



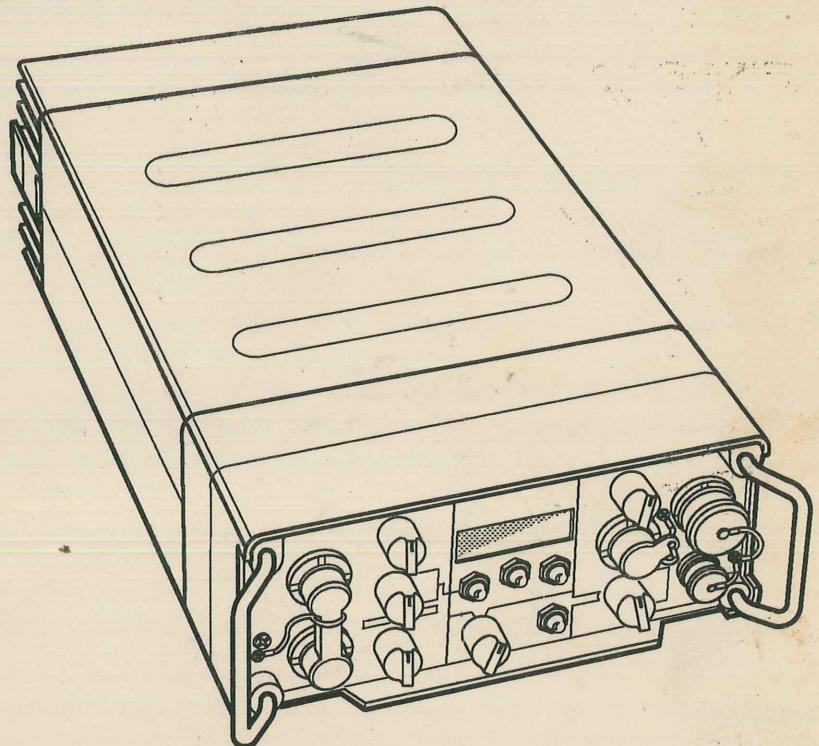
HARRIS

RF COMMUNICATIONS

AN/PRC-117D(E)

**FREQUENCY HOPPING VHF/UHF
FM/AM MANPACK TRANSCEIVER
WITH INTEGRATED RF-3997
ENCRYPTION OPTION**

INSTRUCTION MANUAL





**LIMITED ONE YEAR WARRANTY
HARRIS CORPORATION (RF COMMUNICATIONS DIVISION)**

FROM HARRIS TO YOU – This warranty is extended to the original buyer and applies to all Harris Corporation, RF Communications Division equipment purchased and employed for the service normally intended, except those products specifically excluded.

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Harris Corporation
RF Communications Division
Customer Service
1680 University Avenue
Rochester, NY 14610, U.S.A.

Telephone: (716) 244-5830
Telex: 240313
Cable: RFCOM

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- The performance of the equipment when used in combination with equipment not purchased from Harris.
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IF YOU HAVE ANY QUESTIONS – Concerning this warranty or equipment sales or services, please contact our Customer Service Department.

AN/PRC-117D(E) FREQUENCY HOPPING VHF/UHF FM/AM MANPACK TRANSCEIVER WITH INTEGRATED RF-3997 ENCRYPTION OPTION

INSTRUCTION MANUAL

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Equipment manufactured by Harris Corporation, RF Communications Division meets stringent quality and safety standards. However, high voltages are present in many radio products, and only a skilled technician should attempt to remove outer covers and make adjustments or repairs. All personnel who operate and maintain the equipment should be familiar with this page as a safety preparedness measure. Although this procedure is reproduced as a service to the personnel involved with this equipment, Harris Corporation assumes no liability regarding any injuries incurred during the operation and repair of such equipment, or the administration of this suggested procedure.

ELECTRICAL SHOCK: EMERGENCY PROCEDURE

The victim will appear unconscious and may not be breathing. If the victim is still in contact with the voltage source, disconnect the power source in a manner safe to you, or remove the victim from the source with an insulated aid (wooden pole or rope). Next, determine if the victim is breathing and has a pulse. If there is a pulse but no breathing, administer artificial respiration. If there is no pulse and no breathing, perform CPR (if you have been trained to do so). If you have not been trained to perform CPR, administer artificial respiration anyway. Never give fluids to an unconscious person.

WHEN BREATHING STOPS

FIRST, send someone to get a **DOCTOR**.
THEN, administer first aid to restore breathing (artificial respiration):

1 IF A VICTIM APPEARS TO BE UNCONSCIOUS
TAP VICTIM ON THE SHOULDER AND SHOUT, "ARE YOU OKAY?"

2 IF THERE IS NO RESPONSE
TILT THE VICTIM'S HEAD, CHIN POINTING UP. Place one hand under the victim's neck and gently lift. At the same time, push with the other hand on the victim's forehead. This will move the tongue away from the back of the throat to open the airway.

IMMEDIATELY LOOK, LISTEN, AND FEEL FOR AIR.
While maintaining the backward head tilt position, place your cheek and ear close to the victim's mouth and nose. Look for the chest to rise and fall while you listen and feel for the return of air. Check for about five seconds.

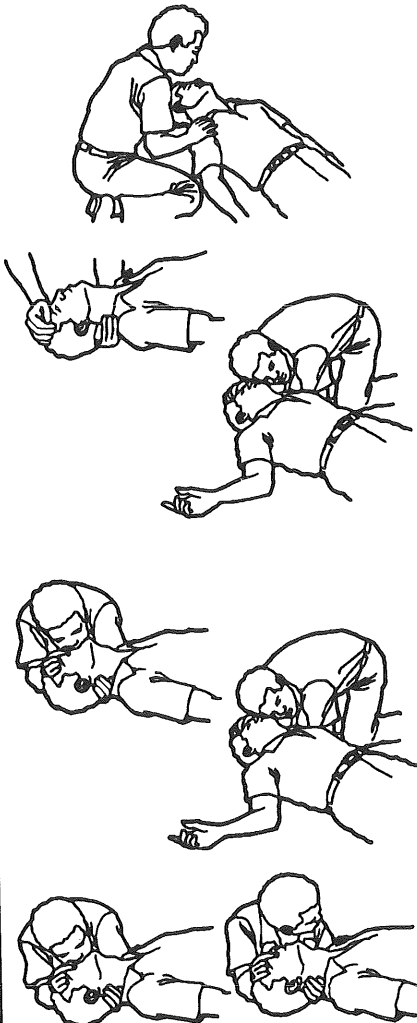
3 IF THE VICTIM IS NOT BREATHING
GIVE FOUR QUICK BREATHS.

Maintain the backward head tilt, pinch the victim's nose with the hand that is on the victim's forehead to prevent leakage of air, open your mouth wide, take a deep breath, seal your mouth around the victim's mouth, and blow into the victim's mouth with four quick but full breaths just as fast as you can. When blowing, use only enough time between breaths to lift your head slightly for better inhalation.

If you do not get an air exchange when you blow, it may help to reposition the head and try again.

AGAIN, LOOK, LISTEN, AND FEEL FOR AIR EXCHANGE.

4 IF THERE IS STILL NO BREATHING
CHANGE RATE TO ONE BREATH EVERY FIVE SECONDS.



For more information about these and other life-saving techniques, contact your Red Cross chapter for training. "When Breathing Stops" reproduced with permission from an American Red Cross Poster.

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SPECIFICATIONS

GENERAL

Frequency Range:

VHF (Low) 30.000 to 89.975 MHz

VHF (High) 116.000 to 173.995 MHz

UHF 225.000 to 419.995 MHz

Channel Spacing:

VHF (Low) 25 kHz

VHF (High) 5 kHz or 6.25 kHz

UHF 5 kHz

Modulation:

VHF (Low) FM (5 or 8 kHz deviation)

VHF (High) AM (90%), FM (5 or 8 kHz)

UHF AM (90%), FM (5 or 8 kHz)

Modes of Operation:

VHF (Low) Simplex;
Half-Duplex;
ECCM: Frequency-Hopping;
Clear Text Voice/Data:
Asynchronous Data up to 16k baud;
Secure Text/Voice:
Synchronous Data = 16k baud

VHF (High) Simplex;
Half-Duplex;
ECCM: Frequency-Hopping;
Clear/Secure Text, same as Low VHF

UHF Simplex;
Half-Duplex;
ECCM: Frequency-Hopping;
Clear Text Voice/Data:
Data = 16k Synchronous; up to 16k Asynchronous;
Secure Text Voice/Data:
Synchronous data = 16k baud

ENCRYPTION Variables: Six (6) traffic variables

Preset Channels: 8 programmable

SPECIFICATIONS (Cont.)

GENERAL (Cont.)

Number of Channels: 2400 (VHF Low)
11, 600 (VHF High, 5 kHz)
9, 280 (VHF High, 6.25 kHz)
39, 000 (UHF)

ENCRYPTION Fill Devices: RF-5961FCP, RF-5960 Master Code Programmer

Power Supply: 12 Vdc (nominal)

Temperature Range: -40°C to +70°C

Shock/Vibration: MIL-STD-810E

Immersion: 3 ft. (0.9 m) of water

Humidity: MIL-STD-810E

Size: 3.0 H x 7.9 W x 13.6 D in.
(7.6 H x 20.0 W x 34.5 D cm)

Weight: 15.25 lbs. (6.9 kg) – includes battery, antenna, and H-250 handset.

RECEIVER

Sensitivity:
VHF (Low) -113 dBm FM for 10 dB SINAD

VHF (High) -113 dBm FM for 10 dB SINAD,
-106 dBm AM for 10 dB SINAD, 30% Modulation

UHF -120 dBm FM for 10 dB SINAD
-110 dBm AM for 10 dB SINAD, 30% Modulation

Adjacent Channel Rejection: Greater than 60 dB

IF Rejection: Greater than 80 dB (VHF)
Greater than 80 dB (UHF)

Desensitization: Less than 3 dB desensitization for an unwanted input signal of 120 dB above .5 uV, at a frequency 10% removed from the desired signal.

Image Rejection: Greater than 60 dB

Limiting (FM Mode): Audio output levels vary not more than 1 dB (maximum) for RF signal levels, from -100 dBm to +5 dBm.

Audio Variation (AM Mode): Audio output levels vary not more than 3 dB for RF signal levels, from -100 dBm to +5 dBm. (30% Modulation)

Ultimate Receiver Quieting: Down 40 dB as referenced to full deviation of 1 kHz modulated signal with input signal level of -60 dBm.

SPECIFICATIONS (Cont.)

RECEIVER (Cont.)

Narrowband Audio Frequency Response:	Within 3 dB for 300 Hz – 3 kHz audio output Down at least 25 dB at 150 Hz, down at least 8 dB at 6 kHz.
Wideband Data Frequency Response:	Within 3 dB for 10 Hz – 10 kHz range
Audio Output:	0.20 – 20 mW into 600 ohms to external handset
Audio Output Level – Fixed:	220 mV \pm 10% into 600 ohms
Audio Distortion:	Less than 5% with RF input signal up to 0 dBm
Squelch (FM Mode):	OFF: No Squelch NOISE: Activated with RF signal greater than –120 dBm. TONE: Levels same as noise, except 150 Hz carrier is added.
Squelch (AM Mode):	OFF: No Squelch NOISE: Activated with RF signal greater than –120 dBm.

TRANSMITTER

Output Power:	LOW (adjustable):	HIGH (fixed):
FM	1, 2, 4, 6, 8, or 10 Watts	10 Watts
AM	1, 2, 4, 6, 8, or 10 Watts (24.5 Watts PEP)	10 Watts (24.5 Watts PEP)
VHF-FM (Low)	1 to 10 Watts \pm 1dB, selectable in 2 Watt increments	
VHF-FM (High)	1 to 10 Watts \pm 1dB, selectable in 2 Watt increments	
VHF-AM (High)	1 to 10 Watts \pm 1dB, selectable in 2 Watt increments (24.5 Watts PEP)	
UHF-AM	1 to 10 Watts \pm 1dB, selectable in 2 Watt increments (24.5 Watts PEP)	
UHF-FM-LOS	1 to 10 Watts \pm 1dB, selectable in 2 Watt increments	
Frequency Stability:	1 part in 10 ⁶	
Modulation Types:		
VHF-FM (Low)	Wideband FM	
VHF-FM (High)	Wideband FM	
VHF-AM (High)	AM	
UHF-FM	Wideband FM	
UHF-AM	AM	

SPECIFICATIONS (Cont.)

TRANSMITTER (Cont.)

Modulation Bandwidth:	Voice – 300 Hz to 3 kHz Data – 10 Hz to 10 kHz
Deviation (Internally Selectable):	–5 kHz (TCS tone 1.875 kHz) –8 kHz (TCS tone 3.0 kHz)
Harmonic Suppression:	Greater than 40 dB referenced to the carrier
Wideband Noise:	–150 dBc/Hz at 10% from carrier frequency
Load VSWR:	No damage to radio system when load impedance is short or open circuit.
Spurious Emission:	At least –70 dB referenced to the carrier at frequencies greater than 200 kHz from the carrier.

ABOUT THIS MANUAL

The main sections of this manual cover the following topics:

- Section 1 – provides a general description of the radio and details its key features, standard equipment, and optional equipment.
- Section 2 – provides instructions on assembling the radio, excluding the UHF antenna.
- Section 3 – provides procedures for radio operation.
- Section 4 – provides a radio-level theory of operation.
- Section 5 – provides maintenance instructions and troubleshooting data.

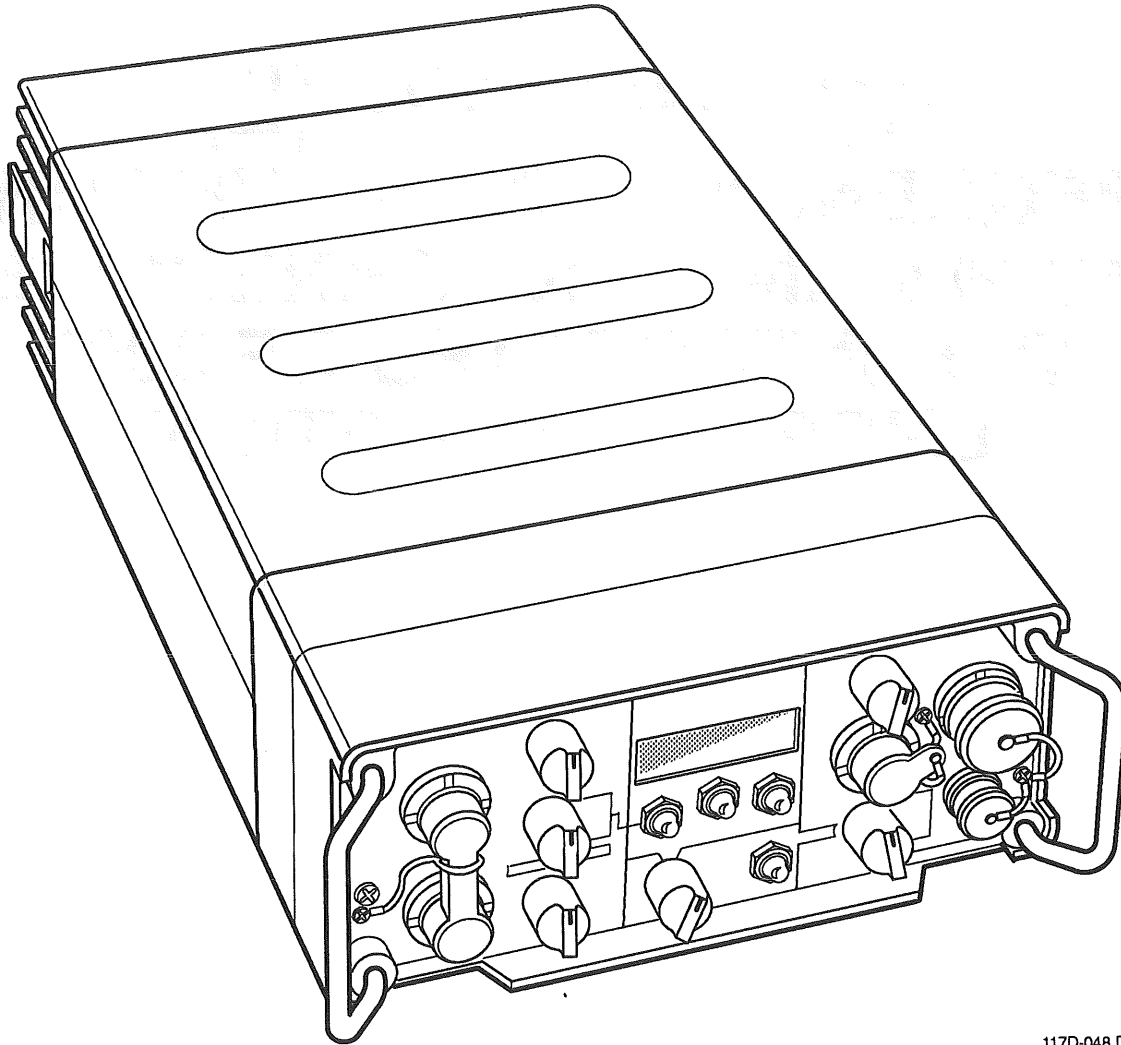
Following section 5, the Unit Instructions sections describe each subassembly of the manpack to the modular level. Units consist of the following:

- R/T Assembly
- A1 Antenna Tuner/Filter Module
- A2 Signal Synchronizer Module
- A3 Microprocessor Module
- A4 Power Supply Module
- A5 Audio Module
- A7 Frequency Synthesizer Module
- A8 Receiver Module
- A9 Transmitter Module
- A10 Front Panel Assembly



**AN/PRC-117D(E)
FREQUENCY HOPPING VHF/UHF
FM/AM MANPACK TRANSCEIVER
WITH INTEGRATED RF-3997
ENCRYPTION OPTION**

INSTRUCTION MANUAL



117D-048 DI

AN/PRC-117D(E) Frequency Hopping VHF/UHF FM/AM Manpack Transceiver

SECTION 1

INTRODUCTION

1.1 GENERAL

This manual describes the AN/PRC-117D(E) VHF/UHF Manpack Transceiver with integrated RF-3997 encryption option, designed and manufactured by Harris Corporation, RF Communications Division, 1680 University Avenue, Rochester, New York 14610.

1.2 ORGANIZATION OF THIS MANUAL

The first five sections of this manual describe the setup and operation of the manpack transceiver. They include:

- Section 1 – Introduction
- Section 2 – Assembling the Radio
- Section 3 – Operation
- Section 4 – Theory of Operation
- Section 5 – Maintenance

Subsequent Unit Instructions describe the subassemblies of the manpack transceiver. A glossary is included at the end of this manual.

1.3 ABOUT THE RADIO

The AN/PRC-117D(E) VHF/UHF Manpack Transceiver is a manpack transceiver, with an optional built-in encryption capability, that adds VHF-Hi, UHF, and AM capabilities to the functions of the AN/PRC-117A VHF-FM full-band frequency-hopping radio. It operates in the frequency ranges, bandwidth, and modes listed in table 1-1.

The transceiver has eight channels. The MANUAL channel is used for manually selecting programming parameters such as frequency, channel mode, and changes to the XMT POWER control when it is set to low power. Channels 1 – 7 are used for preprogrammed (or stored) programming parameters. In single channel programming, these include frequency selections; in Electronic Counter-Countermeasures (ECCM) operation, these include frequency-hopping codes.

The standard parts of the manpack transceiver are as follows:

- RF-2117R/T Receiver-Transmitter Assembly – This unit includes all radio receiver, transmitter, control logic, and encryption capability.
- Handset (P/N H-250/U) – Standard push-to-talk handset common among tactical transceivers.
- Battery Pack (P/N 10012-0300) – Nickel-Cadmium (Ni-Cd) batteries provide +12 V (nominal) to the Receiver-Transmitter Assembly.
- VHF-Low Manpack Blade Antenna (P/N 10012-0201) – 44-inch (1.12 m) blade antenna with flexible neck.
- VHF-Low Manpack Antenna Kit (P/N 10012-0240) – Standard antenna kit including a 10 foot (3.1 m) collapsible whip antenna and flexible base, whip adapter, and canvas antenna bag.

- VHF-Hi/UHF Manpack Antenna (P/N 10369-0205) – Antenna kit for using the radio in the 116 MHz to 420 MHz frequency range.
- Backpack Harness (P/N 10012-0400) – Pack frame for the manpack configuration, similar to the AN/PRC-77 or -25 pack frame design.

Figure 1-1 shows each part of the manpack transceiver.

Table 1-1. Frequency Ranges and Operating Modes

Frequency Range (Bands - in MHz)	Modes (AM or FM)	Channel Spacing (in kHz)
30.000 - 89.975	FM Only	25
116.000 - 173.995	AM or FM	5 or 6.25*
225.000 - 419.995	AM or FM	5

*5.00 kHz is the default.

1.3.1 R/T Assembly

The R/T Assembly is made up of nine removable modules and a front panel assembly, all fitting together in a compact chassis. This arrangement enables quick repair of a faulty radio by module replacement.

1.4 IMPORTANT FEATURES

Distinctive operating features of the manpack transceiver include the following:

- Integrated encryption capability (option)
- Data capability
- Self-identity test
- Built-in self test
- Fault reporting during operation
- Simplex/half-duplex operation
- ECCM: Frequency hopping
- Answer-back scan
- Programmable exclusion frequencies and bands – Future Application.
- Zeroize feature
- Front panel menu programming

The following paragraphs briefly outline these operating features. Subsequent sections of this manual describe radio setup and operation for using each feature.

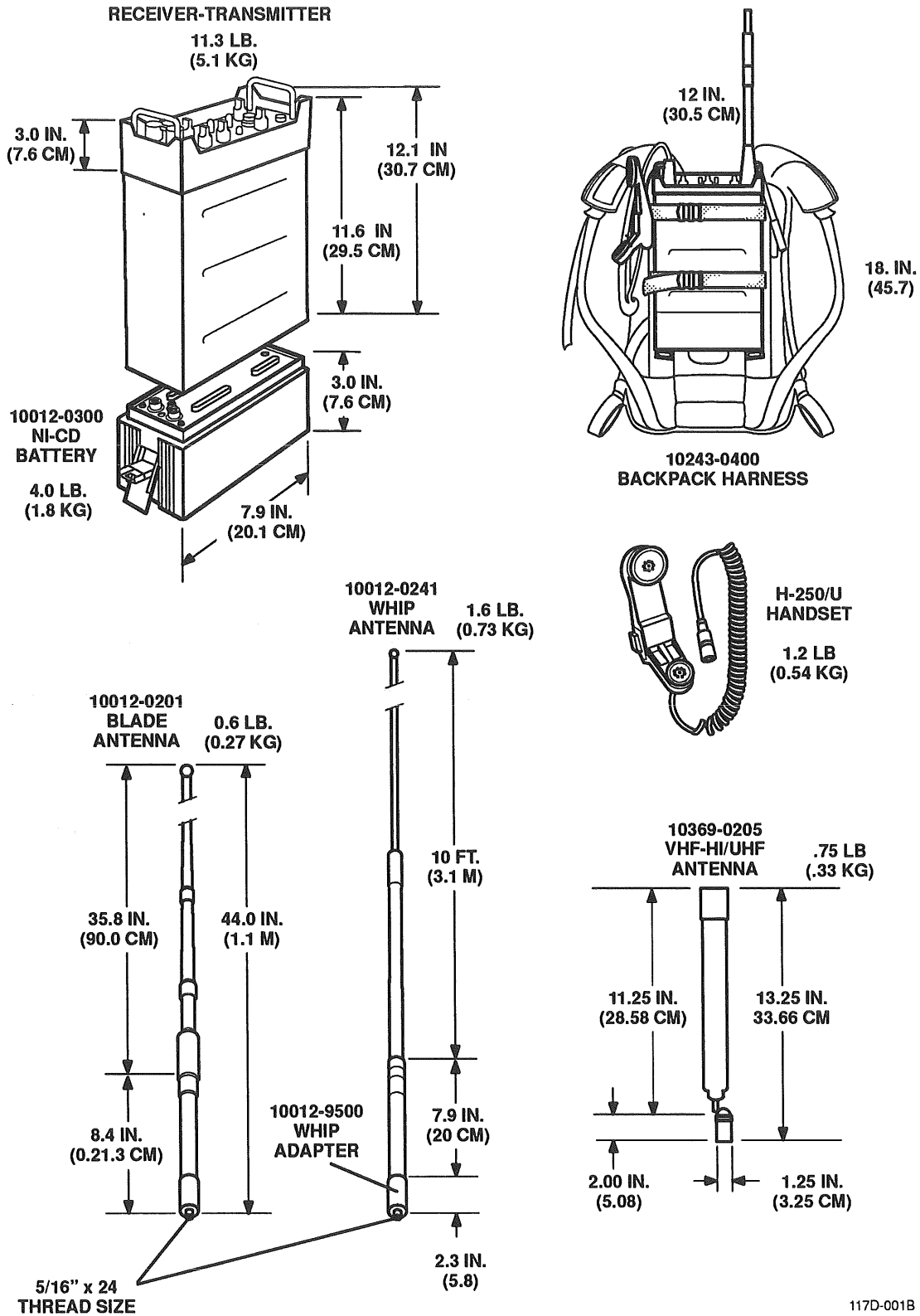


Figure 1-1. Major Items Supplied

117D-001B DI

1.4.1 Integrated ENCRYPTION Capability (Option)

The optional encryption feature allows the transceiver to process signals so that their information content can be extracted only by those authorized and equipped to do so.

The AN/PRC-117D(E) Manpack Transceiver is fully compatible with the AN/PRC-117A manpack and AN/VRC-94A vehicular transceivers in the frequency-hopping mode. It also operates with AN/PRC-77 manpacks and AN/VRC-12 series vehicular radios in the single channel mode.

The AN/PRC-117D(E) with the RF-3997 option provides six traffic variables, erase, secure and clear-text retransmission. The RF-5961 Field Code Programmer is used to load encryption variables into the manpack transceiver.

1.4.2 Data Capability

The AN/PRC-117D(E) Manpack Transceiver can be used with data devices that meet MIL-STD-188-114A specifications. Data rates up to 16 kbps are typical in normal operation.

1.4.3 Self-Identity Test

The R/T Assembly has a number of configuration options. A radio operator can determine the options available on an individual radio by performing the self-identity test. This is done by pressing and holding the front panel TEST/LOAD pushbutton, then placing the XMT POWER switch in the LOW or HIGH position from the RADIO OFF position.

The LED display first shows the radio model number. An F is displayed if the ECCM module is present and an E is displayed if the encryption module is present. After two seconds, the software version is displayed, followed by the radio option number. Compatibility between two or more radios is assured if self-identity numbers are alike.

After two more seconds, the HUB (hold-up-battery) status is displayed. One of two displays is possible:

- **HUB Good** The HUB (hold-up-battery) will maintain encryption variable storage when the main power is disconnected.
- **HUB Bad** The hold-up-battery is weak or missing and should be replaced by qualified service personnel. Under no circumstances should unauthorized personnel attempt to access this battery. Encryption variable storage is impossible when the main power is turned off.

If the ENCRYPTION mode control is in the ERASE position. HUB status cannot be checked.

Finally, the status of the radio battery pack is displayed as battery voltage.

Section 3 describes and illustrates the self-identity test.

1.4.4 Self Test

Self test is a troubleshooting aid which allows operators or maintenance personnel to fully check the radio's performance to the module level. During the brief self-test procedure, the radio tests itself, performing numerous tests of internal circuitry.

To initiate radio self test, the radio must be on, the display must be off, and the TEST/LOAD pushbutton depressed. The display is first tested with all the display elements lit at 50% brightness. The radio then displays the hold-up-battery status followed by the battery pack status. If it detects a faulty component or an incompatibility due to system configuration differences, the front panel LED readout displays a fault code that gives the location of the problem area. This facilitates troubleshooting and fault correction, enabling quick return of the radio to service. If all the tests are passed, PASSED is displayed.

Section 3 describes self test as part of normal radio start-up procedure. Section 5 describes its use in radio troubleshooting.

1.4.5 Fault Reporting

In addition to reporting faults during self test, the AN/PRC-117D(E) also reports any faults that may occur during normal operation.

1.4.6 Simplex/Half-Duplex Operation

Each channel (except when set up as ECCM channels) allows either simplex or half-duplex operation. These types of operations differ in the number of frequencies used per channel:

- Simplex – One frequency is used for both receiving and transmitting.
- Half-duplex – Two frequencies are used: one for receiving, another for transmitting.

Simplex operation may be used for both repeater and non-repeater applications. Half-duplex operation is particularly useful through a repeater, although its use is not restricted to repeater operation.

The range of transmit and receive frequencies in half-duplex operation has only one restriction. The two frequencies must be within the same frequency band. For example, a receive frequency in the VHF-Lo band (30-89.975 MHz) can only have a transmit frequency that is also in the VHF-Lo band. The same applies to the VHF-Hi (116-173.995 MHz) and UHF (225-419.995 MHz) bands.

1.4.7 ECCM: Frequency-Hopping

Frequency hopping is an advanced method of Electronic Counter-Countermeasure (ECCM). With this feature, automatic ECCM operation is available on programmed channels. To best understand frequency hopping, compare it with standard transmission.

In standard FM or AM transmission, the signal occupies a narrow portion of the frequency spectrum, centered on a single carrier frequency. This easily detected signal can be monitored or jammed, and the transmitter location can be found with radio direction-finding equipment.

In narrowband frequency hopping, no single carrier frequency is used. Instead, the radio uses a full 5-MHz bandwidth. The frequency-hopping transmitter hops around the band in a pseudorandom pattern, spending only a few milliseconds at any one frequency. This makes the frequency-hopping signal difficult to detect, and extremely difficult to monitor, jam, or locate.

Wideband frequency hopping can be programmed for frequency hopping on a preprogrammed, pseudorandom pattern within any of the following frequency ranges: 30 to 89.975 MHz (VHF-Lo), 116 to 173.995 MHz (VHF-Hi), and 225 to 419.995 MHz (UHF). The hopping bandwidth, as well as hopping band location, is front-panel programmable. The hopping bandwidth is set in 5 MHz steps for the following ranges:

- 5 – 60 MHz in VHF-Lo
- 5 – 50 MHz in VHF-Hi
- 5 – 195 MHz in UHF

Figure 1-2 compares these types of transmission as they relate to FM signals in the 30 to 89.975 MHz frequency range.

In order to detect the continuously changing frequency-hopping signal, the receiver must hop at exactly the same rate as the transmitter. Synchronizing characters, sent by the transmitter, coordinate this frequency-hopping.

The R/T Assembly microprocessor controls frequency hopping. The pseudorandom pattern of frequencies is determined, in part, by the setup of the radio. One determining factor is the position of internal jumpers installed on the Signal Synchronizer Module supplied for this option. (The R/T Assembly A2 Unit Instructions section shows the position of these jumpers.)

Other setup variables that determine the frequency-hopping pattern include the programmed ECCM hopping code for the channel and the front panel RADIO mode control position.

Refer to section 3 for information on ECCM operation and programming.

1.4.8 Answer-Back Scan

While in the SCAN mode, the operator can transmit on the channel that just received the scan call, regardless of where the operator's CHANNEL control is located.

1.4.9 Exclusion Programming (Future Application)

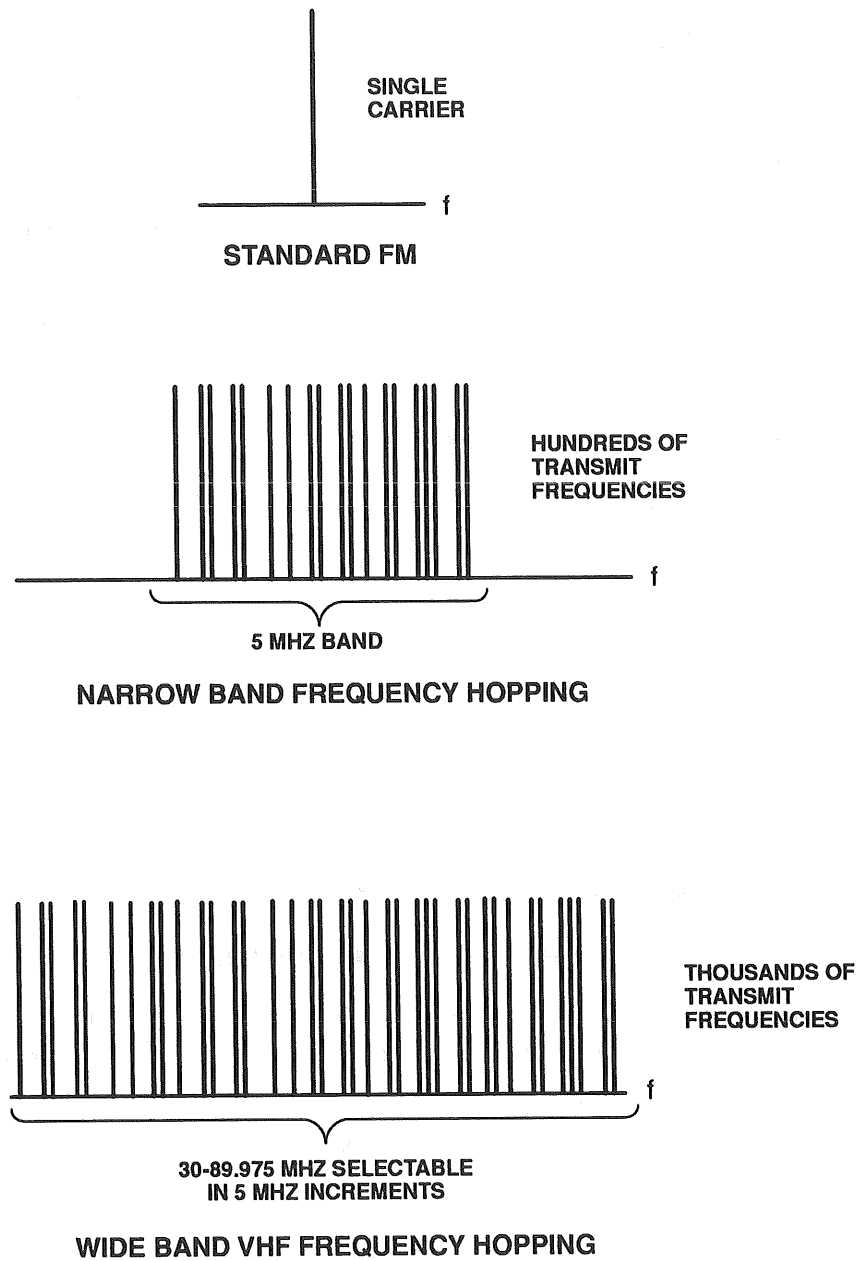
By using the RF-3047FPX option, the receiver-transmitter can be programmed to exclude certain frequencies and/or 5-MHz bandwidths from its hopping operation to avoid areas of the spectrum which are noisy or carry sensitive information.

1.4.10 Zeroize Feature

There are two zeroize features on the AN/PRC-117D(E). They are radio zeroize and encryption zeroize (ERASE). The following paragraphs describe these features.

1.4.10.1 Radio Zeroize

The receiver-transmitter has a radio zeroize feature that allows the operator to change the programmed information of all channels, including encryption variable and exclusion frequency information, to their default values.



117D-002A DI

Figure 1-2. Comparison of FM and Frequency-Hopping Signals

1.4.10.2 Encryption Zeroize

The encryption zeroize feature allows the operator to erase all of the encryption variables. The display shows ENCRYP 0 when this feature is used.

1.4.11 Front Panel Menu Programming

A menu may be accessed from the front panel for two types of programming. They are:

- RADIO OP – Sets the operational parameters for all channels and modes.
- CH SETUP – Sets the parameters for the individual channel selected by the CHANNEL Control.

With the display blank and the RADIO mode control in the PRGRM position, the menus are accessed by pressing TEST/LOAD until RADIO OP or CH SETUP is shown on the LED display. DISPLAY is pressed to choose RADIO OP or CH SETUP. The MHZ toggle switch selects the parameter and the KHZ toggle switch selects the choices for the parameter.

1.5 COMPATIBILITY WITH OTHER RADIOS

The AN/PRC-117D(E) is fully compatible with all fixed-frequency VHF radio systems such as the:

- AN/VRC-12 Series
- AN/VRC-83
- AN/VRC-94A(V) Series
- AN/PRC-128
- AN/PRC-77
- AN/ARC-182
- AN/URC-94
- AN/ARC-164
- Harris RF-280
- Racal Jaguar
- AN/PSC-3 Series
- SINCGARS
- AN/PRC-113 Series
- AN/PRC-138

Note that radio internal setup for selecting such operating parameters as SQUELCH type and frequency deviation (5 kHz or 8 kHz) directly affects the compatibility of the transceiver with other tactical radios.

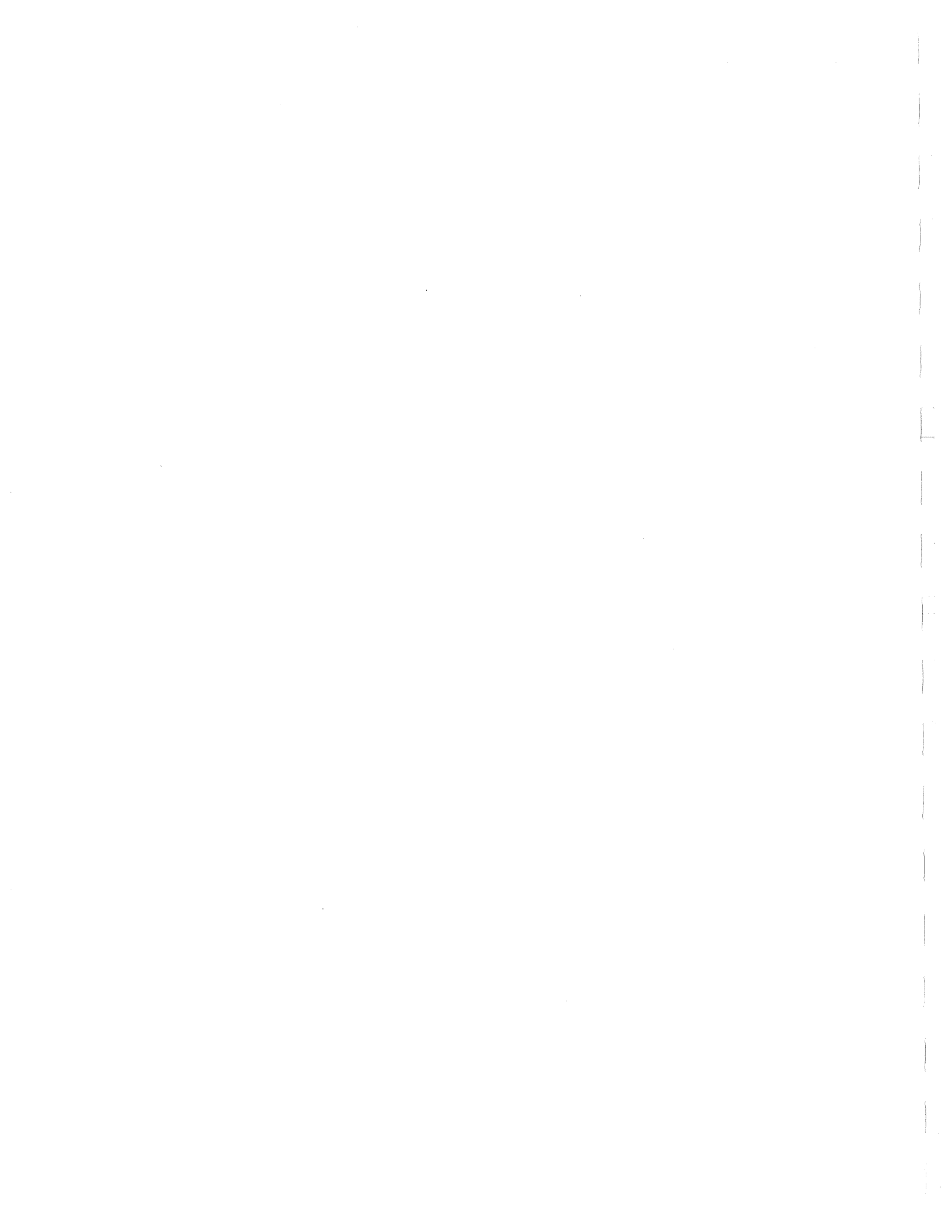
The jumper connections on the A4 module, described in the A4 Unit Instruction section, determines many of the operating parameters that are important for full compatibility with other types of radios.

1.6 OPTIONS

The AN/PRC-117D(E) is available with a number of options and a variety of optional equipment. Table 1-2 lists some of these available options.

Table 1-2. Options Available for the AN/PRC-117D(E) Transceiver

Part No.	Option	Description
AN/PRC-117D(E) SSK	Site Spares Kit	Contains replacement modules to maintain five manpack units in the field
BA-5590/U	Disposable Lithium Battery	Provides greater than three times the life of the Nickel-Cadmium battery (10012-0300) (requires the 10012-0330 battery case)
RF-289A	VHF Log Periodic Transportable Antenna	Tactical portable log periodic antenna (30 – 90 MHz)
RF-290	VHF Omnidirectional Transportable Antenna	For 30 – 90 MHz broadband operation
RF-294-07	Microphone	Palm-held noise-cancelling microphone
RF-294-08	Headset	Two-earphone headset unit
RF-3014-01	Headset with Boom Microphone – Dynamic Mike Element	High-grade Mil headset
RF-3047FPX	Field Programmer – Exclusions	(Future Option) Allows for quick programming of multiple radios
RF-3094-01	Battery Charger/Exerciser	A microprocessor-controlled battery charger and battery checking unit capable of charging seven Nickel-Cadmium (10012-0300) batteries
10012-0330	Battery Case for BA-5590/U	Provides capability to use BA-5590/U Lithium Disposable Battery with the manpack transceiver (battery not included)
10012-0550	Battery Charger – Trickle	Provides simultaneous trickle charging of six Nickel-Cadmium (10012-0300) battery packs
RF-391	Vehicular Antenna (116 – 420 MHz)	Wideband vehicular antenna covering the 116 – 420 MHz frequency range
AS-3013/VRC	Vehicular Antenna (30 – 90 MHz)	Wideband vehicular antenna covering the 30 – 90 MHz frequency range



SECTION 2

ASSEMBLING THE RADIO

2.1 GENERAL

The assembly of the AN/PRC-117D(E) requires no tools. Follow the procedures in paragraph 2.2 to assemble the radio.

For full compatibility, all radio units within a net must have the same internal configuration, with identical jumper placement on radio modules. Paragraph 2.3 outlines these compatibility considerations.

Under certain conditions, it may be necessary to recharge the A3 module memory backup battery as part of radio assembly. Paragraph 2.4 describes this procedure.

Although the HUB (hold-up-battery) is not expected to need replacing, a "HUB Bad" condition should be reported to qualified service personnel. Under no circumstances should unauthorized personnel attempt to access this battery which is located in the front panel module.

2.2 ASSEMBLING THE RADIO

WARNING

If the optional BA-5590 Lithium Battery is used, observe the following:

- If the battery becomes hot, a hissing sound is heard, and an irritating smell occurs. Move the equipment to a well ventilated area or leave the area.
- Do not use a Halon type fire extinguisher on a lithium battery fire.
- Do not dispose of lithium batteries in uncontrolled trash. These batteries contain hazardous materials that can contaminate the environment.

Figure 2-1 shows the parts of the manpack transceiver. Figures 2-2 through 2-5 illustrate the recommended sequence for its assembly.

Figure 2-2 recommends testing battery voltage as soon as the battery pack is attached. A charged battery gives a reading of at least 12.0 V. Use this 12.0 V figure as a general guideline. A voltage reading below 12.0 V indicates that the battery requires charging. (Section 5 describes battery voltage and battery life in detail.)

Handset connection is shown in figure 2-3. Note that the AUDIO/DATA connector is used for this connection. The front panel FILL connector is used for the RF-5961 Field Code Programmer.

Two antenna connections are provided on the transceiver as shown in figure 2-4. The top half of the figure shows the connection of a blade or whip antenna to the top ANT connector. These antennas can only be used in VHF-Lo operation (30 – 90 MHz). The bottom half of the figure shows the connection of the VHF-Hi/UHF antenna to the bottom ANT connector (50-ohm).

The 50-ohm connector is used for the VHF-Hi/UHF and UHF LOS (Line of Sight) antennas. In VHF-Lo operation, the 50-ohm connector is energized when the whip antenna is either removed or not firmly attached.

For field use, the radio is designed to be carried in the backpack harness (P/N 10243-0400). This harness is similar in configuration to the AN/PRC-117A/B, AN/PRC-77, and -25 standard pack frames. Both side straps and handle straps secure the transceiver for carrying. Figure 2-5 shows the strap connections for radio mounting in the backpack harness.

2.3 COMPATIBILITY AMONG UNITS

For full communication, all radios within a net must have identical internal configurations. This means that jumper positions on the following modules must be the same in all units:

- Power Supply Module A4
- Signal Synchronizer Module A2

Optional jumpers on Power Supply Module A4 select such operating parameters as automatic TONE SQUELCH transmission, frequency deviation, and frequency display recall for programmed channels. The A4 Unit Instruction section describes the position of jumpers on this module and their significance. These jumpers are factory-installed, but field modification is possible.

Signal Synchronizer Module A2 is an optional module, required for ECCM frequency-hopping operation only. Jumpers on this module determine, in part, the pseudorandom pattern of frequency hopping. To allow ECCM communication, these jumpers must match exactly for all radios within a network. The A2 Unit Instruction section shows the position of these jumpers. ECCM jumpers are factory-installed, but field modification is possible.

2.4 MEMORY BACKUP BATTERY

After a long period of storage or when the radio is new and has never been used, it may be necessary to charge the memory backup battery as described below.

NOTE

Do not operate the radio with a discharged memory backup battery. The radio will not retain programmed frequency or code values if this battery is discharged.

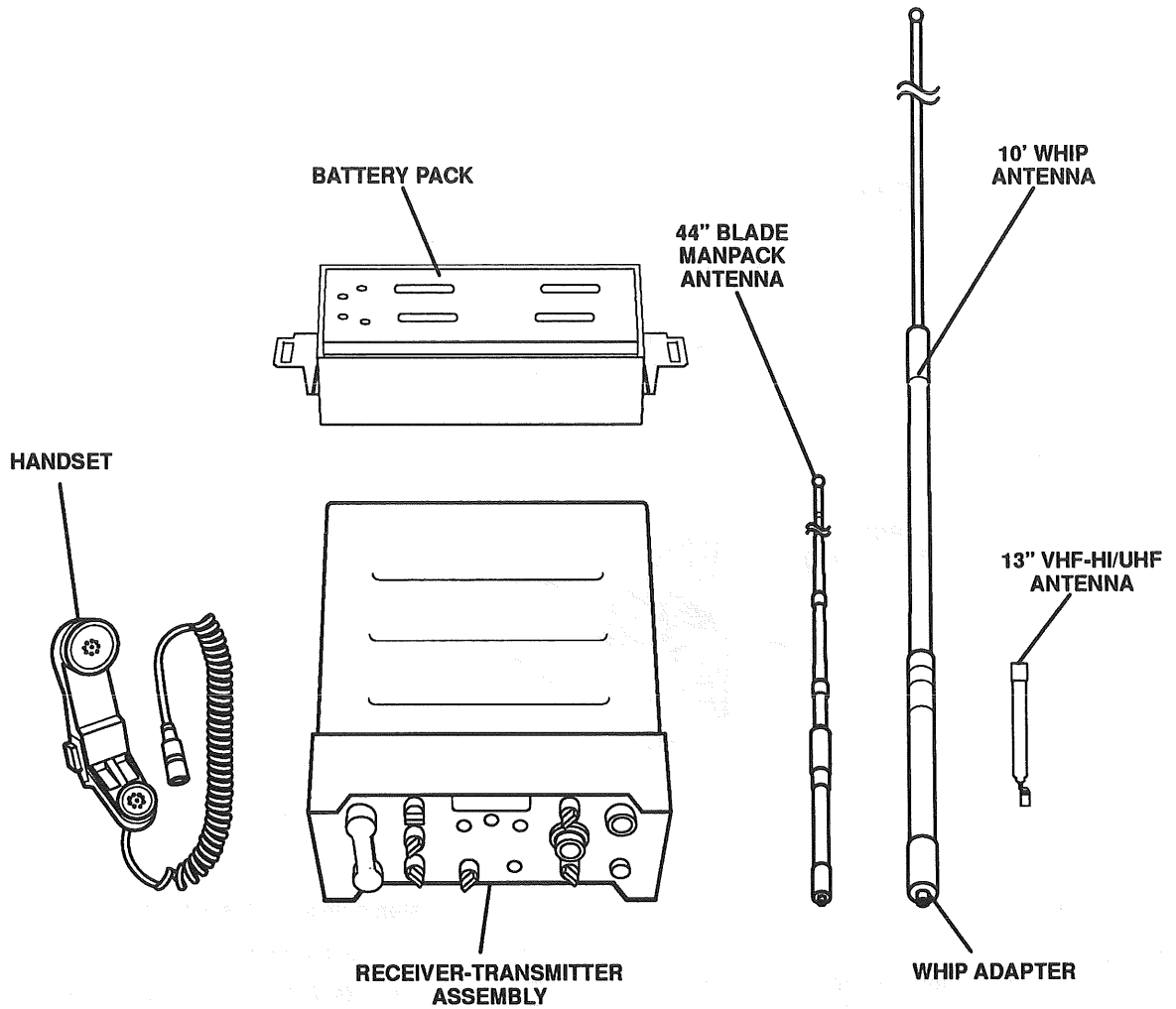
A small backup battery is provided on Microprocessor Module A3 inside the radio. This battery maintains memory contents so that programmed frequencies or ECCM codes are stored while the radio is off. Memory backup is the only purpose of this battery. It does not provide power for radio operation.

The memory backup battery charges only when the radio is on. Once it is fully charged, the backup battery can typically hold its charge and maintain memory contents for several months if the R/T Assembly is stored at moderate temperatures. Regular use of the radio automatically keeps this backup battery at full charge. If the radio has not been used for a month or more, consider the backup battery discharged. This may be the case if the radio is new or has been in storage.

To charge the memory backup battery, turn the radio on for at least one hour, preferably several hours. This should be done before programming any channel information.

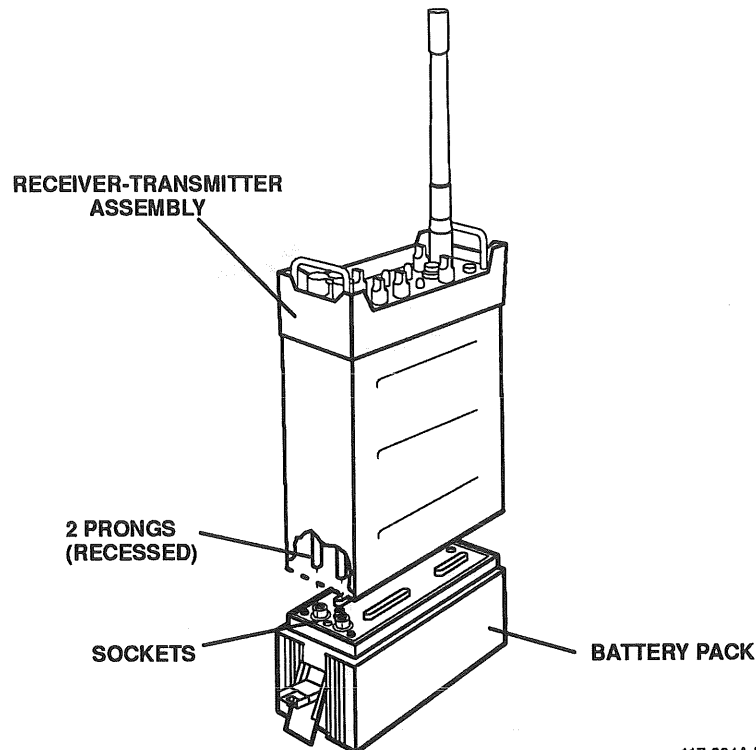
2.5 INDEX TO SIGNALS

Table 2-1 lists the input/output signals of the R/T Assembly. Figure 2-6 shows a pinout diagram of these connectors.



117D-003B DI

Figure 2-1. Standard Manpack Parts



117-034A DI

Attach Battery Pack

The battery pack fits only one way on the back of the Receiver-Transmitter Assembly. Set the battery pack on a flat surface, face up, and follow these steps:

- ① Line up the sockets of the battery pack with the two prongs on the rear of the Receiver-Transmitter.
- ② Press the battery pack firmly against the Receiver-Transmitter. **Do not** force. The battery pack fits easily when correctly lined up.

