerate as it hunts, causing strain to the drive train. Hunting is minimized by adjusting the lag to 2^{o} without degradation of operation.
3-10	3-3		3-1	Item 5, Function column. Change "2 db" to "3db." REASON: The adjustment procedure for the TRANS POWER FAULT indicator calls for a 3 db (500 watts) adjustment to light the TRANS POWER FAULT indicator.
5-6	5-8			Add new step f.1 to read, "Replace cover plate removed in step e.1, above." REASON: To replace the cover plate.
		F03		Zone C 3. On J1-2, change "+24 VDC to "+5 VDC." REASON: This is the output line of the 5 VDC power supply. +24 VDC is the input voltage.

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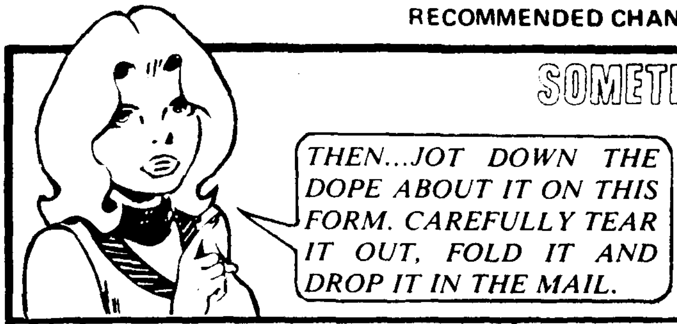

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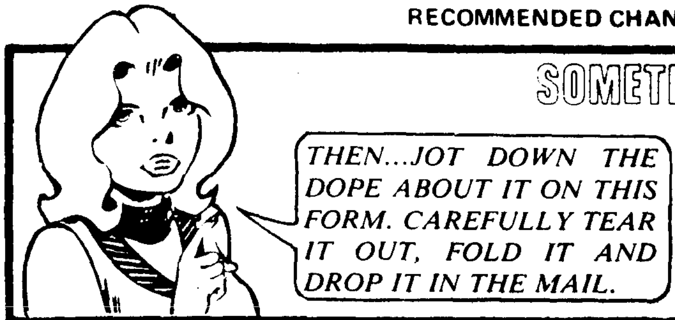

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