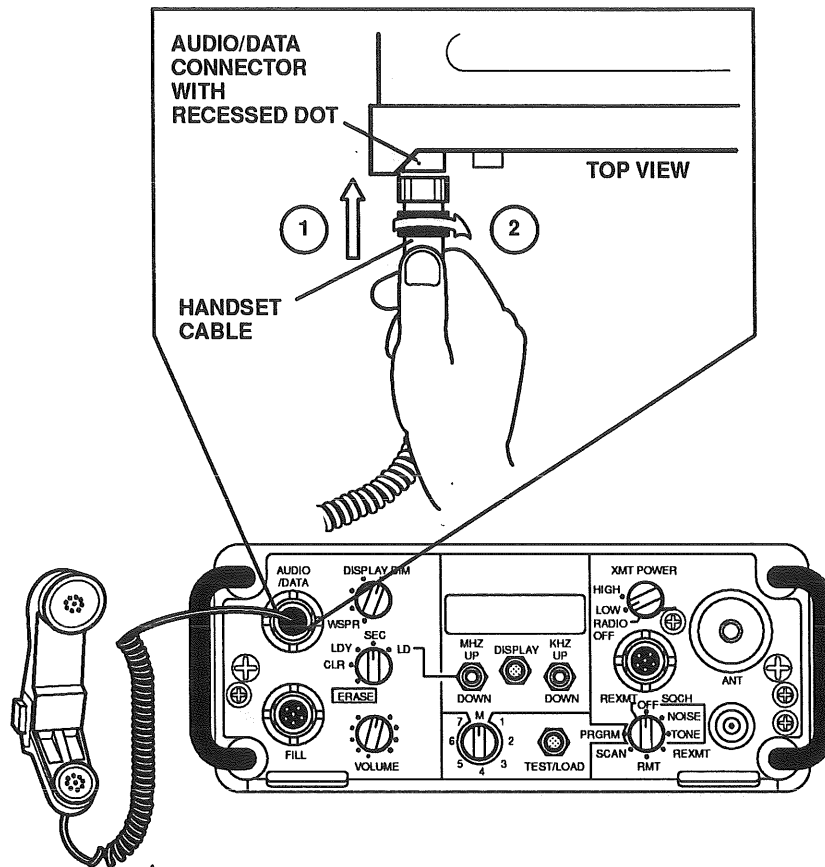
- ③ Fasten both side clasps to attach the pack.
Check battery voltage with this simple test:

- ④ Turn the XMT POWER control from RADIO OFF to HIGH or LOW. After a brief moment, the LED display shows the battery voltage.

For information on battery voltage levels, see section 5, Maintenance.

NOTE: The battery pack must be attached before the manpack transceiver is exposed to water immersion.

Figure 2-2. Attaching Battery Pack



117DE-004A DI

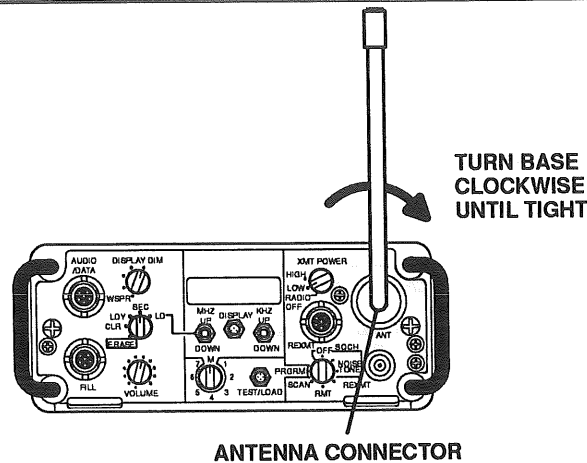
Connect Handset

The handset cable connects to the AUDIO/DATA connector.

To attach the handset, line up the flat surface of the cable connector with the recessed dot on the AUDIO/DATA connector. Push the connector of the handset cable firmly onto the AUDIO/DATA connector and twist clockwise.

After removing the handset, replace the AUDIO/DATA connector cover. (This helps to keep connector contacts clean.)

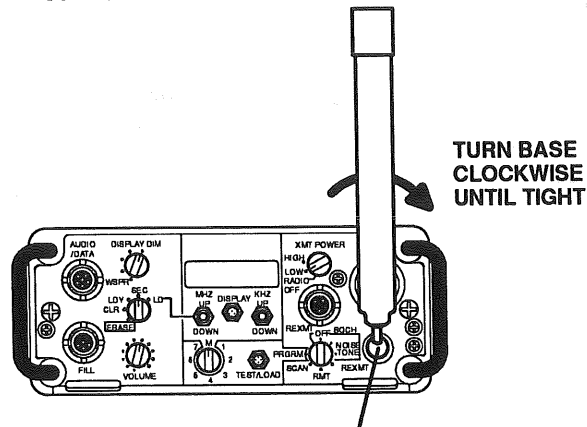
Figure 2-3. Connecting Handset



117DE-005A DI

Connect VHF-Lo Blade or Whip Antenna

Remove the cap from the ANT connector. Engage the antenna base from the VHF-Lo blade or whip antenna securely into this connector.



117DE-006A DI

Connect VHF-Hi/UHF Antenna

Remove the cap from the 50 ohm ANT connector. Engage the antenna base from the VHF-Hi/UHF Antenna securely into this connection.

NOTE

If both antenna connectors are used, only the blade connector (top) will be active (except during multiband scan) when VHF-Low frequencies are used. If using VHF-Low frequencies, make sure no antenna is connected to the top connector if the 50 ohm connector (bottom) is to be used. Both antennas must be installed for multiband scan (VHF and UHF).

Figure 2-4. Connecting Blade, Whip, or VHF-Hi/UHF Antenna

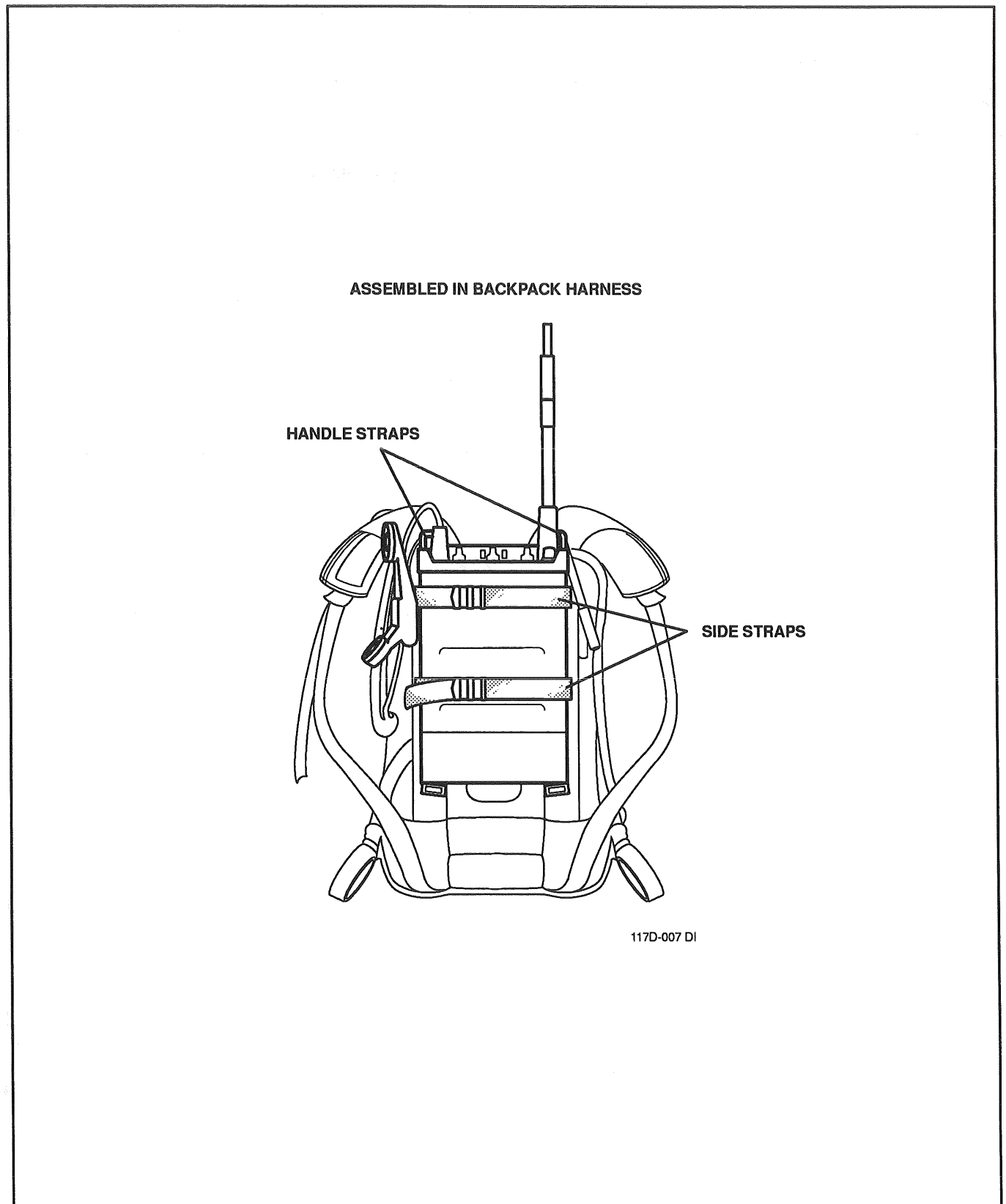


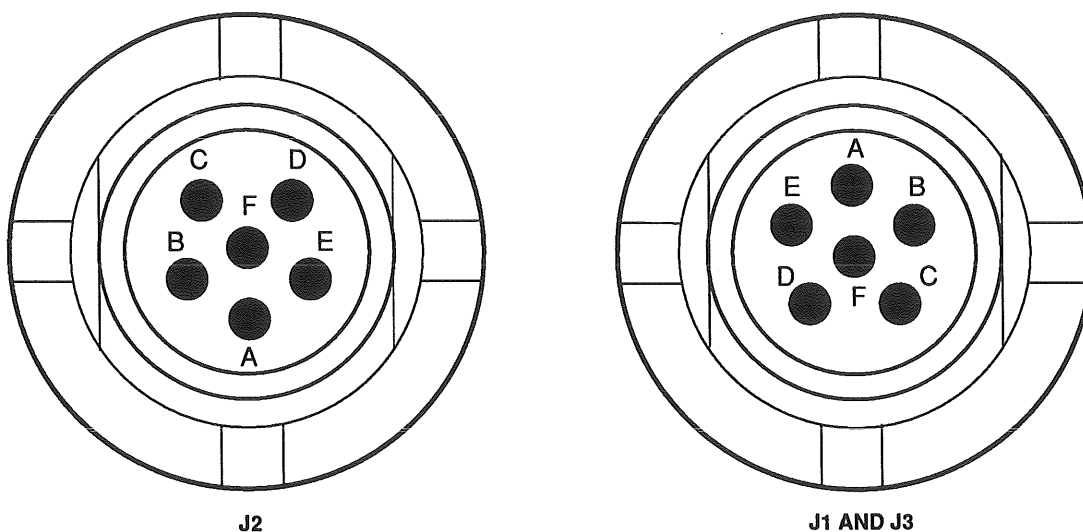
Figure 2-5. Radio Assembled in Backpack Harness

Table 2-1. Index to Signals – R/T Assembly

Name	Pin	Description
AUDIO/DATA - J1		
GROUND	A	
AUDIO/DATA OUT	B	Voice mode adjustable audio output (20 mW MAX) Analog data mode fixed audio output (220 mVrms) Digital mode ± 6.75 V data out (MIL-STD-188-114A)
KEYLINE	C	Apply ground for PTT (Push-to-Talk)
AUDIO IN/DATA CLOCK OUT	D	Voice mode audio input (1 mVrms) Analog data mode input (220 mVrms) Digital mode ± 6.75 V clock out
DIGITAL DATA MODE	E	Apply ground for digital data mode
ANALOG DATA MODE/DATA IN/EXTERNAL SQUELCH	F	Apply ground for analog data mode Digital mode ± 6.75 V data in (MIL-STD-188-114A)
FILL - J2		
GROUND	A	
AUDIO/DATA OUT	B	Voice mode adjustable audio output (20 mW MAX) Digital mode ± 6.75 data out (MIL-STD-188-114A) Analog data mode fixed audio out (220 mV RMS)
REQUEST	C	Output control signal Active low Generated by R/T
MULTIPLEX	D	Future option
CLOCK	E	Output clock Generated by R/T
DATA	F	Input FILL data
REXMIT - J3		
GROUND	A	
AUDIO/DATA OUT	B	REXMIT audio/data out SAE mode encrypted data out (220 mVrms)
KEYLINE/ENCRYPTED DETECT	C	REXMIT mode apply ground for PTT SAE mode encrypted detect out (0 V = encrypted)
AUDIO/DATA IN	D	REXMIT audio/data in SAE mode encrypted data in (220 mVrms)

Table 2-1. Index to Signals – R/T Assembly (Cont.)

Name	Pin	Description
REXMIT - J3 (Cont.) MODE SELECT REXMIT KEY/REMOTE SERIAL	E F	Apply ground for stand-alone encryption mode. (SAE mode causes the RF section to be disabled, input/output of the encrypted module is routed through the REXMIT connector.) REXMIT/SAE mode keyline out, (0 V = keyed) Remote mode current loop



VIEW FACING FRONT PANEL

117D-072A DI

Figure 2-6. Pinout Diagram of J1, J2, and J3 on the Front Panel

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SECTION 3

OPERATION

3.1 GENERAL

The AN/PRC-117D(E) is a manpack transceiver that adds VHF-Hi, UHF, and AM to the functions of the AN/PRC-117A VHF-FM full-band frequency-hopping radio.

The encryption device (ENCRYPTION option RF-3997) is integrated into the front panel module of the AN/PRC-117D(E), but it is possible to operate the AN/PRC-117D(E) with the encryption board removed from the front panel. In such cases, any display operation that occurs while the ENCRYPTION mode control is in any position except CLR (clear text) causes "CLEAR" to appear on the LED display. The radio will continue to operate as a frequency-hopping clear-text transceiver.

NOTE

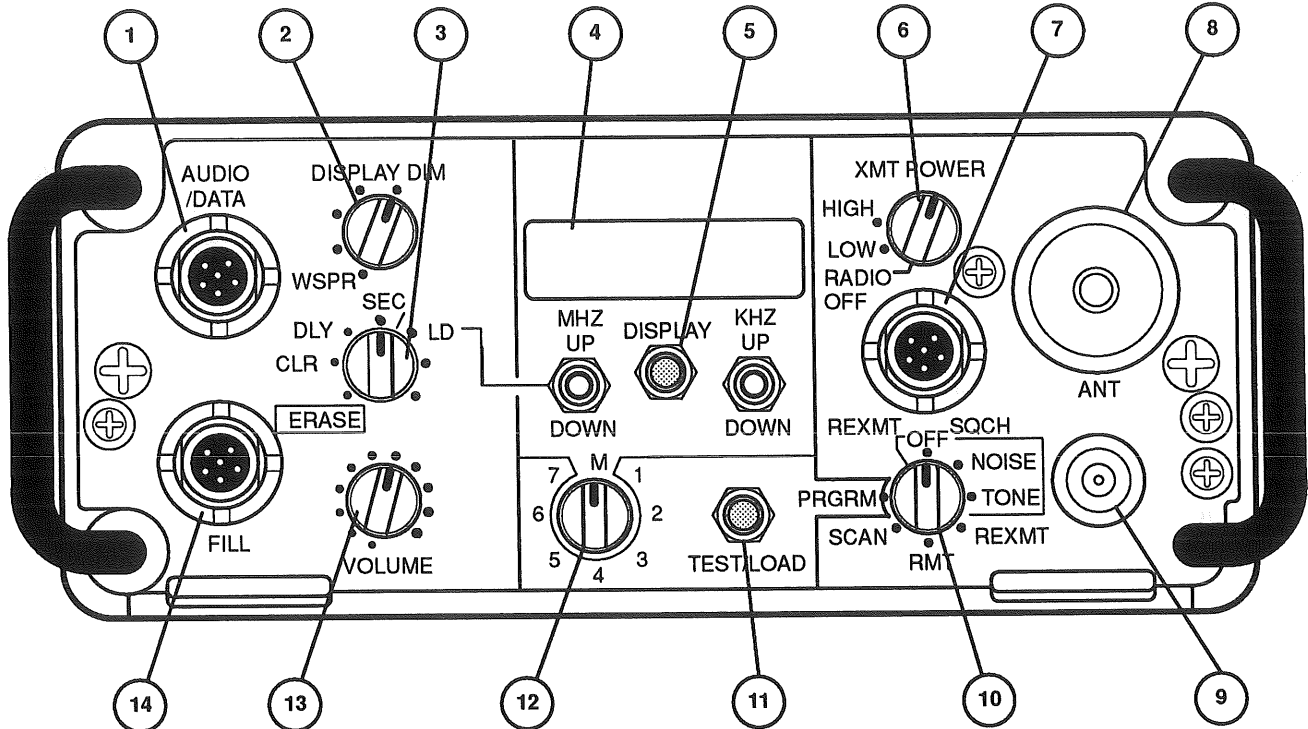
Only authorized personnel can open the front panel assembly.

This section describes:

- Front panel description
- Audible tones
- Considerations before using the radio
- Start-up steps
- Frequency ranges, bandwidths, modes, and scroll increments
- Radio setup
- Single channel programming (MANUAL channel and channels 1 – 7)
- ECCM programming
- ENCRYPTION capabilities
- Data capability
- SCAN capability
- Retransmit operation

3.2 FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS

Figure 3-1 shows the front panel controls, indicators, and connectors briefly described in table 3-1. Detailed operational procedures are given in subsequent paragraphs in this section.



117D-008A DI

Figure 3-1. Front Panel Controls, Indicators, and Connectors

Table 3-1. AN/PRC-117D(E) Front Panel

Figure 3-1 Number	Controls/Indicators/Connectors	Function
1	AUDIO/DATA Connector	Connection for handset or data fill device cable
2	DISPLAY DIM/WSPR	Controls on/off status and intensity of LED display. In the WSPR position, the display brightness is off and a 10 dB amplifier is placed in the microphone audio path.
3	ENCRYPTION Mode Control: CLR DLY SEC LD ERASE	Clear-text operation Secure-text operation with 1 sec time delay after PTT (push-to-talk) Secure-text operation Load encryption variables ERASE (zeroize) all encryption variables

Table 3-1. AN/PRC-117D(E) Front Panel (Cont.)

Figure 3-1 Number	Controls/Indicators/Connectors	Function
4	LED Display	Displays current operational and/or programmed information
5	MHZ and KHZ toggle switches/DISPLAY pushbutton	Used to select and view all programmed information. MHZ and KHZ toggle switches are active only when display is lit
6	XMT POWER	Controls on/off of radio transmitted power. LOW selects programmable power level; HIGH selects a 10 W transmit power level
7	REXMT Connector	Connection for REXMT, SAE, or remote control cable
8	ANT Connector	Connection for antenna base
9	ANT BNC Connector	50-ohm antenna connection
10	RADIO Mode Control: SQUELCH OFF NOISE SQUELCH TONE SQUELCH REXMT RMT SCAN PRGRM	Squelch off Noise squelch in FM, carrier squelch in AM Tone squelch (150 Hz) in FM, carrier squelch in AM Retransmit operations Front panel under remote control Scan the preset channels Program frequencies, codes, bands, and variables for the seven preset channels
11	TEST/LOAD	Used in self-identity testing, self test, programming, and radio zeroize operations and channelized menu parameters
12	CHANNEL Control	Selects channel for programming frequency/bandwidth/Encryption information
13	VOLUME	Volume control for handset
14	FILL Connector	Connection for standard Encryption fill devices

The transceiver has a mounting post to attach the manpack blade antenna (P/N 10012-0201) or the manpack whip antenna (P/N 10012-0241) for VHF-Lo operation. A 50-ohm BNC connector on the front panel is used for the VHF-Hi and UHF antennas. Audio and data signals are combined on one standard connector labeled AUDIO/DATA. This connector accepts the handset and also accommodates MIL-STD-188-114A digital data levels.

The FILL connector accepts encryption variables from the RF-5961 Field Code Programmer. Another connector, labeled REXMT, supports the retransmission function, as well as remote control and stand-alone encryption (SAE). The latter allows the transceiver to operate as an independent encryption device. For retransmission operation two units are connected together via this connector. A retransmission cable routes the proper signals between the two radios.

A green LED display, which meets the requirements for night vision goggle compatibility, provides an indication of frequency, encryption variable, and a variety of messages to indicate current operational status. The display consists of eight alphanumeric characters. When displaying frequency, the three digits closest to the right indicate kHz. The next three digits to the left indicate MHz. A momentary toggle switch allows up/down selection of frequency in 1 MHz increments. A second toggle switch allows up/down selection of frequency in 5 or 6.25 kHz increments, depending on the band used. In order to prevent accidental frequency changes, the KHZ and MHZ toggle switches are disabled unless the LED display is on.

Note that the LED display is lit only when necessary, such as:

- When selecting or programming a frequency or ECCM code
- While in SCAN mode
- Briefly when switched from SEC or DLY to CLR mode
- Briefly during self-identity and self test
- Briefly to display voltage when power is switched on at the XMT POWER control
- When reporting a fault or protection condition

NOTE

The display only lights when the transceiver is keyed in the low power mode, set to the lowest power (1W).

The DISPLAY DIM/WSPR control provides four brightness levels: 100%, 50%, 25%, and off. When the DISPLAY DIM/WSPR control is in the WSPR position, the display brightness is off and a 10 dB amplifier is placed in the microphone audio path.

The VOLUME control provides twelve detent positions. The radio on/off function is combined on the XMT POWER control which turns the radio on and off and controls transmitted power. LOW selects a programmable transmit power level. HIGH selects a 10 W transmit power level. For longest battery life, the XMT POWER control should be set at HIGH only when necessary.

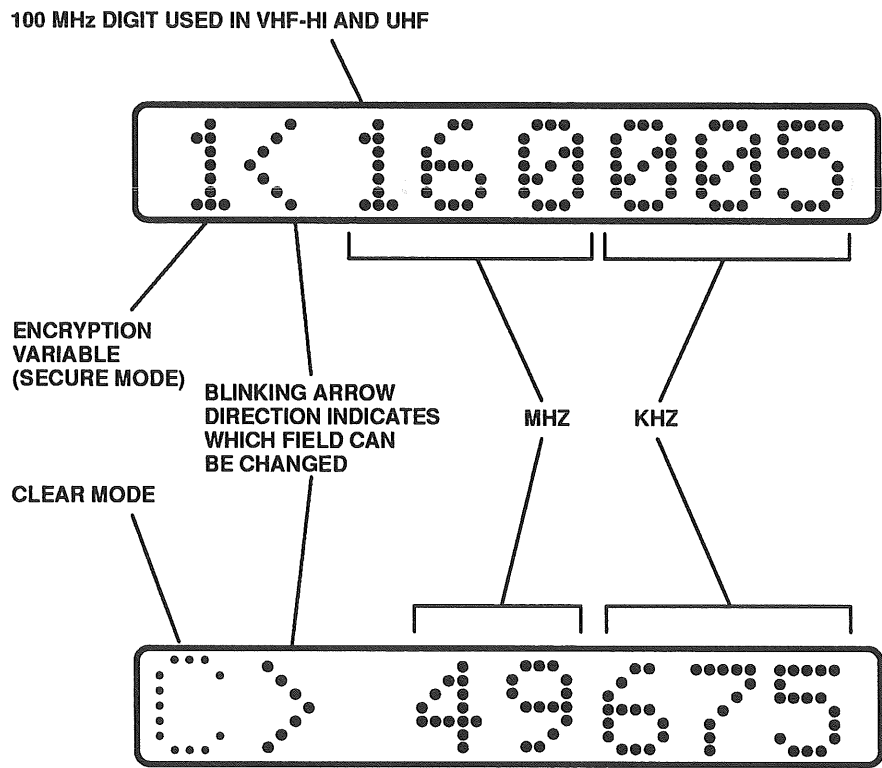
Mode selection is accomplished with two controls: the RADIO mode control and the ENCRYPTION mode control. The functions of these controls are described in table 3-1.

When the RADIO mode control is set to PRGRM, the preset channel frequencies are loaded into each channel position selected by the CHANNEL control. There are seven preset positions, plus one manual position. Channel frequencies are independent of the clear-text/secure-text selection. When the ENCRYPTION mode control is set to LD, the encryption variables are loaded into storage locations selected by the MHZ toggle switch. When the RADIO mode control is in PRGRM and the ENCRYPTION mode control is in LD, a specific encryption variable may be assigned to each channel, including the manual channel. If no variable is assigned, the default for each channel is encryption variable 1.

Encryption variable storage locations 1 through 6 are selected using the MHZ toggle switch when the ENCRYPTION mode control is in the LD mode. The number of the location is displayed in the left-most digit of the display. Encryption variable storage locations 1–6 are erased by placing the ENCRYPTION mode control in the ERASE position. This requires a pull-to-turn action to prevent accidental activation.

The transceiver employs a tamper switch to erase all encryption variable storage locations if the compartment containing the encryption circuit is opened. Accessing other parts of the radio does not cause the erase to occur, since this does not pose a threat to the encryption portion of the radio.

The LED display makes use of directional blinking arrows (< or >), decimal points, and fault codes. The blinking arrows (identified in figure 3-2) point to the part of the display that can be changed.



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Figure 3-2. Typical LED Displays (Excluding VHF-Hi 6.25 kHz Increments)

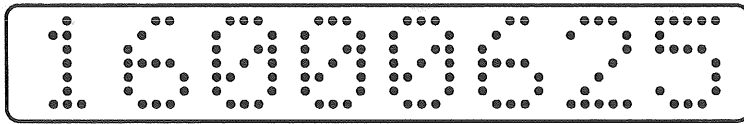
When the radio is in VHF-Hi (116-174 MHz) and the KHZ toggle switch is set to scroll in 6.25 kHz increments, the front panel LED display shows the operating frequency in a different manner. Refer to table 3-2 for the frequencies. Figure 3-3 illustrates the display characteristics. The VHF-Hi frequency with 6.25 kHz scroll increments is displayed as follows:

- a. Immediately after DISPLAY (or MHZ or KHZ toggle switch) is activated. – Mode and blinking arrow are not displayed and the frequency shifts to the left.
- b. Two seconds after. – The 100 Hz digits are cut off.
- c. Five seconds after. – The display blanks. A second toggle switch allows up/down selection of frequency in 5 or 6.25 kHz increments, depending on the band used.

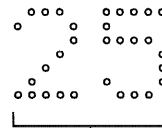
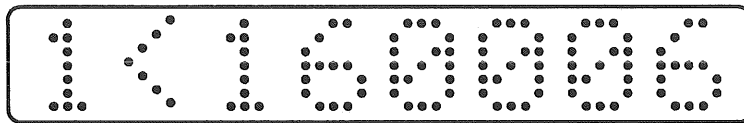
Table 3-2. VHF-Hi Frequency Display Example

Actual Frequency (Displayed just after DISPLAY pressed.)	Displayed Frequency (Displayed two seconds after DISPLAY pressed.)	Truncated Digits (Not Displayed) Two seconds after DISPLAY pressed.
120.00625	120.006	25
120.01250	120.012	50
120.01875	120.018	75
120.02500	120.025	00
120.03125	120.031	25
120.03750	120.037	50
120.04375	120.043	75
120.05000	120.050	00
120.05625	120.056	25
120.06250	120.062	50
120.06875	120.068	75
120.07500	120.075	00
120.08125	120.081	25
120.08750	120.087	50
120.09375	120.093	75
120.10000	120.100	00

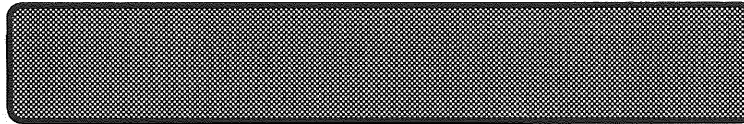
1. IMMEDIATELY AFTER DISPLAY, MHZ, OR KHZ TOGGLE SWITCH ACTIVATED:



2. APPROXIMATELY 2 SECONDS AFTER.



3. APPROXIMATELY 5 SECONDS AFTER.



100HZ DIGITS NOT
SHOWN ON DISPLAY

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Figure 3-3. VHF-Hi Frequency Display with 6.25 kHz Channel Spacing

3.3 AUDIBLE TONES

Audible tones, heard in the earpiece of the handset, denote the manpack transceiver's operating condition. Some tones indicate normal operation, while other tones (or lack of tones) show equipment problems. Table 3-3 describes the tones and their meanings.

Table 3-3. Audible Tones

Condition	Tone	Description
Low Battery	Single beep Continuous tone/Continuous beep	Occurs every 7 seconds, if battery voltage is less than 11.0 V. Occurs when a handset is keyed, if battery voltage is less than 10.5 V. Also beeps every two seconds in receive. The tones indicate that the battery pack should be changed.
Program Mode	Continuous tone	A continuous tone is heard in the handset when programming data.
Clear Net Entry	Single beep	In clear-text only, indicates presence of clear channel signal.
Self Test	Single beep	Indicates failure.
ECCM/Clear Text	Single beep	Transmit message after beep. At end of message, person receiving message hears a beep.
ENCRYPTION Initialization	Continuous beeps	This is an encryption alarm and occurs until encryption circuit is initialized. To clear this tone, key the handset twice when ENCRYPTION mode control is in SEC or DLY.
Secure TX Ready	Single beep	Occurs after keydown in secure transmit mode to indicate speech can begin.
Secure RX Ready	Single beep	Occurs when receive encryption synchronization is achieved in secure voice mode. A single beep followed by a rush of noise, then silence, indicates TX and RX encryption keys do not match, or a weak signal.
Receiving Clear Text	Double beep	Occurs when a clear-text signal is received in SEC or DLY. A double beep is heard when the signal is first received, and every 10 seconds while the signal is being received.
Encryption Alarm	Continuous tone	This is a parity alarm that occurs when one of the following conditions exists: <ul style="list-style-type: none"> a. There is no encryption variable loaded on channel during ENCRYPTION initialization. To clear this tone, change to channel with valid encryption variable or select a valid encryption variable and key the handset twice. b. No encryption variable is present when keyed. To clear, change to channel with valid encryption variable or select a valid encryption variable and key the handset.
ENCRYPTION Zeroize (ERASE)	Continuous beeps	This is an encryption alarm and occurs if ENCRYPTION mode control is in ERASE. To clear this beep, change ENCRYPTION control out of ERASE position to SEC or DLY and key handset twice.
Loading Variables	Single beep Continuous beeps	Indicates a successful load. Indicates a bad load. To clear this tone, see Loading Encryption Variables from a Fill Device.

3.4 CONSIDERATIONS BEFORE USING THE RADIO

NOTE

To operate in any encryption mode, the radio must be ENCRYPTION initialized each time it is turned on.

Before operating the manpack transceiver, consider the following:

- ENCRYPTION initialization
- Self-identity compatibility
- Configuration compatibility
- Status of memory backup battery (see section 2)

3.4.1 ENCRYPTION Initialization

Each time the power is turned on in any encryption mode except CLR, continuous beeps are heard in the handset. To operate the radio in any mode except CLR (clear text), requires ENCRYPTION initialization.

To initialize the radio, set the ENCRYPTION mode control to DLY or SEC and key the handset twice. If no valid encryption variable is associated with the selected channel, a continuous tone is heard in the handset. If a valid encryption variable is associated with the channel, the tone stops.

3.4.2 Self-Identity Test

The self-identity test, shown in figure 3-4, determines compatibility between two or more radios. It is performed by pressing and holding the front panel TEST/LOAD pushbutton and then switching the XMT POWER control from RADIO OFF to the LOW or HIGH position. LOW selects a programmable transmit power level and HIGH selects a 10 W transmit power level.

The LED display first shows the radio model number. An F indicates the presence of the ECCM module and an E indicates the presence of the encryption module. After two seconds, the software version is displayed, followed by the secure radio option software number, and finally the radio option number. Compatibility between two or more radios is assured if these self-identity numbers are alike.

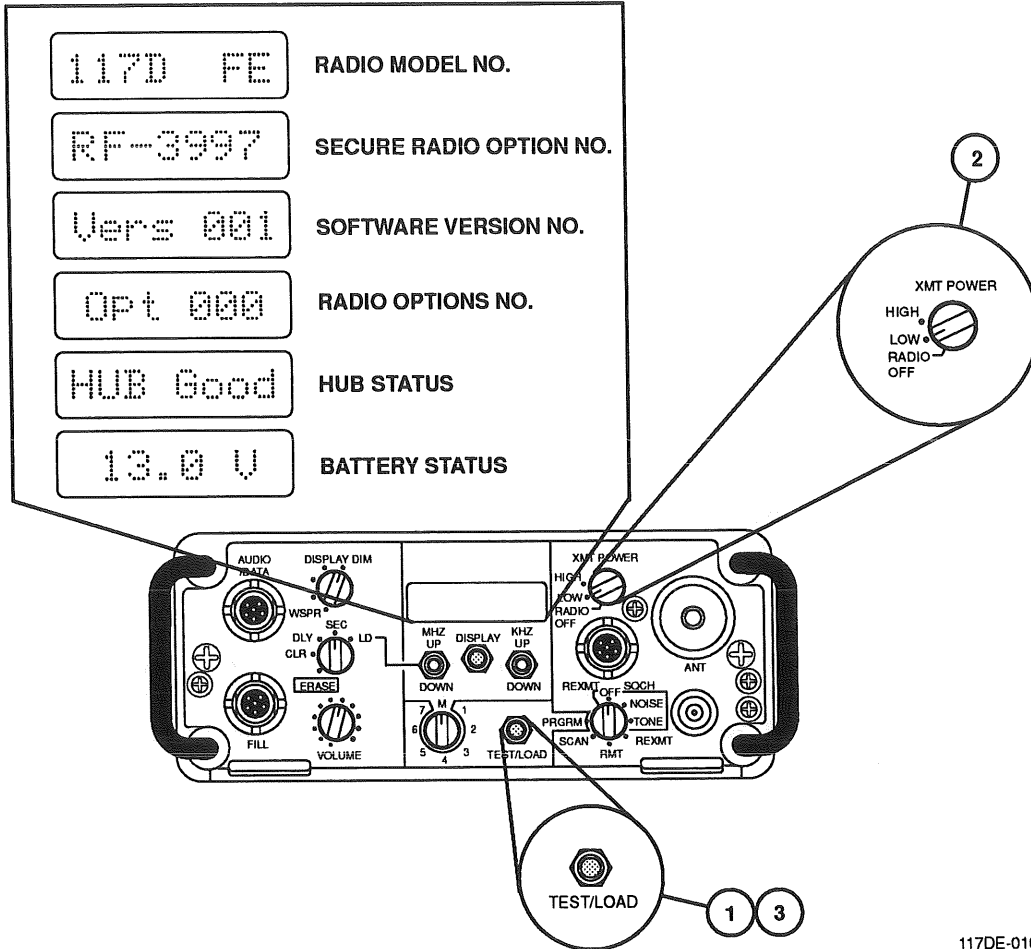
After two more seconds, the status of the hold-up-battery (HUB) displays. If the hold-up-battery is capable of encryption storage, "HUB Good" displays. If the hold-up-battery is weak or missing, and storage of encryption variables is in jeopardy, "HUB Bad" displays, and the unit should not be used for encryption storage. If the ENCRYPTION mode control is in the ERASE position, the display reads "ENCRYP 0." Change the ENCRYPTION mode control to another position to check the HUB status.

NOTE

The hold-up-battery is housed in the front panel module and may not be accessed by operators or crew.

Finally, the status of the radio battery is displayed as battery voltage. (Section 5 describes battery voltage and battery life in detail.)

SELF-IDENTITY TEST



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- ① Push and hold the TEST/LOAD pushbutton.
- ② Turn XMT POWER from RADIO OFF to LOW or HIGH.

This initiates self-identity. The LED display shows numbers or letters that represent:

- Radio model
- Secure Radio option
- Software version
- Radio options
- HUB status
- Battery status

- ③ Release TEST/LOAD.
Use self-identity to determine compatibility of radio equipment.

NOTE: The letter F in the radio model display indicates the presence of hopping capabilities and the letter E indicates the presence of the encryption module.

Figure 3-4. Self-Identity Test

3.4.3 Configuration Compatibility Among Units

The R/T Assembly allows a number of configuration options. For full compatibility of radios within a network, set up each radio in exactly the same manner. Depending on the desired mode of operation, consider the following setup factors for radio compatibility:

- Programming of the AM squelch level, radio zeroize (if needed), and the battery type. (Refer to paragraph 3.7.1.)
- Programming of the channel type and the VHF-Hi front panel channel spacing. (Refer to paragraph 3.7.2.)
- Programming of frequencies, bandwidth, and mode. (Refer to paragraphs 3.8)
- Jumpers on Audio Module A5. (Refer to the A5 Unit Instruction section.)
- Jumpers on Power Supply Module A4. (Refer to the A4 Unit Instruction section.)
- Jumpers on Signal Synchronizer Module A2. (Refer to the A2 Unit Instruction section.)

Optional jumpers on Power Supply Module A4 select operating parameters such as automatic 150-Hz tone transmission, frequency deviation, and frequency display recall for programmed channels. The A4 Unit Instruction section describes the position of jumpers on this module and their significance. These jumpers are factory-installed, but field modification is possible.

Signal Synchronizer Module A2 is an optional module, required for ECCM frequency-hopping operation. Jumpers on this module determine, in part, the pseudorandom pattern of frequency hopping. To allow ECCM communication, these jumpers must have matching configurations for all radios within the network. The A2 Unit Instruction section shows the position of these jumpers. ECCM jumpers are factory-installed, but field modification is possible.

Jumper 2 on the Audio Module A5 must be removed for proper radio operation.

3.5 START-UP STEPS

Turn the power on by switching the XMT POWER control from RADIO OFF to the LOW or HIGH position. The hold-up-battery (HUB) is checked first. If the HUB status is good, no display shows on the LED display. If the hold-up-battery is weak, too low to register, or missing, "HUB Bad" displays. A display of "ENCRYP 0" indicates that the ENCRYPTION mode control is in ERASE. The status of the radio battery pack is then displayed as battery voltage.

NOTE

If A03 or A10 flashes on the LED display, the radio needs servicing and is not usable.

3.5.1 Self Test

WARNING

Self test causes the radio to place a signal on the air. Transmitted radiation from the antenna can damage the eyes and other body parts. To be safe, make sure the antenna is at least 16 inches away from the body.

The self test, shown in figure 3-5, gives the operator a quick check of proper radio operation. To initiate self test, the XMT POWER control must be in the LOW or HIGH position and the LED display must be blank. Then press the TEST/LOAD pushbutton. First, the LED display is tested with all the display elements lit at 50% brightness, then the display reverts to the setting selected on the DISPLAY DIM/WSPR control. Next, the hold-up-battery (HUB) is checked. If the HUB status is good, no display shows on the LED display. If it is weak, too low to register, or missing, "HUB Bad" displays. The status of the battery pack then displays as battery voltage. The range for a charged battery is 12.0 to 13.6 V. The radio continues through the test sequence. If all the tests are passed, "PASSED" displays on the LED display. If a faulty module is present, it displays as a fault code; e.g., A04, which indicates that the A4 Power Supply module needs replacement (see section 5).

Use self test as often as needed during radio operation to check HUB, radio battery pack, and overall radio functions. Self test can be executed in any mode except PRGRM or RMT.

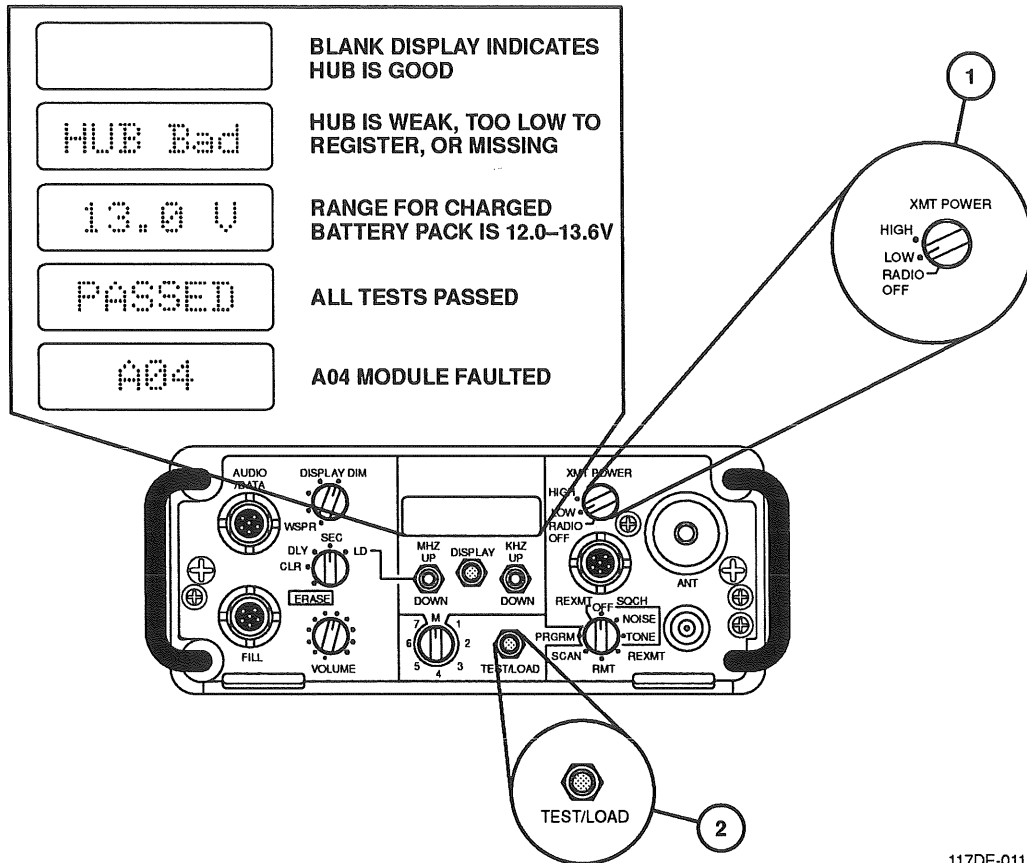
3.5.2 Squelch Operation

There are differences in squelch operation, depending upon whether the radio is being operated in clear text, ECCM, or secure mode. The squelch mode of the radio is determined by the squelch position on the RADIO mode control. The ENCRYPTION mode control can be in any mode position except LD, or ERASE.

If the RADIO mode control is in a squelch position and the ENCRYPTION mode control is moved to the CLR position, the LED display indicates that the clear-text mode has been entered:

*** CLEAR! ***

SELF TEST



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- ① Turn XMT POWER from RADIO OFF to LOW or HIGH.

To initiate self test, the LED display must be blank.

- ② Push TEST/LOAD.

The LED display shows the status of the hold-up-battery, radio battery pack, and radio modules.

- HUB status is checked first.
- Radio battery pack voltage is displayed.
- Radio modules are checked. Fault codes flash on the LED.

Self test can be used in any radio mode except PRGRM or RMT.

NOTE: Using self test causes the radio to place a signal on the air.

Figure 3-5. Self Test

3.5.2.1 Squelch Response for Clear-Text FM Operation

For clear-text FM operation the squelch positions operate as described below and as illustrated in figure 3-6.

- OFF – No squelch is applied. In the absence of a signal, a rushing sound comes from the handset.
- NOISE – The receiver is squelched in the absence of a signal. The receiver unsquelches when the received signal power level is approximately at the 10 dB SINAD level.
- TONE – The receiver is squelched unless the received signal has the proper characteristics. The received signal must be modulated by a 150 Hz subcarrier tone. Signal power must be equal to that for NOISE SQUELCH.

NOTE

TONE SQUELCH is not used in VHF-Hi and UHF. NOISE SQUELCH is used regardless of the NOISE or TONE setting.

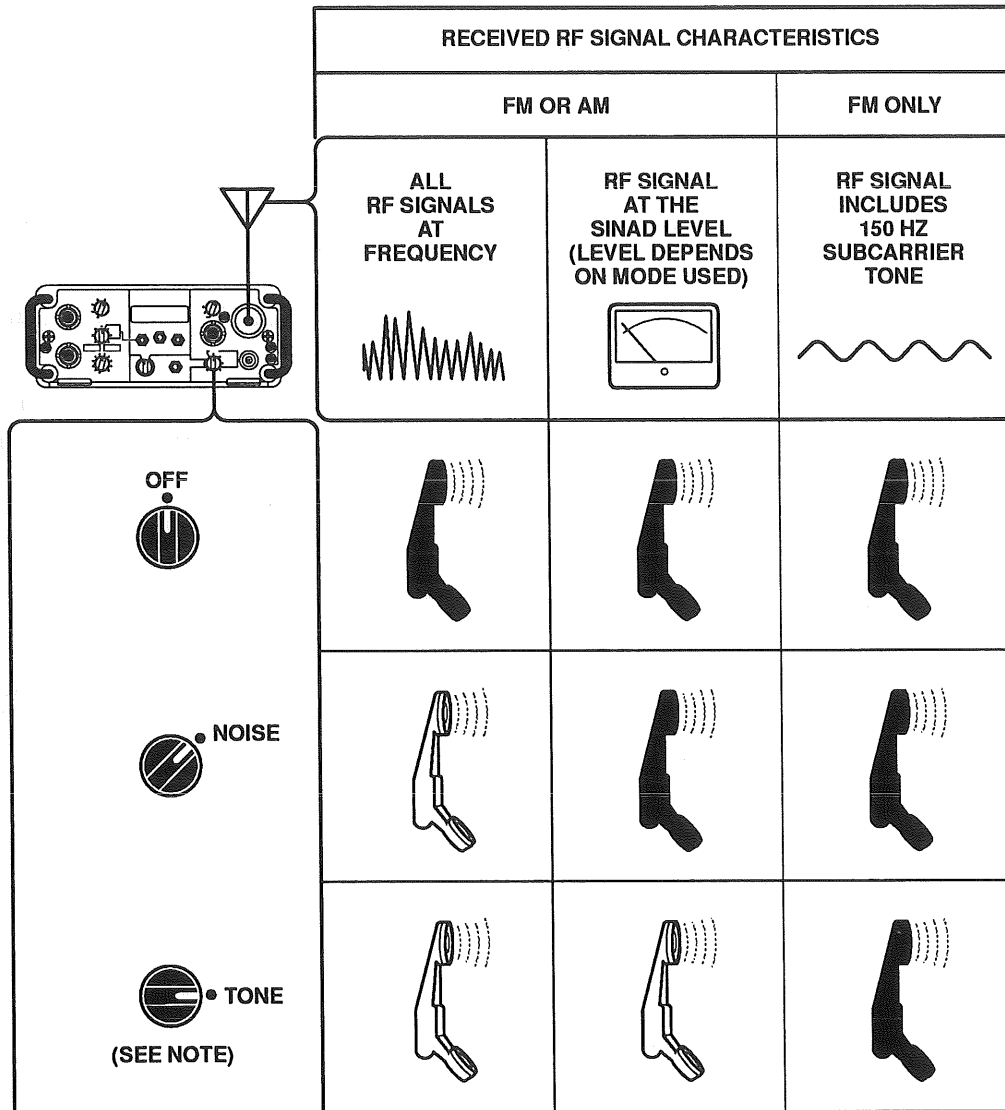
3.5.2.2 Squelch Response for Clear-Text AM Operation

For clear-text AM operation the squelch positions operate as described below and as illustrated in figure 3-6.

- OFF – No squelch is applied. In the absence of a signal, a rushing sound comes from the handset.
- NOISE (AM SQL HI – Set by menu) – The receiver is squelched in the absence of a signal. The radio unsquelches when the received signal power level is at approximately the 15 dB SINAD level.
- NOISE (AM SQL LO – Set by menu) – The receiver is squelched in the absence of a signal. The radio unsquelches when the received signal power level is at approximately the 4 dB SINAD level.

NOTE

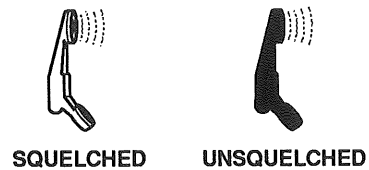
TONE SQUELCH is not used in AM. NOISE SQUELCH is used regardless of the NOISE or TONE setting.



APPLIES TO NON-ECCM OPERATION ONLY

NOTE:
IN VHF-HI AND UHF, NOISE SQUELCH IS USED REGARDLESS OF THE NOISE OR TONE SETTING.

LEGEND:



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Figure 3-6. Squelch Responses for Clear-Text Non-ECCM Operation

3.5.2.3 Squelch Response for Clear-Text ECCM Operation

There are two types of ECCM transmission, each compatible with the other. The squelch position on the RADIO mode control selects one of the following:

- TONE SQUELCH ECCM – RADIO mode control in TONE
- NOISE SQUELCH ECCM – RADIO mode control in NOISE or OFF

These two frequency-hopping methods differ in one essential way; i.e., use of synchronizing characters.

In TONE SQUELCH ECCM the transmitter sends a burst of synchronizing characters each time the handset is keyed and unkeyed. The handset beeps each time the radio is keyed.

In NOISE SQUELCH ECCM the timing of the keying burst is somewhat different. The transmitter sends a synchronizing burst when first keyed, but only intermittently thereafter.

Figure 3-7 shows the timing of synchronizing bursts (simplified) for both types of ECCM operation. To understand the advantages of each ECCM type and how radios in a network are synchronized with each ECCM type, compare the timing sequences in figure 3-7.

With NOISE SQUELCH ECCM, an initial synchronizing burst establishes the ECCM contact. Once radios in the network are synchronized, resynchronizing is not necessary if radio contact is maintained with only brief intervals between transmissions (2 – 3 seconds). This means that synchronizing bursts are infrequent, providing added security. This complicates any attempt to monitor or jam ECCM transmission.

Audio modulation is inhibited during the brief synchronizing burst. A beep in the handset (approximate duration 1/3 second) indicates that the burst is being sent. Because synchronizing bursts are infrequent with NOISE SQUELCH ECCM, faster back-and-forth communication is possible in this mode.

As figure 3-7 shows, TONE SQUELCH ECCM timing differs significantly from NOISE SQUELCH ECCM timing. Each time a transmitter is keyed, all radios in the network are resynchronized. This continuous resynchronizing of all network radios means that radios in the network are less dependent on a single synchronizing burst to maintain communication. Each time a transmitter is keyed, however, audio modulation is inhibited during the handset beep.

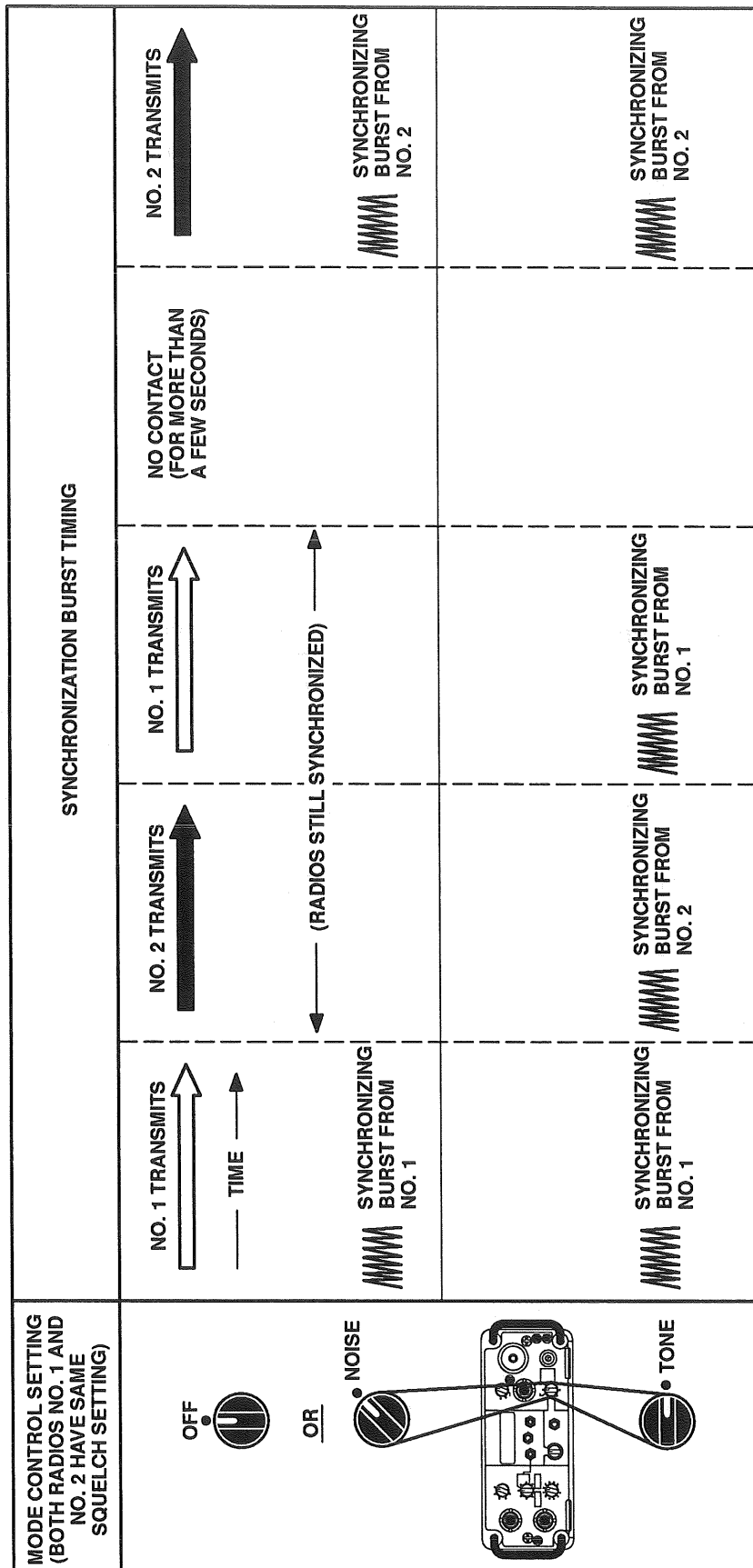
In addition to the initial synchronizing burst, both NOISE SQUELCH ECCM and TONE SQUELCH ECCM modes provide an end-of-message burst, sent each time a transmitter is unkeyed. The end-of-message burst also causes a beep in each receiving handset.

The receiving operator should wait for the end-of-message beep before keying. This is particularly important when in TONE SQUELCH ECCM mode because radios require an end-of-message burst before they accept the next synchronizing burst.

NOTE

TONE SQUELCH ECCM refers to a synchronization method only. There is no subcarrier tone associated with TONE SQUELCH ECCM operation.

The recommended procedure for ECCM operation is to set all network radios to the same SQUELCH mode. With this coordination, synchronization burst timing consistently follows the appropriate pattern shown in figure 3-7. Note, however, that radios set for different SQUELCH ECCM modes are fully compatible within the network. This is because the end-of-message burst switches all receiving radios in the network to the mode of the transmitting radio. Upon receiving the end-of-message burst, radios automatically assume the proper ECCM SQUELCH mode for subsequent transmission and reception.



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Figure 3-7. Clear-Text ECCM Squelch Mode Synchronization Burst Timing

3.5.2.4 Squelch Response for Secure Operation (Non-ECCM and ECCM)

For secure-text, non-ECCM operation, the radio is squelched automatically so the squelch position of the RADIO mode control is ignored. When a secure-text signal is received, the radio unsquelches.

For secure-text, ECCM operation, the radio operates exactly as it does for clear-text ECCM operation so that both TONE squelch and NOISE squelch ECCM transmission are possible.

A clear-text signal may be received in non-ECCM secure-text operation, if the radio transmitting in clear text is on the same frequency and is transmitting a 150-Hz tone. For ECCM secure-text operation, a clear-text signal may be received if the receiving and transmitting radios have the same code and bandwidth. Clear text received in secure-text operation only needs the 150-Hz tone in the 30 – 89.975 MHz band. For the 116 – 173.995 MHz band, NOISE squelch is used exclusively. When a clear-text signal is received in secure-text operation, a double beep is heard at the beginning of the signal and repeated every ten seconds.

3.6 FREQUENCY RANGES, MODES, AND SCROLL INCREMENTS

Table 3-4 lists the operating frequency ranges and modes of the AN/PRC-117D(E). Also included in the table are the scroll increments of the KHZ toggle switch on the front panel when using the different frequencies. The far right column describes the frequencies that are excluded from ECCM (hopping).

Table 3-4. Frequency Ranges, Bandwidths, Modes, and Scroll Increments

Frequency Range (Bands in MHz)	Modulation Types (AM or FM)	Frequency Scroll Increments (KHZ Switch)	Frequencies Excluded from ECCM (in MHz)
VHF-Lo 30.000 – 89.975	FM Only	25 kHz	None
VHF-Hi 116.000 – 173.995	AM or FM	5 or 6.25* kHz	116.000 to 119.995 170.000 to 173.995
UHF 225.000 – 419.995	AM or FM	5 kHz	240.000 to 269.995

*5.00 kHz is the default, but may be changed from the CH SETUP menu (see paragraph 3.7.2).

3.7 RADIO SETUP

For full compatibility of radios within a network, set up each radio in exactly the same manner. Front panel menus allow radio setup to be quick and easy. Two sets of menus are available from the front panel. They are:

- RADIO OP – Sets the operational parameters for all channels and modes. Allows selection of the AM squelch level, battery type, and radio zeroize (if needed).
- CH SETUP – Sets the parameters for the individual channel selected by the CHANNEL control. Allows selection of the channel type (single channel or ECCM) and channel spacing for the VHF-Hi band.

With the display blank and the RADIO mode control in the PRGRM position, these two menus are accessed by pressing TEST/LOAD until RADIO OP or CH SETUP appears on the LED display. Press DISPLAY to select RADIO OP or CH SETUP. The MHZ toggle switch selects the parameter and the KHZ toggle switch selects the choices for the parameter.

3.7.1 RADIO OP Programming

The RADIO OP menu sets the following radio parameters:

- AM Squelch Level
- Battery Type
- Radio Zeroize

3.7.1.1 RADIO OP – Setting the AM Squelch Level

Figure 3-8 describes how to set the AM squelch level for low or high squelch.

3.7.1.2 RADIO OP – Selecting the Battery Type

This menu choice selects or deselects internal current limit circuitry which provides extra protection when a lithium battery is used. The selections are “Lith” for a lithium battery and “Othr” for the Ni-Cd battery and other power supplies.

CAUTION

If a lithium battery is used, and “Lith” is not selected from the menu, the internal current limit circuitry is disabled. With no current limiting, the internal fuse in the lithium battery may blow out.

NOTE

The radio (and menu) defaults to the lithium battery type when the primary power source (such as the battery) is interrupted and whenever the radio is turned off.

Perform the steps in figure 3-9 to select the battery type.

3.7.1.3 RADIO OP – Performing Radio Zeroize

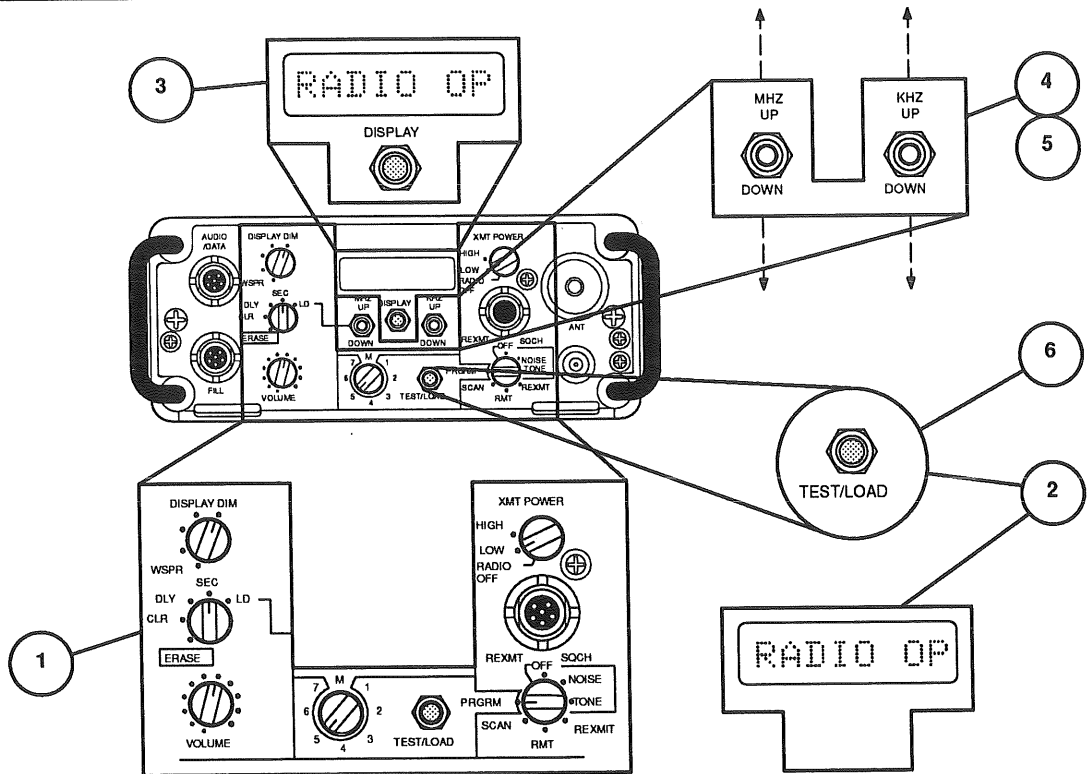
Zeroizing the radio changes the channels to their default values. These default values are shown in table 3-5.

Perform the steps described in figure 3-10 to zeroize the radio.

Table 3-5. Default Channel Values For Radio Zeroize

Channel	RX Frequency (MHz)	TX Frequency (MHz)	Bandwidth (kHz)	Mode	Channel Type	Low Power Setting (W)
M	244.000	244.000	25	FM	Single	1
1, 2, 3	60.000	60.000	25	FM	Single	1
4	300.000	300.000	25	AM	Single	1
5, 6, 7	60.000	60.000	25	FM	117B	1

RADIO OP – SETTING THE AM SQUELCH LEVEL

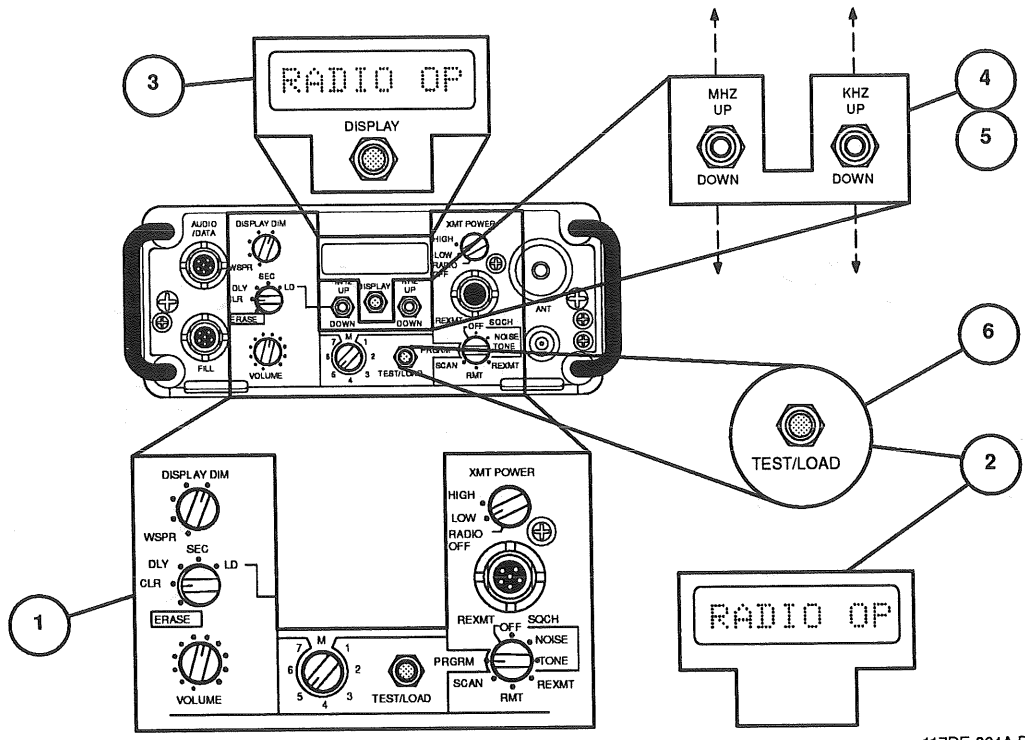


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- | | |
|---|---|
| <p>① Set the following controls:</p> <ul style="list-style-type: none"> ● XMT POWER – LOW or HIGH ● CHANNEL – 1–7 or M ● RADIO Mode – PRGRM ● ENCRYPTION Mode – CLR, DLY, or SEC <p>② After LED display blanks, push and hold TEST/LOAD until RADIO OP or CH SETUP appears.</p> | <p>③ Push DISPLAY until RADIO OP appears on the LED display.</p> <p>④ Toggle the MHZ switch UP or DOWN until AM SQ>Hi or AM SQ>Lo displays.</p> <p>⑤ Toggle the KHZ switch UP or DOWN to select the desired squelch level (Hi or Lo).</p> <p>⑥ Push TEST/LOAD to store the new parameter.</p> |
|---|---|

Figure 3-8. RADIO OP – Setting the AM Squelch Level

RADIO OP – SELECTING THE BATTERY TYPE

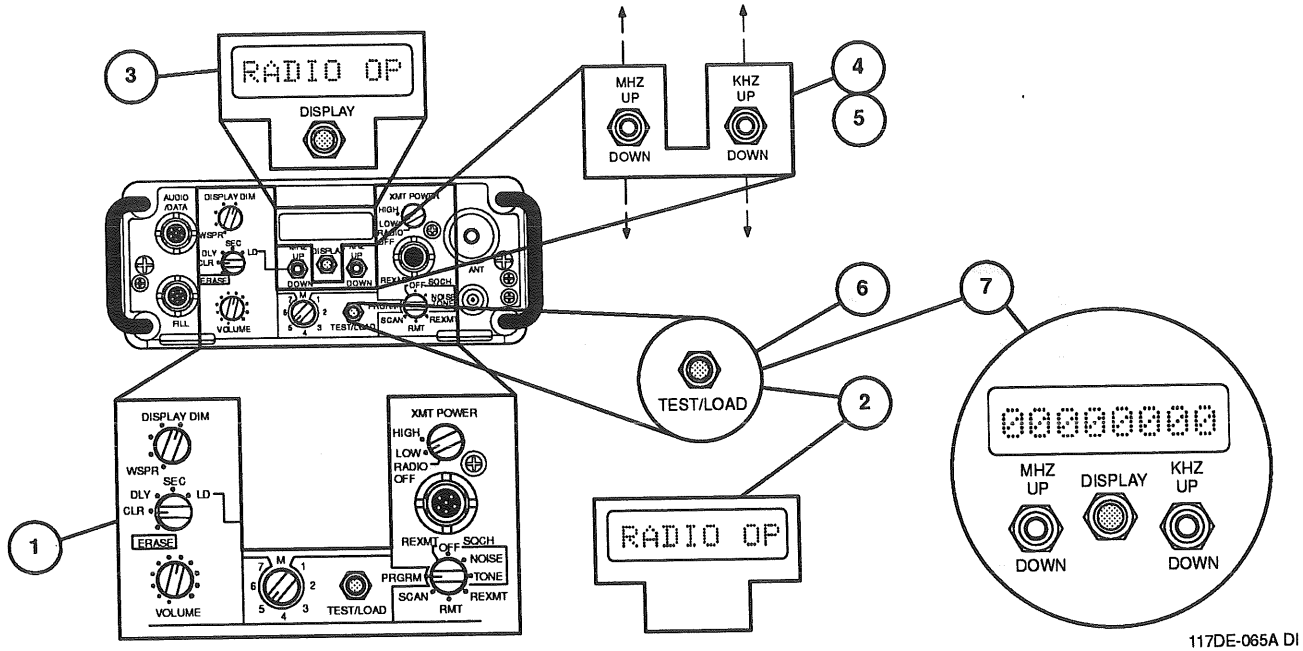


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- | | |
|---|---|
| <p>① Set the following controls:</p> <ul style="list-style-type: none"> ● XMT POWER – LOW or HIGH ● CHANNEL – 1–7 or M ● RADIO Mode – PRGRM ● ENCRYPTION Mode – CRL, DLY, or SEC <p>② After LED display blanks, push and hold TEST/LOAD until RADIO OP or CH SETUP appears.</p> | <p>③ Push DISPLAY until RADIO OP appears on the LED display.</p> <p>④ Toggle the MHZ switch UP or DOWN until BAT>Lith or BAT>Othr displays.</p> <p>⑤ Toggle the KHZ switch UP or DOWN to select the desired battery type (Lith or Othr). Lith is for the lithium battery and Othr is for all other batteries and power supplies</p> <p>⑥ Push TEST/LOAD to store the new parameter.</p> |
|---|---|

Figure 3-9. RADIO OP – Selecting the Battery Type

RADIO OP – PERFORMING RADIO ZEROIZE



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- | | |
|--|--|
| <p>① Set the following controls:</p> <ul style="list-style-type: none"> ● XMT POWER – LOW or HIGH ● CHANNEL – 1–7 or M ● RADIO Mode – PRGRM ● ENCRYPTION Mode – CLR, DLY, or SEC <p>② After LED display blanks, push and hold TEST/LOAD until RADIO OP or CH SETUP appears.</p> <p>③ Push DISPLAY until RADIO OP appears on the LED display.</p> | <p>④ Toggle the MHZ switch UP or DOWN until ZERO>No displays.</p> <p>⑤ Toggle the KHZ switch UP or DOWN to select the desired ZEROIZE display. No is used to keep the programmed variables and Yes is used to change the variables to their default values.</p> <p>⑥ Push and hold TEST/LOAD. The LED display goes blank.</p> <p>⑦ Release TEST/LOAD. The LED display changes to 00000000 for approximately 2.5 seconds. The channels are then set to the values listed in table 3-5.</p> |
|--|--|

Figure 3-10. RADIO OP – Performing Radio Zeroize

3.7.2 CH SETUP Programming

The CH SETUP menu sets the following channel parameters for the currently selected channel (1-7 or M).

- Channel type selection [single channel or ECCM (HOP)]
- Channel spacing for the VHF-Hi band

3.7.2.1 CH SETUP – Selecting the Channel Type

This menu choice selects either a fixed frequency (Sngl) or ECCM frequency-hopping (HOP) channel.

Perform the steps in figure 3-11 to select the channel type.

3.7.2.2 CH SETUP – Selecting Channel Spacing for VHF-Hi

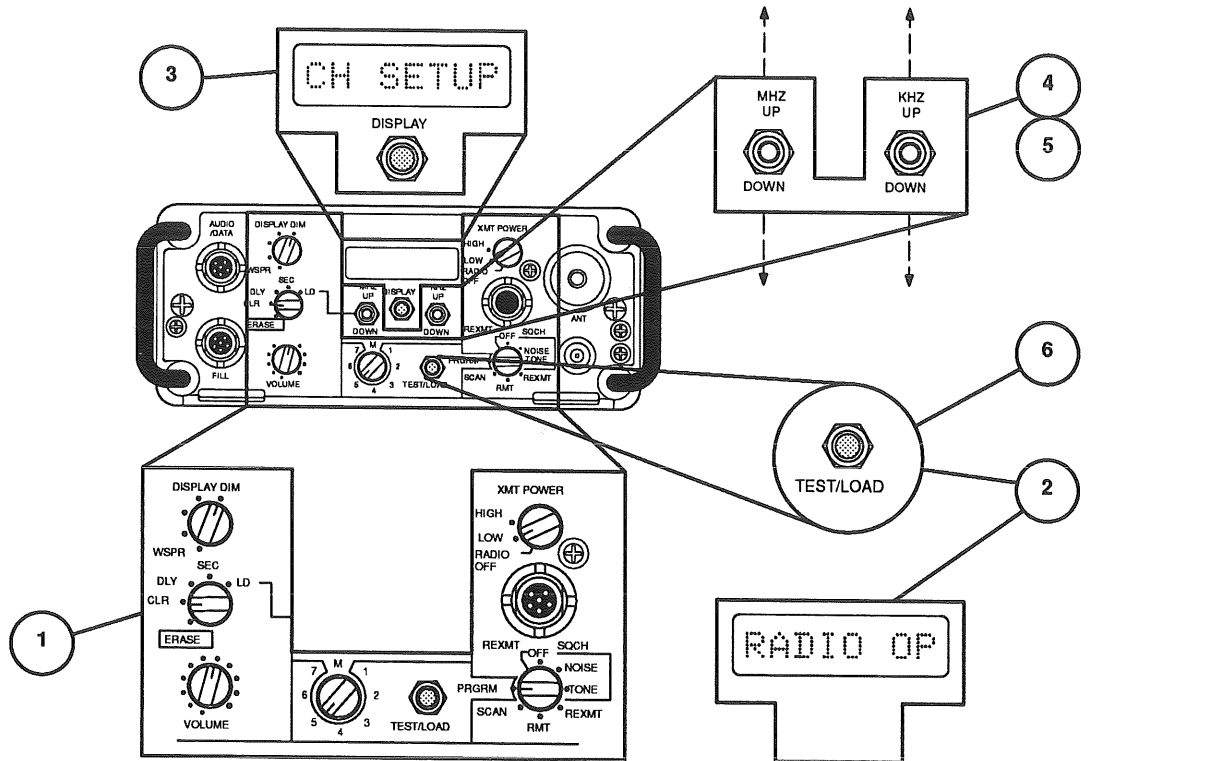
This menu choice selects the channel spacing for VHF-Hi (116.000 to 173.995 MHz). The channel spacing can be set to 5 kHz or 6.25 kHz.

NOTE

Refer to table 3-2 and figure 3-3 for the display characteristics of the 6.25 kHz channel spacing.

Perform the steps described in figure 3-12 to set the channel spacing.

CH SETUP – SELECTING THE CHANNEL TYPE

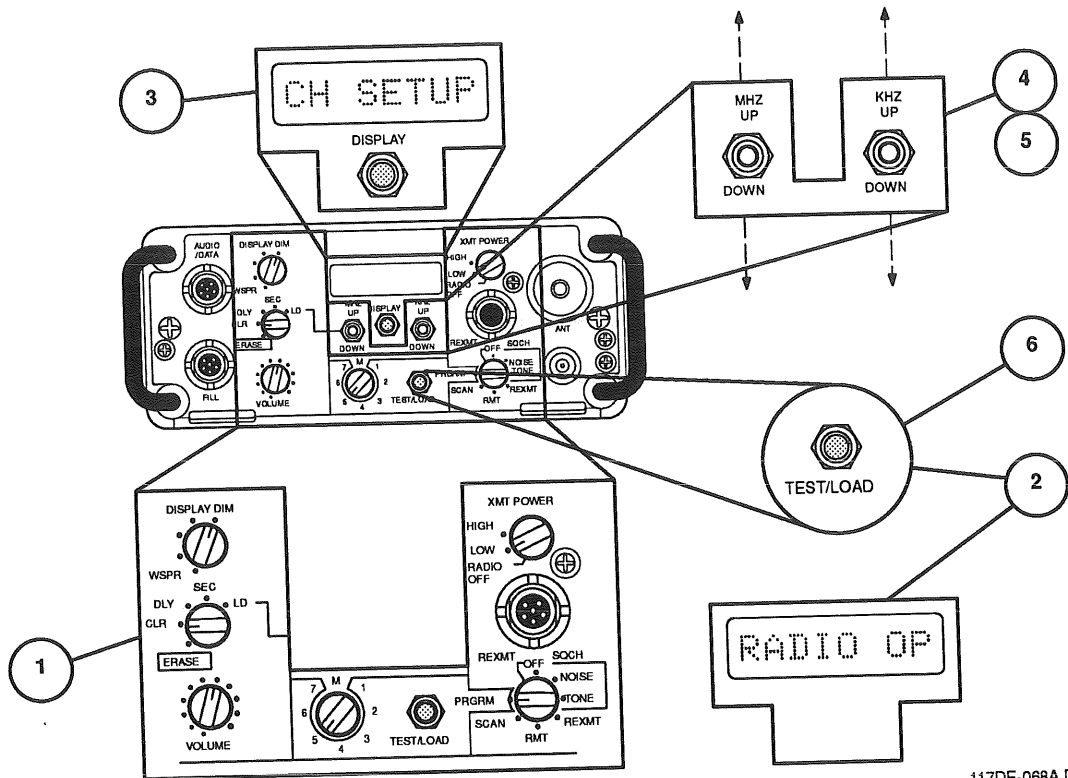


117DE-066A DI

- ① Set the following controls:
 - XMT POWER – LOW or HIGH
 - CHANNEL – 1–7 or M
 - RADIO Mode – PRGRM
 - ENCRYPTION Mode – CLR, DLY, or SEC
- ② After LED display blanks, push and hold TEST/LOAD until RADIO OP or CH SETUP appears.
- ③ Push DISPLAY until CH SETUP appears on the LED display.
- ④ Toggle the MHZ switch UP or DOWN until TYP>Sngl or TYP>HOP displays.
- ⑤ Toggle the KHZ switch UP or DOWN to select the desired channel type. Sngl is used for single channel and HOP is used for ECCM channels.
- ⑥ Push TEST/LOAD to store the new parameter.

Figure 3-11. CH Setup – Selecting the Channel Type

CH SETUP – SELECTING THE CHANNEL SPACING FOR VHF-HI



117DE-068A DI

- | | |
|---|--|
| <p>① Set the following controls:</p> <ul style="list-style-type: none"> ● XMT POWER – LOW or HIGH ● CHANNEL – 1-7 or M ● RADIO Mode – PRGRM ● ENCRYPTION Mode – CLR, DLY, or SEC <p>② After LED display blanks, push and hold TEST/LOAD until RADIO OP or CH SETUP appears.</p> | <p>③ Push DISPLAY until CH SETUP appears on the LED display.</p> <p>④ Toggle the MHZ switch UP or DOWN until SPC>500 or SPC>625 displays.</p> <p>⑤ Toggle the KHZ switch UP or DOWN to select the channel spacing for VHF-Hi operation. A value of 500 selects 5 kHz channel spacing and a value of 625 selects a channel spacing of 6.25 kHz.</p> <p>⑥ Push TEST/LOAD to store the new parameter.</p> |
|---|--|

Figure 3-12. CH Setup – Selecting the Channel Spacing for VHF-Hi

3.8 SINGLE (SNGL) CHANNEL PROGRAMMING

Single channel programming can be performed for the manual channel or for channels 1 – 7.

3.8.1 Manual Channel Selections for Single Channel Operation

When the CHANNEL control is set to M (manual channel), selections of frequency, bandwidth, channel mode, and low transmit power setting can be made without first entering the PRGM mode.

3.8.1.1 Setting Frequency – Manual Channel

Follow the steps in figure 3-13 when selecting a MANUAL channel frequency. For simplex operation (same frequency for both transmit and receive), use steps 1 through 3. For half-duplex operation (receive on one frequency, transmit on another frequency), use steps 1 through 7.

WARNING

The transmitter is active while the handset is keyed during half-duplex manual channel programming. Touching the antenna connections can result in personal injury.

The MHZ and KHZ toggle switches control the frequency only when the LED display is lit and the directional cursor is pointing to the right. This helps to prevent an accidental change of frequency during operation.

3.8.1.2 Selecting the Channel Mode (for VHF-Hi and UHF frequencies) – Manual Channel

The channel mode (MODE>AM or MODE>FM) can only be selected for VHF-Hi and UHF frequencies. Perform the steps in figure 3-14 to set the channel mode for the manual channel.

3.8.1.3 Setting Low Transmit Power – Manual Channel

When the XMT POWER control is set to low, the power level can be adjusted for all frequencies of the AN/PRC-117D(E). The power level is adjusted for 1, 2, 4, 6, 8, and 10 Watts.

NOTE

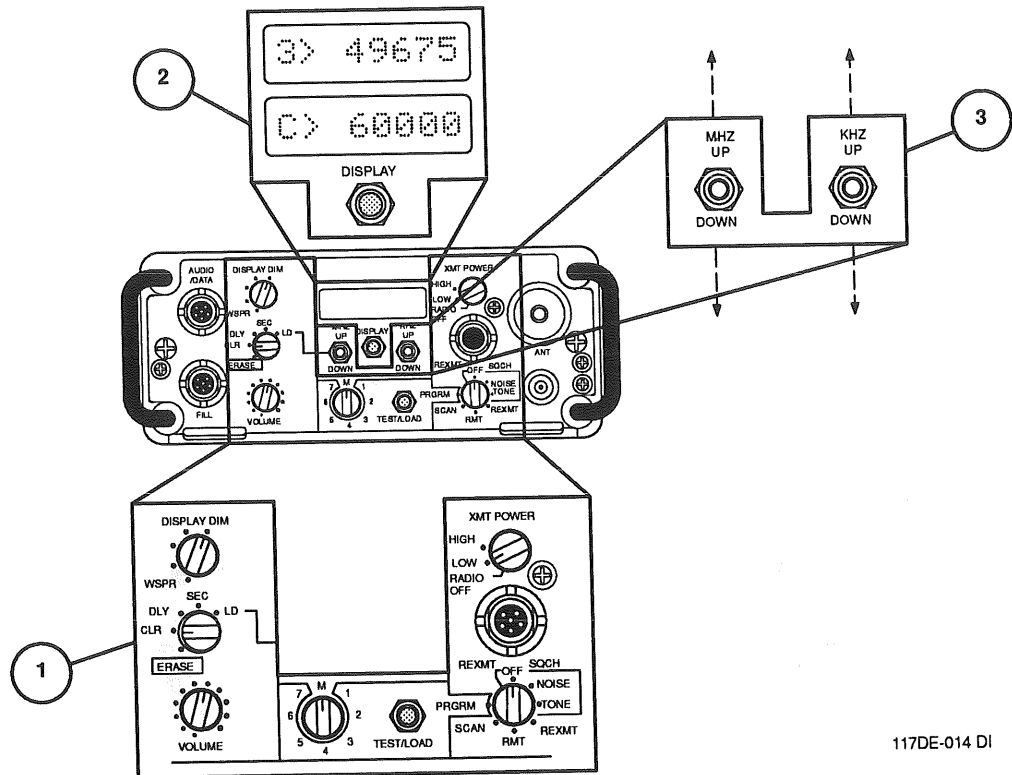
The transmit power level is reset to 1 W when the frequency or mode is changed or the radio is powered off.

NOTE

Low transmit power can also be adjusted when the RADIO mode control is in REXMT, TONE, NOISE, or OFF.

Figure 3-15 describes how to adjust the XMT POWER control when it is set to LOW.

SETTING FREQUENCY – MANUAL CHANNEL



117DE-014 DI

SIMPLEX: STEPS ① – ③
HALF-DUPLEX: STEPS ① – ⑦

Begin here for simplex (same transmit/receive frequency) or half-duplex (different transmit/receive frequencies):

- ① Set the following controls:
- XMT POWER – LOW or HIGH
 - CHANNEL – M
 - RADIO Mode – any position other than RMT, SCAN, or PRGRM
 - ENCRYPTION Mode – CLR, DLY, or SEC (Initialize encryption per para. 3.4.1.)
- Set DISPLAY DIM and VOLUME as desired.

② Push DISPLAY.

Encryption variable storage location and frequency or C (if ENCRYPTION control is in CLR) and frequency displays. Display must be lit for frequency to be changed.

③ Select frequency.

Toggle the MHZ and KHZ switches UP or DOWN.

Display blanks automatically after a few seconds.

To recheck the frequency, push DISPLAY.

STOP HERE for simplex operation.

Figure 3-13. Setting Frequency – Manual Channel (Sheet 1 of 2)

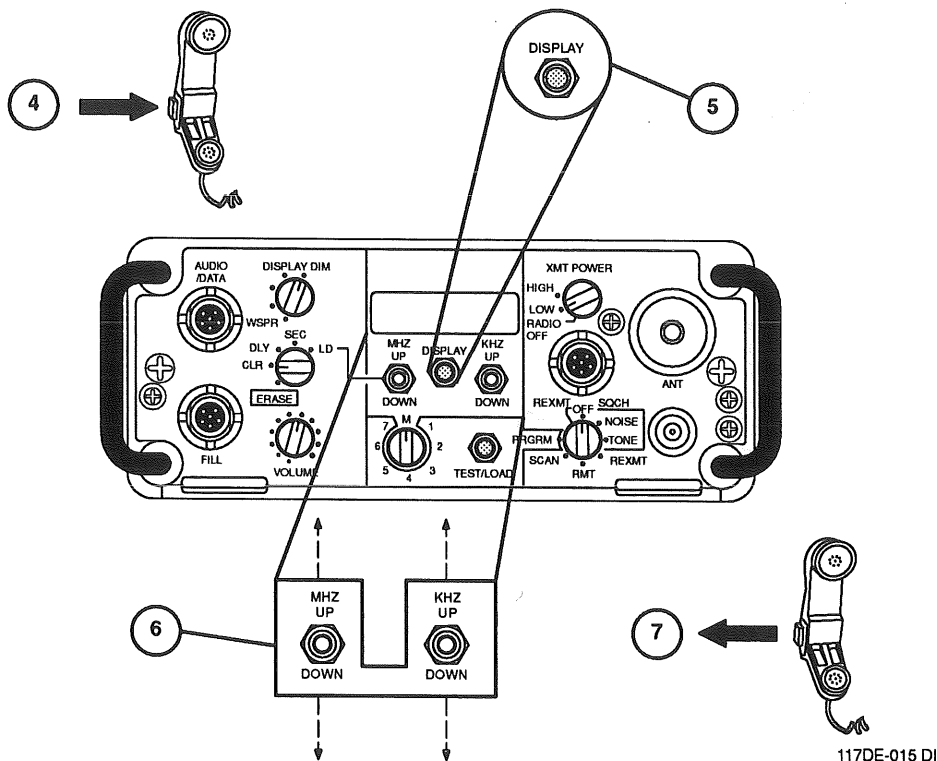
SETTING FREQUENCY – MANUAL CHANNEL (CONT.)

HALF-DUPLEX ONLY

Continue with steps 4-7 if transmit frequency differs from receive frequency.

NOTE: When setting the transmit frequency in MANUAL channel, XMT POWER must be set to LOW and be at the lowest power level (1 W).

For half-duplex operation on the MANUAL channel, first enter the receive frequency using steps 1-3 (on previous page). Then install the handset and continue with steps 4 to 7:



- ④ Key the handset. (Keep keyed until step 7.)
- ⑤ Push DISPLAY.
Current transmit frequency displays.
- ⑥ Select the transmit frequency.
Toggle the MHZ and KHZ switches UP or DOWN.
- ⑦ Release the handset key.
Display blanks automatically after a few seconds.

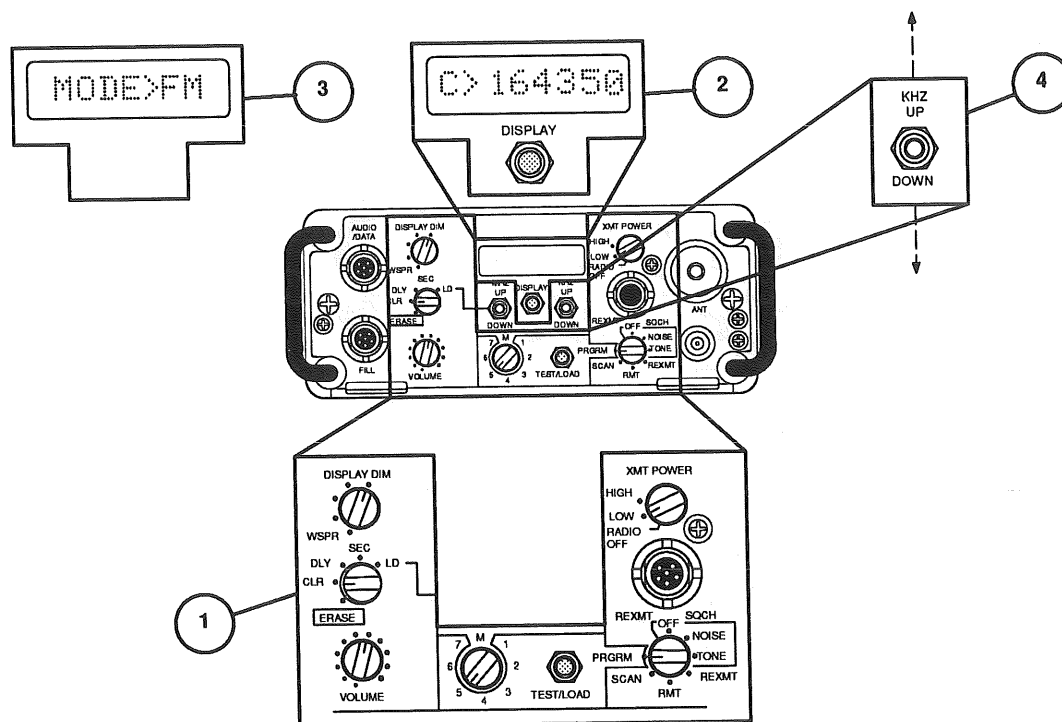
To recheck the receive frequency, push DISPLAY. To recheck the transmit frequency, key the handset, then push DISPLAY.

NOTE: The transmitter is active while the handset is keyed during half-duplex manual channel programming.

Figure 3-13. Setting Frequency – Manual Channel (Sheet 2 of 2)

SELECTING THE CHANNEL MODE – MANUAL CHANNEL

NOTE: For VHF-Hi and UHF frequencies only.

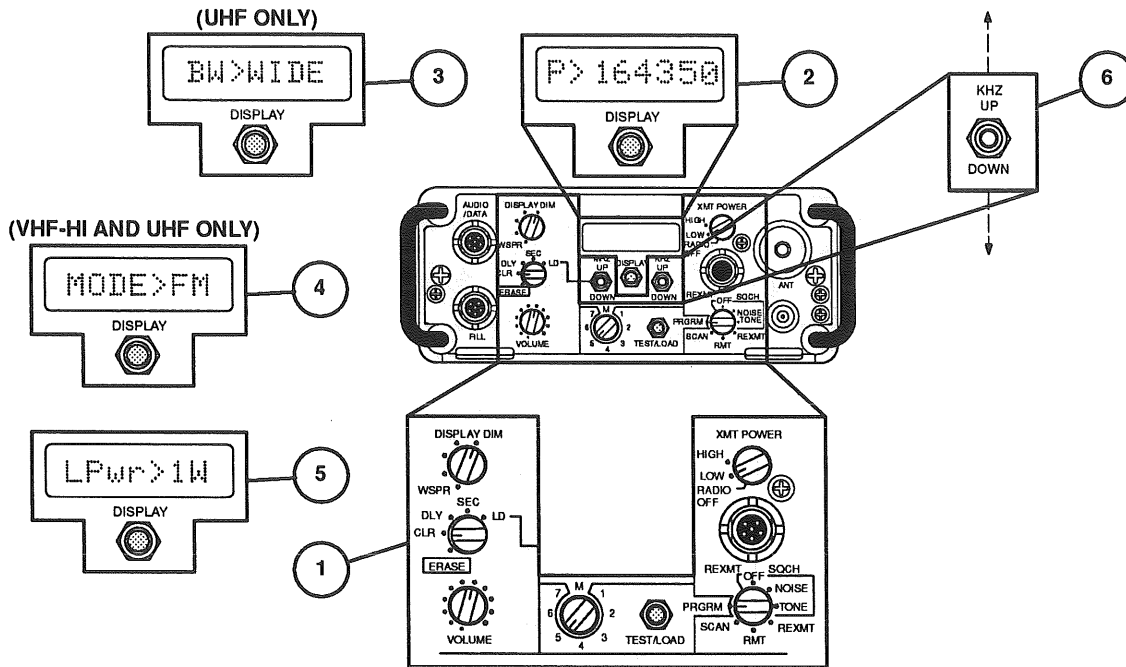


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- ① Set the following controls:
 - XMT POWER – LOW or HIGH
 - CHANNEL – M
 - RADIO Mode – PRGRM
 - ENCRYPTION Mode – CLR, DLY, or SEC
- ② Push DISPLAY. The frequency is displayed on the LED display.
- ③ Push DISPLAY again. The display changes to MODE>FM or MODE>AM.
- ④ Toggle the KHZ switch UP or DOWN until the desired mode (MODE>FM or MODE>AM) displays. After the KHZ switch is released, the radio automatically loads the new mode setting.

Figure 3-14. Selecting the Channel Mode – Manual Channel

SETTING LOW TRANSMIT POWER – MANUAL CHANNEL



117DE-101A DI

- | | |
|---|---|
| <p>① Set the following controls:</p> <ul style="list-style-type: none"> ● XMT POWER – LOW ● CHANNEL – M ● RADIO Mode – PRGRM ● ENCRYPTION Mode – CLR, DLY, or SEC <p>② Push DISPLAY. The frequency is displayed on the LED display.</p> | <p>③ VHF-Hi and UHF Only
Push DISPLAY again. The display changes to MODE>FM or MODE>AM.</p> <p>④ Push DISPLAY again. The display changes to LPwr>1W.</p> <p>⑤ Toggle the KHZ switch UP or DOWN until the desired low power setting (LPwr>1W, 2W,...10W) displays. After the KHZ switch is released, the radio automatically loads the new low power setting.</p> <p>NOTE: The transmit power level resets to 1W when the frequency or mode is changed or the radio is turned off.</p> |
|---|---|

Figure 3-15. Setting Low Transmit Power – Manual Channel

3.8.2 Programming Channels 1 – 7 for Single Channel Operation

3.8.2.1 Programming Frequency – Channels 1 – 7

NOTE

If the radio has not been used for a month or more, charge the memory backup battery before programming channel 1–7 frequencies. See section 2.

NOTE

Frequency programming applies only to channels set in the single (Sngl) channel mode using the CH SETUP menu.

Follow the steps in figure 3-16 when programming single channel frequencies for channels 1–7. For simplex operation (same frequency for both transmit and receive), perform steps 1 through 4. For half-duplex operation (receive on one frequency, transmit on another frequency), perform steps 1 through 9.

Figure 3-16 also describes how to recheck the programmed frequency. (Remember that the RADIO mode control must be in PRGRM mode.) Recall of programmed frequencies can be intentionally prevented by placing a jumper on Power Supply Module A4. If this were done, 60.000 would display whenever recall was attempted, regardless of the actual programmed frequency. Using this optional jumper prevents unauthorized attempts to display the frequencies programmed. In addition, removal of this jumper and subsequent insertion of the A4 module clears radio memory circuitry which stored the programmed values, again defeating the attempt to display frequencies. See the A4 Unit Instruction section for further details on A4 module jumpers.

Sensitive frequency and bandwidth information can also be removed from the radio by using the radio zeroize feature (see paragraph 3.7.1.3).

3.8.2.2 Programming the Channel Mode (for VHF-Hi and UHF frequencies) – Channels 1 – 7

The channel mode (MODE>AM or MODE>FM) can only be selected for VHF-Hi and UHF frequencies.

Perform the steps in figure 3-17 to select the channel mode for channels 1–7.

3.8.2.3 Programming Low Transmit Power – Channels 1 – 7

When the XMT POWER control is set to low, the power level can be adjusted for all frequencies of the AN/PRC-117D(E). The power level is adjusted for 1, 2, 4, 6, 8, and 10 Watts.

NOTE

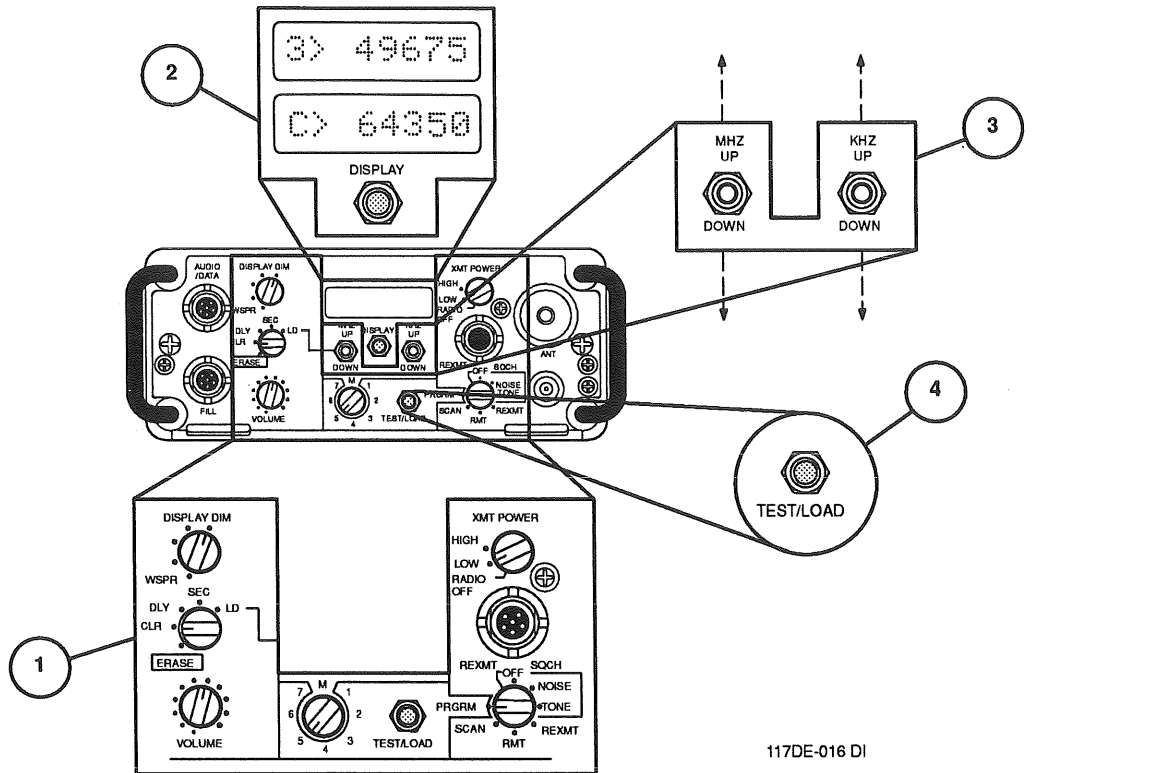
The transmit power level is reset to 1 W when the frequency or mode is reprogrammed or the radio is powered off.

NOTE

Low transmit power can also be adjusted when the RADIO mode control is in REXMT, TONE, NOISE, or OFF.

Figure 3-18 describes how to adjust the XMT POWER control when it is set to LOW.

PROGRAMMING FREQUENCY – CHANNELS 1-7



117DE-016 DI

Begin here for simplex (same transmit/receive frequency) or half-duplex (different transmit/receive frequencies):

- | | |
|---|--|
| <p>① Set the following controls:</p> <ul style="list-style-type: none"> • XMT POWER – LOW or HIGH • CHANNEL – 1-7 • RADIO Mode – PRGRM • ENCRYPTION Mode – CLR, DLY, or SEC (Initialize encryption per para. 3.4.1.) <p>Set DISPLAY DIM and VOLUME as desired.</p> <p>② Push DISPLAY.</p> <p>Encryption variable storage location and frequency or C (if ENCRYPTION control is in CLR) and frequency displays. Display must be lit for frequency to be changed.</p> | <p>③ Select frequency.</p> <p>Toggle the MHZ and KHZ switches UP or DOWN.</p> <p>④ With frequency displayed, push TEST/LOAD.</p> <p>The display blanks when TEST/LOAD is pressed, reappears when it is released. Display stays on for 5 seconds, then goes blank.</p> <p>To recheck the frequency, push DISPLAY. (EXCEPTION: If 60.000 displays, an internal jumper prevents recall of frequency.)</p> |
|---|--|

STOP HERE for simplex operation.

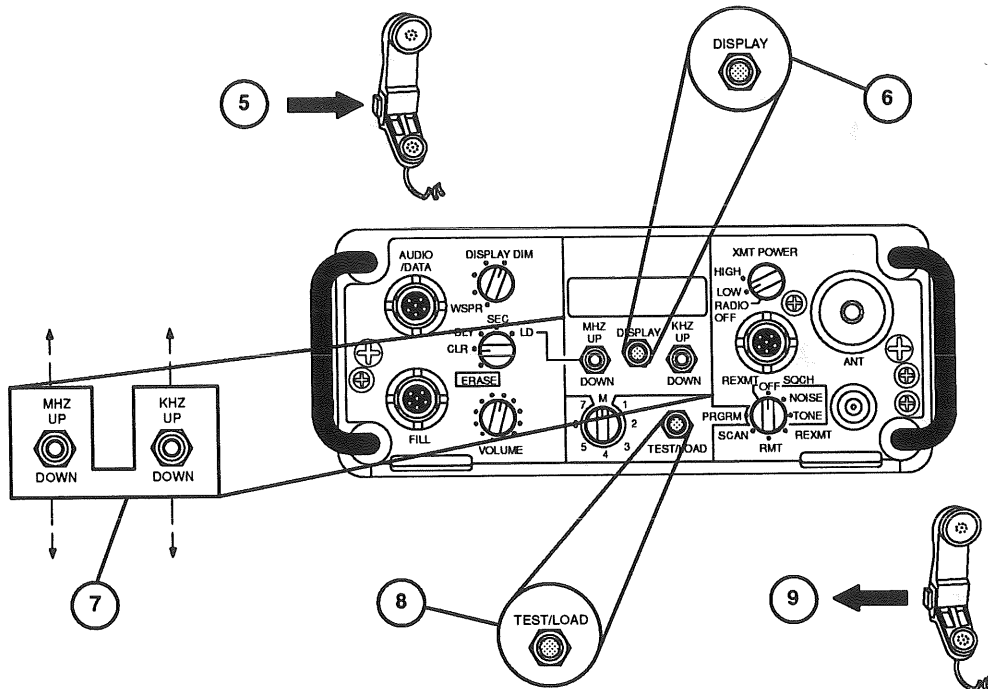
Figure 3-16. Programming Frequency – Channels 1 through 7 (Sheet 1 of 2)

PROGRAMMING FREQUENCY – CHANNELS 1–7 (CONT.)

HALF-DUPLEX ONLY

Continue with steps 5–9 if transmit frequency differs from receive frequency.

For half-duplex operation on programmed frequency channels, first enter the receive frequency using steps 1–4 (on previous page). Then install the handset and continue with steps 5 to 9:



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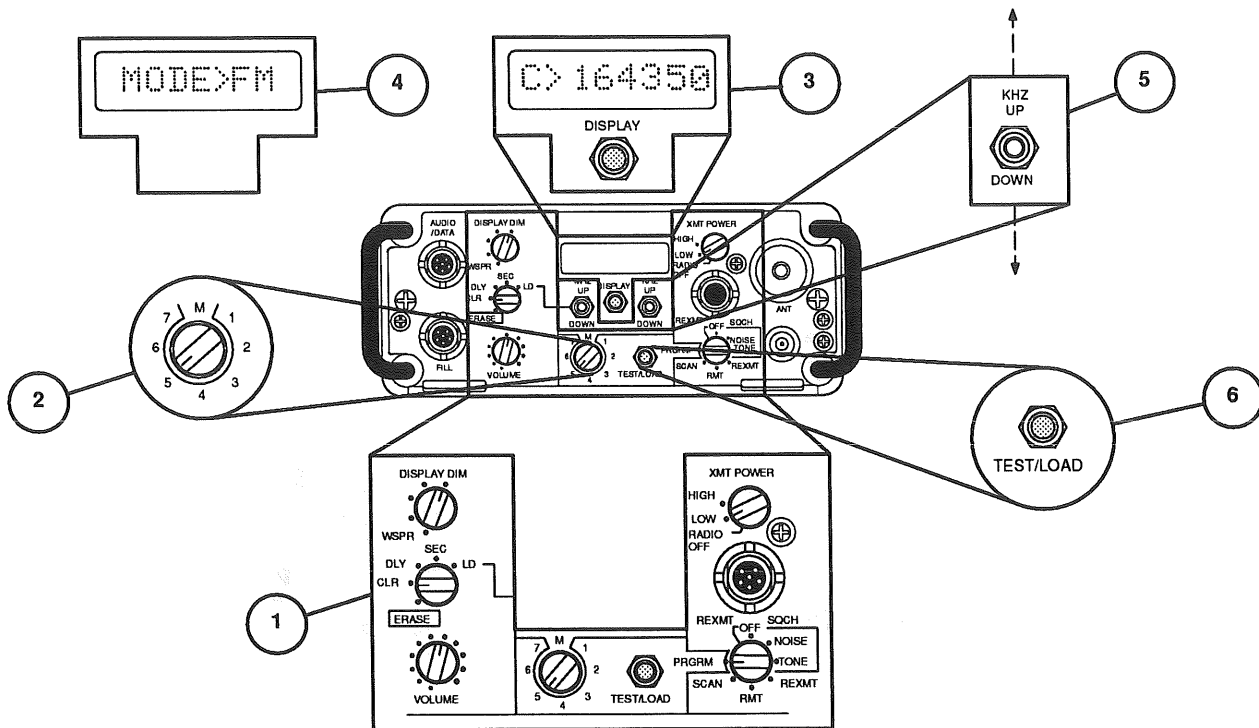
- 5 Key the handset. (Keep keyed until step 9.)
- 6 Push DISPLAY.
Current transmit frequency displays.
- 7 Select the transmit frequency.
Toggle the MHZ and KHZ switches UP or DOWN.
- 8 With frequency displayed, push TEST/LOAD.
The display blanks when TEST/LOAD is pressed, reappears when it is released. Display stays on for 5 seconds, then goes blank.

- 9 Release the handset key.
Display blank automatically after a few seconds.
To recheck the receive frequency, push DISPLAY. To recheck the transmit frequency, key the handset, then push DISPLAY. (EXCEPTION: If 60.000 displays, an internal jumper prevents recall of frequency.)
- NOTE: Whenever the receiver frequency is reprogrammed, the transmit frequency automatically reverts to the new receive frequency.

Figure 3-16. Programming Frequency – Channels 1 through 7 (Sheet 2 of 2)

PROGRAMMING THE CHANNEL MODE – CHANNELS 1–7

Note: For VHF-Hi and UHF frequencies only.

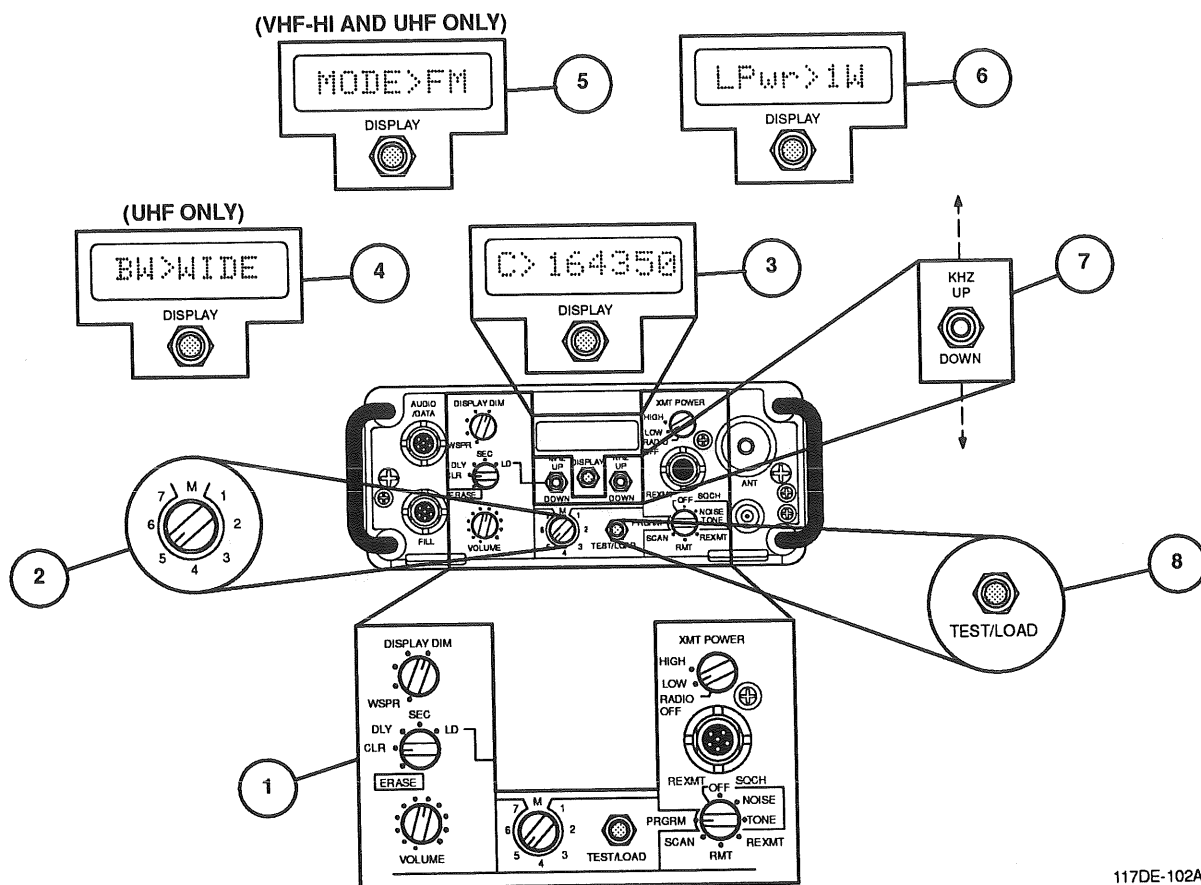


117DE-070 DI

- | | |
|---|---|
| <p>① Set the following controls:</p> <ul style="list-style-type: none"> ● XMT POWER – LOW or HIGH ● CHANNEL – 1–7 [Setup for single (Sngl) channel] ● RADIO Mode – PRGRM ● ENCRYPTION Mode – CLR, DLY, or SEC | <p>③ Push DISPLAY. The frequency displays on the LED display.</p> |
| <p>② Move the CHANNEL Control to the desired channel (1–7).</p> | <p>④ Push DISPLAY again. The display changes to MODE> FM.</p> |
| | <p>⑤ Toggle the KHZ switch UP or DOWN until the desired mode (MODE>FM or MODE>AM) displays.</p> |
| | <p>⑥ Push TEST/LOAD.</p> |

Figure 3-17. Programming the Channel Mode – Channels 1 through 7

PROGRAMMING LOW TRANSMIT POWER – CHANNELS 1–7



117DE-102A DI

- | | |
|--|---|
| <p>① Set the following controls:</p> <ul style="list-style-type: none"> ● XMT POWER – LOW ● CHANNEL –1–7 [Setup for single (Sngl) channel] ● RADIO Mode – PRGRM ● ENCRYPTION Mode – CLR, DLY, or SEC <p>② Move the CHANNEL Control to the desired channel (1–7).</p> <p>③ Push DISPLAY. The frequency displays on the LED display.</p> | <p>④ VHF-Hi and UHF Only
Push DISPLAY again. The display changes to MODE>FM or MODE>AM.</p> <p>⑤ Push DISPLAY again. The display changes to LPwr>1W.</p> <p>⑥ Toggle the KHZ switch UP or DOWN until the desired low power setting (LPwr>1W, 2W,... 10W) displays. After the KHZ switch is released, the radio automatically loads the new low power setting.</p> <p>⑦ Push TEST/LOAD.</p> <p>NOTE: The transmit power level is reset to 1W when the frequency or mode is reprogrammed or the radio is turned off.</p> |
|--|---|

Figure 3-18. Programming Low Transmit Power – Channels 1 through 7

3.9 ECCM PROGRAMMING

For the most part, operating the radio using its ECCM frequency-hopping channels is similar to operating the radio using its standard channels. However, there are some differences in radio operating technique due to ECCM timing requirements and the need for network synchronization.

Recommendations to the operator when using ECCM channels include the following:

- When keying the handset, wait for the beep to end before beginning to talk.
- When receiving, wait for the end-of-message beep before keying. This is especially important when using TONE SQUELCH ECCM (see paragraph 3.5.2.3).

The SCAN feature of the radio does not detect ECCM frequency-hopping signals. In SCAN mode, keying does not initiate frequency-hopping transmission (see paragraph 3.12.2).

3.9.1 Programming ECCM Channels

ECCM channels are programmed with ECCM codes rather than with frequencies. The ECCM bandwidth defaults to a 5-MHz (narrow) band selected by the first two or three (MHz) digits of the ECCM code (see tables 3-6 through 3-8). The first two or three digits must be within the ends of the band for that band to be chosen. The six-digit (3 MHz digits and 3 kHz digits) number determines part of the pseudorandom hopping pattern for ECCM transmission and reception on this channel. Figure 3-19 illustrates the significance of this programmed code for an ECCM channel.

The hopping bandwidth, however, does not have to be tied to the ECCM code. The operator can manually change the 5-MHz default ECCM band to another bandwidth distinct from the default position. This selection can be made anywhere in the range of the selected band (VHF, VHF-Hi, UHF), but the bandwidth must always remain a multiple of 5 MHz; e.g., 5, 10 60 MHz.

When loading an ECCM code, the hopping bandwidth is set to the default for 5-MHz (narrowband) hopping. To change the bandwidth of wideband hopping, press DISPLAY and the current ECCM code displays. Press DISPLAY a second time and the current hopping bandwidth displays. While the bandwidth is displayed, the MHZ toggle switch moves the lower limit up and down, and the KHZ toggle switch moves the upper limit up and down. Each number changes in increments of 5 MHz. (They always stay a minimum of 5 MHz apart.) When the desired hopping bandwidth is displayed, press TEST/LOAD.

A second six-digit ECCM code can be entered by keying the handset. This second code is optional, but the six digits of this second code change the number of hopping patterns available. This optional code can be programmed anywhere in the 30.000–89.975, 120.000–169.975, or 225.000–419.975 ranges.

Programming ECCM channels with narrowband hopping is shown in figure 3-20; programming ECCM channels with wideband hopping is shown in figure 3-21.

Table 3-6. 5 MHz Default ECCM Bands For VHF-Lo Frequencies

VHF ECCM Frequency Bands (MHz)			
ECCM Code	ECCM Band	ECCM Code	ECCM Band
30.000 – 34.975	30 – 35	60.000 – 64.975	60 – 65
35.000 – 39.975	35 – 40	65.000 – 69.975	65 – 70
40.000 – 44.975	40 – 45	70.000 – 74.975	70 – 75
45.000 – 49.975	45 – 50	75.000 – 79.975	75 – 80
50.000 – 54.975	50 – 55	80.000 – 84.975	80 – 85
55.000 – 59.975	55 – 60	85.000 – 89.975	85 – 90

Table 3-7. 5 MHz Default ECCM Bands For VHF-Hi Frequencies

VHF-Hi ECCM Frequency Bands (MHz)			
ECCM Code	ECCM Band	ECCM Code	ECCM Band
120.000 – 124.975	120 – 125	145.000 – 149.975	145 – 150
125.000 – 129.975	125 – 130	150.000 – 154.975	150 – 155
130.000 – 134.975	130 – 135	155.000 – 159.975	155 – 160
135.000 – 139.975	135 – 140	160.000 – 164.975	160 – 165
140.000 – 144.975	140 – 145	165.000 – 169.975	165 – 170

NOTE: Frequencies from 116.000 to 119.995 MHz and 170.000 to 173.995 MHz are excluded from ECCM operation.

Table 3-8. 5 MHz Default ECCM Bands For UHF Frequencies

UHF ECCM Frequency Bands (MHz)			
ECCM Code	ECCM Band	ECCM Code	ECCM Band
225.000 – 229.975	225 – 230	335.000 – 339.975	335 – 340
230.000 – 234.975	230 – 235	340.000 – 344.975	340 – 345
235.000 – 239.975	235 – 240	345.000 – 349.975	345 – 350
240.000 – 269.975	240 – 270	350.000 – 354.975	350 – 355
270.000 – 274.975	270 – 275	355.000 – 359.975	355 – 360
275.000 – 279.975	275 – 280	360.000 – 364.975	360 – 365
280.000 – 284.975	280 – 285	365.000 – 369.975	365 – 370
285.000 – 289.975	285 – 290	370.000 – 374.975	370 – 375
290.000 – 294.975	290 – 295	375.000 – 379.975	375 – 380
295.000 – 299.975	295 – 300	380.000 – 384.975	380 – 385
300.000 – 304.975	300 – 305	385.000 – 389.975	385 – 390
305.000 – 309.975	305 – 310	390.000 – 394.975	390 – 395
310.000 – 314.975	310 – 315	395.000 – 399.975	395 – 400
315.000 – 319.975	315 – 320	400.000 – 404.975	400 – 405
320.000 – 324.975	320 – 325	405.000 – 409.975	405 – 410
325.000 – 329.975	325 – 330	410.000 – 414.975	410 – 415
330.000 – 334.975	330 – 335	415.000 – 419.975	415 – 420

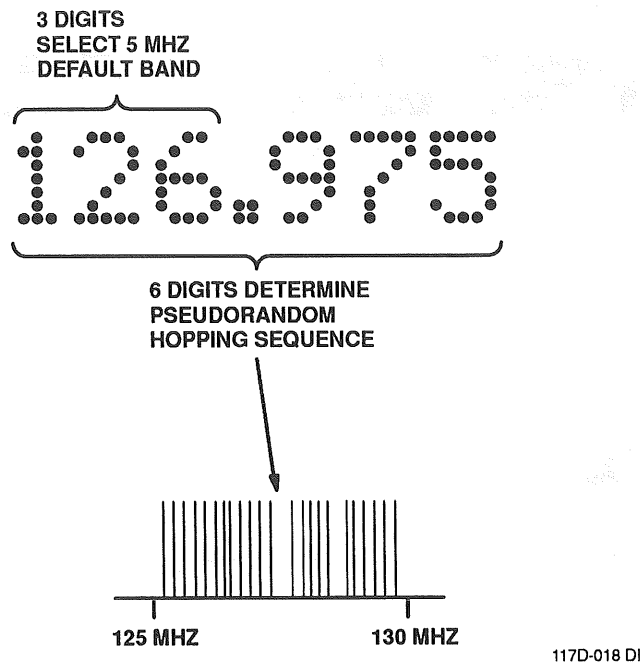


Figure 3-19. ECCM Channel Frequency Value

3.9.2 Coordinating Radio Setup for ECCM

ECCM communication between two or more transceivers requires identical setup conditions. The radios must have:

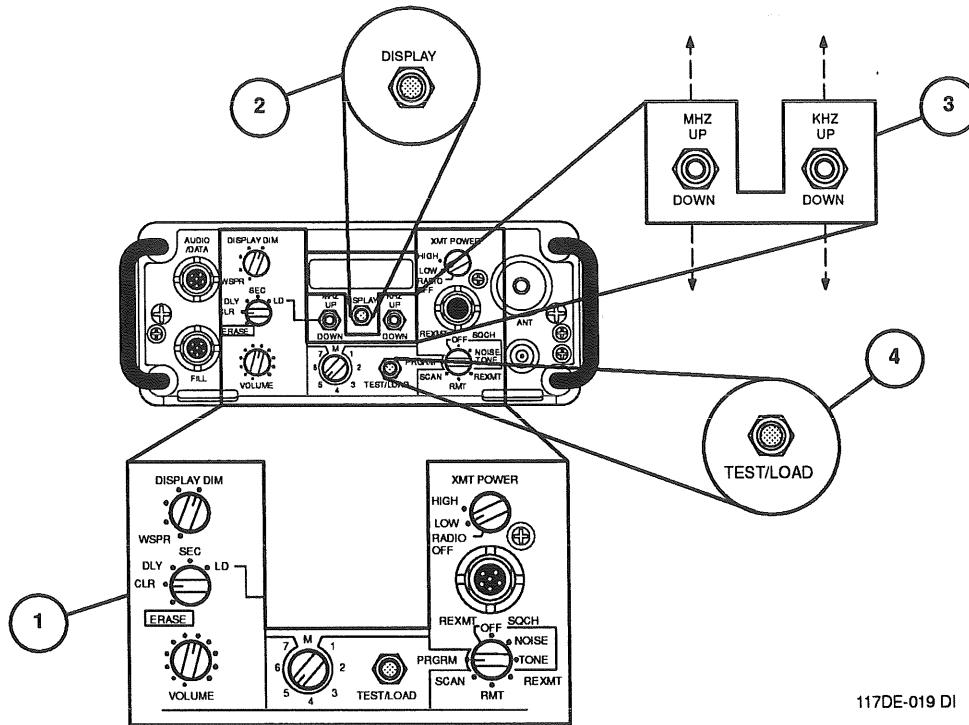
- Identically programmed frequency codes and bandwidths
- Identical jumper positions on the Signal Synchronizer Module A2 (Refer to the A2 Unit Instruction section.)

In addition to these conditions, a compatible SQUELCH setting is recommended (see paragraph 3.5.2.3).

Recheck each of these conditions to coordinate frequency-hopping communication within a radio network.

PROGRAMMING ECCM CHANNELS (NARROW-BAND)

ECCM channels are programmed with a required 6-digit code (steps 1 to 4 for narrow-band). An optional 6-digit code (steps 5 to 9) changes the number of available hopping patterns.



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- ① Make sure channel type is 117B (see para 3.8.2.1) and set these controls:
- XMT POWER – LOW or HIGH
 - CHANNEL – 1–7, M
 - RADIO Mode – PRGRM
 - ENCRYPTION Mode – CLR, DLY, or SEC (Initialize encryption per para. 3.4.1.)

Set DISPLAY DIM and VOLUME as desired.

- ② Push DISPLAY.
- Encryption variable storage location or C (if encryption control is in CLR) and 6-digit ECCM code displays. Display must be lit to change 6-digit ECCM code.

- ③ Select 6-digit ECCM code.
- Toggle the MHZ switch to select the ECCM band and the KHZ switch to determine part of the pseudorandom hopping pattern.

- ④ With 6-digit ECCM code displayed, push TEST/LOAD.

The display goes blank when TEST/LOAD is pressed, reappears when the it is released. Display will stay on for 5 seconds, then goes blank.

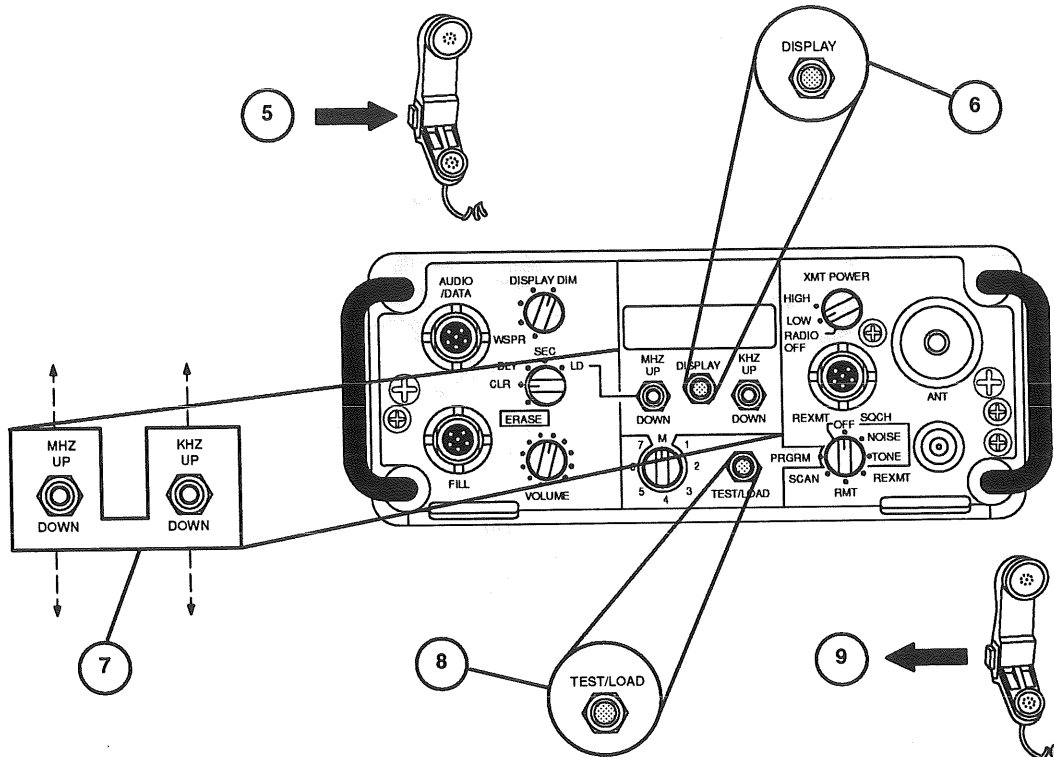
NOTE: The first three digits of the required 6-digit ECCM code determine the default 5 MHz narrow hopping bandwidth.

- Refer to table 3-7 for the 5 MHz default ECCM band for VHF-Lo.
- Refer to table 3-8 for the 5 MHz default ECCM band for VHF-Hi.
- Refer to table 3-9 for the 5 MHz default ECCM band for UHF.

To recheck the 6-digit ECCM code, push DISPLAY. (EXCEPTION: If 60.000 displays, an internal jumper prevents recall of ECCM code.)

Figure 3-20. Programming ECCM Channels with Narrow-Bandwidth Hopping (Sheet 1 of 2)

PROGRAMMING ECCM CHANNELS (NARROW-BAND) (CONT.)



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OPTIONAL 12-DIGIT ECCM HOPPING CODE

Continue with steps 5-9 to enter a second 6-digit ECCM code to extend the hopping code to 12 digits. First enter the required 6-digit ECCM code using steps 1-4 (on previous page). Then install the handset and continue with steps 5 to 9:

- 5 Key the handset. (Keep keyed until step 9.)
- 6 Push DISPLAY.
Current optional ECCM code displays.
- 7 Select the second ECCM code anywhere in the band chosen in step 3. Toggle the MHZ and KHZ switches UP or DOWN.
- 8 With second ECCM code displayed, push TEST/LOAD.

The display blinks when TEST/LOAD is pressed, reappears when it is released. Display will stay on for 5 seconds, then go blank.

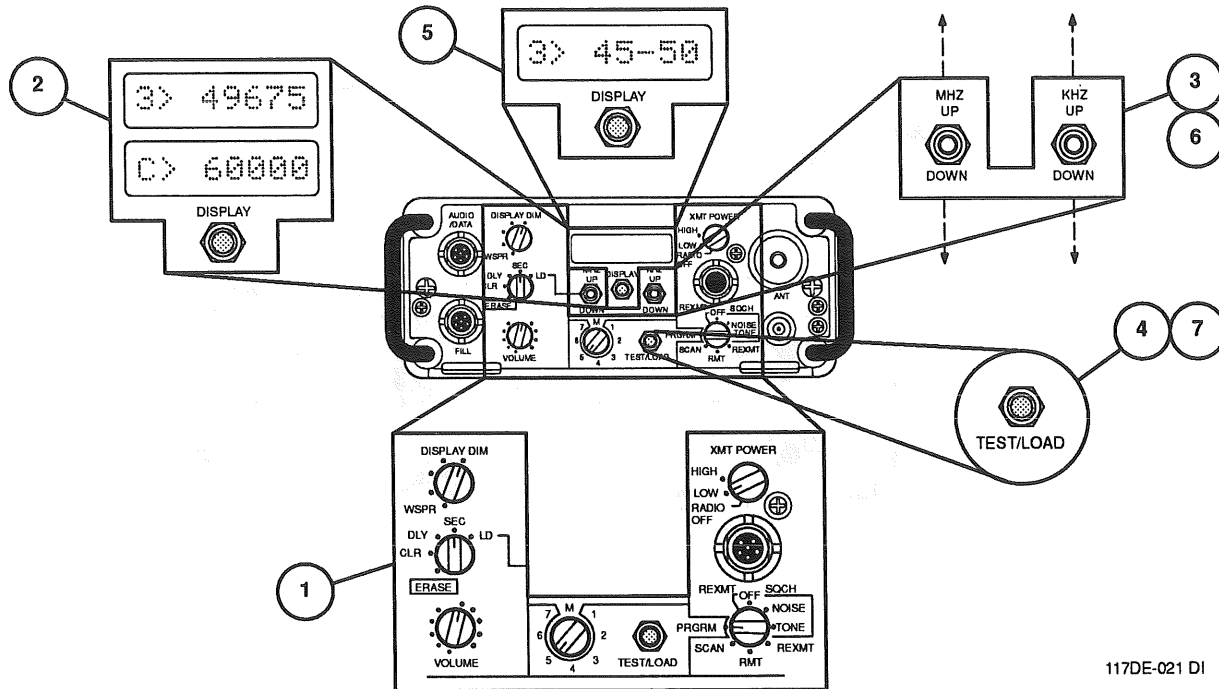
- 9 Release the handset key.
Display blanks automatically after a few seconds.

To recheck the optional ECCM code, key the handset then push DISPLAY.
(EXCEPTION: If 60,000 displays, an internal jumper prevents recall of optional ECCM code.)

Figure 3-20. Programming ECCM Channels with Narrow-Bandwidth Hopping (Sheet 2 of 2)

PROGRAMMING ECCM CHANNELS (WIDE-BAND)

ECCM channels are programmed with a required 6-digit code (steps 1 to 7 for wide-band). An optional 6-digit code (steps 8 to 13) changes the number of available hopping patterns.



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- ① Make sure channel type is 117B (see para 3.8.2.1) and set these controls:
 - XMT POWER – LOW or HIGH
 - CHANNEL – 1-7, M
 - RADIO Mode – PRGRM
 - ENCRYPTION Mode – CLR, DLY, or SEC (Initialize encryption per para. 3.4.1.)

Set DISPLAY DIM and VOLUME as desired.

- ② Push DISPLAY.
Encryption variable storage location or C (if ENCRYPTION control is in CLR) and 6-digit ECCM code displays. Display must be lit to change 6-digit ECCM code.

- ③ Select 6-digit ECCM code.
Toggle the MHZ and KHZ switches UP or DOWN to select the ECCM codes. Bandwidth defaults to 5-MHz narrowband selected by the MHZ digits.

- ④ With 6-digit ECCM code displayed, push TEST/LOAD.

The display goes blank when TEST/LOAD is pressed, reappears when the it is released. Display will stay on for 5 seconds, then goes blank.

- ⑤ To change the bandwidth for wideband hopping, push DISPLAY twice.

Bandwidth displays. Display must be lit to change bandwidth.

- ⑥ Select bandwidth. Toggle the MHZ switch to select the low end of the band. Toggle the KHZ switch to select the high end of the band.

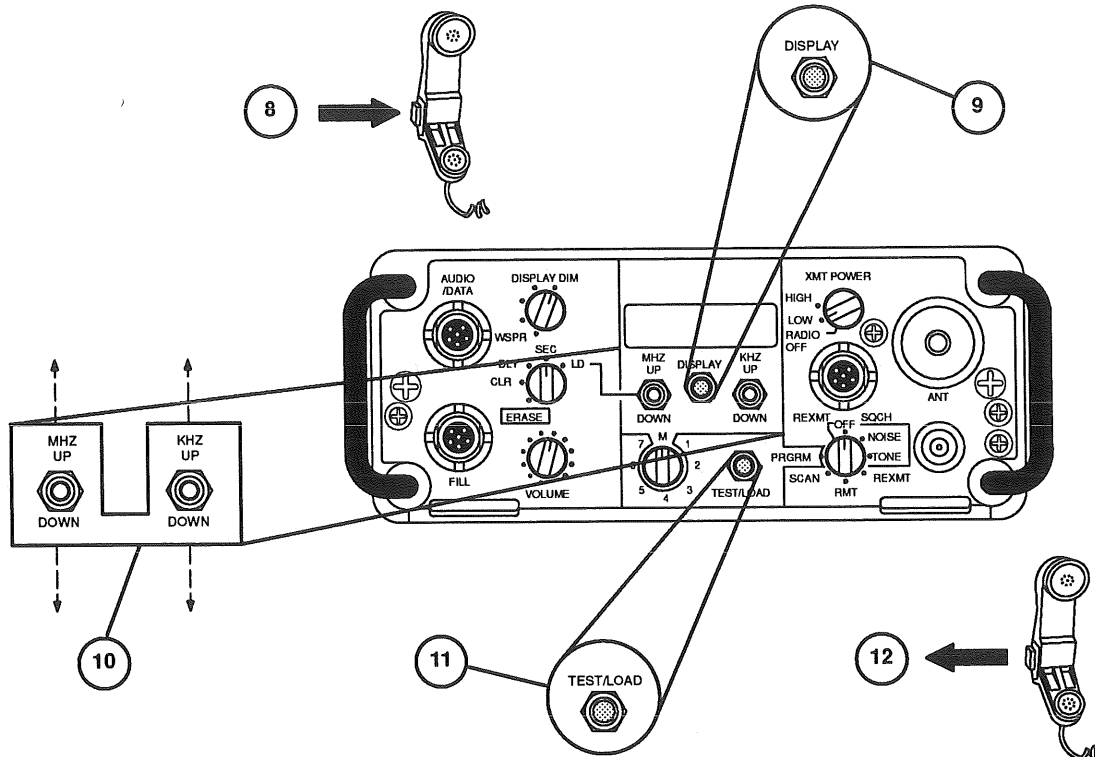
- ⑦ With bandwidth displayed, push TEST/LOAD.

The display blanks when TEST/LOAD is pressed, reappears when it is released. Display will stay on for 5 seconds, then go blank.

To recheck the 6-digit ECCM code, push DISPLAY. To recheck the bandwidth, push DISPLAY again. (EXCEPTION: If 60.000 or 60-65 displays, an internal jumper prevents recall of ECCM code or bandwidth.)

Figure 3-21. Programming ECCM Channels with Wide-Bandwidth Hopping (Sheet 1 of 2)

PROGRAMMING ECCM CHANNELS (WIDE-BAND) (CONT.)



117DE-022A DI

OPTIONAL 12-DIGIT ECCM HOPPING CODE

Continue with steps 8-13 to enter a second 6-digit ECCM code to extend the hopping code to 12-digits. First enter the required 6-digit ECCM code selection using steps 1-7 (on previous page), then install the handset and continue with steps 8 to 13:

- ⑧ Key the handset. (Keep keyed until step 12.)
- ⑨ Push DISPLAY.
Current optional ECCM code displays.
- ⑩ Select the second ECCM code. Toggle the MHZ and KHZ switches UP or DOWN.
- ⑪ With second ECCM code displayed, push TEST/LOAD.
- ⑫ Release the handset key.
Display blanks automatically after a few seconds.
- ⑬ Enter hopping bandwidth, using steps 5 to 7.

The display goes blank when TEST/LOAD is pressed, reappears it is released. Display will stay on for 5 seconds, then blank.

To recheck the optional ECCM code, key the handset then push DISPLAY.
(EXCEPTION: If 60.000 displays, an internal jumper prevents recall of optional ECCM code.)

Figure 3-21. Programming ECCM Channels with Wide-Bandwidth Hopping (Sheet 2 of 2)

3.9.3 Clear-Net Entry (Clear-Text Mode Only)

NOTE

Clear-Net Entry is not a function in secure-text operation.

During ECCM operation in clear-text mode, this automatic scanning sequence responds to an incoming signal from a clear (non-ECCM) call. When the radio is set to an ECCM channel, it automatically monitors a specific clear (non-ECCM) channel. Each ECCM channel has a single corresponding clear FM channel. This channel relationship is shown in table 3-9.

The radio monitors the appropriate clear FM channel when it is not actively transmitting or receiving on its selected ECCM channel.

Table 3-9. ECCM and Monitored Channel Relationship

ECCM Channel	Monitored Channel (Clear Channel)
M	4
1	5
2	6
3	7
4	M
5	1
6	2
7	3

3.9.3.1 Setup for Using Clear-Net Entry

Follow these setup rules below to use the clear-net entry feature:

- a. Select the clear channel frequency so that it is within the hopping band of the corresponding ECCM signal.
- b. The clear channel frequency must be programmed into the preset channel that is 180° from the frequency-hopping channel on the CHANNEL control. Refer to table 3-9.
- c. If the ECCM frequency-hopping bandwidth is within the 30–90 MHz band, the radio performing the clear-net entry must transmit the 150-Hz subcarrier tone required for TONE SQUELCH operation. For all other ECCM hopping bandwidths, only the carrier required for NOISE SQUELCH operation needs to be transmitted.

3.9.3.2 Clear Channel Signal Detected

When the transceiver detects the clear channel signal, it alerts the operator in two ways:

- A beep is heard in the handset once every four seconds. If the operator does not respond to this signal, the beeping stops after three beeps, but the display stays on. Receiving or transmitting ECCM or changing the channel re-enables the handset to beep.
- “Chan #” (where # is channel 0 through 7) displays for the appropriate channel.

To transmit or receive on the clear channel, set the CHANNEL control to the number of the clear channel; otherwise, ECCM operation continues.

3.10 ENCRYPTION CAPABILITY

3.10.1 Selecting Encryption Variable Storage Locations

There are six encryption variable storage locations that can be associated with each channel on the manpack transceiver. These locations are selected by following the procedure shown in figure 3-22.

3.10.2 Loading Encryption Variables from a Fill Device

Encryption variables are loaded into the encryption variable storage locations by attaching a fill device to the FILL connector on the front panel.

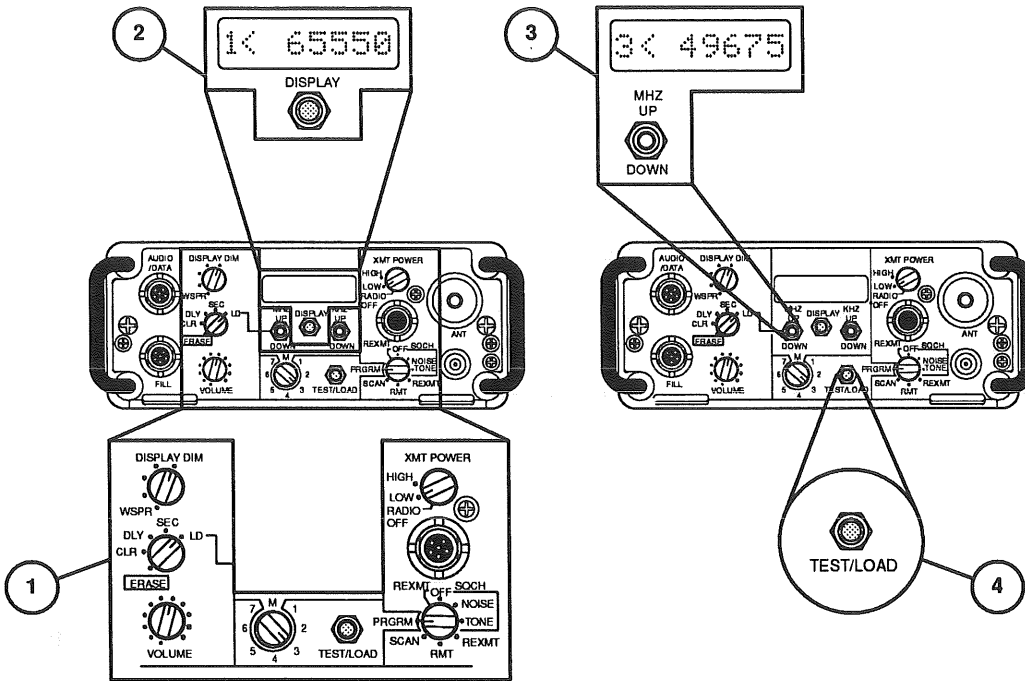
Encryption variables are loaded into the encryption variable storage locations by attaching the RF-5961 Field Code Programmer to the FILL connector on the front panel. Variables are loaded one at a time or all at once.

Figure 3-23 outlines the steps for selecting an encryption variable storage location and preparing the transceiver to receive encryption variables.

If the encryption variable does not load properly, check the loading instructions for the fill device and repeat the loading steps.

To verify fill operation, disconnect the fill device, set the ENCRYPTION mode control to SEC, then communicate with a transceiver that is known to be properly loaded.

SELECTING ENCRYPTION VARIABLE STORAGE LOCATIONS



117DE-023 DI

- ① Set these controls:

 - XMT POWER – LOW or HIGH
 - CHANNEL – as desired
 - RADIO Mode – PRGRM
 - ENCRYPTION Mode – LD (Initialize encryption 3.4.1.)

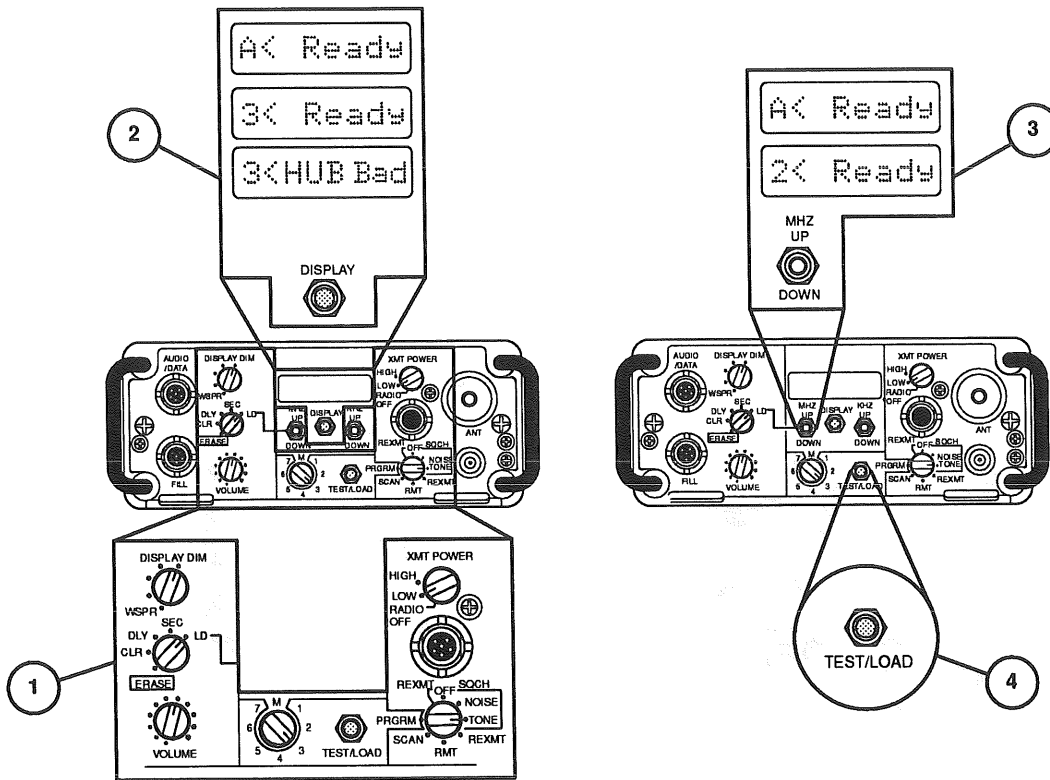
Set DISPLAY DIM and VOLUME as desired.
- ② Push DISPLAY.

Encryption variable storage location and frequency or code displays. Note that the blinking arrow points to the left. Display must be lit to change encryption variable storage location.
- ③ Select encryption variable storage location. Toggle the MHZ switch UP or DOWN.
- ④ With encryption variable storage location (and status) displayed, push TEST/LOAD.

The display blanks when TEST/LOAD is pressed, reappears when it is released. Display will stay on for 5 seconds, then go blank.

Figure 3-22. Selecting Encryption Variable Storage Locations

LOADING ENCRYPTION VARIABLE FROM FILL DEVICE



117DE-024 DI

- 1 Set these controls:
 - XMT POWER – LOW or HIGH
 - CHANNEL – as desired
 - RADIO Mode – OFF, NOISE, TONE, REXMT
 - ENCRYPTION Mode – LD
(Initialize encryption per para. 3.4.1.)
- 2 Set DISPLAY DIM and VOLUME as desired.
Push DISPLAY.
The current encryption variable storage location or "A" (ALL) displays with the blinking arrow pointing to it. The display also indicates if the radio is ready to be loaded. A HUB status display appears as a warning if a HUB problem exists. If "A" displays to the left of the blinking arrow, all six variable locations are loaded from the fill device at the same time. If a number displays, only that variable location is loaded by the fill device.

NOTE

A variable may be loaded if a HUB problem exists, however, variables are not saved when the radio is turned off. "HUB Bad" display indicates that the HUB is low or missing and loaded variables will be lost if radio power is lost.

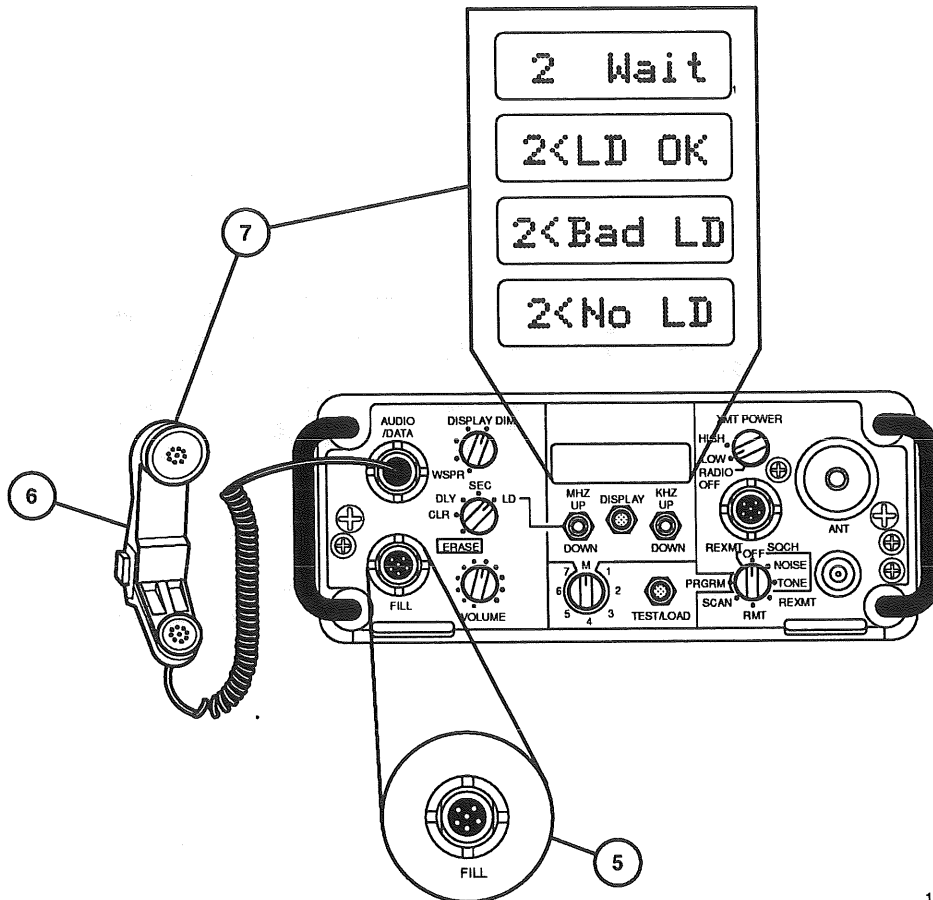
- 3 To select another encryption variable storage location or "A", toggle the MHZ switch UP or DOWN. The display must be lit to change the encryption variable storage location.

With encryption variable storage location or "A" displayed, push TEST/LOAD.

- 4 The display blanks when TEST/LOAD is pressed, reappears when it is released. Display will stay on for 10 seconds, then go blank.

Figure 3-23. Loading Encryption Variable from Fill Device (Sheet 1 of 2)

LOADING ENCRYPTION VARIABLE FROM FILL DEVICE (CONT.)



117DE-025 DI

- 5 Attach the RF-5961 fill device to the FILL connector on the front panel.
- 6 Attach handset to the AUDIO/DATA connector.
- 7 Key the handset and release.
- 7 The display will indicate "Wait" while the transfer is taking place, then "LD OK" if the fill is successful. A beep is also heard in the handset to indicate successful transfer.

NOTE

If the variable has not been properly loaded, "Bad LD" is displayed and a continuous tone is heard. If there is no response from the fill device, "No LD" is displayed. Repeat above steps. If variable still does not load properly, try a new fill device.

- 8 Repeat steps 2 through 7 to load other variables. If "A" was used, all variables (1-6) are loaded at the same time and no further loading is necessary.

Figure 3-23. Loading Encryption Variable from Fill Device (Sheet 2 of 2)

3.10.3 ENCRYPTION Zeroize (ERASE)

The ENCRYPTION zeroize feature allows the operator to erase the stored encryption variables from the transceiver.

With the XMT POWER turned on, rotating the ENCRYPTION mode control to the ERASE position zeroizes (deletes) the encryption variable storage locations 1 through 6. This action deletes all encryption variables from the manpack transceiver. No secure communication can be performed with this unit until new encryption variables are loaded (see paragraph 3.10.2).

NOTE

With the XMT POWER turned off (RADIO OFF) all encryption variables can be deleted by rotating the ENCRYPTION control mode to the ERASE position and leaving it there for at least 45 seconds.

To store the radio with no valid encryption keys (keys erased), leave the ENCRYPTION mode control in the ERASE position.

NOTE

The display does not light when XMT POWER is turned off (RADIO OFF).

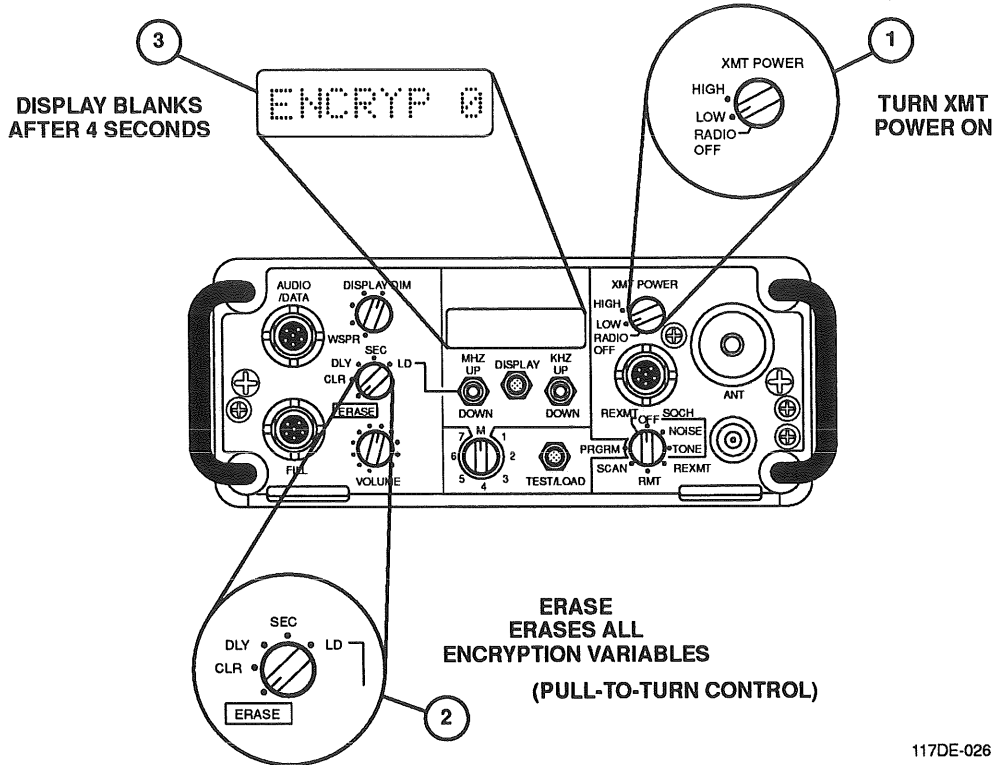
The ERASE position on the ENCRYPTION mode control is entered by a pull-to-turn action in order to prevent accidental zeroizing of the encryption variables.

CAUTION

The ENCRYPTION zeroize feature erases stored variables and should only be used as appropriate.

Figure 3-24 illustrates the ENCRYPTION zeroize feature.

ENCRYPTION ZEROIZE



NOTE

Rotating the ENCRYPTION Mode Control to the ERASE position zeroizes ALL encryption variables from the manpack transceiver. NO secure communication can be performed with this unit.

- 1** Turn XMT POWER from RADIO OFF to LOW or HIGH.
- 2** To delete ALL of the stored variables, switch the ENCRYPTION mode control to ERASE (pull-to-turn action).

- 3** NOTE: With the XMT POWER turned to OFF, ERASE deletes ALL stored variables.
- "ENCRYP 0" is displayed. The LED display blanks after four seconds.

Figure 3-24. Using ENCRYPTION Zeroize

3.10.4 Stand-Alone Encryption (SAE) Operation

The Stand-Alone Encryption (SAE) feature allows an operator to use the manpack transceiver as an encryption device to encrypt/decrypt information for transmission/reception for a radio that has no encryption device. During SAE mode, only the front panel of the manpack transceiver is functioning; the receiver and transmitter are disabled. A special cable (optional) is required to enable SAE operations. The design of the cable varies according to the radio.

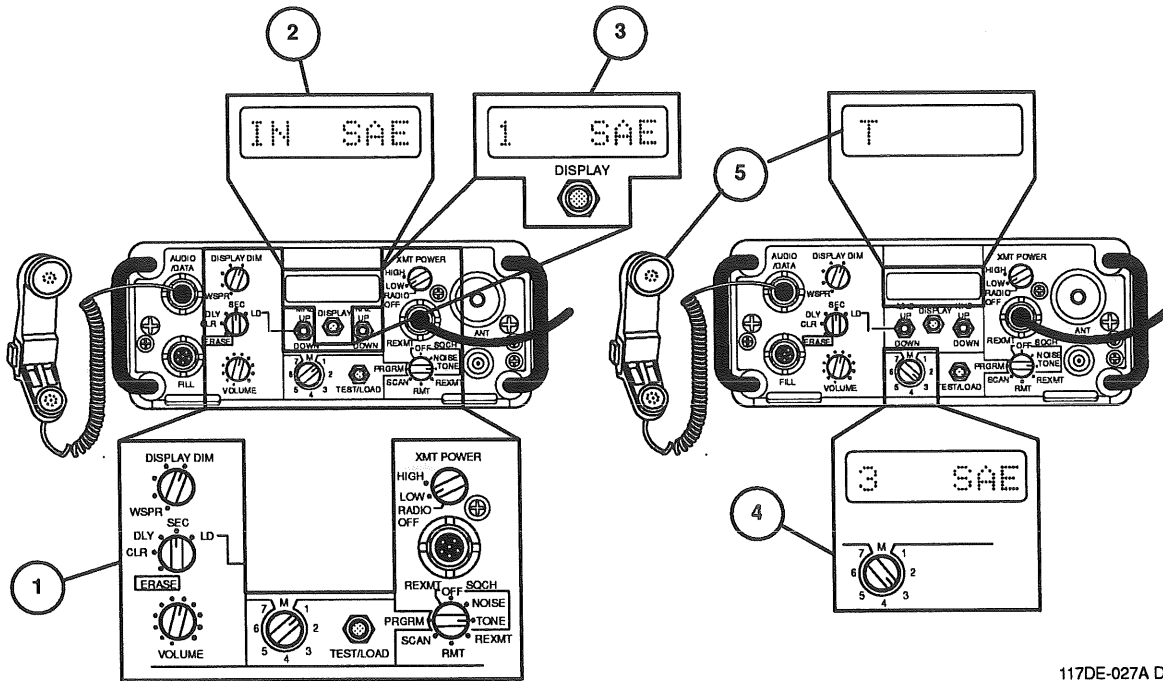
To operate in SAE with another radio, the Stand-Alone Encryption cable is attached to the REXMT connector of the manpack transceiver and to the appropriate connector on the other radio. Figure 3-25 describes SAE operation.

The procedure to change the encryption variable storage location is the same as shown in figure 3-22. The RADIO mode control is placed in PRGRM and the ENCRYPTION mode control is placed in LD. The default value of the encryption variable storage location is changed by using the MHZ switch, then pressing TEST/LOAD. The default value is the channel number, as selected by the CHANNEL control, with channels M and 7 being assigned variable 1.

To change encryption variable storage locations in SAE, the optional SAE cable must be attached to the REXMT connector on the manpack transceiver front panel. When this is done, the LED display indicates that the radio is in SAE:

1 < S A E

STAND ALONE ENCRYPTION OPERATION



117DE-027A DI

- 1 Set these controls:
 - XMT POWER – LOW or HIGH
 - CHANNEL – as desired
 - RADIO Mode – OFF, NOISE, TONE, REXMT
 - ENCRYPTION Mode Control – DLY or SEC (Initialize encryption per para. 3.4.1.)

Set DISPLAY DIM and VOLUME as desired.
- 2 Attach the optional SAE cable to the REXMT connector. The LED display shows that the unit is in Stand-Alone Encryption (IN SAE) operation.

NOTE: If the cable is already attached when the unit is powered up, the "IN SAE" message displays after the normal power up sequence.
- 3 Push DISPLAY.

Encryption variable storage location in use displays.

- 4 Use the CHANNEL control to select encryption variable storage location or see figure 3-26. The encryption variable storage location matches the CHANNEL control number for channels 1–6. Channels M and 7 are assigned encryption variable storage location 1.
- 5 Key the handset.

The SAE transmit indicator (T) is displayed for 5 seconds or until the PTT pushbutton is released.

NOTE 1: If the ENCRYPTION mode control is in CLR or switched to CLR from another mode and the display button is pressed, the display indicates an "Invalid" operation.

NOTE 2: When Stand Alone Encryption (SAE) is used in the frequency-hopping mode of operation, the SAE unit must be in DLY mode.

Figure 3-25. Stand Alone Encryption Operation

3.11 DATA CAPABILITY

The manpack transceiver can be used with data devices that meet MIL-STD-188-114A specifications, such as the RF-3490 Digital Data Buffer/Processor. Operating procedures depend on the data device that is used, but the following information explains the steps for preparing the transceiver to operate in data clear-text and secure-text modes.

3.11.1 Clear-Text Data Operation

For clear-text data operation, set the following controls:

- CHANNEL – any channel
- RADIO Mode – OFF, NOISE, TONE
- ENCRYPTION Mode – CLR

Attach the data device to the front panel AUDIO/DATA connector; the digital data mode control pin E must be grounded. The data is asynchronous; no transmit or receive clock is provided.

If the radio is on, the LED display shows that the clear-text mode has been entered:

*** CLEAR! ***

NOTE

To use the AN/PRC-117D(E) in clear-text mode other than 16 kbps in ECCM or REXMT, an external squelch signal (ground applied) must be applied to the DATA IN/ANALOG DATA MODE/EXTERNAL SQUELCH pin F of the AUDIO/DATA connector.

3.11.2 Secure-Text Data Operation

For secure-text data operation, set the following controls:

- CHANNEL – any channel
- RADIO Mode – OFF, NOISE, TONE
- ENCRYPTION Mode – DLY or SEC

Attach the data device to the front panel AUDIO/DATA connector. Data must be 16 kbps for proper operation. A clock is supplied on the data clock out pin when transmitting or receiving valid secure data. The digital data mode control pin E must be grounded.

Analog data can be used by attaching the appropriate device and grounding the analog data mode control pin. Analog data mode is asynchronous and does not supply a clock.

3.12 SCAN CAPABILITIES

The AN/PRC-117D(E) is capable of scanning all available bands (VHF-Lo, VHF-Hi, and UHF) either individually or simultaneously. This requires that an antenna configuration consists of the following:

- Either the VHF-Lo blade or whip antenna must be installed in the ANT connector; and
- The VHF-Hi/UHF antenna must be installed in the 50 ohm antenna connector.

For SCAN operation, set the following controls:

- XMT POWER – LOW or HIGH
- CHANNEL – any channel (keying is enabled on selected channel)
- RADIO Mode – SCAN
- ENCRYPTION Mode – CLR or DLY

Set DISPLAY DIM and VOLUME, as desired.

Figure 3-26 shows the function of the display during SCAN. As the radio scans, it blinks the decimal point of the LED display.

If a clear-text signal is received when the ENCRYPTION mode control is set for CLR or DLY, a C and the channel number display. If a secure-text signal is received and the ENCRYPTION mode control is set for DLY, an S and the channel number display. A secure signal cannot be received if the ENCRYPTION mode control is set for CLR. (Note that the MANUAL channel frequency displays as “Chan 0.”)

NOTE

For best performance in SCAN mode, the transmitting radio should be in DLY during secure operation.

The transceiver locks in the channel, allowing the operator to hear the received signal. The radio continues to lock in a channel as long as the signal is being received. The display goes blank after five seconds. When contact is broken, the transceiver continues to scan, beginning with the next channel in sequence.

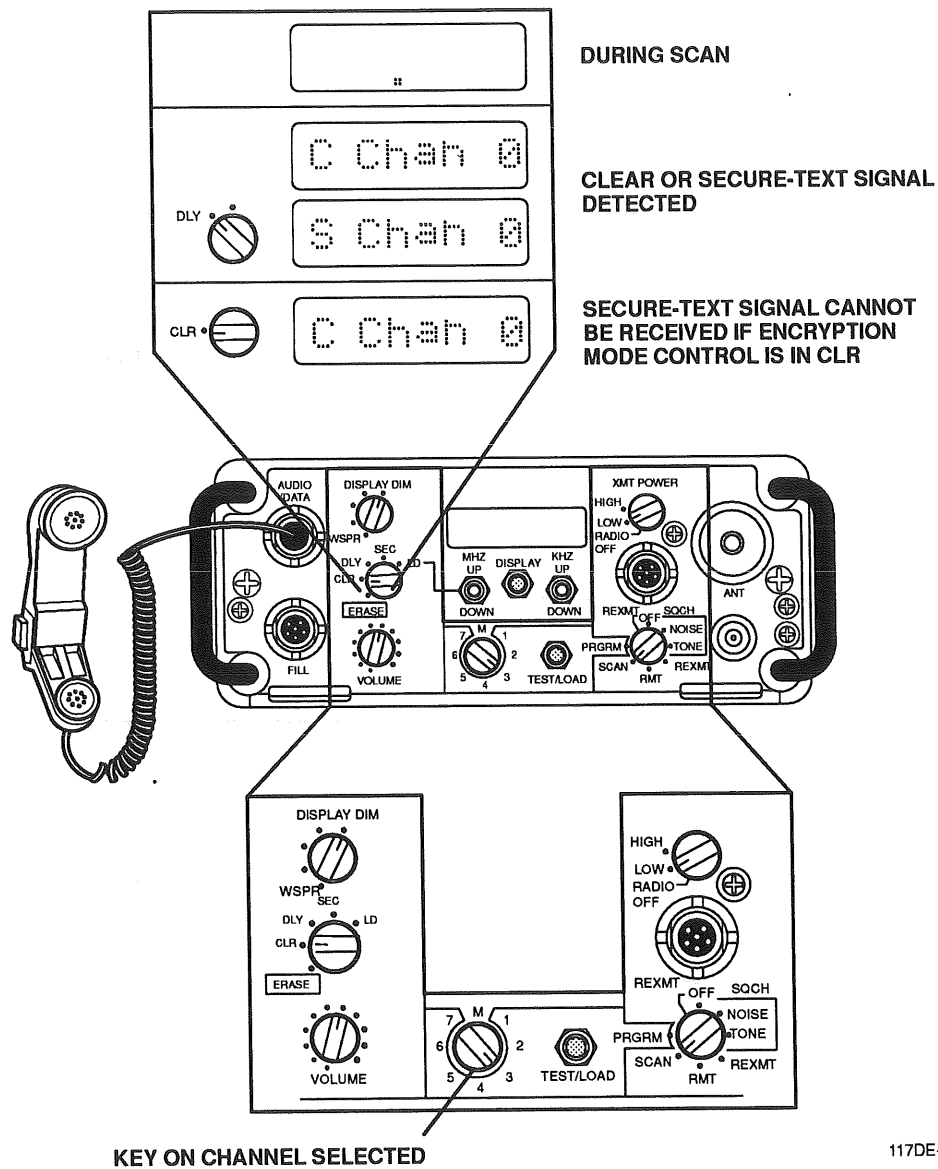
The radio scans at a rate of approximately ten channels per second. When scanning fewer than eight channels, it may be advantageous to load the same frequencies more than once, using otherwise unused channels to shorten scan response time.

3.12.1 Transmitting in SCAN Mode

The radio normally transmits on the channel selected on the front panel. Keying up within three seconds after receiving a scan call initiates the Answer-Back scan feature. This allows transmission in the SCAN mode on the channel that just received the scan call, regardless of where the CHANNEL control is set. By keying up, the radio is automatically changed to the channel on which the call was received, and the antenna is automatically tuned for transmission on this channel. Keying or unkeying the radio causes the LED display to indicate the channel being used for transmission. The transmission of clear or secure information is dependent on the ENCRYPTION mode control. For example, to answer a clear-text signal, the ENCRYPTION mode control must be in CLR.

The radio may or may not be set up to transmit the 150-Hz subcarrier tone for TONE SQUELCH when in SCAN mode (only applies to VHF-Lo channels). An internal jumper selection on Power Supply Module A4 determines whether or not the 150-Hz tone is transmitted in SCAN mode.

When using the SCAN mode, remember that the radio continues scanning in this mode when not transmitting.
(The radio could lock in a channel different from the one in use, temporarily preventing reception in this mode.)



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Figure 3-26. SCAN Setup and Display

3.12.2 Scanning ECCM Channels

ECCM operation is not compatible with SCAN mode operation because of the unique characteristics of the frequency-hopping signal.

NOTE

The radio cannot detect ECCM transmission while in SCAN mode, and the radio does not transmit with a frequency-hopping signal when keyed in SCAN mode.

In SCAN mode, the radio treats ECCM channels the same as other radio channels; it scans for a signal at the frequency entered in any of these channels. It transmits when keyed, but this transmission is standard single channel transmission, not ECCM frequency-hopping transmission.

3.13 RETRANSMIT OPERATION

A retransmission or repeater station receives a signal transmitted at one frequency and retransmits it at another frequency, enabling communication over a greater range possible than using individual radios. A retransmission or repeater station for extending communication range can be set up using two AN/PRC-117D(E) Transceivers.

3.13.1 Setup

The following two types of radio operation are available using the setup described here:

- Simplex operation, commonly termed retransmission
- Half-duplex operation, commonly termed repeater operation

Both types of operation use the same equipment and setup. The basic difference between retransmission and repeater operation is how the retransmission/repeater station is used by other radios.

Figure 3-27 shows simplex operation. The station uses one frequency (F1) to communicate with one group of radios, both to receive and to transmit. It uses a second frequency (F2) to communicate with a second group of radios, both receiving and transmitting on this other frequency. The retransmission operation can be summarized as follows:

- Signals received on F1 are retransmitted on F2
- Signals received on F2 are retransmitted on F1

Other radios using the retransmission station for simplex operation use simplex channels; the same frequency serves for both transmitting and receiving. Use simplex operation when using ECCM channels through a repeater.

Figure 3-28 shows half-duplex operation. The repeater only receives on a single frequency (F1), and only transmits on a single frequency (F2). With this setup, all radios use the repeater transmit on F1 and receive on F2. Using this arrangement, all units communicate with each other through the repeater.

Radios using the repeater for half-duplex operation use half-duplex channels. All transmitting is on one frequency (F1); all receiving is on another frequency (F2).

3.13.2 Hardware for Retransmission/Repeater Setup

Equipment setup is the same for both simplex and half-duplex operation as follows:

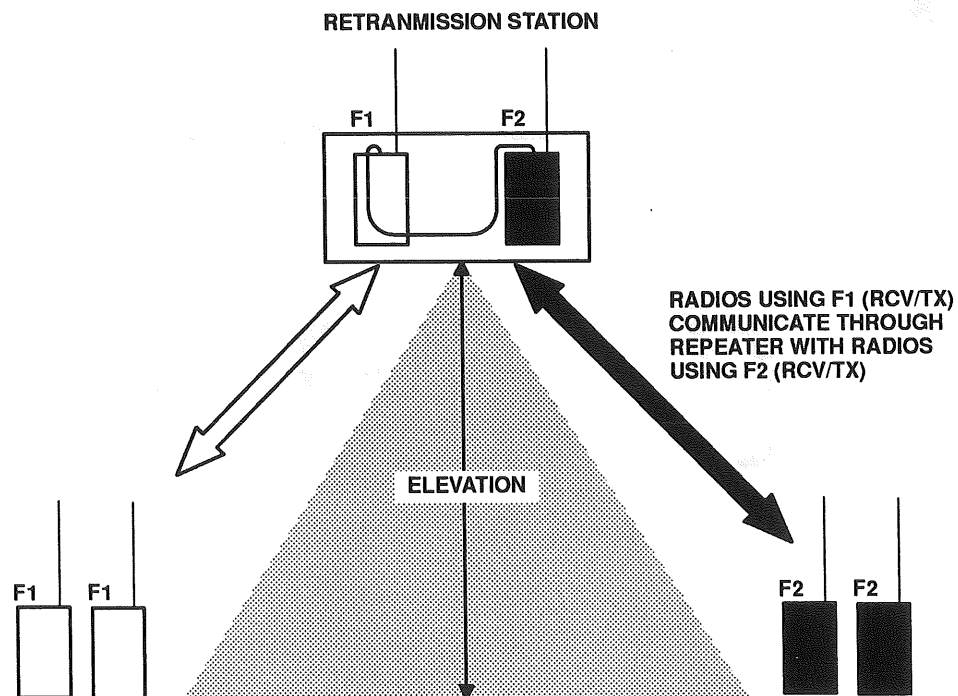
- Two AN/PRC-117D(E) Manpack Transceivers (with antenna and battery pack)
- One REXMT cable

Figures 3-29 and 3-30 show the standard retransmission/repeater control settings and hardware configuration. For optimum signal transmission, the repeater site should be elevated above the level of radios that communicate through the repeater. The REXMT cable connects at the REXMT connector on each radio. Where possible, separate the radio units by the full length of the REXMT cable. This helps to prevent receiver desensitization and RF interference between units.

The repeater normally is configured to retransmit in TONE SQUELCH mode when in the VHF-Lo band. (A jumper on the Power Supply Module A4 can be removed to change to NOISE SQUELCH during retransmission. See the A4 Unit Instruction section.)

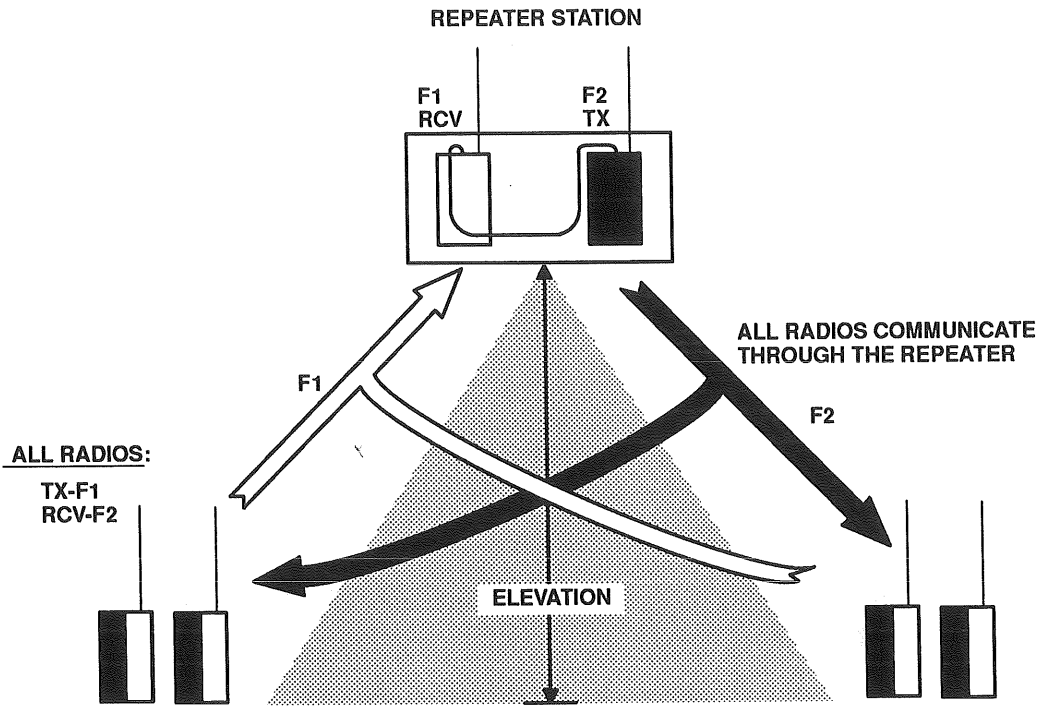
NOTE

With frequency-hopping ECCM retransmission, all radios using the repeater must be set to TONE SQUELCH mode.



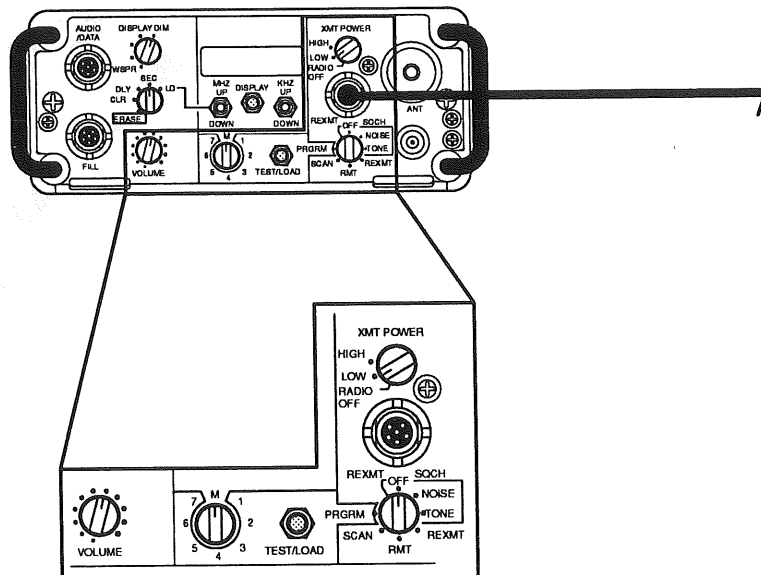
117D-030A DI

Figure 3-27. Simplex (Retransmission) Operation



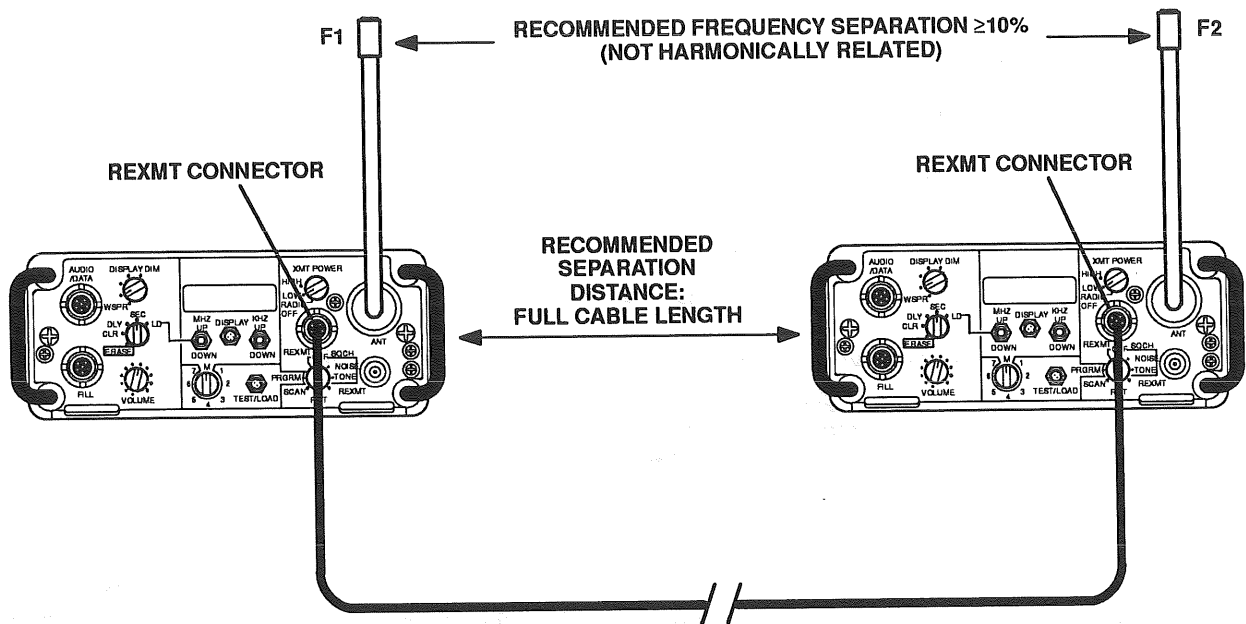
117D-031A DI

Figure 3-28. Half-Duplex (Repeater) Operation



117DE-032A DI

Figure 3-29. Retransmission/Repeater Control Settings



117DE-033A DI

Figure 3-30. Retransmission/Repeater Hardware Setup

3.13.2.1 Internal Jumpers for Repeater Operation

The E5-E10 jumper on the Power Supply Module A4 affects radio operation in REXMT mode. Jumper E5-E10 determines radio squelch response and operation for normal clear-text audio transmission. Refer to the A4 Unit Instruction section for a description of the function of this jumper.

3.13.3 Retransmit Operation

Set the following front panel controls at both R/T Assemblies used in setting up the retransmission/repeater station:

- XMT POWER – LOW or HIGH
- CHANNEL – Select desired channel.
- RADIO Mode – REXMT
- ENCRYPTION Mode – CLR, DLY, or SEC

Set DISPLAY DIM and VOLUME, as desired.

NOTE

The XMT POWER setting determines the operating life of the retransmission/repeater. Low battery voltage levels at a retransmission/repeater station can be detected at other radios using the station. A transmitted beeping tone or sudden signal loss may indicate the need for replacement at the retransmission/repeater site.

Select channel, whether simplex or half-duplex communication is intended. Remember, the other radios that communicate through the retransmission/repeater station determine whether the overall configuration is simplex or half-duplex. When in secure operation, the radios using the retransmission/repeater station should be in DLY mode for best results.

Attach the REXMT cable to the REXMT connector.

If the ENCRYPTION mode control is in CLR, only clear-text information is retransmitted. When the ENCRYPTION mode control is in SEC or DLY, both clear-text and secure-text information is retransmitted.

A handset can be attached to the receiving radio to monitor the incoming signals. Any clear-text traffic being received can be monitored at the handset. When in a secure mode (SEC or DLY), the correct encryption variable must be selected for that channel in order to monitor secure traffic.

With the handset attached, keying the handset causes either clear or secure information to be transmitted (depending on the position of the ENCRYPTION mode control) on the radio originating the transmission (not through the REXMT cable).

For data (secure or clear text) retransmit operation, set the ENCRYPTION mode control to SEC or DLY and all other controls as above. A data device or other device must be connected to the AUDIO/DATA connector grounding the DIGITAL DATA MODE control pin in order to be in DATA mode. All data going through the retransmission/repeater site must be 16 kbps in secure mode. In clear-text mode, the data rate should be 16 kbps. Other data rates are available in clear-text data mode, but external circuitry is required to key the transmitting radio if 16 kbps data is not used. This data is monitored at the receiving radio if a MIL-STD-188-114A data device is attached to the AUDIO/DATA connector.

To monitor, attach a data device to the front panel AUDIO/DATA connector, grounding the DIGITAL DATA MODE control pin to place the radio in DATA mode. A clock is present on the DATA CLOCK OUT pin when 16 kbps data is sensed. In order to monitor data in a secure mode, the correct encryption variable must be selected for that channel.

Note that the transceivers being used in the retransmission/repeater site do not have to have encryption variables loaded for proper operation, however, in order to monitor transmissions, the correct variable must be loaded. A summary of retransmit operations is shown in table 3-10.

Table 3-10. Retransmit Operations Summary

Mode	ENCRYPTION Control	DDMC Pin	Comments
Encrypted Audio	SEC or DLY	Open	DDMC must be GND to monitor. 16 kbps data only
Clear Audio	CLR, SEC, or DLY	Open	
Encrypted Data	SEC or DLY	GND or Open	
Clear Data (16 kbps)	CLR, SEC, or DLY	GND	
Clear Data (non 16 kbps)	CLR	GND	
			Need external circuitry to key transmitting radio.

3.13.4 Frequency Separation

Set each transceiver to a simplex or ECCM channel:

- F1 and F2 must not be within 10% of each other.
- F1 and F2 must not be harmonics of each other.
- When using ECCM operations, separate hopping bands by at least one 5-MHz band.
- F1 and F2 should not be image-related. (F1 and F2 frequencies should not differ by exactly 21.8 MHz.)



SECTION 4

THEORY OF OPERATION

4.1 INTRODUCTION

The R/T Assembly is made up of eight removable modules and a front panel assembly. This design allows troubleshooting by module replacement, enabling quick repair and return to service of a faulted radio. This section describe the theory of operation of the radio modules.

4.2 SIGNAL PATHS

Figures 4-1 and 4-2 summarize the receive and transmit operation of the transceiver during clear-text mode. A brief comparison of these figures shows the importance of Microprocessor Module A3. This assembly controls and monitors most functions of the other R/T Assembly modules, thus controlling the radio.

Two of the modules use the same circuitry for both transmit and receive paths. The Frequency Synthesizer Module A7 controls VCO (Voltage Controlled Oscillator) frequencies in both receive and transmit signal paths. Audio Module A5 handles audio/data signals in both receive and transmit directions.

Other modules perform different functions on the transmit and receive paths. Antenna Tuner/Filter Module A1 uses important circuitry to control the transmit signal, but also performs the whip impedance matching and routing of the receive signal. The Antenna Tuner/Filter Module A1 contains low pass filters which are used in both transmit and receive.

The circuitry on these and other modules is switched into or out of the signal path as needed, all controlled by Microprocessor Module A3.

4.2.1 Receive Signal Path

The receive signal path, shown in figure 4-1, begins at one of two antenna ports available on the front panel. The Antenna Tuner/Filter Module A1 provides whip antenna impedance matching and receive signal routing for the selected receive frequency, and low pass filters to reject some of the unwanted interfering signal sources.

The Receiver Module A8 bandpass filters the RF signal through digitally tuned preselectors. The RF signal is then amplified by the noise amplifiers before being converted to the first IF of 109 MHz. The signal passes through a 109 MHz crystal filter and is then converted to a second IF of 10.7 MHz. From here, the signal is filtered by a wide or narrow crystal filter, depending on the operating mode. Then, the signal is routed to either the AM or FM demodulators. The resulting audio/data is then delivered to the Audio Module A5 for further baseband processing.

Synthesizer Module A7 contains four VCOs to cover all the bands used on the AN/PRC-117D(E). The VCO outputs go into a combiner through the mute circuitry, then to Receive Module A8 as the first LO.

Audio Module A5 filters and amplifies the audio/data signal and detects the necessary squelch conditions. The Front Panel Assembly A10 provides audio power amplifier circuitry for the audio/data signal to give sufficient amplification to drive the handset earpiece.

The following receive path functions are controlled by Microprocessor Module A3:

- Filter and antenna port selection on Antenna Tuner/Filter Module A1
- Audio power amplifier gain (retransmission only) on Power Supply Module A4
- First Receive LO frequency setup on the Synthesizer Module A7
- Preselector, IF filter, and detector or demodulator selection on Receiver Module A8
- Filter, audio path, squelch circuitry, and amplifier selection on Audio Module A5

Signal Synchronizer Module A2 coordinates frequency-hopping ECCM reception with Microprocessor Module A3.

4.2.1.1 Receive Path – SCAN Mode

In SCAN mode, the radio scans sequentially through the receive frequencies on each of its eight channels at a period of approximately 0.1 second per channel. When sufficient signal strength is available to break squelch on a receive channel, the receiver circuitry stops scanning and stays on the active channel as long as it receives this signal. After contact is broken, the radio continues scanning, beginning with the next channel.

4.2.1.2 SQUELCH Detection

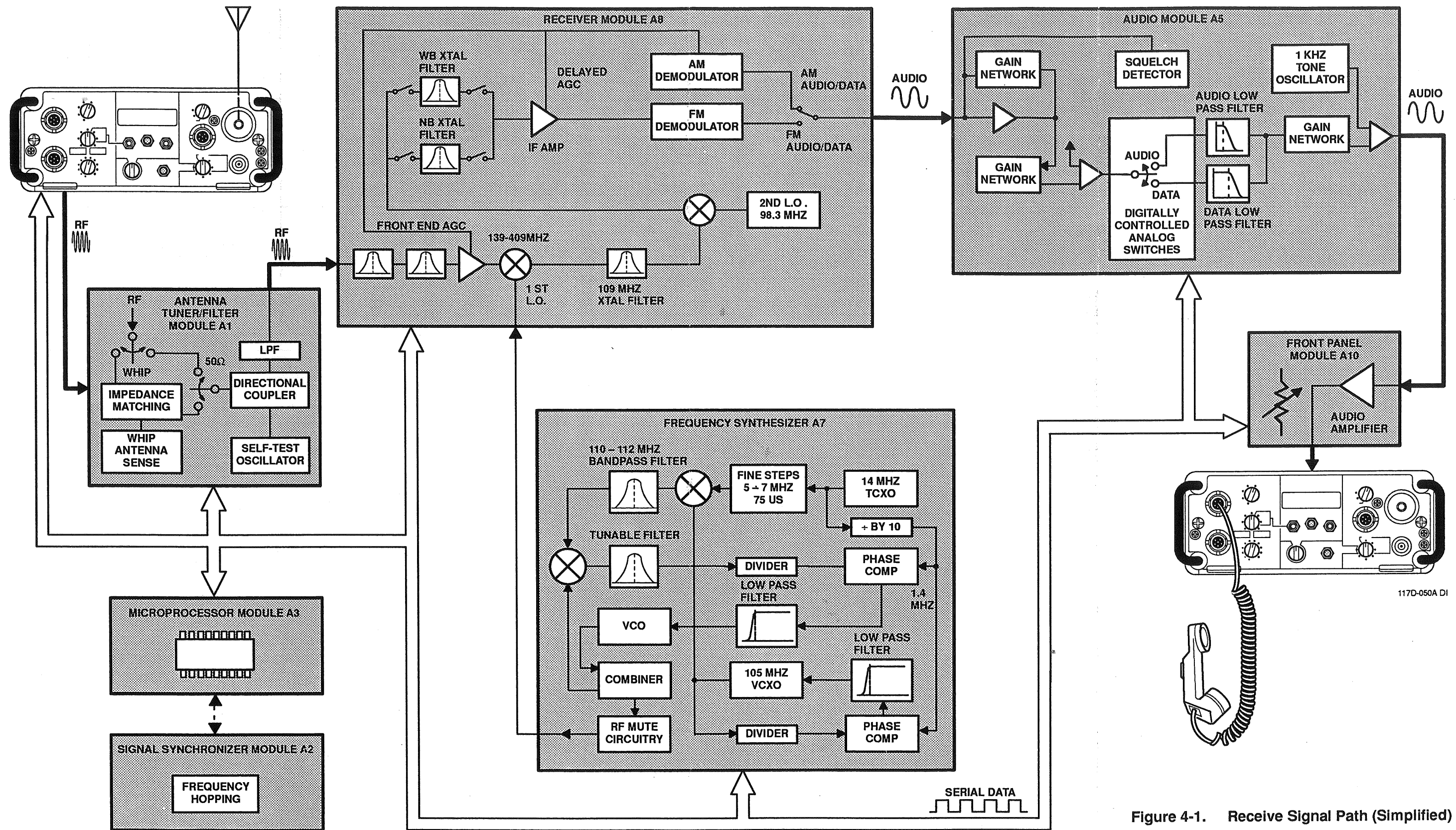
In clear-text mode, SQUELCH detection circuitry on Audio Module A5 determines whether or not to enable audio output. In FM mode the squelch type is determined by the R/T Assembly front panel RADIO mode control. In clear-text FM, the selectable SQUELCH responses are:

- OFF – No squelch.
- NOISE – The receiver is squelched until there is sufficient carrier signal strength.
- TONE – The receiver, in low band VHF, is squelched until there is both sufficient carrier strength and the received signal has an added 150-Hz subcarrier tone.

In AM mode SQUELCH detection circuitry on the Receiver Module A8 determines whether or not to enable audio output. In clear-text AM, the selectable SQUELCH responses are:

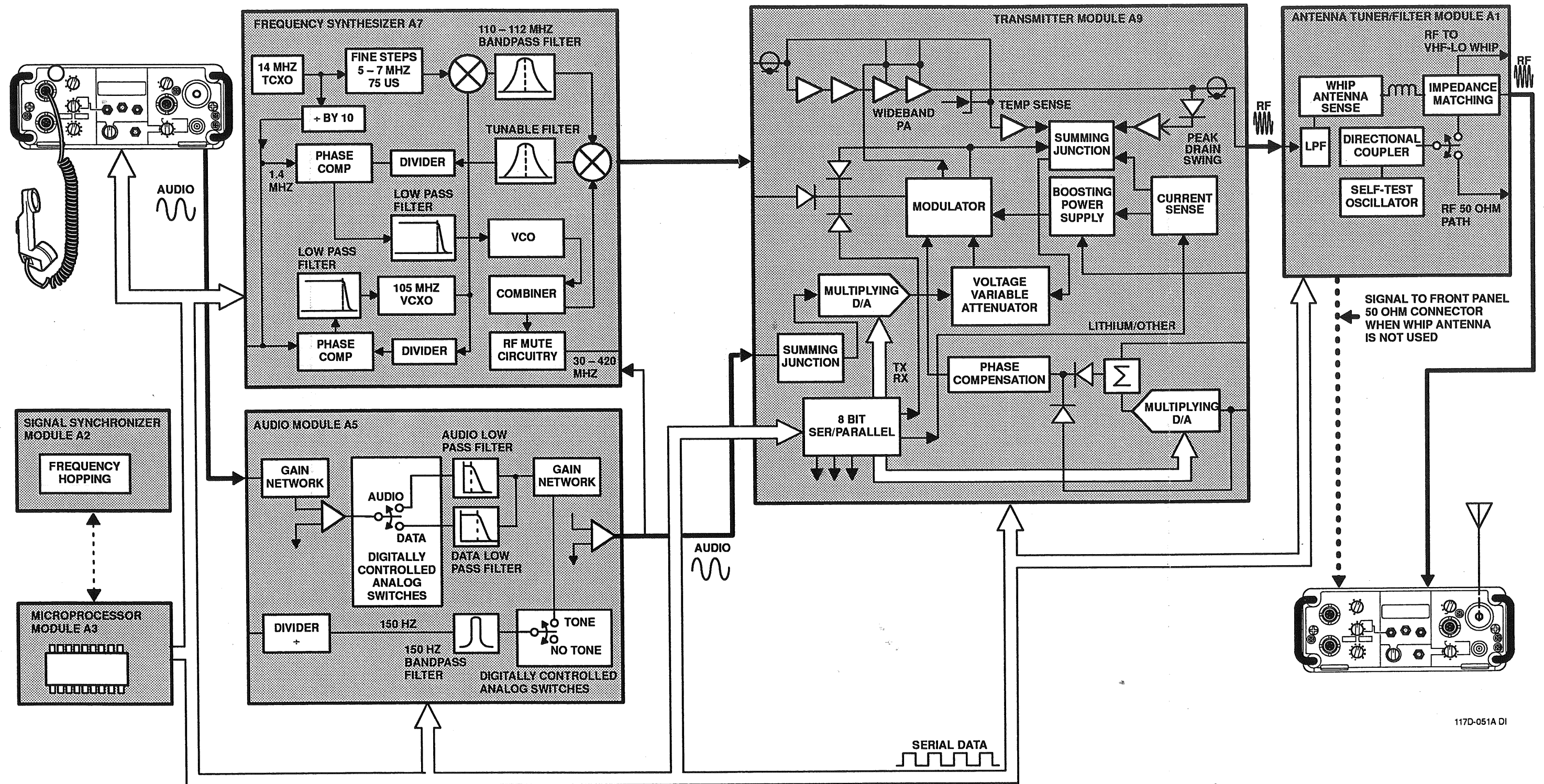
- OFF – No squelch.
- NOISE (AM SQL LO) – The receiver is squelched until there is sufficient carrier signal strength (at the 4 dB SINAD level).
- NOISE (AM SQL HI) – The receiver is squelched until there is sufficient carrier signal strength (at the 15 dB SINAD level).

In secure-text mode, SQUELCH response is determined by the encryption circuit. For secure-text non-ECCM operation, the radio is automatically set in TONE squelch. For secure-text ECCM operation, the radio operates exactly as it does for clear-text ECCM operation so that both TONE squelch and NOISE squelch ECCM transmission are possible. Section 3 contains a description of squelch operation.



117D-050A DI

Figure 4-1. Receive Signal Path (Simplified)



117D-051A DI

Figure 4-2. Transmit Signal Path (Simplified)

4.2.2 Transmit Signal Path

Keying the radio activates the transmit signal path, shown in figure 4-2. The input audio/data signal originates at the Front Panel Assembly A10, then goes on to Audio Module A5, where the signal is filtered and amplified. A 150-Hz subcarrier tone is added at the audio module in low band VHF if TONE SQUELCH is selected on the front panel or the jumper from E3 to E8 is installed on the Power Supply Module A4.

In general, Transmitter Module A9 provides modulation function in AM mode, Synthesizer Module A7 provides modulation function in FM mode.

In AM mode the modulating audio/data signal goes on to Transmitter Module A9 through a summing junction, digital-to-analog converter, and a variable voltage attenuator. The signal then goes through a modulator before being applied to the wideband PA. The modulator senses the various VSWR, temperature, battery, and PA current conditions to control the amount of modulated audio going to the PA.

Synthesizer Module A7 contains four VCOs to cover all the bands used on the AN/PRC-117D(E). The VCO outputs go into a combiner, through the mute circuitry, then on to Transmitter Module A9 via Modem Module A6.

The synthesizer frequency goes to the Transmitter Module A9 where it is directed to the wideband PA. In AM, the signal is modulated by the audio from the modulator, and the result goes on to the Antenna Tuner/Filter Module A1.

Antenna Tuner/Filter Module A1 matches the whip antenna impedance to the radio for the transmit frequency selected if the VHF-Lo whip is installed. In high band VHF, UHF, and when the VHF-Lo is not installed, the power is routed through the Antenna Tuner/Filter Module A1 to the 50-ohm front panel ANT connector.

Microprocessor Module A3 controls numerous transmit path functions, including:

- Filter, audio path, tone squelch circuitry, and amplifier selection on Audio Module A5
- Transmit carrier frequency selected on Synthesizer Module A7
- HIGH/LOW power, PA selection, and power cutback on Transmitter Module A9
- Filter and antenna selection on Antenna Tuner/Filter Module A1
- Audio power amplifier gain (retransmission only) on Power Supply Module A4

The audio power amplifier on Power Supply Module A4 feeds back an audio sidetone to the handset earpiece in clear-text operation. This gives the handset a more natural feel and is useful for testing the audio circuitry of the radio (see section 5).

Signal Synchronizer Module A2 coordinates frequency-hopping transmission with Microprocessor Module A3.

4.3 ENCRYPTION THEORY OF OPERATION

In secure operation, audio from the handset is encrypted in the Front Panel Module A10 and sent to the transmitter. In clear-text operation, audio from the handset goes directly to the transmitter. In a similar manner, received secure data is decrypted in the Front Panel Module A10 and sent to the handset, while received information goes directly to the handset in clear-text mode. Sidetone is generated in the front panel module for secure-text operation.

4.4 SELF TEST

Microprocessor Module A3 executes the self-test routine when the R/T Assembly front panel TEST/LOAD pushbutton is pressed (any mode except PRGRM and RMT). Immediately following the self-test procedure, the R/T Assembly indicates the display test, HUB status, battery voltage, and the source of any detected fault. (Section 3 briefly describes using self test during radio operation. Section 5 describes using self test for radio troubleshooting.)

The self-test routine momentarily inhibits reception and transmission.

Self-test includes checks of each of the following:

- Encryption portion of front panel
- Non-Encryption portion of front panel
- Battery voltage
- Hold-up-battery (HUB) status
- Power supply module voltages
- Front panel encryption assembly
- Microprocessor and memory
- Frequency synthesizer operation
- Antenna tuner/low pass filter matching module (when manpack antenna is properly connected)
- Receiver sensitivity
- Audio output
- Transmit power output
- Vehicular configuration
- Whip antenna power (when manpack antenna is properly connected)
- Encryption power supply in front panel
- Front panel hybrid

The R/T Assembly checks its own modules for self-test faults A01–A10 (see section 5.5 for self-test fault conditions).

SECTION 5

MAINTENANCE

5.1 GENERAL

Use the procedures in this section to maintain and troubleshoot the manpack transceiver.

This section is organized as follows:

- Paragraph 5.2 describes preventive maintenance procedures.
- Paragraph 5.3 describes battery maintenance.
- Paragraph 5.4 provides a troubleshooting approach for repair of the radio.
- Paragraph 5.5 describes self test as a troubleshooting procedure.
- Paragraph 5.6 describes how to identify and correct setup problems.
- Paragraph 5.7 provides procedures for checking receiver sensitivity.
- Paragraph 5.8 provides procedures for checking output power.
- Paragraph 5.9 describes audio circuitry and handset testing.
- Paragraph 5.10 describes fuse protection.

Also included in this section is information that pertains to the handling of static sensitive CMOS devices. To protect static sensitive devices from damage, the following suggested precautions should be followed:

- Keep all static sensitive devices in their protective packaging until needed. This packaging is usually conductive and should provide adequate protection for the device. Storing or transporting static sensitive devices in conventional plastic containers could be destructive to the device.
- Disengage power prior to insertion or extraction of sensitive devices. This also applies to printed wiring boards containing sensitive devices.
- Double check test equipment voltages and polarities prior to conducting any tests. Verify that no transients exist.
- Use only soldering irons and tools that are properly grounded. Ungrounded soldering tips will destroy these devices. Never use soldering guns.
- Avoid contact with the leads of the device. The component should always be handled very carefully by the ends or the side opposite the leads.
- Avoid contact between printed wiring board circuits or component leads and synthetic clothing while handling static sensitive devices or assemblies containing them.

5.2 PREVENTIVE MAINTENANCE

The manpack transceiver is essentially maintenance-free. For reliable operation, prevent dirt build-up anywhere in the system. Keep electrical contacts clean and free from corrosion. To clean contacts, use a soft cloth or cotton dipped in alcohol.

Use the protective covers provided for each front panel connector, shown in figure 5-1. When the handset or antenna is removed, verify that the appropriate protective cover is installed.

5.2.1 Replaceable Front Panel Hardware

Replace any cracked, broken, or badly worn cover, control knob, or protective rubber boot on the R/T Assembly front panel. Use the part numbers shown in figure 5-1 to reorder these parts. Unscrew rubber boots to remove them from toggle switches and pushbuttons. A thin coat of silicone may be applied to the protective rubber boots to further life expectancy.

5.3 BATTERIES

The manpack transceiver is supplied with the rechargeable Nickel-Cadmium Battery Pack (P/N 10012-0300), but it can be powered by the BA-5590/U Disposable Lithium Battery.

The Nickel-Cadmium Battery Pack, shown in figure 5-2, contains rechargeable nickel-cadmium (Ni-Cd) cells, and provides +12 Vdc (nominal) to the manpack transceiver.

The BA-5590/U Disposable Lithium Battery Pack is a high-energy power battery with a longer operation life than the nickel-cadmium battery. The battery case (P/N 10012-0330) is required to adapt the lithium battery for use with the manpack transceiver. Refer to paragraph 5.3.4 for information on installing the battery in the battery case.

5.3.1 Battery Life

Battery life is the approximate amount of time a battery pack can be used before a nickel-cadmium battery needs recharging or a lithium battery needs replacing. The chief factor in determining battery life is transmission power and duty cycle. The guidelines defined in table 5-1 are based on the setting of the front panel XMT POWER control, and assume an R/T ratio of 9:1 (radio receives 90% of the time and transmits 10% of the time).

Another important factor in determining battery life is temperature. The Ni-Cd cells in the rechargeable battery pack are rated for use at ambient temperatures between -4°F (-20°C) and 158°F (70°C). These batteries are more effective at moderate to cooler temperatures. Excessive heat reduces the effective battery life before recharging. Excessive cold also degrades battery performance.

The lithium battery performs effectively at temperatures between -20°F (-29°C) and 131°F (55°C). Since venting can occur, lithium batteries should not be exposed to temperatures above 160°F (71°C).

5.3.2 Battery Voltage

The manpack transceiver continuously monitors battery pack voltage for acceptable levels. It displays the voltage upon power-up and during self test. To understand the relationship of this voltage to battery life, refer to figure 5-3. This simplified voltage curve shows an important characteristic of the Ni-Cd battery; it maintains a relatively steady voltage for most of its useful life. When the battery charge is depleted, this voltage drops quickly.

The disposable lithium battery maintains relatively steady voltage under normal power drain and moderate temperatures, but voltage drops rapidly in high power situations and colder temperatures.

A charged Ni-Cd battery pack typically gives a display between 12.0 V and 13.6 V during self test. A display below 12.0 V indicates a Ni-Cd battery pack requires charging or a lithium battery needs replacing.

As battery voltage drops, the radio responds to conserve the remaining power and alerts the operator as follows:

- 11.0 V – Below this voltage, the radio cuts transmitting power to 1 W, regardless of the setting of the XMT POWER control. The handset beeps every five seconds as a warning.
- 10.5 V – Below this voltage, the radio stops transmitting. A continuous warning tone comes from the handset if keyed. The handset beeps once per second in receive.

Figure 5-4 summarizes radio response to low-battery conditions.

Battery voltage may vary, depending upon whether the radio is receiving or transmitting, and whether its XMT POWER control setting is HIGH or LOW. A good check of battery condition is to key the radio with its XMT POWER control set HIGH for 15 seconds. Then use self test to check battery voltage. If this value is below 12.0 V, assume that the Ni-Cd battery pack requires recharging or the lithium battery needs to be replaced.

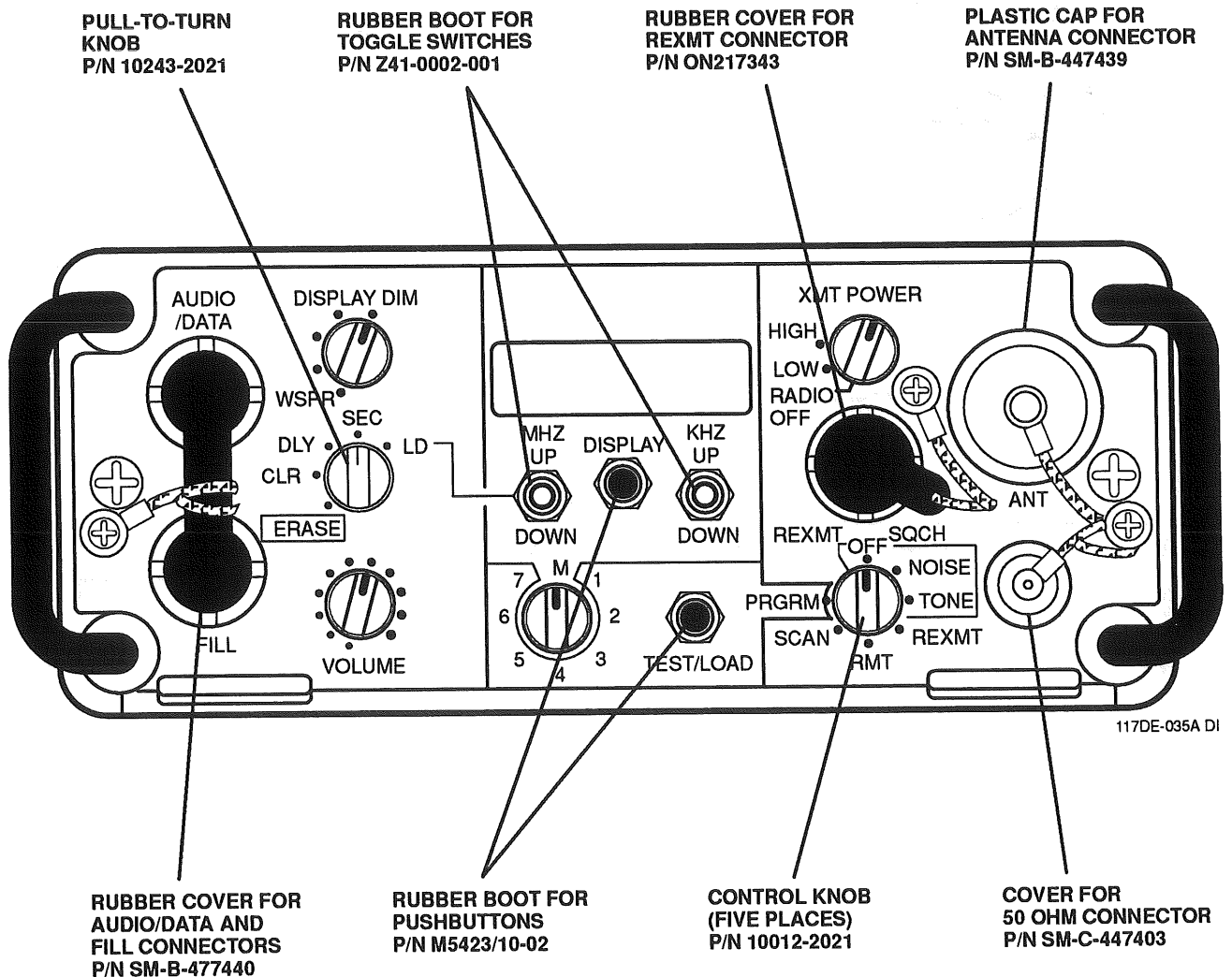
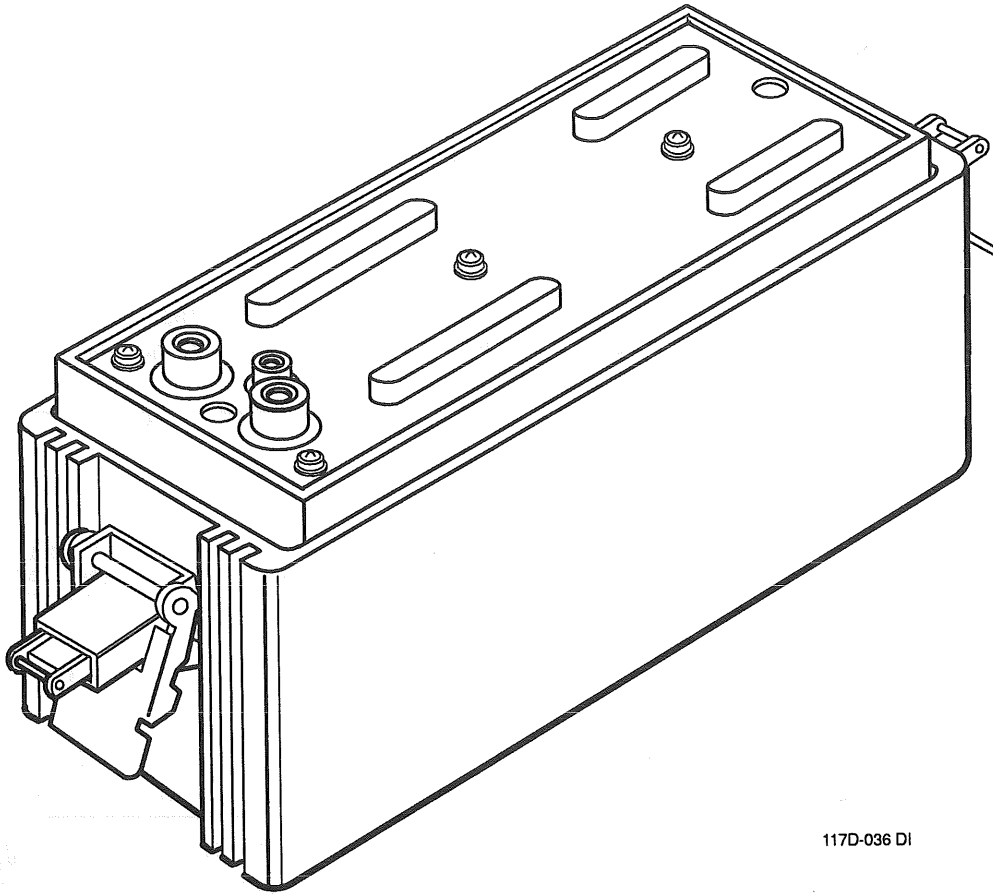


Figure 5-1. Replaceable Front Panel Hardware – R/T Assembly

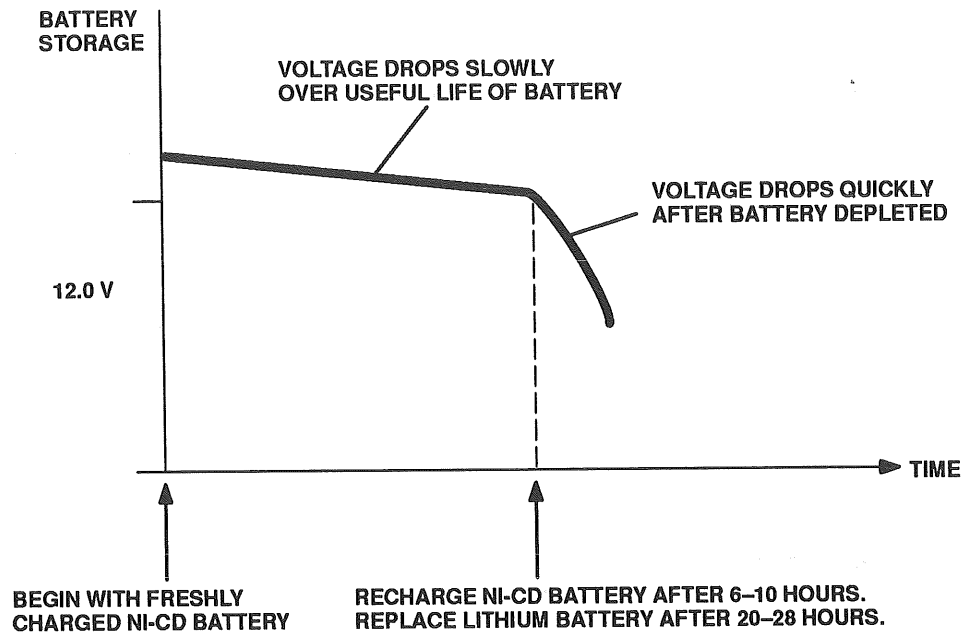


117D-036 DI

Figure 5-2. Nickel-Cadmium Battery Pack

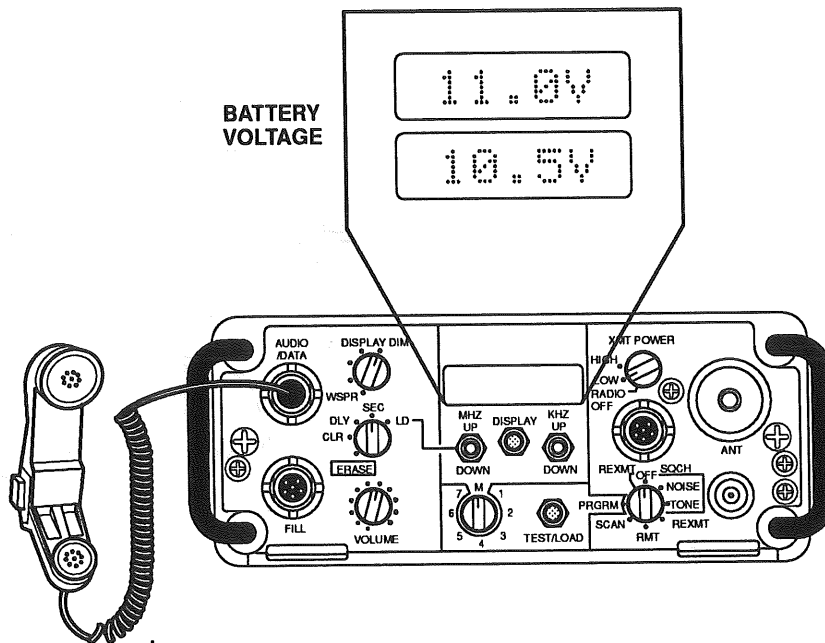
Table 5-1. Battery Life

Front Panel Setting	Ni-Cd Battery Pack	Lithium Battery
LOW (1W)	10 hours	28 hours
HIGH (10W)	6 hours	20 hours



117D-037B DI

Figure 5-3. Simplified Voltage Curve (Ni-Cd Batteries)



117DE-038 DI

Figure 5-4. Response to Low-Battery Conditions

5.3.3 Recharging the Ni-Cd Battery Packs

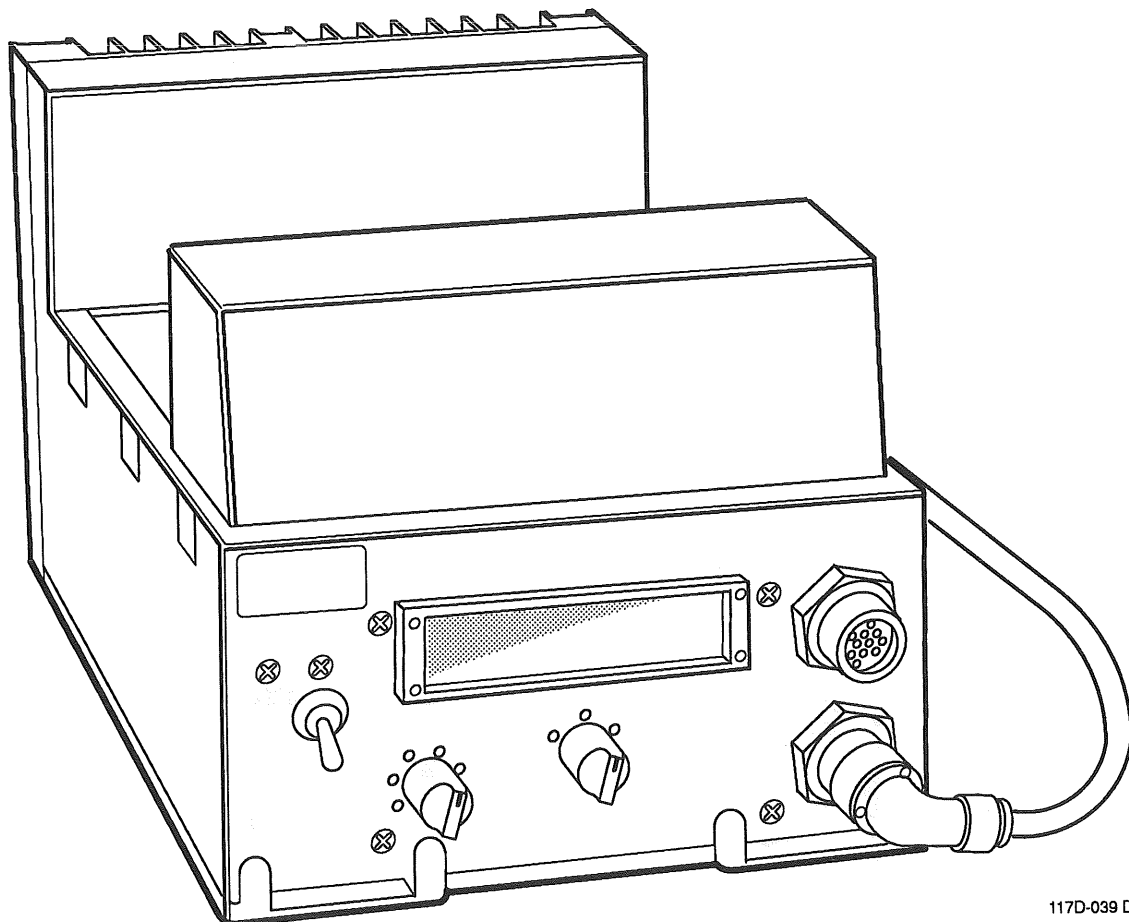
WARNING

Do not recharge a BA-5590/U Disposable Lithium Battery.

Recharge the Ni-Cd battery pack following the battery life guidelines outlined in the preceding paragraphs.

The RF-3094-01 Battery Charger is shown in figure 5-5. This unit provides fully automatic battery charging, a selectable test routine, and fault detection. The battery charger connects with as many as seven battery packs and charges them in sequence, two at a time. It displays the status of each connected pack during operation.

Battery charger operation is described in an operator guide, publication number 10012-0502. The instruction manual for the charger is publication number 10012-0503.



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Figure 5-5. RF-3094-01 Battery Charger

5.3.4 Installing the Lithium Battery

Many safety features are built into the lithium battery to ensure stability under combat conditions. Anyone, however, who handles lithium batteries should observe the following warnings.

WARNING

Do not charge, short circuit, incinerate, or mutilate the BA-5590/U Lithium Battery. Do not expose to fire or temperatures above 160°F (71°C); otherwise battery may vent or rupture, releasing toxic material.

WARNING

If the battery becomes hot, a hissing sound is heard, and an irritating smell occurs; move the equipment to a well-ventilated area or leave the area.

If a lithium battery should accidentally rupture, ventilate the area and wash away any spilled residue with water.

Figure 5-6 shows how to install a lithium battery in the battery case, P/N 10012-0330. The lithium battery slides into the top section of the case and fastens securely to the connector. Then, the battery slides into the bottom section of the battery case with the rubber pad on the back of the case resting securely against the battery.

5.3.5 Disposing of the Lithium Battery

WARNING

Do not dispose of lithium batteries in uncontrolled trash. A partially discharged lithium battery is considered to be hazardous waste.

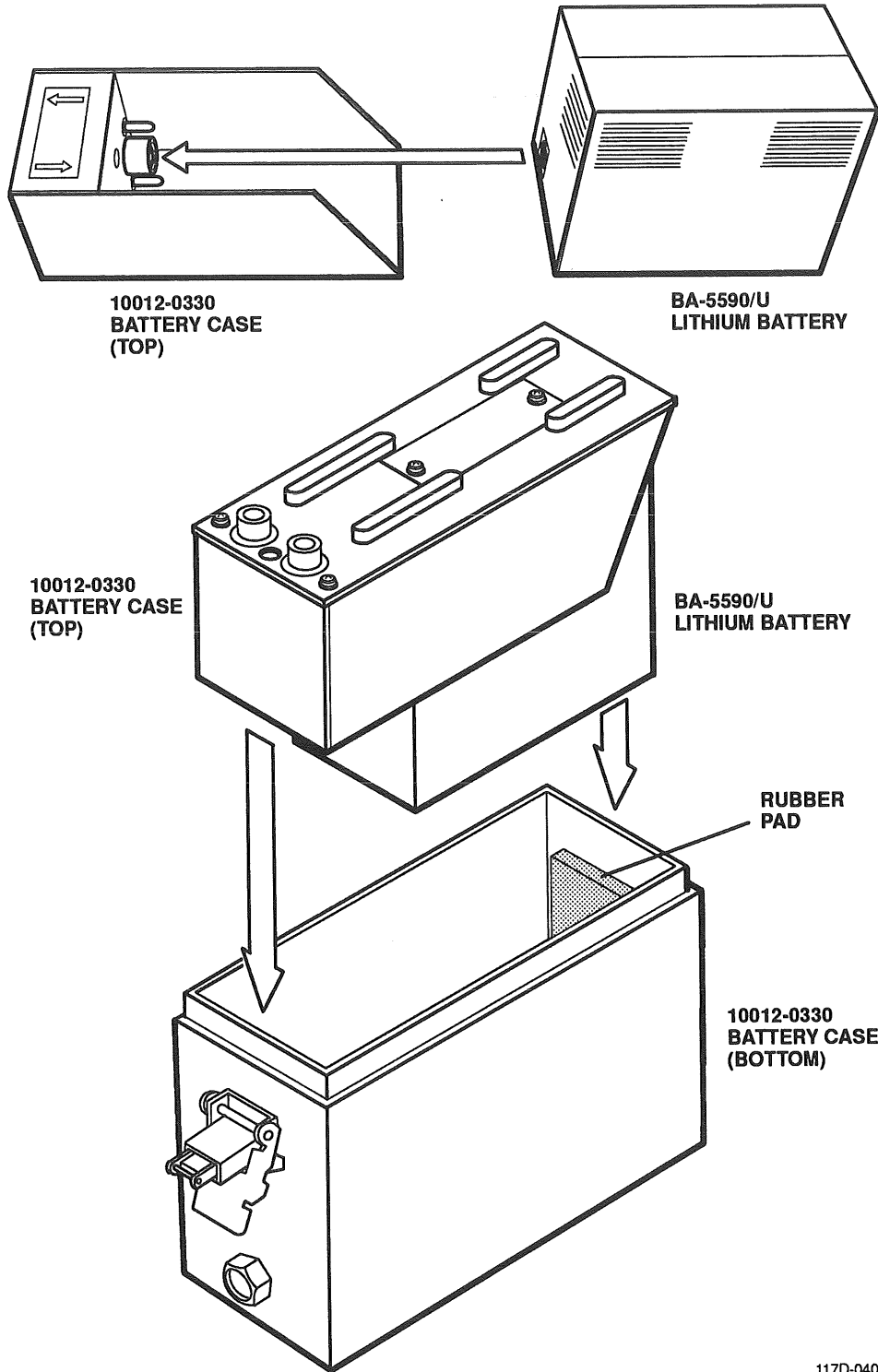
Completely discharged batteries are not considered hazardous or reactive. Where practical, connect a resistive load (typically 82 ohms) across each section of the battery and allow the battery to discharge for one week prior to disposal. The battery can then be treated as non-hazardous material. Soaking the battery in a solution of salt water for two weeks also ensures that the battery is completely discharged.

Partially discharged batteries may contain a significant amount of energy and should be handled with care. The battery pack should be wrapped with insulating material such as plastic and packed for disposal. Do not place lithium batteries in trash compactors.

5.4 TROUBLESHOOTING

Primary troubleshooting does not normally require extensive technical background or sophisticated test equipment. Relying heavily on self test, the procedure for isolating a faulted major assembly is normally within the abilities of the experienced radio operator. Using this procedure, the operator can quickly identify the major assembly or module that is faulted, replace the assembly or module, and return the radio to service.

Self test is the primary tool for R/T Assembly troubleshooting, as described in this manual. The procedures given here cover R/T Assembly repair to the module replacement level only.



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Figure 5-6. Installing the Lithium Battery

5.5 SELF TEST

The self-test routine, executed and controlled by the R/T Assembly, performs numerous checks on radio operation and displays the source of a fault condition when one is detected. Use self test when powering up the radio and as often as necessary during operation. Use self test as the first procedure in troubleshooting.

Self test provides automatic checks of the circuits on the modules, which consist of the following:

- Encryption portion of front panel
- Non-Encryption portion of front panel
- Battery voltage
- Hold-up-battery (HUB) status
- Power supply module voltages
- Front panel encryption assembly
- Microprocessor and memory
- Frequency synthesizer operation
- Antenna tuner/low pass filter matching module
- Receiver sensitivity
- Audio output
- Transmit power output
- Whip antenna power
- Encryption power supply in front panel
- Front panel hybrid

In addition to the 10 modules, self test displays an A11 fault if a vehicular fault has occurred.

To initiate self test, power up the transceiver. The LED display must be blank for self test. Then push TEST/LOAD. Observe the R/T Assembly display for self-test results. The LED display is tested with all the display elements lit at 50% brightness, then the display reverts to the selected setting on the DISPLAY DIM/WSPR control. The radio then checks the status of the hold-up-battery (HUB). If the battery is good, there is no display. If it is weak, too low to register, or missing, "HUB Bad" displays. The radio then displays the detected primary power battery voltage. For voltage levels below 11.0 V, this display flashes, indicating that battery replacement is required. If the radio passes self test, "PASSED" displays.

If the radio detects a fault, it displays a fault code, A01 through A10. This fault code indicates a faulted assembly or module which is the most likely source of a fault. An A11 fault indicates a problem when the radio is used in a vehicular configuration. Table 5-2 lists the unit identified by each fault code. (Signal Synchronizer Module A2 is not listed in table 5-2 and not tested during self test.) The handset gives a one-second beep when a fault is detected, enabling the operator to use self test when the LED display is not readily visible. Figure 5-7 summarizes self-test responses.

NOTE

The self-test display may indicate a problem with the assembly or module itself, or with internal cable connection to the assembly or module. Use the module as the starting point for troubleshooting.

Normal transmission and reception are inhibited during self test.

NOTE

When using self test, disconnect sensitive test equipment, such as RF signal generators, from the front panel ANT connector or the 50 ohm connector. As part of self test, the transmitter may energize its high power output values, approximately 10 W. This could damage some types of test equipment. Always perform self test without antenna or cables attached to the transceiver.

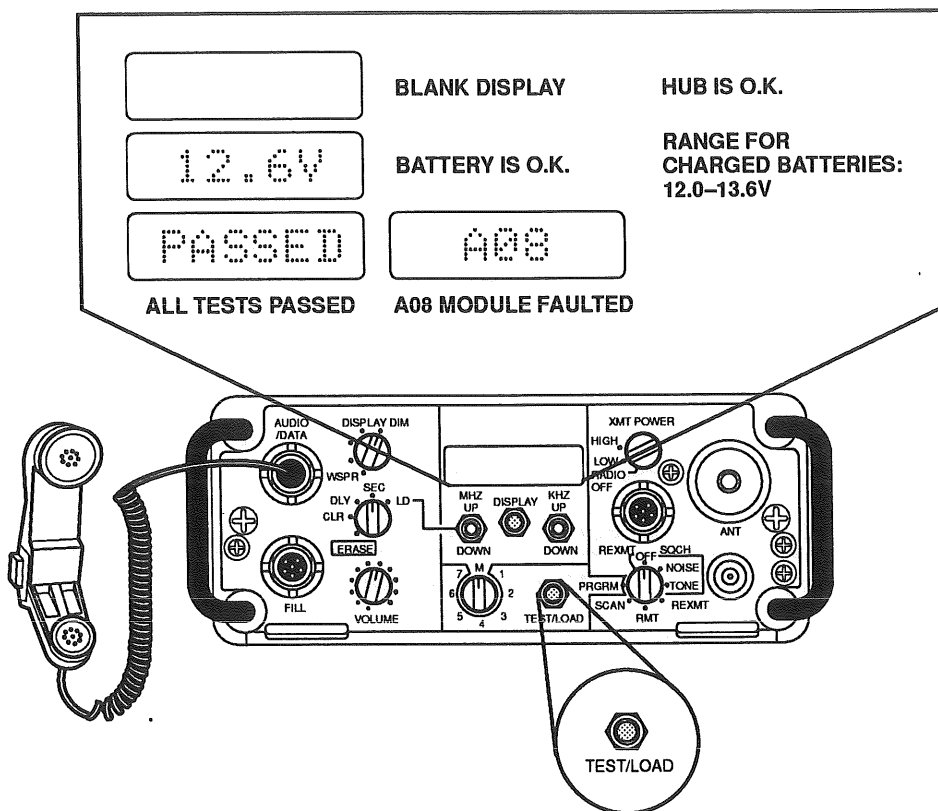
Keep the following considerations in mind when using self test:

- A08 display (normally indicating a Receiver Module A8 fault) can mean that a strong interfering signal is being received at the channel frequency. To recheck whenever A08 is displayed, momentarily unscrew the antenna from the front panel ANT connector and initiate self test again.
- A05 display (normally indicating an Audio Module A5 fault) can mean that a strong interfering signal hinders self-test SQUELCH checking. To recheck whenever A05 is displayed, momentarily unscrew the antenna from the front panel ANT connector and initiate self test again.
- Antenna Tuner Module A1 VHF-Lo whip antenna transmit power is not checked by self test unless the antenna is screwed firmly into the front panel ANT connector.

If self test does not appear to work at all, turn the DISPLAY DIM/WSPR control fully clockwise and try again. Then, if self test gives no response, refer to the procedures in paragraph 5.6.

Table 5-2. Self-Test Designations

Self-Test Code	Module or Assembly Identified
A01	Antenna Tuner/Filter Module
A03	Microprocessor Module
A04	Power Supply Module
A05	Audio Module
A07	Frequency Synthesizer Module
A08	Receiver Module
A09	Transmitter Module
A10	Front Panel Assembly



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Figure 5-7. Self-Test Response

5.5.1 Module Replacement

Refer to these procedures to replace a faulted R/T Assembly module identified by self test or to check module jumper positions. Disassemble the radio and remove the faulted module as shown in figure 5-8. Note that there is a hole in the chassis labeled for each of the nine internal modules. An extractor poked into the hole loosens the identified module from its socket. Use a blunt, narrow instrument to serve as an extractor, as shown in figure 5-8. A small tab located on the edge of the shielded cover serves this purpose.

NOTE

Only authorized personnel can open the front panel (A10).

Following this section are Unit Instruction sections which describe each module in detail. These sections give the PWB chassis placement, cable connections, and a brief description of module functions. Refer to the appropriate section to identify the module to be replaced. Use only the correct module as replacement.

When replacing either Signal Synchronizer Module A2, Power Supply Module A4, or Audio Module A5; compare jumper positions of old and replacement modules. These modules must be jumpered in exactly the same manner for full compatibility. (Refer to the Unit Instruction sections for the A2, A4, and A5 modules.)

Install the replacement module as shown in figure 5-9. As figure 5-9 shows, self test enables a quick check of radio operation with the replacement module.

If self test gives the same error reading after replacement of the suspected module, check cable connections to the module from other locations in the chassis. Note that cable connections are color-coded for quick identification. A label on the inside of the shielded cover summarizes cable routing and shows the color codes.

Verify that the replacement module seats securely in the chassis.

5.6 IDENTIFYING AND CORRECTING SETUP PROBLEMS

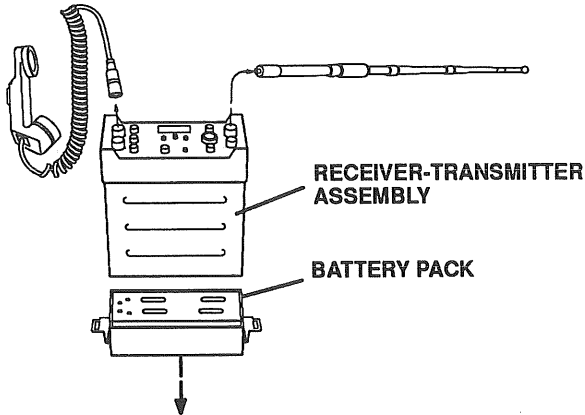
Problems not detected during self test may be the result of incorrect setup. Table 5-3 lists common types of setup problems and their solutions.

Remember that for full receive/transmit compatibility, two radios must be jumpered in exactly the same manner on Power Supply Module A4, Audio Module A5, and on the optional Signal Synchronizer Module A2. For details on these R/T Assembly jumpers, refer to Unit Instructions sections for each module.

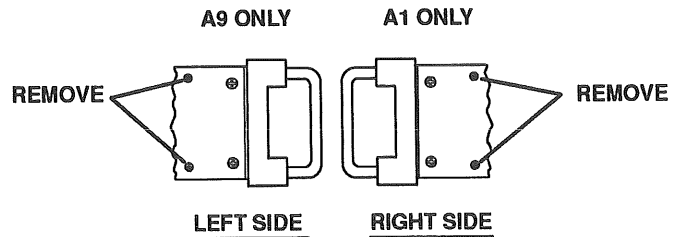
If self test does not energize the front panel display, check that the radio is on (XMT POWER control) and that it is in a mode other than PRGRM or RMT. Turn the DISPLAY DIM control fully clockwise and push the TEST/LOAD pushbutton. If self test still does not work, check these possible sources on the problem:

- **BATTERY VOLTAGE** – Test this by turning the radio off (at XMT POWER control), then back on. Battery voltage should display. If voltage does not display, replace the battery pack with a freshly charged unit. Try this procedure again with the new battery pack.
- **MICROPROCESSOR MODULE A3** – Because it controls the front panel display and executes self test, suspect the A3 module if self test does not work as described. (See paragraph 5.5.1 for module replacement procedure.)
- **FRONT PANEL ASSEMBLY** – Check the ribbon cable connection from this assembly to the A4 module. Recheck all troubleshooting procedures before attempting removal and replacement of the front panel assembly. To remove this assembly, remove the outer case and shielded cover, then disconnect cables and remove the four screws that secure it to the chassis.
- **TRANSMITTER MODULE A9 FUSE PROTECTION** – Refer to section 5.10.

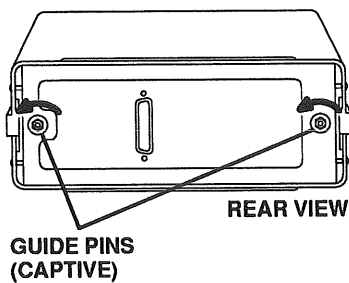
- 1 DETACH RECEIVER-TRANSMITTER ASSEMBLY FROM OTHER PARTS OF RADIO.



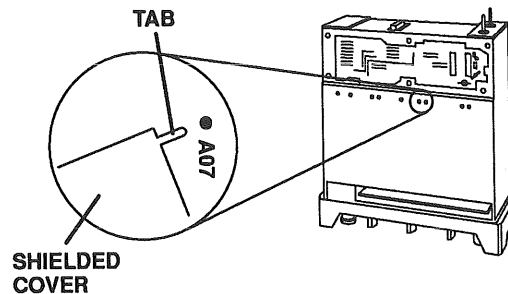
- 5 FOR MODULES A1 AND A9 ONLY, REMOVE SIDE SCREWS. (NOTE LOCATION OF EACH SIDE SCREW REMOVED. SIDE SCREW LENGTHS ARE CRITICAL. SIDE SCREWS MUST BE REPLACED IN THEIR CORRECT LOCATIONS)



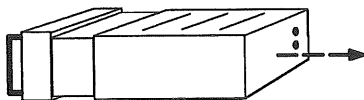
- 2 LOOSEN REAR GUIDE PINS.



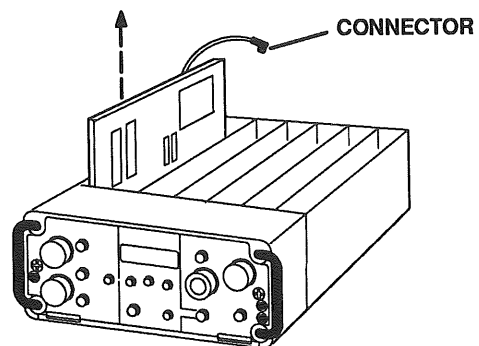
- POKE MODULE EJECTOR TAB (ON FRONT OF SHIELDED COVER) THRU CHASSIS HOLE ON BOTTOM OF RADIO.



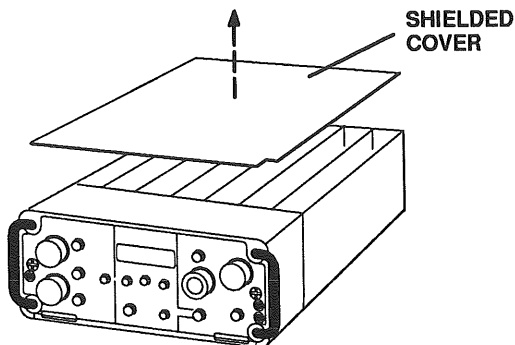
- 3 REMOVE OUTER CASE.



- 7 REMOVE CABLE CONNECTIONS AND LIFT MODULE OUT. TO AVOID MODULE LOCATION ERRORS, REMOVE ONLY ONE MODULE AT A TIME.



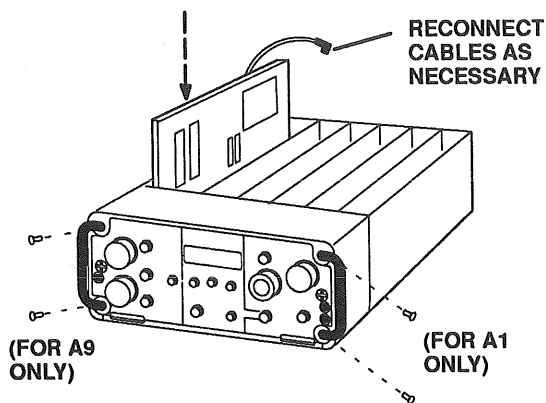
- 4 REMOVE CAPTIVE SCREWS (6 PLACES) AND LIFT SHIELDED COVER.



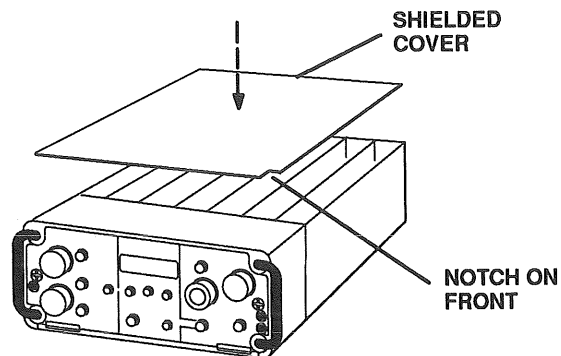
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Figure 5-8. Removing a Module

- ① FIRMLY PRESS MODULE INTO CHASSIS SLOT. DO NOT FORCE. THE CORRECT MODULE SLIDES EASILY INTO PLACE. CONNECT CABLES TO REPLACEMENT MODULE.



- ③ REPLACE SHIELDED COVER.



FOR MODULE A1 AND A9, REPLACE SIDE SCREWS. (SIDE SCREW LENGTHS ARE CRITICAL. MAKE SURE THAT ALL SIDE SCREWS ARE REUSED IN THEIR CORRECT LOCATIONS.)

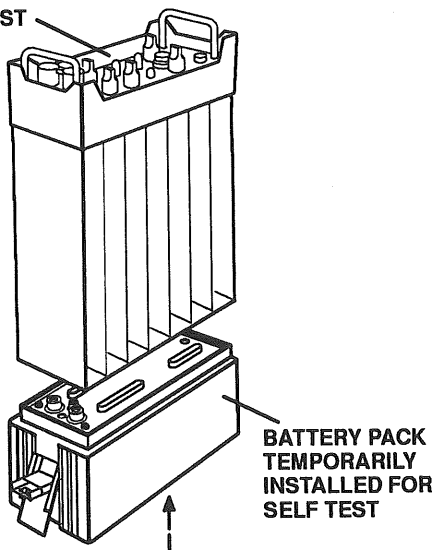
- ② CHECK REPLACEMENT USING SELF TEST. TO DO THIS, SET CHASSIS BACK INTO BATTERY PACK AS SHOWN.

SET THESE CONTROLS:

- XMT POWER – LOW OR HIGH
- RADIO MODE – ANY (EXCEPT REXMT, PRGRM)

PUSH TEST/LOAD.

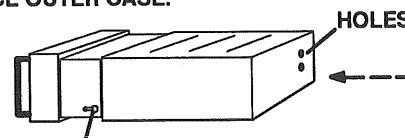
RUN SELF TEST



IF SELF TEST SHOWS A FAULT, FIRST RECHECK PROCEDURE AND RECHECK CABLE CONNECTIONS AND THEN TRY ANOTHER REPLACEMENT.

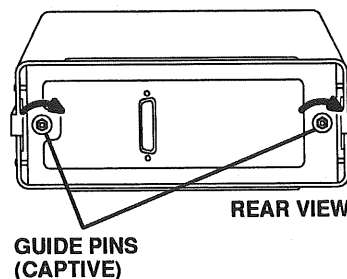
TURN RADIO OFF AND REMOVE CHASSIS FROM BATTERY PACK BEFORE CONTINUING.

- ④ REPLACE OUTER CASE.

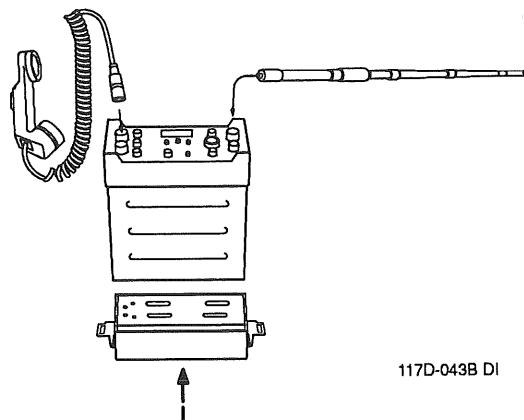


BE CAREFUL NOT TO DAMAGE COAX CABLE ON RIGHT SIDE OF UNIT

- ⑤ TIGHTEN REAR GUIDE PINS.



- ⑥ REASSEMBLE THE RADIO TO THE PROPER OPERATING CONFIGURATION.



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Figure 5-9. Installing a Module

Table 5-3. Correcting Setup Problems

Problem	Possible Solution	Reference
No power	Check battery pack connections and voltage	Section 2
Very poor sensitivity	Check antenna connection	Section 2
No one receives your signal	Check that handset is in the AUDIO/DATA connector Check ENCRYPTION Mode Control position Check for proper encryption variable	Section 2 Section 3 Section 3
Continuous tone in handset	Check RADIO Mode Control position (not in PRGRM?) Check ENCRYPTION Mode Control Check battery voltage	Section 3 Section 3 Section 2, 5
Programmed channel (1-7); frequency/ECCM code cannot be recalled	Check memory backup battery charge	A3 Unit Instructions
Programmed channel (1-7); frequency displays 60.000 upon attempted recall	Recall is purposely inhibited by jumper. Check transmit frequency programming	A4 Unit Instructions
Half-duplex operation; reception but no transmission	Check transmit frequency programming	Section 3

5.7 CHECKING RECEIVER SENSITIVITY

Use the tests given in this paragraph to verify proper receiver performance. If necessary, use these procedures after self test and the other troubleshooting steps described in this section.

The following test equipment is required:

- Signal generator (HP-8640B, 50-ohm output)
- Distortion analyzer (HP-332)

Sensitivity is a measurement of how well the receiver recovers the desired low-level signal from the surrounding noise. Manpack transceiver sensitivity is specified as the following:

- VHF-Lo FM 8 kHz deviation -113 dBm (0.50 uV) for 10 dB SINAD
- VHF-Hi FM 8 kHz deviation -113 dBm (0.50 uV) for 10 dB SINAD
- UHF-FM8 kHz deviation -120 dBm (0.22 uV) for 10 dB SINAD
- VHF-Hi AM -106 dBm (1.12 uV) modulated 30% for 10 dB SINAD
- UHF-AM -110 dBm (0.71 uV) modulated 30% for 10 dB SINAD

The signal generator must have 50-ohm output impedance and should be capable of testing the complete 30-420 MHz range of the radio. Always consider test cable losses when performing the following tests.

5.7.1 Checking Receiver Sensitivity in FM

Figure 5-10 shows a typical setup for checking FM receiver sensitivity. Here, the FM carrier from the signal generator, modulated at 8 kHz deviation by a 1 kHz audio signal, goes to the 50-ohm connector of the radio. The radio demodulates this signal, making the 1 kHz signal available at its audio output. The distortion analyzer measures the relative noise level in the received signal, in units of dB SINAD.

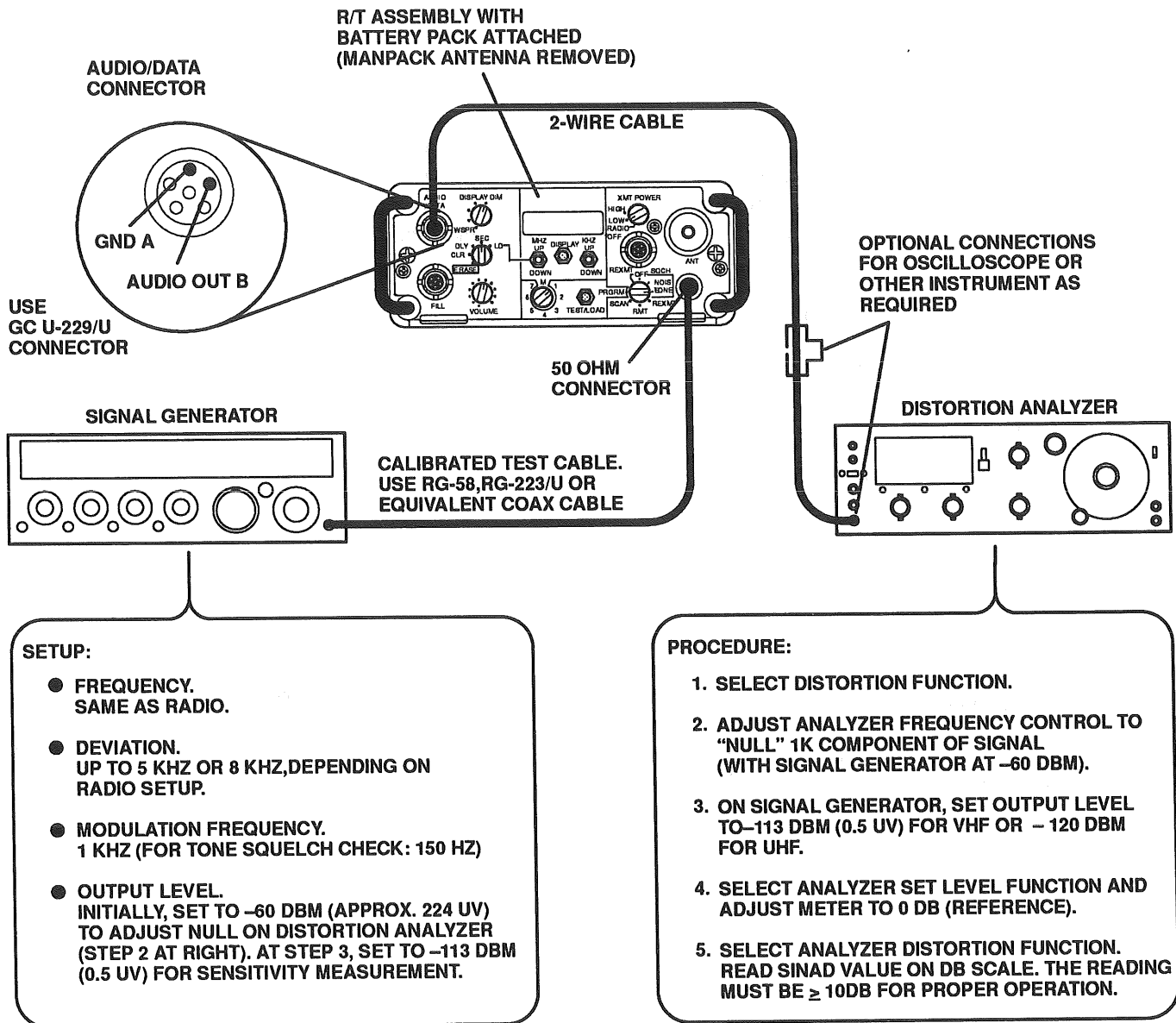
CAUTION

Do not initiate self test with the RF signal generator connected to the radio. Self test keys the transmitter at its HIGH output power which could damage a connected RF signal generator. To protect the RF signal generator from accidental self-test initiation, connect a 30 dB, >20 W attenuator to the transceiver ANT connector. Be sure to account for the attenuator value during sensitivity evaluation.

The following settings are required for this test:

- XMT POWER – LOW or HIGH
- VOLUME – mid-scale (or comfortable level)
- RADIO Mode – OFF (No SQUELCH)
- ENCRYPTION Mode – CLR
- CHANNEL Control – M
- Frequency – same as selected on signal generator
- Channel Mode – selected or programmed for FM (toggled after pressing DISPLAY)

Choose at least one frequency in each 10-MHz band. Select frequencies not in use or subject to local interference. Use frequencies that are not harmonics of frequencies in use in the area.



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Figure 5-10. Equipment Setup for Checking Receiver Sensitivity in FM

5.7.2 Checking Receiver Sensitivity in AM

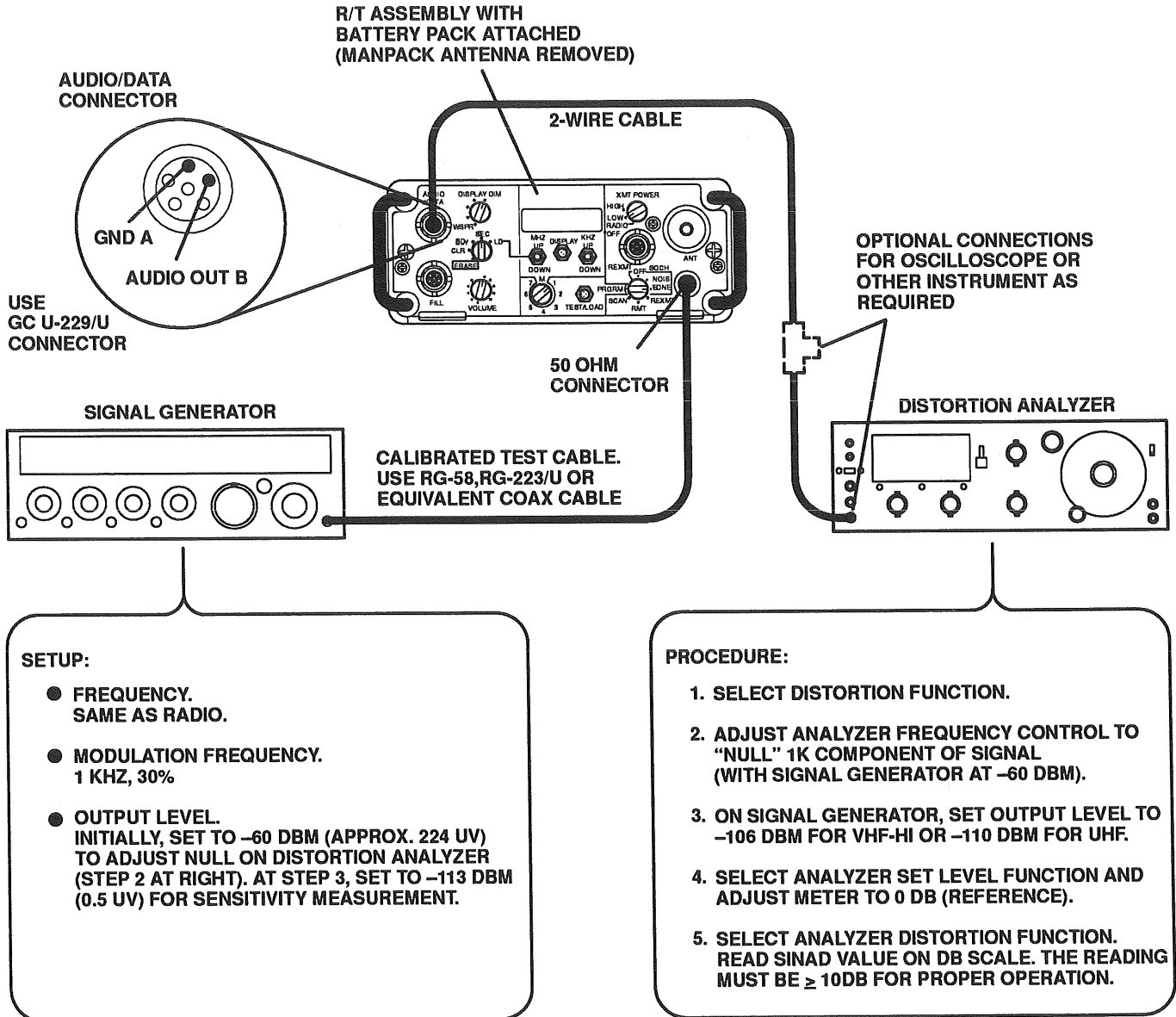
Figure 5-11 shows a typical setup for checking receiver sensitivity. Here, the AM carrier from the signal generator, modulated at 30% AM by a 1 kHz audio signal, goes to the 50-ohm connector of the radio. The radio demodulates this signal, making the 1 kHz signal available at its audio output. The distortion analyzer measures the relative noise level in the received signal, in units of dB SINAD.

CAUTION

Do not initiate self test with the RF signal generator connected to the radio. Self test keys the transmitter at its HIGH output power which could damage a connected RF signal generator. To protect the RF signal generator from accidental self-test initiation, connect a 30 dB, >20 W attenuator to the transceiver ANT connector. Be sure to account for the attenuator value during sensitivity evaluation.

- The following settings are required for this test:
- XMT POWER – LOW or HIGH
- VOLUME – mid-scale (or comfortable level)
- RADIO Mode – OFF (No SQUELCH)
- ENCRYPTION Mode – CLR
- CHANNEL Control – M
- Frequency – same as selected on signal generator
- Channel Mode – selected or programmed for AM (toggled after pressing DISPLAY)

Choose at least one frequency in each 10-MHz band in the VHF-Hi or UHF frequency range. Select frequencies not in use or subject to local interference. Use frequencies that are not harmonics of frequencies in use in the area.



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Figure 5-11. Equipment Setup for Checking Receiver Sensitivity in AM

5.7.3 Checking SQUELCH Circuitry in FM

NOISE and TONE SQUELCH modes inhibit the rushing noise (audible when receiving in the OFF SQUELCH mode) when a received signal does not have sufficient strength or proper signal characteristics. The following are three R/T Assembly SQUELCH settings in the FM mode:

- OFF – No squelch is applied. The rushing sound is present when no signal is being received.
- NOISE – In this mode, the received signal must have a minimum level (10 dB SINAD) to unsquelch the receiver.
- TONE – In this mode, the received signal must have the minimum level necessary for NOISE SQUELCH and must be modulated by a 150-Hz subcarrier tone to break squelch. This mode is only available in low band VHF.

Figure 3-5 summarizes receiver response for each of these SQUELCH settings.

To check the SQUELCH response, disconnect the distortion analyzer from the test setup of figure 5-10. Install the handset at the R/T Assembly front panel AUDIO/DATA connector.

Perform the following procedure to test NOISE SQUELCH:

- a. Set the radio to NOISE SQUELCH mode. Set the VOLUME control to mid-position.
- b. With the signal generator set up as described in paragraph 5.7.1, slowly vary the signal power level above and below the NOISE SQUELCH threshold of the following values:
 - -113 dBm (0.50 uV) for VHF
 - -120 dBm (0.22 uV) for UHF
- c. Listen in the handset and detect the level where the receiver is squelched and where it is unsquelched. The receiver should be unsquelched with an input signal level above the following:
 - -113 dBm (0.50 uV) for VHF
 - -120 dBm (0.22 uV) for UHF

The receiver should be squelched if the input signal level is below the following:

- -120 dBm (0.22 uV) for VHF
- -125 dBm (0.125 uV) for UHF

Perform the following procedure to test TONE SQUELCH (in low band VHF):

- a. On the signal generator, set the power level slightly above the NOISE SQUELCH threshold as determined using the procedures above. For the moment, leave other controls as they were after performing the NOISE SQUELCH testing.
- b. Set the radio to TONE SQUELCH. Set the VOLUME control to mid-position.
- c. Listen to the handset. At this point, there should be no rushing sound from the handset. The receiver is squelched because the 150-Hz modulating tone is not being received.
- d. Set the signal generator modulation to 150 Hz.
- e. Change the deviation of the signal generator based on its setting from the above procedures, as follows:
 - If original setting was 5 kHz, adjust deviation to 1.875 kHz.
 - If original setting was 8 kHz, adjust deviation to 3 kHz.

When the radio detects the 150-Hz tone, it unsquelches the receiver.

5.7.4 Checking SQUELCH Circuitry in AM

NOISE SQUELCH modes inhibit the rushing noise (audible when receiving in the OFF SQUELCH mode) when a received signal does not have sufficient strength or proper signal characteristics. The following are four R/T Assembly SQUELCH settings in the AM mode:

- OFF – No squelch is applied. The rushing sound is present when no signal is being received.
- NOISE (AM SQL HI) – In this mode, the received signal must have a minimum level (15 dB SINAD) to unsquelch the receiver.
- NOISE (AM SQL LO) – In this mode, the received signal must have a minimum level (4 dB SINAD) to unsquelch the receiver.
- TONE – Same operation as NOISE in AM mode.

Figure 3-5 summarizes receiver response for each of these SQUELCH settings.

To check the SQUELCH response, disconnect the distortion analyzer from the test setup of figure 5-10. Install the handset at the R/T Assembly front panel AUDIO/DATA connector.

Perform the following procedure to test NOISE SQUELCH (AM SQL LO):

- a. Verify that AM SQL LO is set from the RADIO OPS menu.
- b. Set the radio to NOISE SQUELCH mode. Set the VOLUME control to mid-position.
- c. With the signal generator set up as described in paragraph 5.7.2, slowly vary the signal power level above and below the NOISE SQUELCH threshold of the following values:
 - -106 dBm (1.12 uV) for VHF-Hi
 - -120 dBm (0.22 uV) for UHF
- d. Listen in the handset and detect the level where the receiver is squelched (no audio) and where it is unsquelched (audio). The receiver should be unsquelched with an input signal level above the following:
 - -106 dBm (1.12 uV) for VHF-Hi
 - -120 dBm (0.22 uV) for UHF

The receiver should be squelched if the input signal level is below the following:

- -120 dBm (0.22 uV) for VHF-Hi
- -125 dBm (0.125 uV) for UHF

Perform the following procedure to test NOISE SQUELCH (AM SQL HI):

- a. Verify that the AM SQL HI is set from the RADIO OPS menu.
- b. Set the radio to NOISE SQUELCH mode. Set the VOLUME control to mid-position.
- c. With the signal generator set up as described in paragraph 5.7.2, slowly vary the signal power level above and below the NOISE SQUELCH threshold of the following values:
 - -100 dBm (2.24 uV) for VHF-Hi
 - -114 dBm (0.45 uV) for UHF
- d. Listen in the handset and detect the level where the receiver is squelched and where it is unsquelched.

The receiver should be unsquelched with an input signal level above the following:

- -100 dBm (2.24 uV) for VHF-Hi
- -114 dBm (0.45 uV) for UHF

The receiver should be squelched if the input signal level is below the following:

- -104 dBm (1.41 uV) for VHF-Hi
- -118 dBm (0.282 uV) for UHF

5.8 CHECKING OUTPUT POWER

Use the following procedures for periodic checks of transmitter output power performance. If necessary, use these procedures after attempting self test and the other troubleshooting steps described in this section.

The following test equipment is required:

- Directional wattmeter (Bird Model 43 and 10 W Slugs)
- Dummy load (50 ohm Bird Model 8164)

The radio transmit power level depends on its XMT POWER control setting.

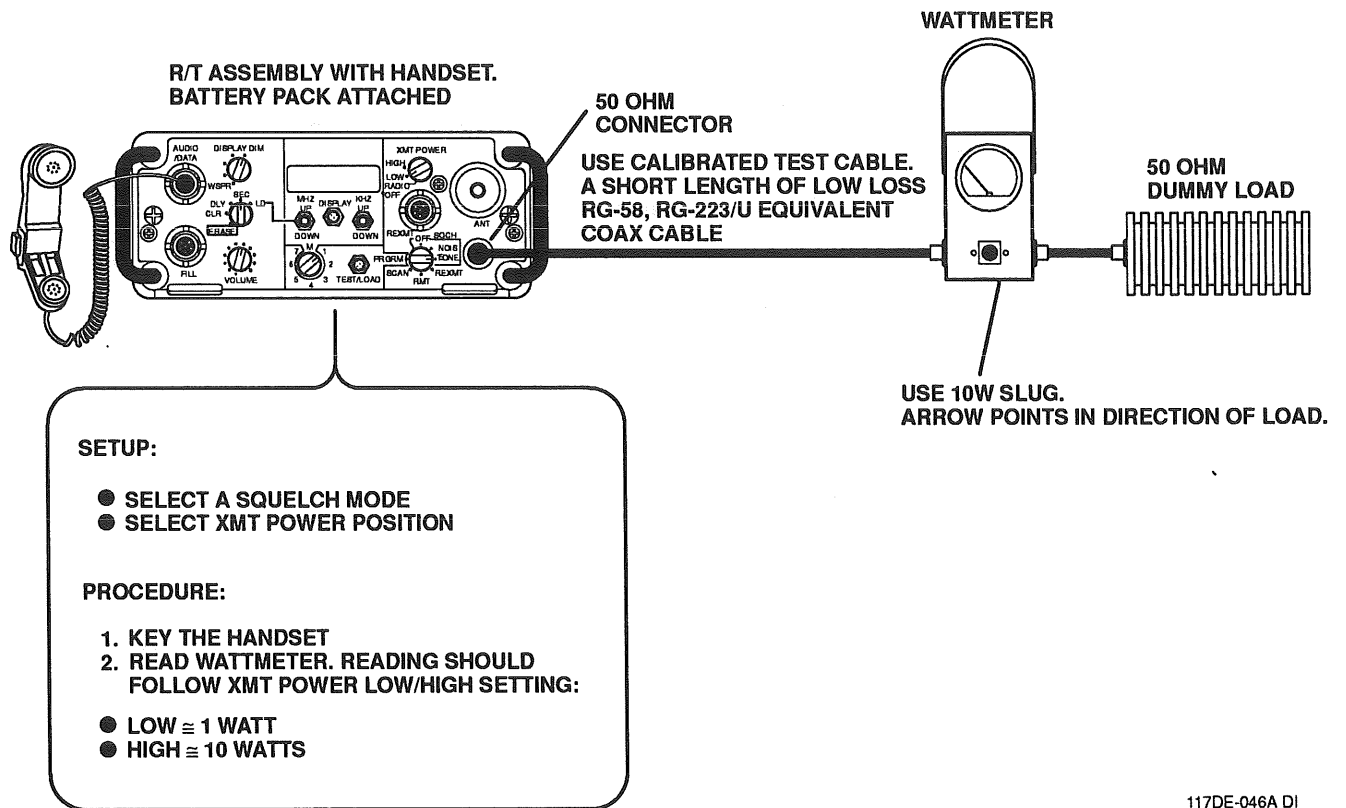
- LOW = 1 W (± 1 dB)
- HIGH = 10 W (± 1 dB)

Test output power using a directional wattmeter in series with a 50-ohm dummy load. Figure 5-12 shows a typical setup for transmitter output power testing. Follow the procedures shown in this figure for both LOW and HIGH settings of the XMT POWER control. Always consider test cable losses when performing transmit power output tests.

Check transmit power with at least one frequency from each of the following bands:

- 30.000 – 49.975 MHz
- 50.000 – 89.975 MHz
- 116.000 – 173.995 MHz
- 225.000 – 419.995 MHz

Full output power values, 1 W and 10 W, are rated for a fully charged battery pack (minimum 12.0 V).



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Figure 5-12. Equipment Setup for Output Power Testing

5.9 AUDIO CIRCUITRY AND HANDSET TESTING

Use the following procedures to verify proper operation of audio circuitry. These procedures begin with a brief functional checkout using the handset (paragraph 5.9.1). This simple testing determines whether or not R/T Assembly audio circuitry is operating.

5.9.1 Checking the Receive Audio Path

Connect the handset to the front panel AUDIO/DATA connector and set the following R/T Assembly controls:

- XMT POWER – LOW or HIGH
- VOLUME – Set to mid-position
- RADIO Mode – Set to OFF (SQUELCH)
- Encryption Mode – CLR

The rushing noise indicates that the receive audio path is operable. This indicates that the following R/T Assembly components are functioning:

- Demodulator or detector circuitry on Receiver Module A8
- Audio Module A5
- Audio power amplifier on Power Supply Module A4
- Handset earpiece

Section 4 briefly describes the function of these components and their relationship to the receive audio signal path.

5.9.2 Checking the Transmit Audio Path

Use the same setup given in paragraph 5.9.1 to test the transmit audio path.

Key the handset and talk in the mouthpiece while listening for the audio sidetone in the earpiece. When the transmit audio path is operational, this audio sidetone is fed back through the audio power amplifier (A4 module). This indicates that the following components are functioning:

- Handset (mouthpiece and earpiece)
- Front panel assembly preamplifier circuitry
- Audio Module A5
- Audio power amplifier on Power Supply Module A4

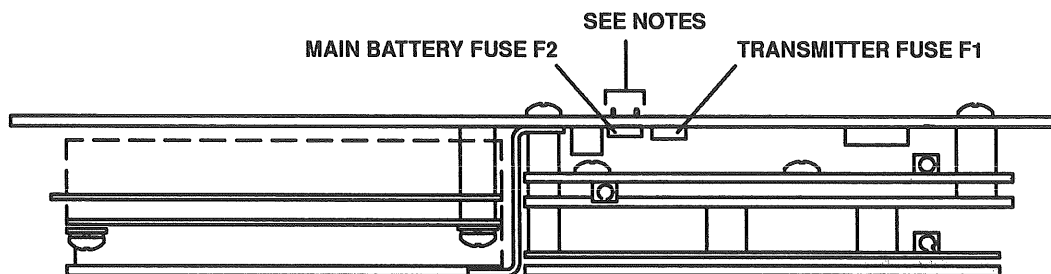
5.10 FUSE PROTECTION

The R/T Assembly is fused as follows:

- 10 A fuse (F2) on Transmitter Module A9 – Protects the radio from reversed polarity and protects the battery and radio wiring from high current conditions due to faults in the Transmitter Module A9.
- 1 A fuse (F1) on Transmitter Module A9 – Protects the rest of the radio from incidental damage due to high current conditions. F1 is self-resetting when the over current condition is eliminated.

If either fuse or both fuses are blown (open), an indicator lights on the top edge of the Transmitter Module A9 when the power switch is placed in the LOW or HIGH position.

Refer to figure 5-13 for the locations of these fuses on Transmitter Module A8.



- NOTES: 1. USE ALL PRECAUTIONS FOR ELECTROSTATIC SENSITIVE DEVICES (SEE PARAGRAPH 5.1).
2. F2 IS A 10 AMP PICO FUSE™ SOLDERED INTO BIFURCATED TERMINALS PERMANENTLY ATTACHED TO A9A1.

117D-096A

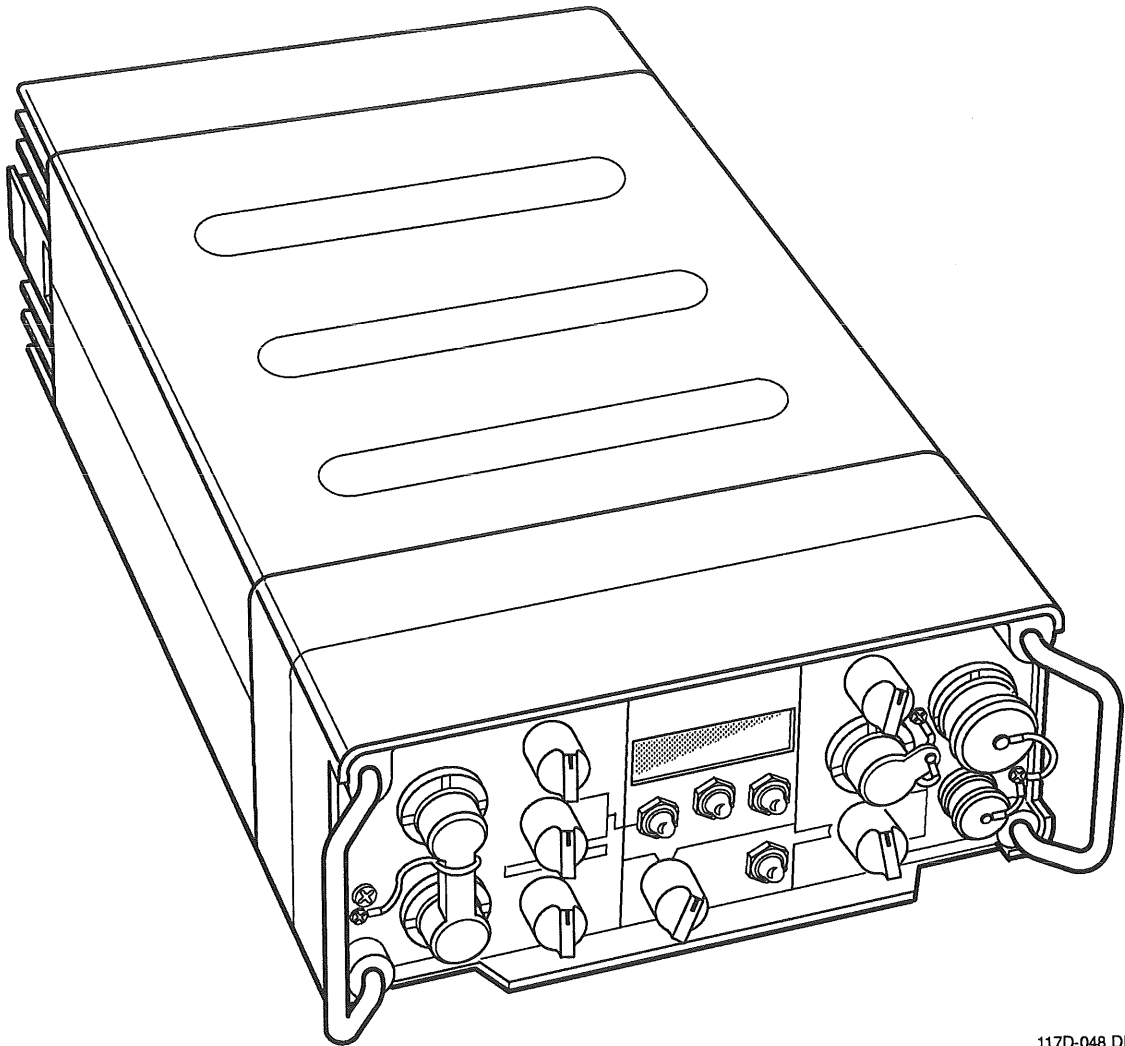
Figure 5-13. Fuse Locations on Transmitter Module A9

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R/T ASSEMBLY



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R/T ASSEMBLY

1. GENERAL DESCRIPTION

The R/T Assembly contains the basic circuitry of the transceiver.

2. PHYSICAL CHARACTERISTICS

The R/T Assembly chassis houses eight removeable modules and a front panel assembly, as shown in figure 1. Table 1 lists the standard parts of the R/T Assembly.

Modular design simplifies the troubleshooting and repair of the R/T Assembly. Use self test to identify the suspected source of an R/T Assembly fault as described in the Operation section of this manual. After self test, simply replace the faulted module to restore full radio operation. No alignment or other component adjustments are required after module replacement.

3. OPERATION

Refer to the Theory of Operation section of this manual for the basic operation of the R/T Assembly.

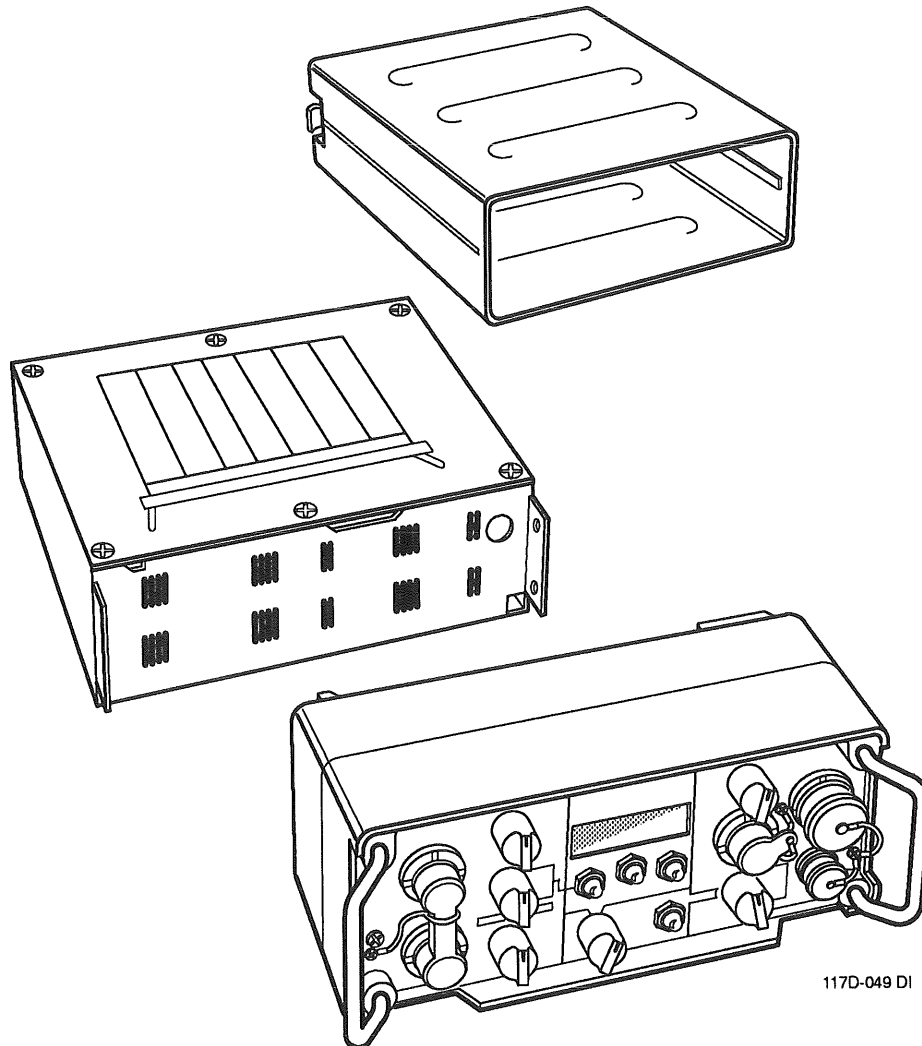
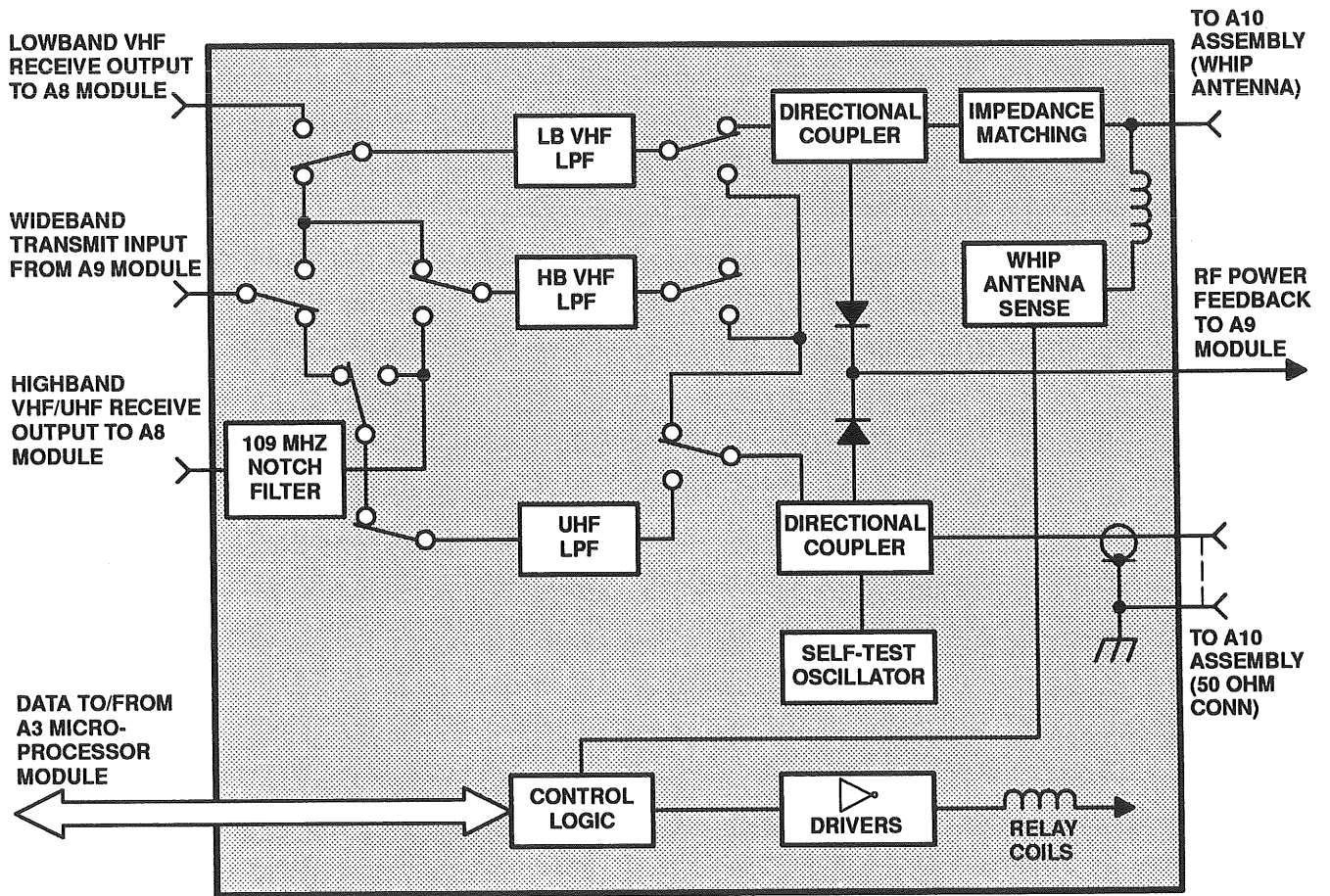


Figure 1. R/T Assembly

Table 1. R/T Assembly Parts List (10369-1100-120 Rev. F)

Ref. Desig.	Part Number	Description
A1	10369-4500	Antenna Tuner Module
A2	10012-2700	Signal Synchronizer Module
A3	10369-2400-121	Microprocessor Module
A4	10012-2200	Power Supply Module
A5	10012-4900-002	Audio Module
A7	10369-5300	Frequency Synthesizer Module
A8	10369-3000	Receiver Module
A9	10369-4000-120	Transmitter Module
A10	10369-2000-120	Front Panel Assembly

A1 ANTENNA TUNER/FILTER MODULE



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A1 ANTENNA TUNER/FILTER MODULE

1. GENERAL DESCRIPTION

Antenna Tuner/Filter Module A1 matches the impedance of the radio to the antenna to maximize the signal power transfer at the operating frequency. This module also contains low pass filters to attenuate unwanted harmonics and transmit power feedback circuitry which the transmitter uses to maintain the correct transmit output power.

This module is designed for use with the following:

- 44 inch (1.1 m) VHF-Low Manpack Blade Antenna (P/N 10012-0201)
- 10 foot (3.1 m) VHF-Low Manpack Whip Antenna Kit with adaptor (P/N 10012-0240)
- VHF-Hi/UHF Antenna Kit (P/N 10369-0205)

2. PHYSICAL CHARACTERISTICS

Figure 1 shows Antenna Tuner/Filter Module A1. Figure 2 shows the A1 module position in the R/T Assembly chassis. As shown in figure 2, six cables connect to this module. These cables are color coded, and can be described as follows:

- Black – From front panel assembly
- Blue – VHF/UHF from Transmitter Module A9
- White – UHF to Receiver Module A8
- Blue – VHF-Lo to Receiver Module A8
- No Color – Forward/reflected power detect to Transmitter Module A9

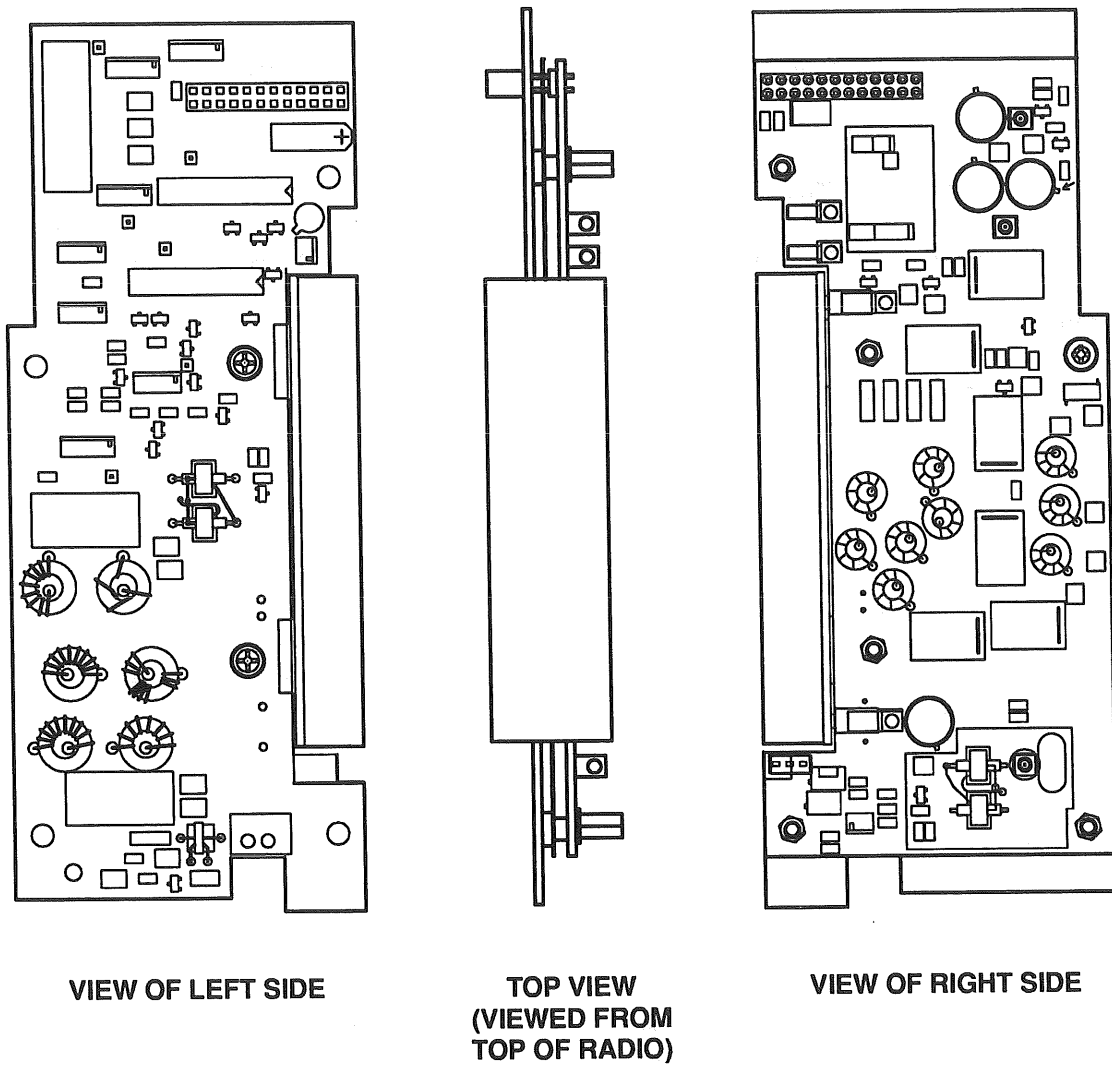
The backplane connector of this module is marked A01. For positive identification, locate the following numbers on A1 module printed wiring boards:

- 10369-4510
- 10369-4520
- 10369-4530

3. OPERATION

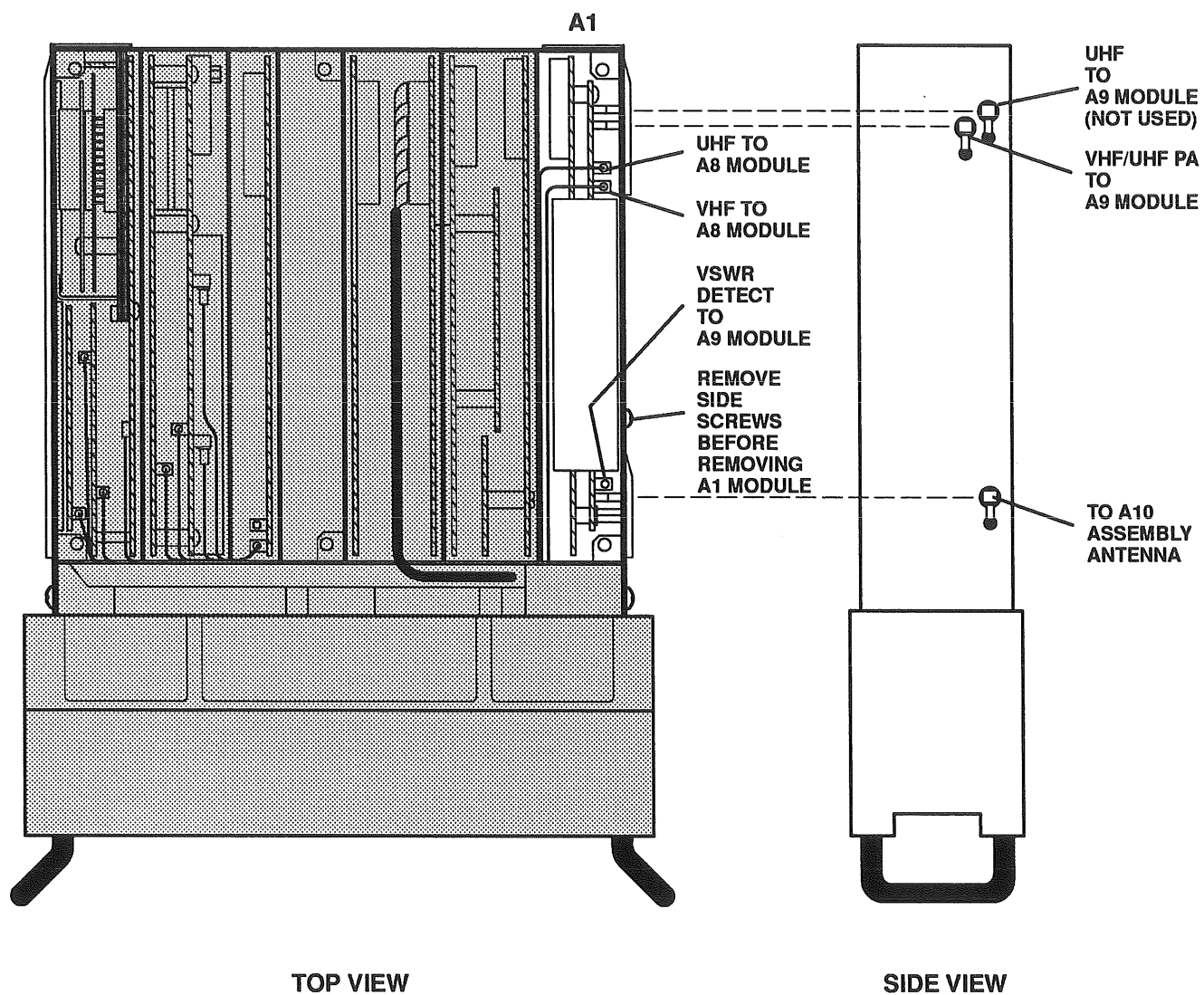
A functional block diagram of the antenna tuner/filter module is located on the cover of this section. The A1 module has impedance matching circuitry for the VHF-Lo band whip antenna. Also contained on this module are the low pass filters and IF notch filter. Relays under control of Microprocessor Module A3 switch the impedance matching circuitry and the low pass filters, based on the transmit and receive frequencies selected by the operator.

Also contained on this module are the control and sense circuitry. The directional couplers and RF power feedback circuitry provide for the proper R/T transmit power output levels by providing the necessary control signals on the Transmit Module A9. The whip antenna sense circuitry allows automatic routing of the transmit signal to either the whip antenna or the 50-ohm port. Control logic and relay coils allow Microprocessor Module A3 to select the relays required at the selected frequency. The 15 MHz self-test oscillator is used for receive checks during self test. The module also provides a receiver protection function by opening the path to the receiver during overload conditions.



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Figure 1. A1 Antenna Tuner/Filter Module



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Figure 2. Chassis Position – A1 Antenna Tuner Module

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A2 SIGNAL SYNCHRONIZER MODULE

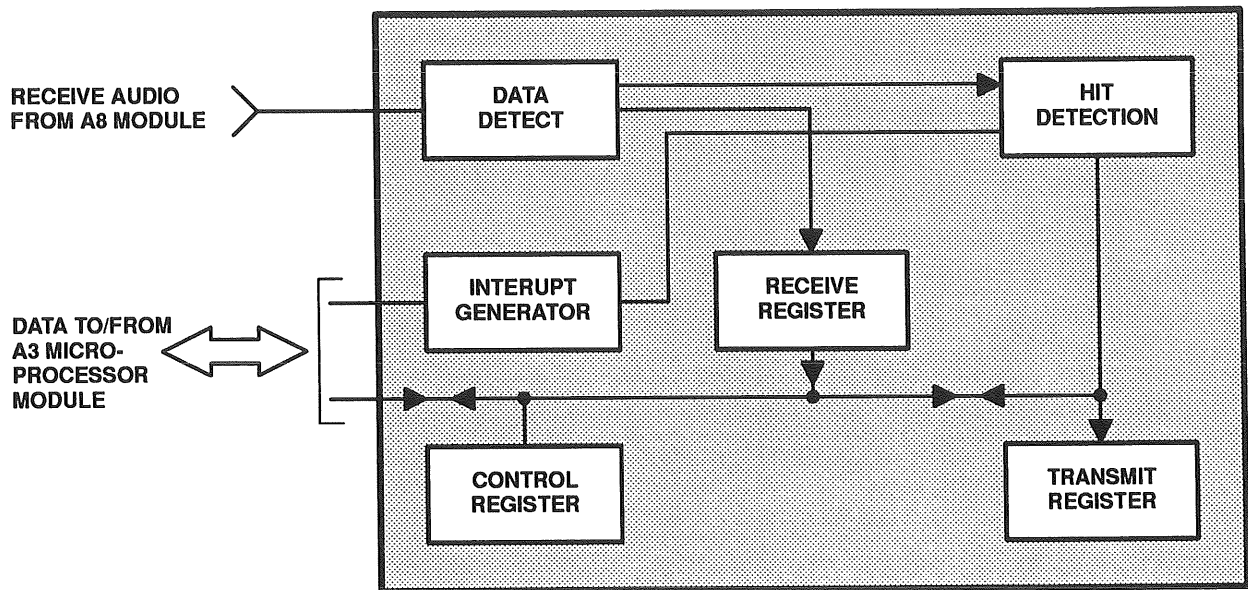


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A2 SIGNAL SYNCHRONIZER MODULE

1. GENERAL DESCRIPTION

Signal Synchronizer Module A2, in conjunction with Microprocessor Module A3, controls the frequency-hopping ECCM transmission and reception.

2. PHYSICAL CHARACTERISTICS

Figure 1 shows Signal Synchronizer A2. Figure 2 shows the A2 module position in the R/T Assembly chassis. There are no cable connections to this module.

The backplane connector of this module is marked A02. For positive identification, locate the following numbers on A2 module printed wiring boards:

- 10012-2800
- 10012-2809
- 10012-2909

2.1 Jumper Positions

Jumpers installed on the Signal Synchronizer Module A2 determine part of the pseudorandom pattern in frequency-hopping ECCM operation. Jumper location on the module is shown in figure 3.

As figure 3 shows, there are eight possible jumper positions available. Any or all eight jumpers can be installed on this module, allowing 256 different possibilities for jumper placement.

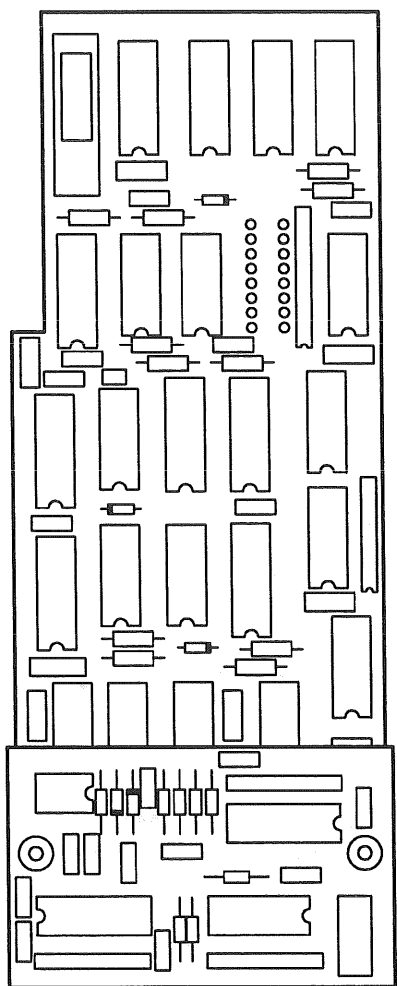
NOTE

In order for ECCM communication, radios must be jumpered in exactly the same configuration on the A2 module.

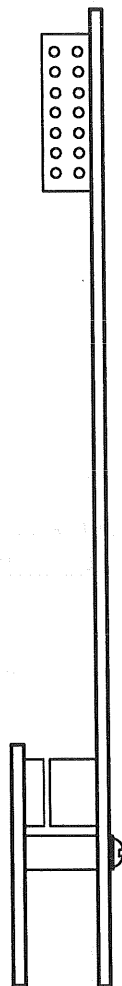
3. OPERATION

Refer to the cover of this section for a functional block diagram of the Signal Synchronizer Module A2. This module works with Microprocessor Module A3 and Receiver Module A8 to control frequency-hopping operation. The module is not required for operation for single channel operation.

For ECCM compatibility among a group of radios, their A2 module jumpers (as described in section 2) must be installed in exactly the same positions. In addition, programmed ECCM code values must match. (Refer to the Operation section of this manual for a review of ECCM setup and operation.)



**VIEW OF LEFT SIDE
(COMPONENT SIDE)**

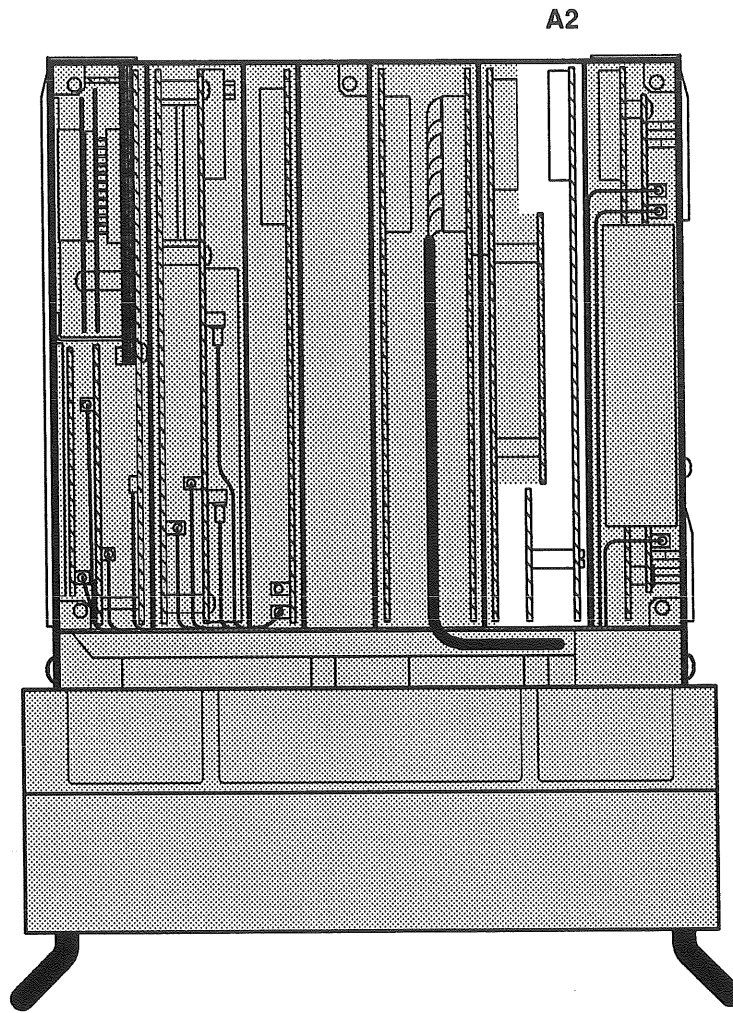


**TOP VIEW
(VIEWED FROM
TOP OF RADIO)**

**NOTE:
RIGHT SIDE OF PWB
NOT SHOWN
(SINGLE SIDED PWB)**

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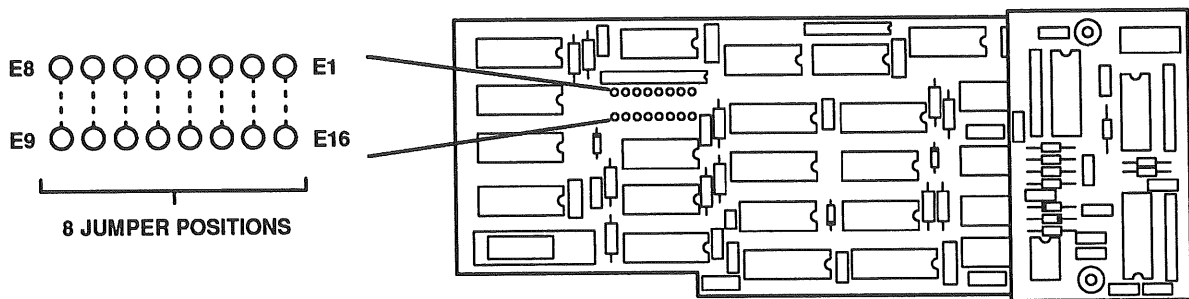
Figure 1. A2 Signal Synchronizer Module



TOP VIEW

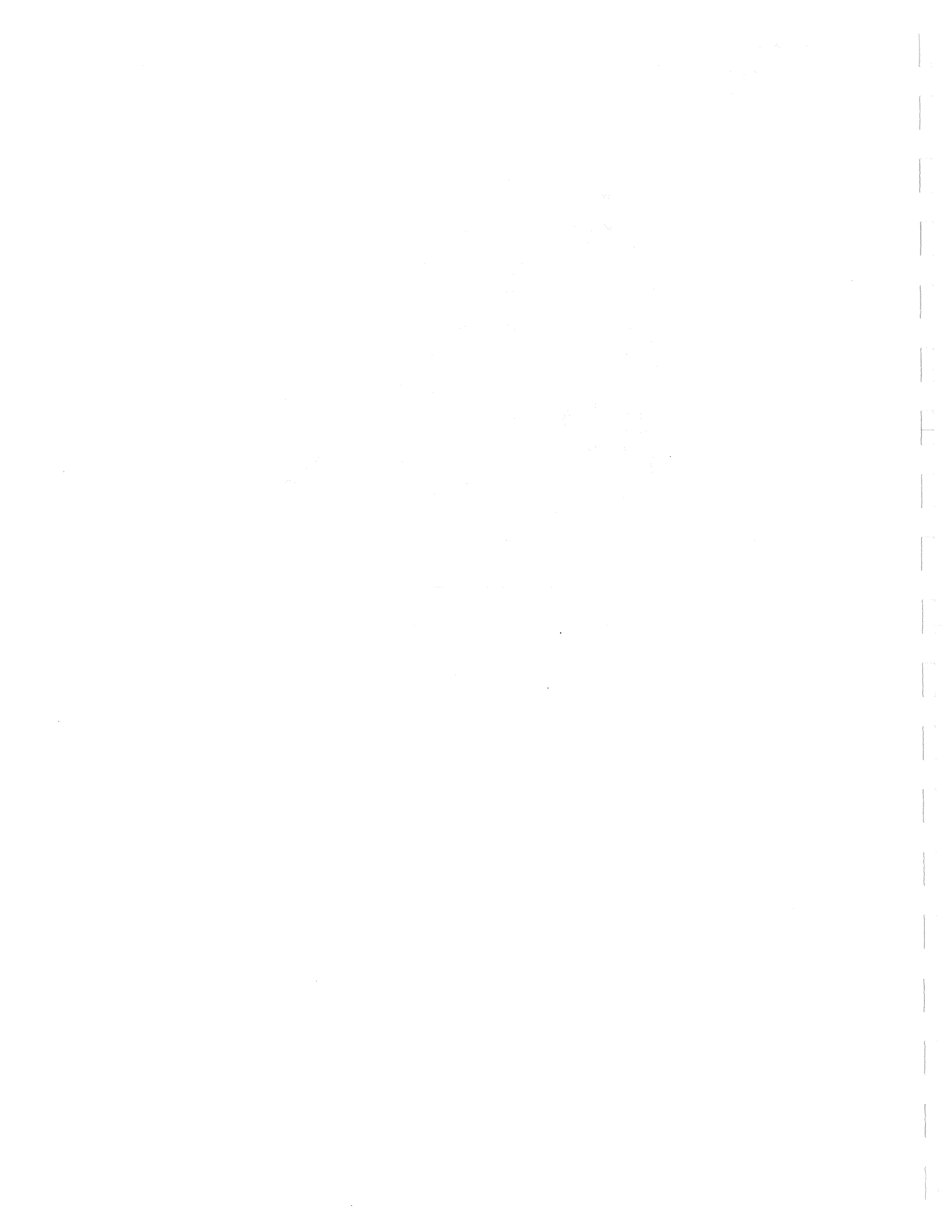
117D-077 DI

Figure 2. Chassis Position – A2 Signal Synchronizer Module



117D-073 DI

Figure 3. Jumper Positions – A2 Signal Synchronizer Module



A3 MICROPROCESSOR MODULE

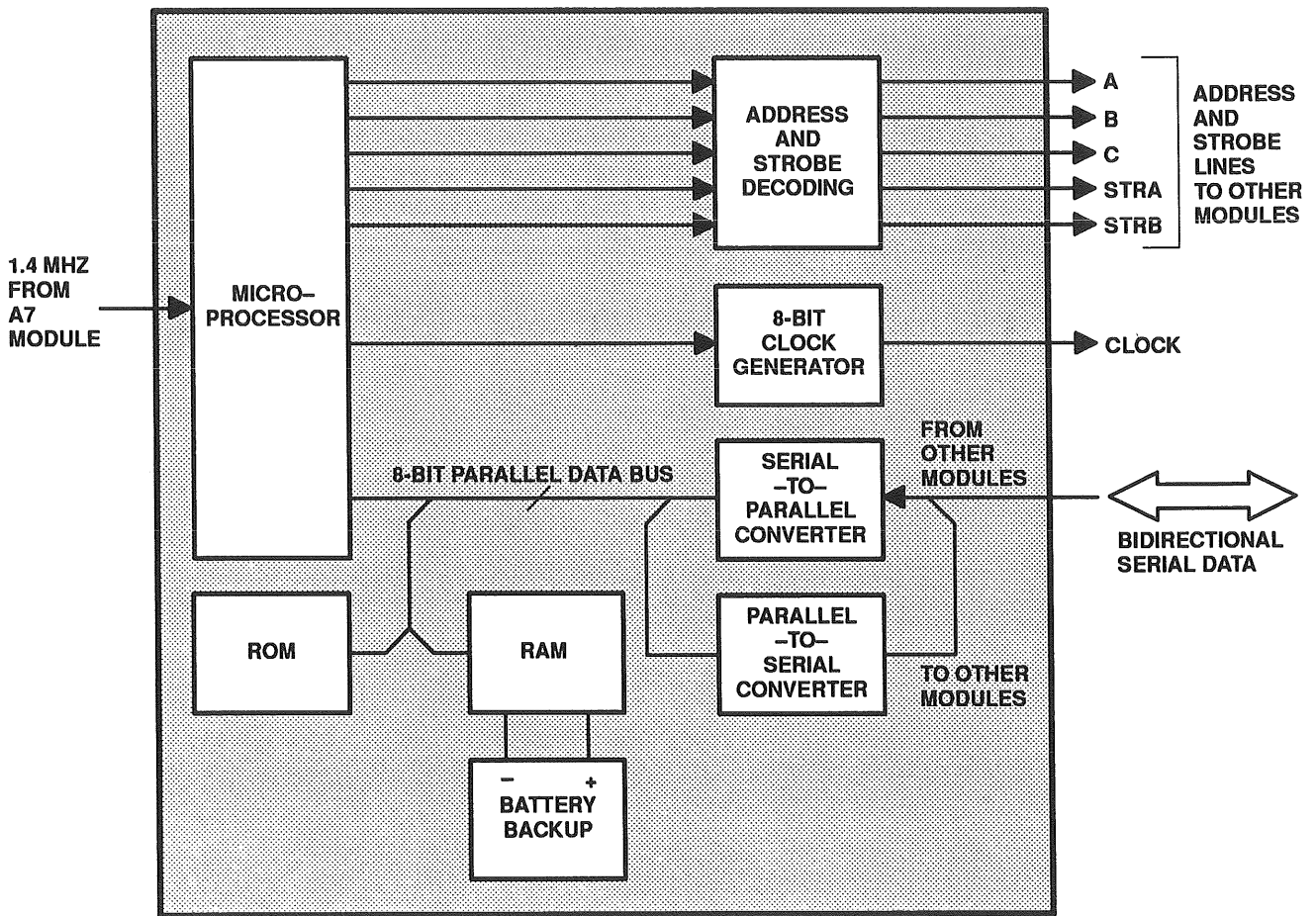


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A3 MICROPROCESSOR MODULE

1. GENERAL DESCRIPTION

Microprocessor Module A3 controls and monitors radio functions using digital logic.

2. PHYSICAL CHARACTERISTICS

Figure 1 shows Microprocessor Module A3. Figure 2 shows the A3 module position in the R/T Assembly chassis. There are no cable connections to this module.

The backplane connector of this module is marked A03. For positive identification, locate the following identifying numbers on A3 module printed wiring boards:

- 10012-2500-01
- 10012-2509
- 10012-2630-121
- 10012-2639

2.1 Memory Backup Battery

A small backup battery on Microprocessor Module A3 maintains memory contents so that programmed frequencies are stored while the radio is off. (Memory backup is the only purpose of this battery; it does not provide power for radio operation.) After a long period of storage or when the radio is new and has never been used, it may be necessary to charge the memory backup battery.

The memory backup battery charges only when the radio is on. Once it is fully charged, the backup battery can typically hold its charge and maintain memory contents for several months, provided that the R/T Assembly is stored at moderate temperatures. Regular use of the radio automatically keeps this backup battery at full charge.

NOTE

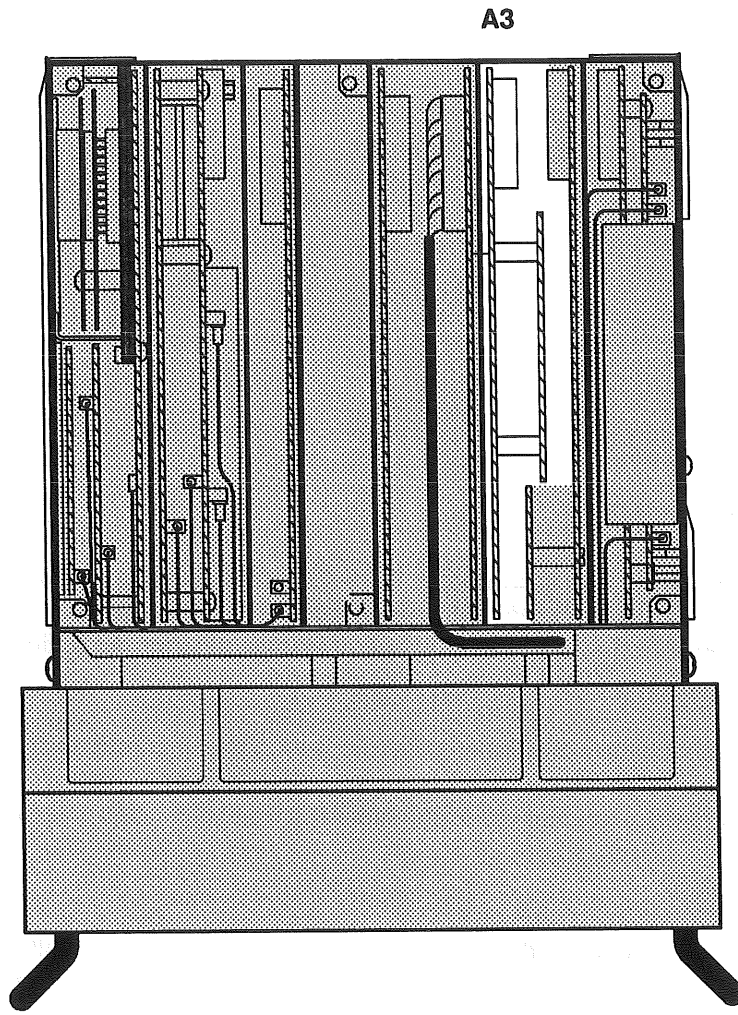
Do not operate the radio with a discharged memory backup battery. The radio will not retain programmed frequency values if the battery is discharged.

Consider the backup battery discharged if the radio has not been used for a month or more. This may be the case, for example, if the radio is new or has been in storage.

To charge the memory backup battery, turn on the radio for at least one hour, preferably several hours. Do this for programming channel 1–7 frequencies or ECCM code values.

NOTE

Handle the A3 module carefully. Do not short module pins or component leads to each other. Because there is a backup battery on this module, improper handling can damage module circuitry or the battery itself.



TOP VIEW

117D-078 DI

Figure 1. A3 Microprocessor Module

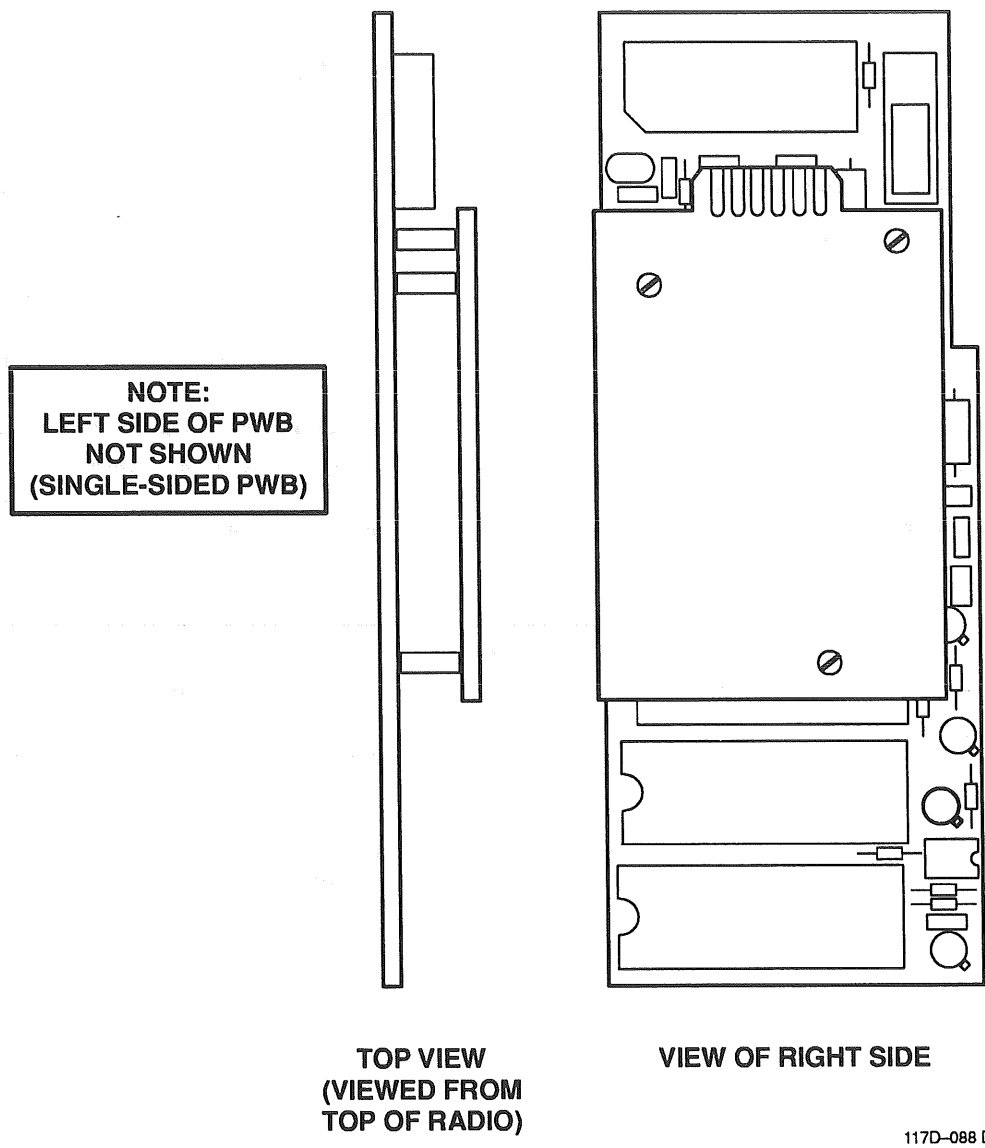


Figure 2. Chassis Position – A3 Microprocessor Module

3. OPERATION

Functions of the microprocessor module include:

- Contains self-identity information
- Performs self test
- Stores frequency values programmed by the operator
- Controls analog and relay switches in audio and antenna tuner modules
- Selects the VCOs in Frequency Synthesizer Module A7
- Coordinates frequency-hopping operation in conjunction with Signal Synchronizer Module A2
- Controls front panel LED display
- Continuously polls front panel controls, switches, and keyline; and controls the radio accordingly

The front cover of this section gives a block diagram of the A3 module. The microprocessor on this module is the central processing unit that is programmed to control the functions of the radio. This module communicates with every other module in the radio chassis by first generating a unique address recognized by an individual module. The microprocessor generates special address and strobe lines to identify the various radio modules and assemblies. The A3 module then reads or writes serial data from/to the module. The A3 module controls the timing of each data transfer by clocking the serial data to read/write 8 bits at a time.

This module contains two types of memory circuitry:

- ROM (Read-Only-Memory) stores the control instructions which direct microprocessor function. ROM contents are factory-programmed, and do not change during radio operation.
- RAM (Random-Access-Memory) stores the operator-programmed frequency values for channels. RAM contents may be changed as often as needed by reprogramming.

The module provides battery backup to maintain RAM contents during battery pack replacement/recharging. A small battery mounted on the main printed wiring board of this module provides continuous memory backup power.

A4 POWER SUPPLY MODULE

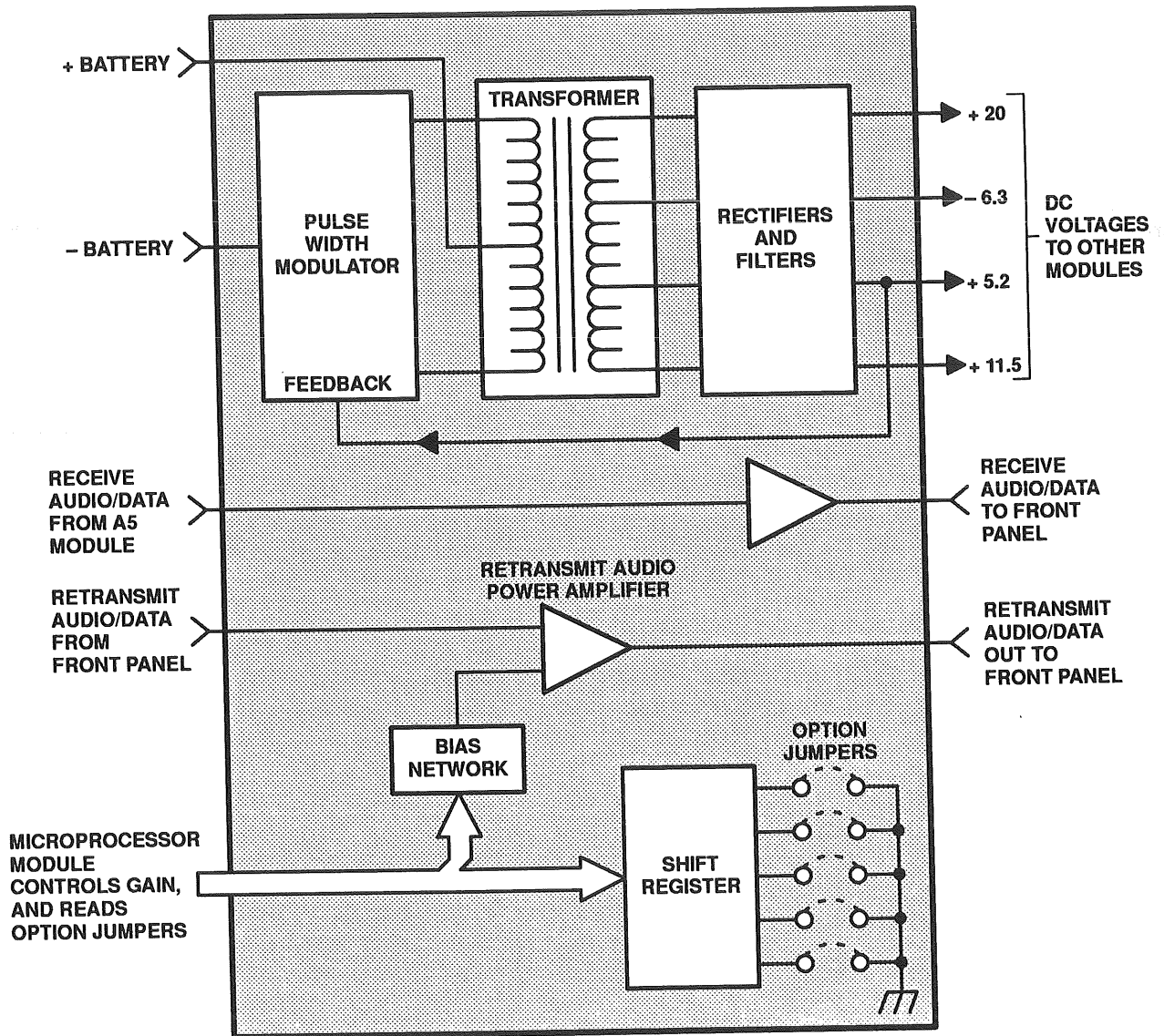


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A4 POWER SUPPLY MODULE

1. GENERAL DESCRIPTION

Power Supply Module A4 generates, from source power, the dc voltages required for radio operation. For the vehicular configuration, source voltage is from the adaptor unit 12 or 12.3 Vdc. For the manpack configuration, source voltage is supplied by the battery pack (12.6 Vdc, nominal). As a separate function, the A4 module also provides the audio power amplifier for use in REXMT and SAE (Stand-Alone Encryption) modes.

2. PHYSICAL CHARACTERISTICS

Figure 1 shows Power Supply Module A4. Figure 2 shows the A4 module position in the R/T Assembly chassis. As figure 2 shows, the multiconductor ribbon cable from the front panel assembly connects to this module.

The backplane connector of this module is marked A04. For positive identification, locate the following identifying numbers on the A4 module:

- 10369-2300
- 10369-2310

2.1 A4 Module Jumper Positions

Jumpers located on Power Supply Module A4 control the functions of other radio modules. Position these jumpers to set up important radio operating parameters. Figure 3 shows the location of jumpers on the module. Table 1 lists individual jumper location and the significance of each jumper.

NOTE

For full compatibility, radios must be jumpered in exactly the same configuration on the A4 module.

For the most part, A4 module jumper options do not affect operator procedures. There is one exception: the "recall inhibit" jumper (E4 to E9). This jumper provides added communications security. When this jumper is installed, the programmed channel frequency or code cannot be recalled after being programmed. Instead, 60.000 displays whenever frequency or code recall is attempted. This prevents unauthorized attempts to identify selected frequencies or codes.

An added security feature is provided when this jumper is installed. If this jumper is removed and the A4 module reinstalled in the chassis, Microprocessor Module A3 detects this and clears RAM memory, erasing the programmed values for each channel. This prevents unauthorized attempts to defeat the recall inhibit option by removing the E4 to E9 jumper.

Jumper E2 to E7 selects frequency deviation, either 5 kHz or 8 kHz. Frequency deviation is an important factor for compatibility with other types of radios. Generally, earlier tactical VHF-FM transceivers were designed for 8 kHz deviation. Newer radios may offer 5 kHz deviation, either as standard or as an option. The primary advantage of 5 kHz deviation is that the signal uses a narrower bandwidth and is less easily detected than the signal with 8 kHz deviation. Receiver sensitivity is also optimized if 5 kHz deviation is selected. Select the frequency deviation (either 5 kHz or 8 kHz) that is compatible with that of other equipment.

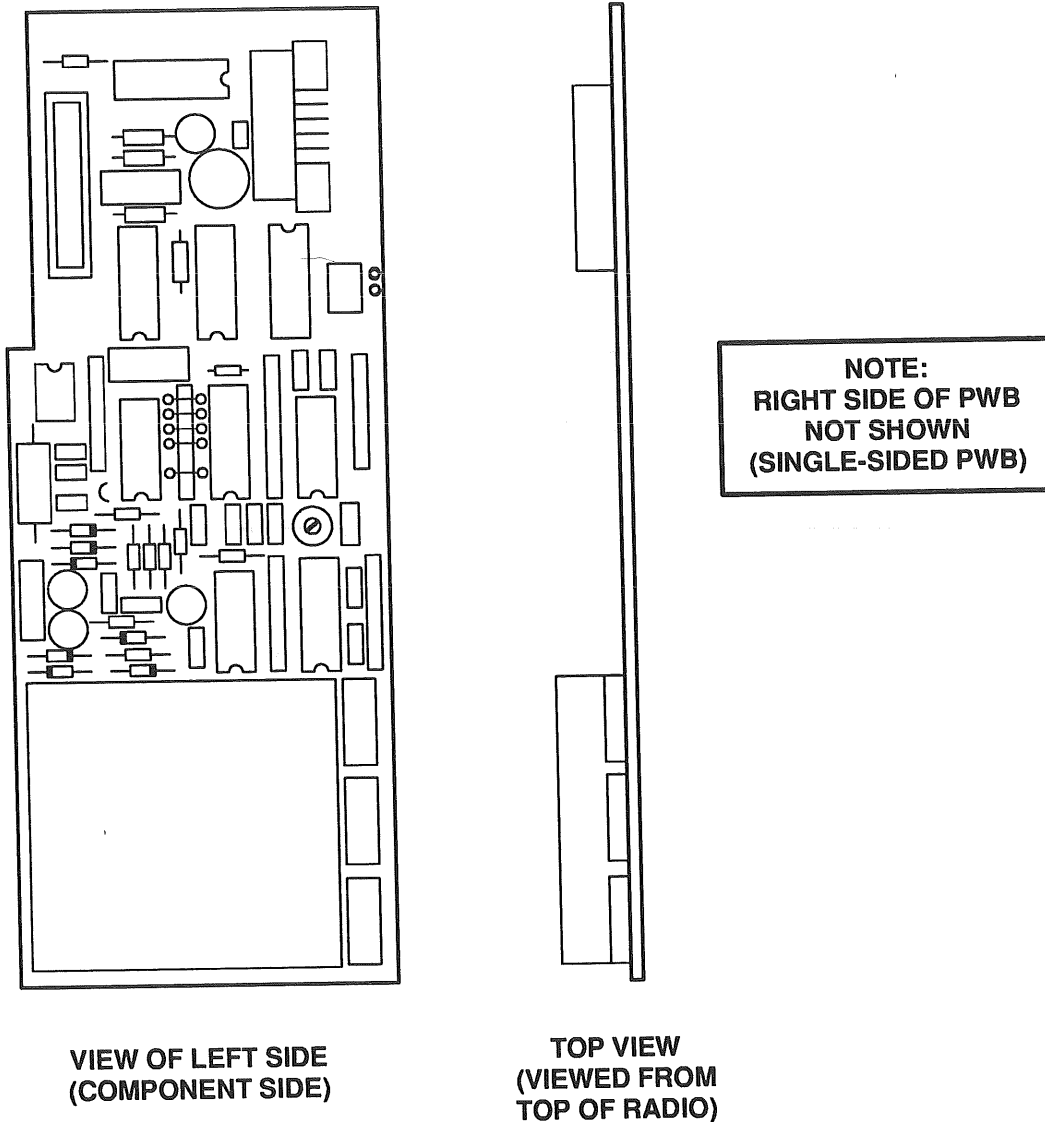
Jumper E3 to E8 controls the automatic transmission of the 150-Hz subcarrier tone when the radio is keyed (VHF-Lo only). The 150-Hz tone is required to unsquelch the receiver when in TONE SQUELCH mode. (See figure 3-5 for a description of receiver squelch response.) If this jumper is removed, the radio can only transmit the 150-Hz tone when keyed in TONE SQUELCH mode.

Jumper E5 to E10 also affects radio squelch response. This jumper determines the type of squelch used in REXMT and SCAN modes for both transmission and reception. With this jumper installed, the receiver

unsquelches only for signals with the 150-Hz subcarrier tone. Likewise, the transmitter sends the 150-Hz subcarrier tone whenever keyed in REXMT or SCAN.

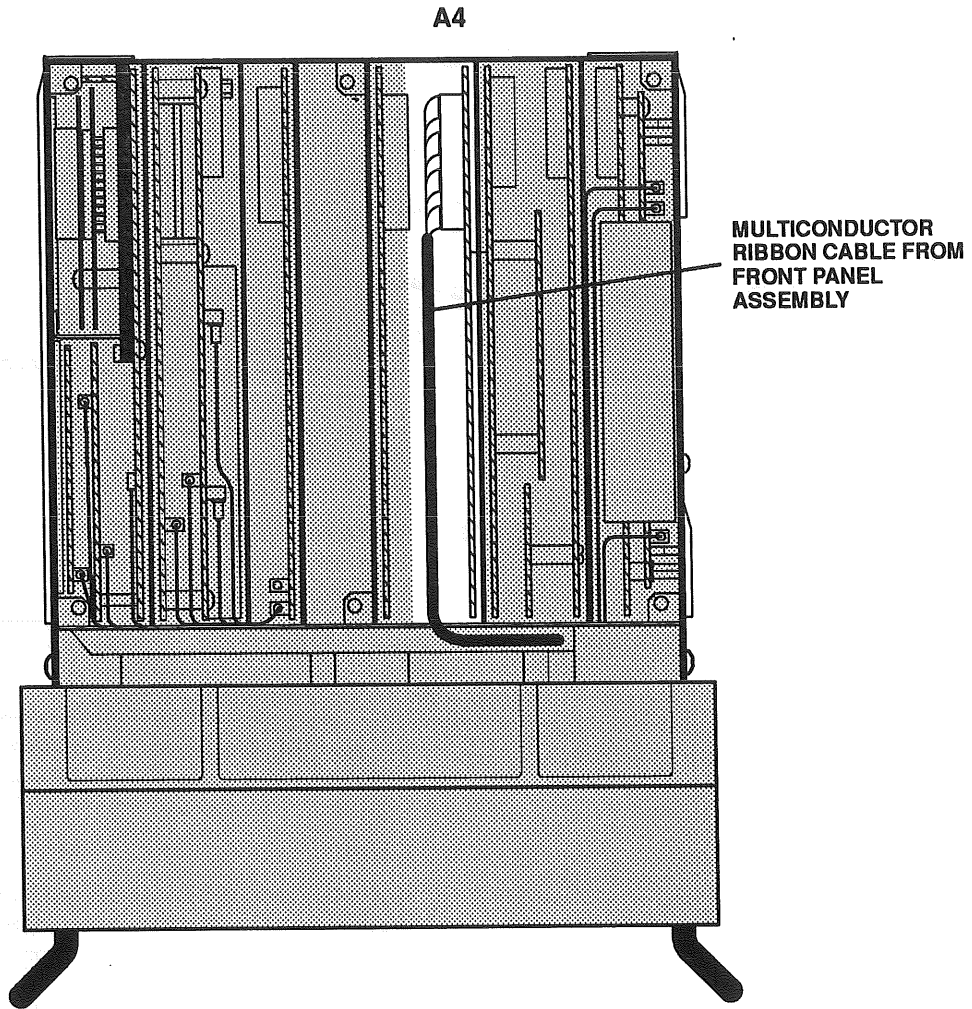
With the E5 to E10 jumper removed, the radio operates with NOISE SQUELCH for both receiving and transmitting in REXMT and SCAN modes.

Jumper E1 to E6 is significant only when using REXMT mode for retransmission/repeater setup. For REXMT mode audio transmission, jumper E1 to E6 should normally be present.; however, when using REXMT mode for data transmission, it may be necessary to remove this jumper.



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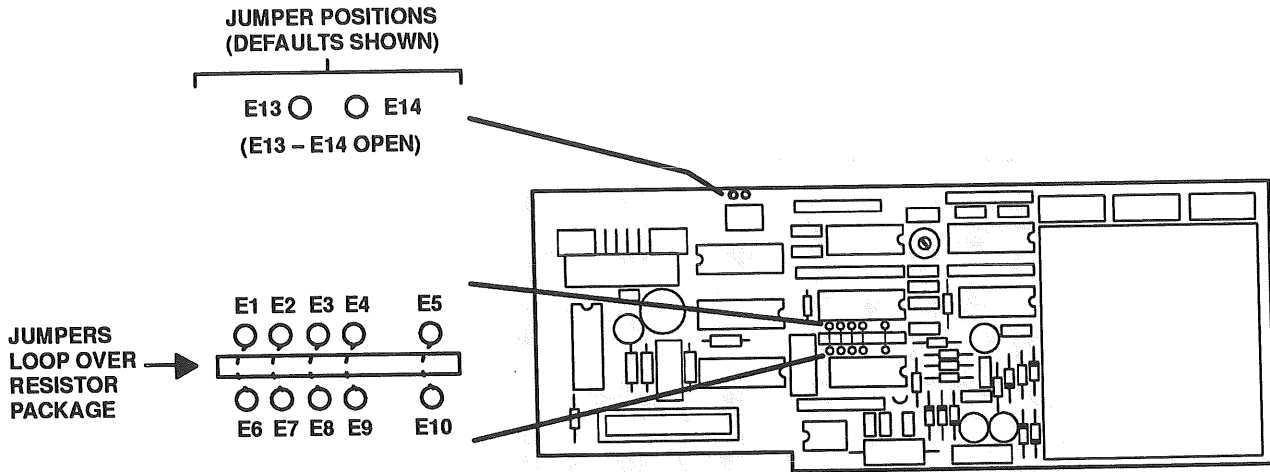
Figure 1. A4 Power Supply Module



TOP VIEW

117D-079 DI

Figure 2. Chassis Positions – A4 Power Supply Module



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Figure 3. Jumper Locations – A4 Power Supply Module

Table 1. Jumper Options – A4 Power Supply Module

Jumper	Operating Option	Jumper Present	Jumper Absent
E1 to E6	Reserved for future use.	*	Not Present
E2 to E7	Frequency deviation	8 kHz *	5 kHz
E3 to E8	TONE SQUELCH transmission (all modes except REXMT)	Always transmits 150 Hz tone. *	Sends 150 Hz tone only when in TONE SQUELCH mode.
E4 to E9	Frequency display recall inhibit (for programmed channels 1-7)	Programmed frequencies cannot be recalled.	Recall of programmed frequencies allowed.*
E5 to E10	SQUELCH in REXMT and SCAN modes	TONE *	NOISE

* Indicates the most likely configuration (and factory defaults).

NOTE: TONE SQUELCH (150-Hz tone) is only allowed in VHF-Lo band.

3. OPERATION

The two primary A4 module functions are:

- Generates the needed dc voltages
- Amplifies the AUDIO/DATA signal in retransmit mode going out the REXMT connector

The cover of this section gives a block diagram showing these functions of the module.

The power supply module generates the following dc voltages:

- + 20 V
- + 11.5 V
- - 6.3 V
- + 5.2 V

To develop these voltages, a pulse-width modulator varies source voltage across the transformer primary. The needed voltages are then tapped at the transformer secondary, rectified, and filtered to provide stable dc outputs. The pulse-width modulator varies the width of the pulses at the transformer primary based on voltage feedback sensed at the transformer secondary. This circuitry monitors the amount of current drawn from the dc source and limits current if necessary.

The audio power amplifier on the A4 module outputs audio and data signals to the front panel REXMT connector. For REXMT, the audio/data signal level is fixed. This is only used in REXMT and Stand-Alone Encryption modes of operation.

Microprocessor Module A3 controls analog switches on the A4 module to control amplifier gain levels and operating mode. The microprocessor also controls D/A (Digital-to-Analog) converter circuitry to measure battery input voltage and monitor module output voltages. The A3 module also reads the status of option jumpers on Power Supply Module A4.



A5 AUDIO MODULE

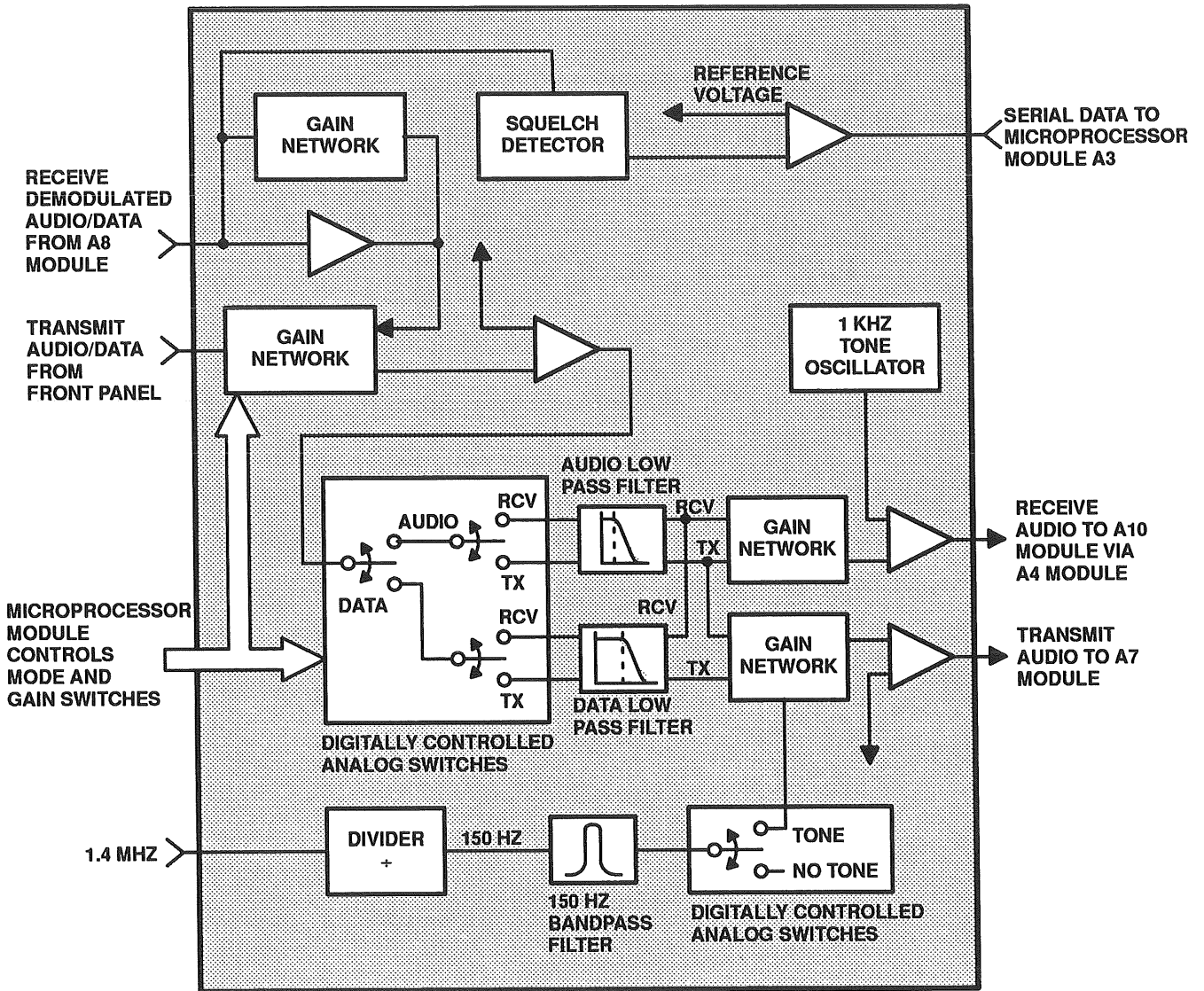


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A5 AUDIO MODULE

1. GENERAL DESCRIPTION

Audio Module A5 handles both received audio/data and transmit audio/data signals. The many functions of this module include audio signal filtering and amplification, generation of the TONE SQUELCH signal (in the transmit path), and detection of TONE or NOISE SQUELCH (in FM receive).

2. PHYSICAL CHARACTERISTICS

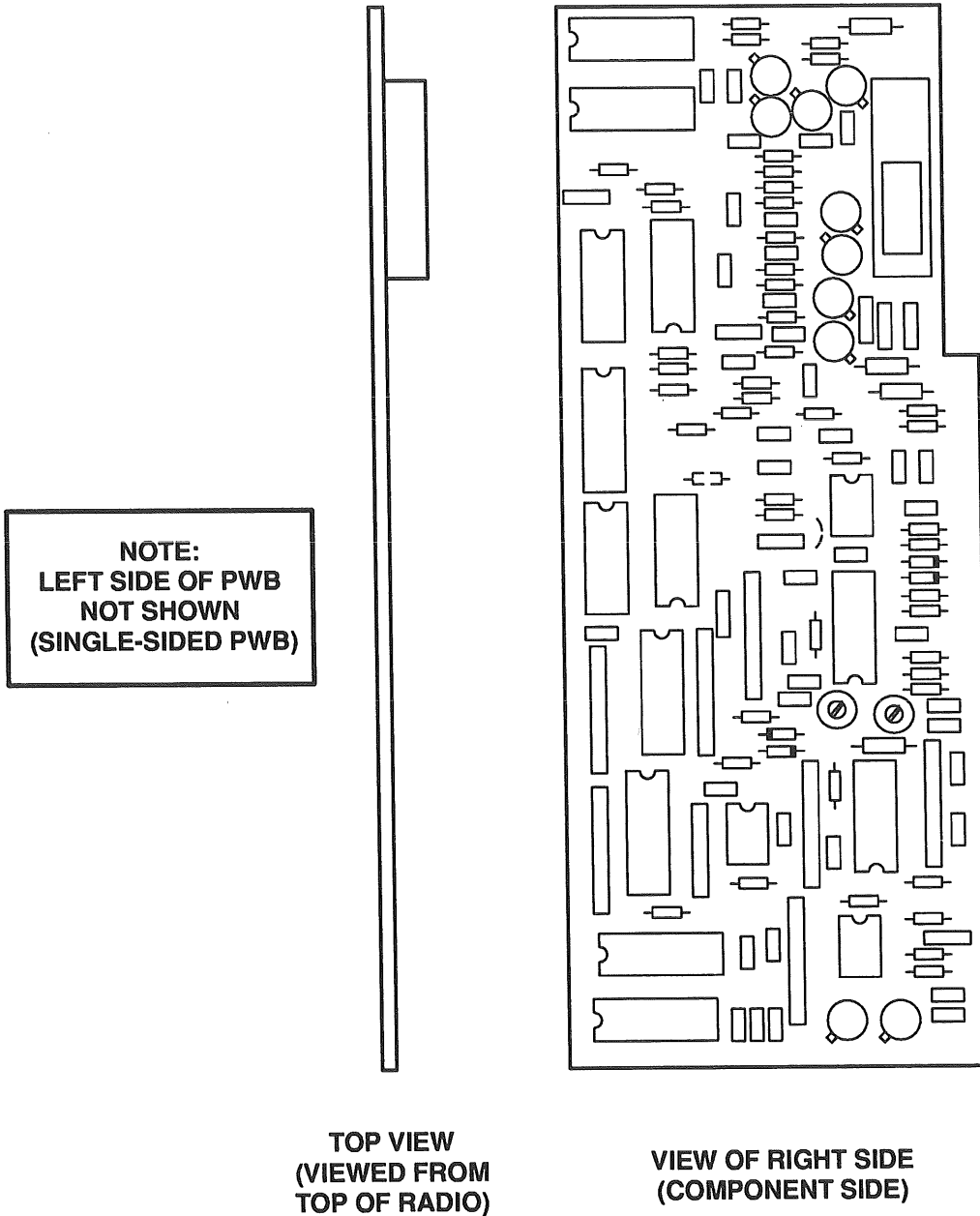
Figure 1 shows audio module A5. Figure 2 shows the A5 module in the R/T Assembly chassis. As figure 2 shows, there are no cable connections to this module.

The backplane connector of this module is marked A05. For positive identification, locate the following numbers on module printed wiring boards:

- 10012-4900-002
- 10012-4009

2.1 Jumper Position

Jumper 1 (JMP 1) and Jumper 2 (JMP 2) must be removed for proper radio operation. The jumper location on the module is shown in figure 3.



117D-090 DI

Figure 1. A5 Audio Module

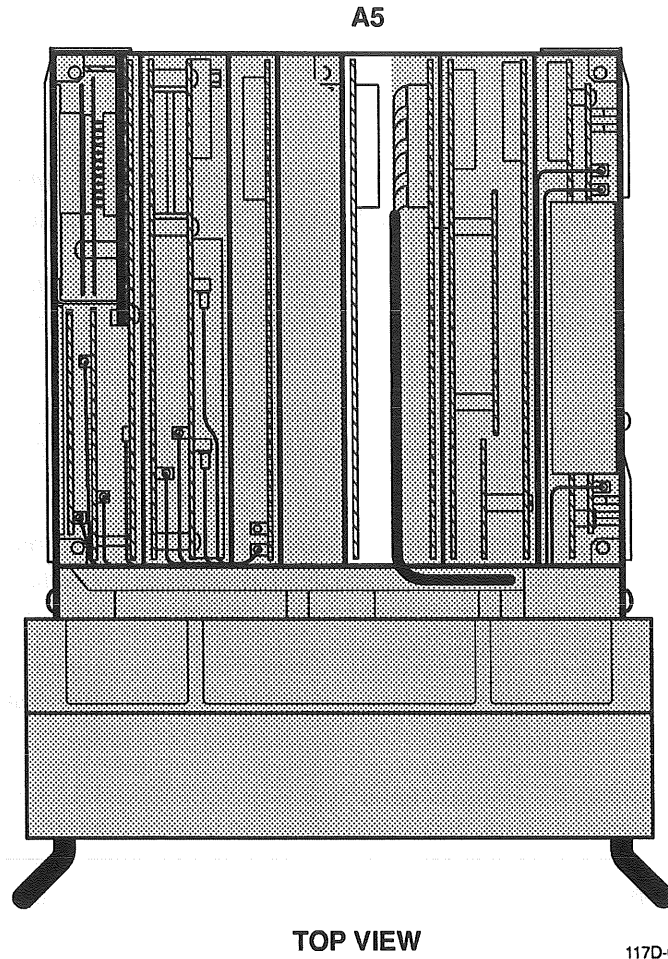


Figure 2. Chassis Position – A5 Audio Module

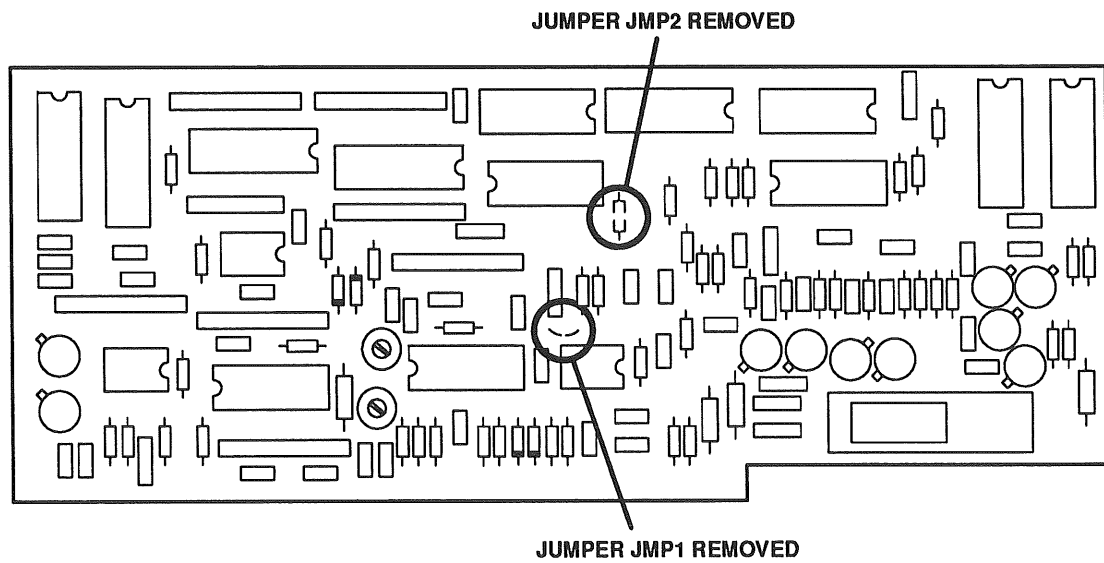


Figure 3. Jumper Positions – A5 Audio Module

3. OPERATION

The front cover of this section gives a block diagram of the A5 module.

Audio Module A5 handles audio and data signals as follows:

- Received audio/data. The module filters, normalizes, and amplifies the demodulated audio/data signal from Receiver Module A8. It outputs received audio/data to Front Panel Module A10.
- The A5 module also detects received signal level (for NOISE SQUELCH) and 150-Hz tone component (for TONE SQUELCH) in FM mode. Results of this detection are read by the Microprocessor Module A3, which then controls squelch response on the A5 module.
- Transmit audio/data. The module filters, limits, and amplifies this signal received from the front panel. The module outputs this transmit signal to Frequency Synthesizer Module A7, and Transmitter Module A9.

At any one time, the module handles only one type of signal (audio or data) in one direction (receive or transmit). As the cover figure shows, much of the module circuitry is shared or common to more than one signal path. For example, low pass filters for data signals are used for both transmit and received data signals. Likewise, the same audio signal filter is used for both transmit and receive signal paths.

Depending on the type of signal and signal direction, Microprocessor Module A3 digitally controls which sections of A5 module circuitry are enabled.

The A5 module adds the 150-Hz tone to the transmit audio signal for TONE SQUELCH operation. (The 150-Hz subcarrier tone is transmitted whenever the front panel RADIO mode control is set to TONE SQUELCH. Jumper options on the A4 module enable the 150-Hz subcarrier tone to be automatically transmitted in any mode.) The module digitally divides the 1.4-MHz signal from the A7 module to derive the 150-Hz tone.

The audio module also generates the 1-kHz beep tone, heard in the handset during:

- ECCM synchronizing
- Low-battery detection
- PRGRM mode
- Self-test detection of a fault
- Receive plain text in secure mode

Through control by Microprocessor Module A3, this module provides the additional audio signal gain required with the front panel DISPLAY DIM/WSPR control at its WSPR setting when in clear-text mode.

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A7 FREQUENCY SYNTHESIZER MODULE

1. GENERAL DESCRIPTION

Frequency Synthesizer Module A7 controls the generation of the transmit and receive LO frequencies and the signal used during tone squelch.

2. PHYSICAL CHARACTERISTICS

Figure 1 shows Frequency Synthesizer Module A7. Figure 2 shows the A7 module position in the R/T chassis. As shown in figure 2, two cables connect to this module. These cables are color coded and can be described as follows:

- Red – Receive LO from Receiver Module A8
- Green – Transmit LO from Transmitter Module A9

The backplane connector of this module is marked A07. For positive identification, locate the following numbers on the A7 printed wiring boards:

- 10369-5400
- 10369-5430

3. OPERATION

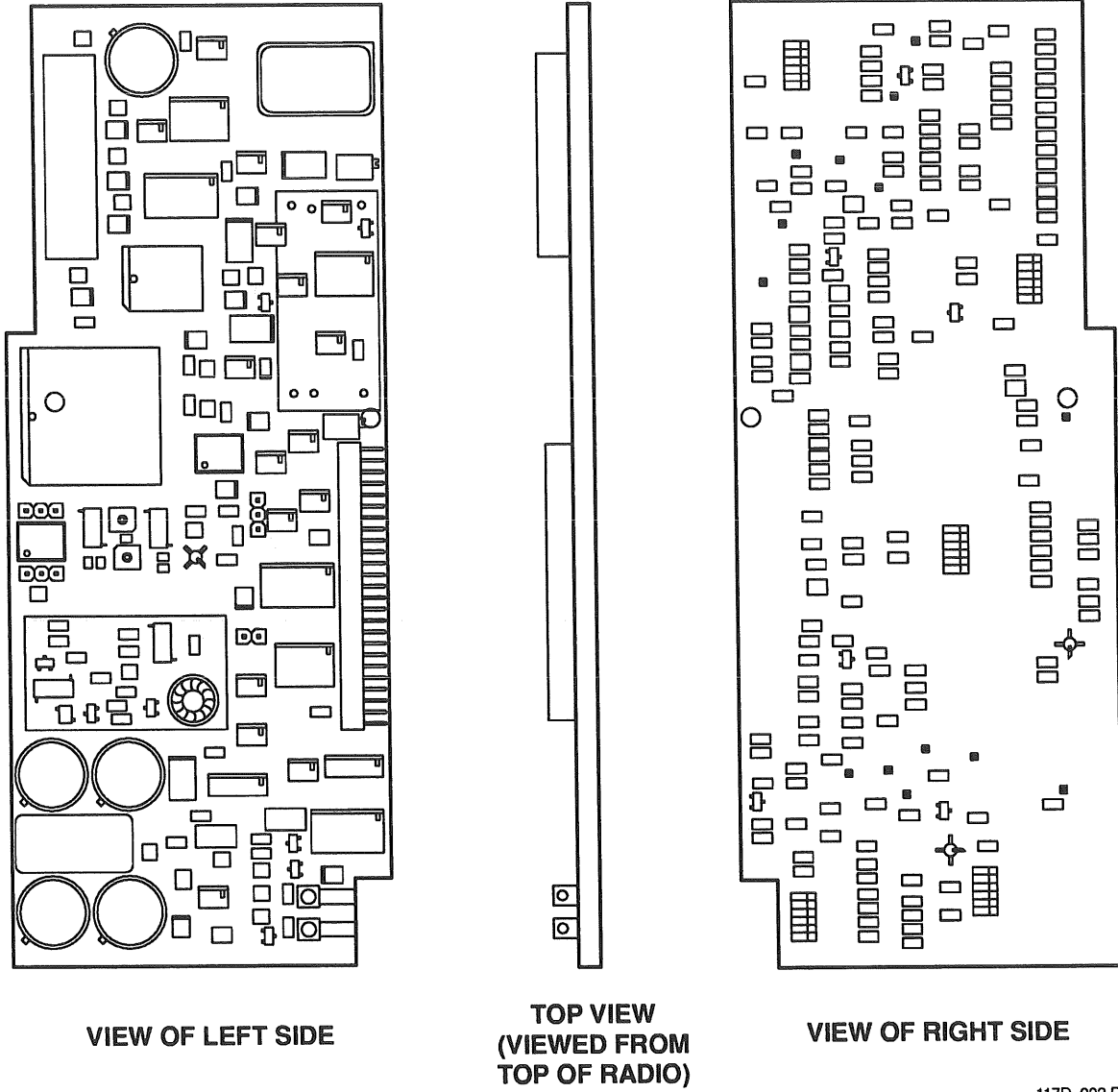
A functional block diagram of the frequency synthesizer module is located on the cover of this section. The A7 module controls and generates the frequencies used in the radio which include the following:

- Receiver first LO frequency, 139 to 409 MHz, mixed with the incoming receive signal on Receiver Module A8.
- Transmit frequency, 30 to 419.995 MHz, modulated on Transmit Module A9.
- 1.4 MHz, divided on Audio Module A5 for 150-Hz tone, used in tone squelch.

The three Phase Locked Loops (PLL) used to generate the synthesizer TX and RX to outputs are all locked to the 14 MHz TCXO (Temperature Controlled Crystal Oscillator). The 14 MHz is also divided down to 1.4 MHz for use by other radio modules. Fine frequency adjustment of the 14 MHz TCXO, and thus the radio transmit frequency is possible using 10-turn potentiometer R₁. R₁ is accessible at the upper edge of the A7 assembly while installed in the radio chassis.

The 14 MHz TCXO is divided down for use in each of the three PLL circuits. The fine frequency steps (5.0 or 6.25 kHz up to 1 MHz) are generated by the fine steps loop, which produces a 5–7 MHz output. The 105 MHz loop uses a low-noise 105 MHz Voltage Controlled Crystal Oscillator (VCXO), and is FM-modulated by the premodulated audio from the A5 Audio Assembly. The 5–7 MHz fine steps output and 105 MHz FM loop are mixed together and filtered to produce a 110–112 MHz offset signal. The 110 MHz offset signal can be FM modulated and tunes in 5.0 or 6.25 kHz steps to provide the radio channel spacing.

The four output VCOS provide the capability to generate frequencies from 30 to 419.995 MHz. The four VCOS are combined into one common output (only one VCO at a time is enabled by the A7 Assembly Control circuitry). The VCO output is fed to the output mute, T/R switch circuits, and to the offset mixer. At the offset mixer, the VCO output is mixed with the 110–112 MHz offset signal and filtered by a tunable bandpass filter. The filtered signal is divided and input to a phase detector, along with the divided 14 MHz TCXO signal. The PLL filters the phase detector output and uses it to generate the VCO control voltage to phase lock the VCO to the 14 MHz TCXO. By using the 110–112 MHz offset signal, any fine tuning steps or FM which is present on the offset signal will also appear on the synthesizer Lo output.



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Figure 1. A7 Frequency Synthesizer Module

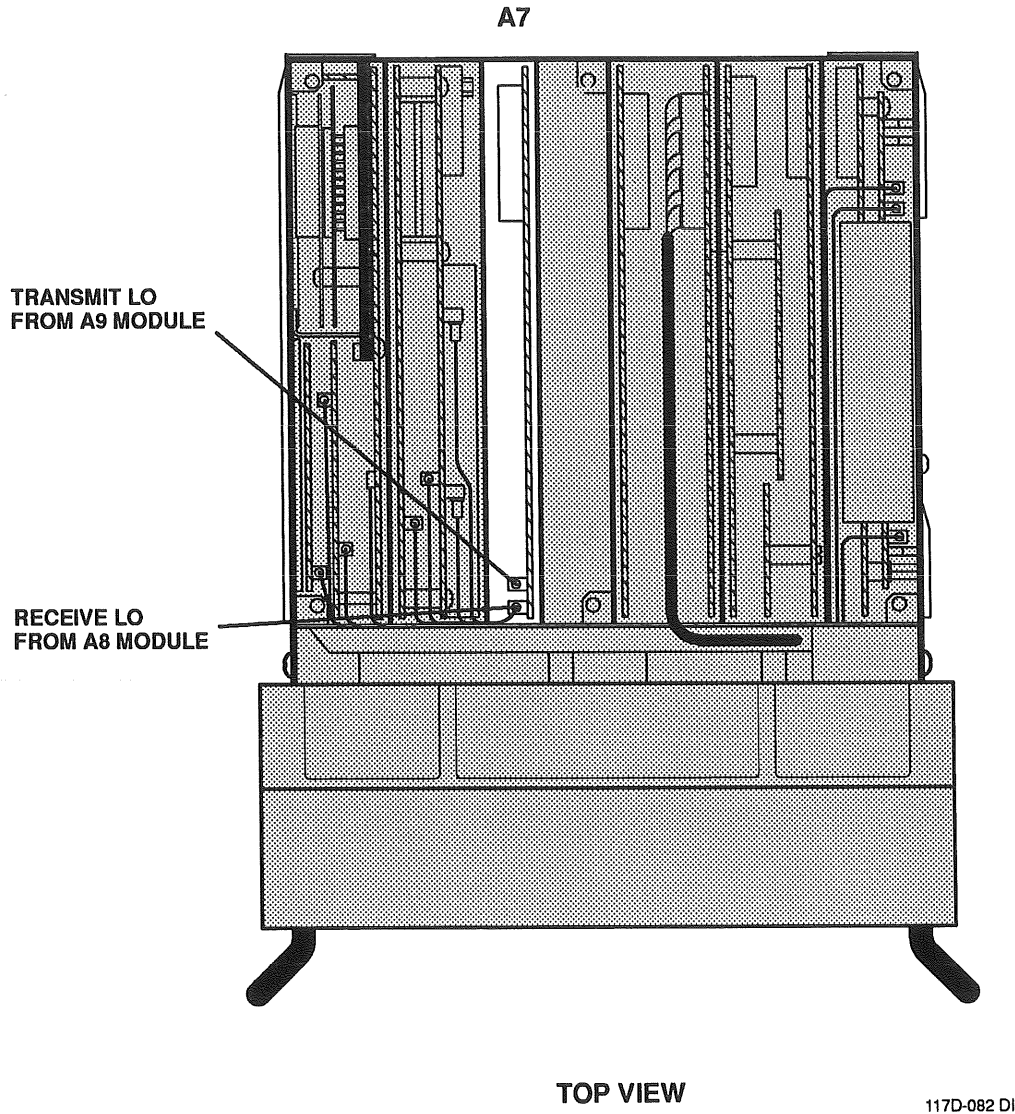


Figure 2. Chassis Position – A7 Frequency Synthesizer Module

A8 RECEIVER MODULE

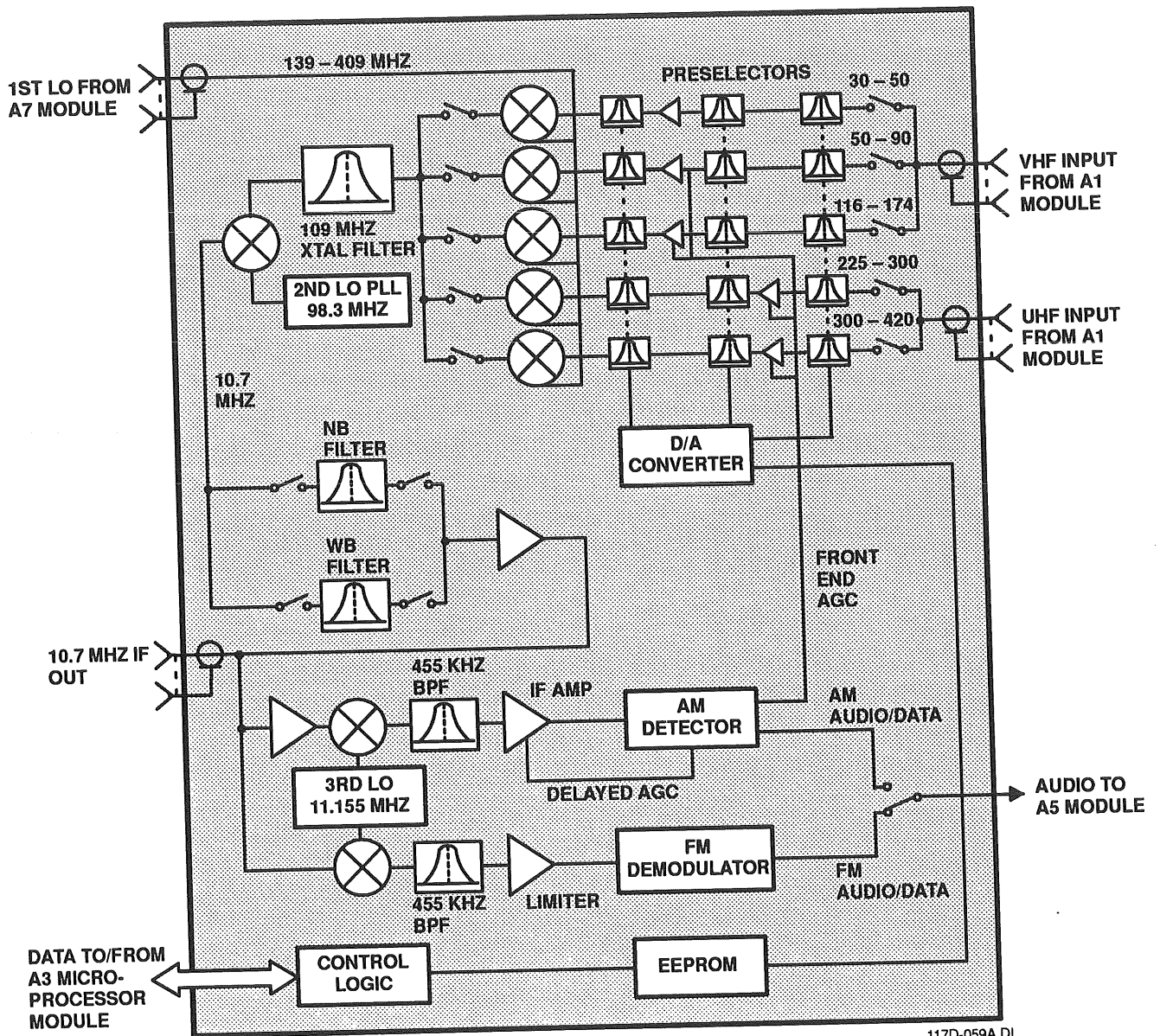


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A8 RECEIVER MODULE

1. GENERAL DESCRIPTION

Receiver Module A8 demodulates received FM signals, detects received AM signals, and outputs audio/data signals.

2. PHYSICAL CHARACTERISTICS

Figure 1 shows Receiver Module A8. Figure 2 shows the A8 module position in the R/T Assembly chassis. As shown in figure 2, three cables connect to this module. These cables are color coded and can be described as follows:

- Red – Receive LO to Synthesizer Module A7
- Blue – VHF receive to Antenna Tuner/Filter Module A1
- White – UHF receive to Antenna Tuner/Filter Module A1

The backplane connector of this module is marked A08. For positive identification, locate the following numbers on A8 printed wiring boards:

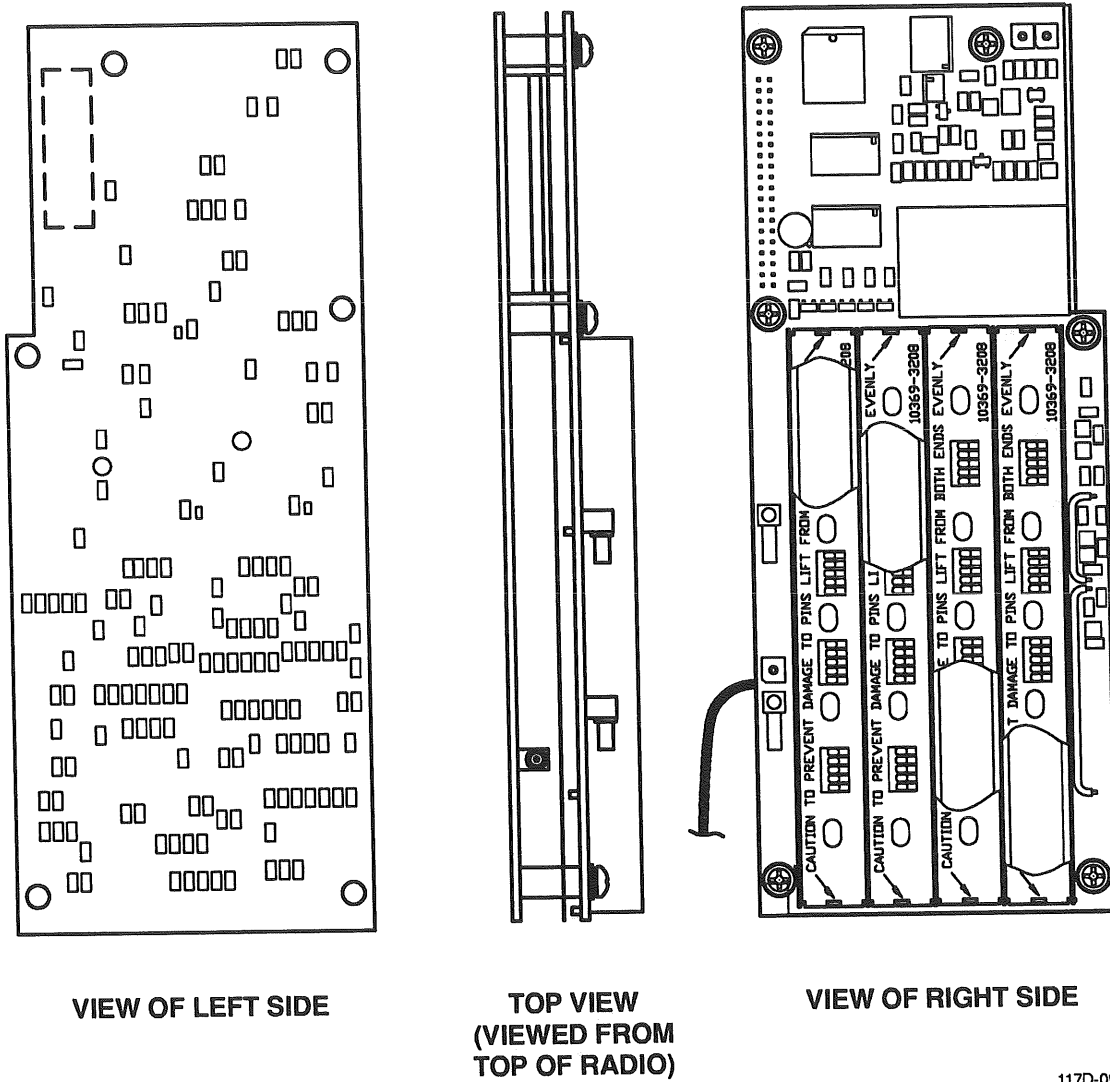
- 10369-3100
- 10369-3200
- 10369-3210
- 10369-3220
- 10369-3230
- 10369-3240

3. OPERATION

Receiver Module A8 filters the received RF signal through tuned preselector circuitry. The RF signal is then converted to the 109-MHz first IF. The first IF goes through a crystal filter before getting mixed to the 10.7-MHz second IF. From here, the signal is filtered through a wideband or narrowband filter, depending on the mode of operation used. For voice signals, the second IF splits into two separate mixers. Both mixers output 455-kHz third IFs, which are filtered by 455-kHz bandpass filters. One third IF goes into an IF amplifier and AM detector for AM operation. The other third IF goes into a limiter and FM demodulator for FM operation. The audio output from either the detector or demodulator then goes on to the Audio Module A5 for further processing.

The following functions are controlled by the control logic circuitry:

- Preselector switching
- IF bandwidth switching
- Switching between AM detection or FM demodulation



117D-093

Figure 1. A8 Receiver Module

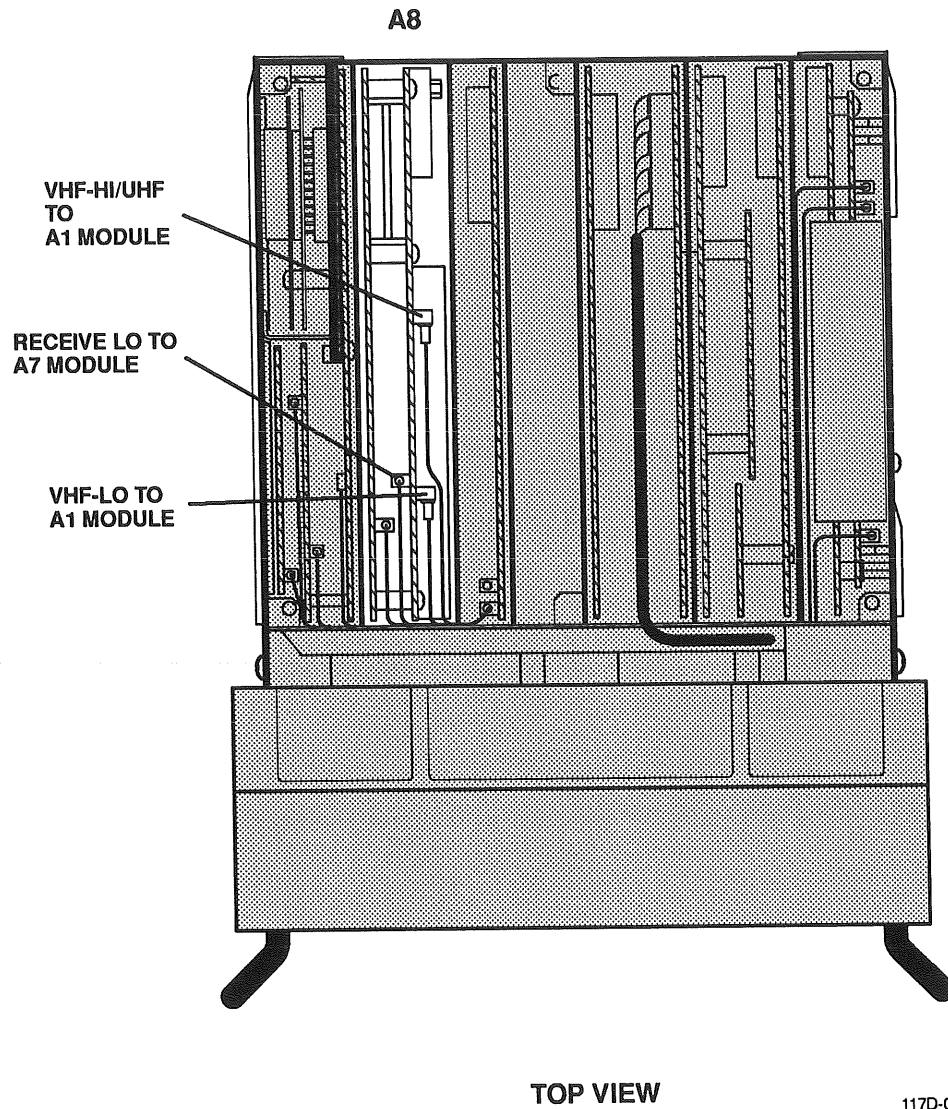


Figure 2. Chassis Position – A8 Receiver Module

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that this is crucial for ensuring the integrity of the financial statements and for providing a clear audit trail. The text also mentions that proper record-keeping is essential for identifying and correcting errors in a timely manner.

2. The second part of the document focuses on the role of internal controls in preventing fraud and misstatements. It highlights that a strong internal control system is necessary to ensure that all transactions are properly authorized, recorded, and classified. The document also notes that internal controls should be designed to provide reasonable assurance of the reliability of the financial reporting process.

3. The third part of the document discusses the importance of segregation of duties. It explains that this principle is essential for preventing fraud and ensuring the accuracy of the financial statements. The text also mentions that segregation of duties should be implemented in a way that ensures that no single individual has control over all aspects of a transaction.

4. The fourth part of the document discusses the importance of regular reconciliations. It explains that reconciling accounts is a key component of the internal control system and is essential for ensuring that the financial statements are accurate. The text also notes that reconciliations should be performed regularly and by someone other than the person who prepared the original entries.

5. The fifth part of the document discusses the importance of maintaining up-to-date records. It explains that records should be kept for a sufficient period of time to allow for a complete audit. The text also mentions that records should be stored in a secure and accessible location to ensure that they are available when needed.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that this is crucial for ensuring the integrity of the financial statements and for providing a clear audit trail. The text also mentions that proper record-keeping is essential for identifying and correcting errors in a timely manner.

A9 TRANSMITTER MODULE

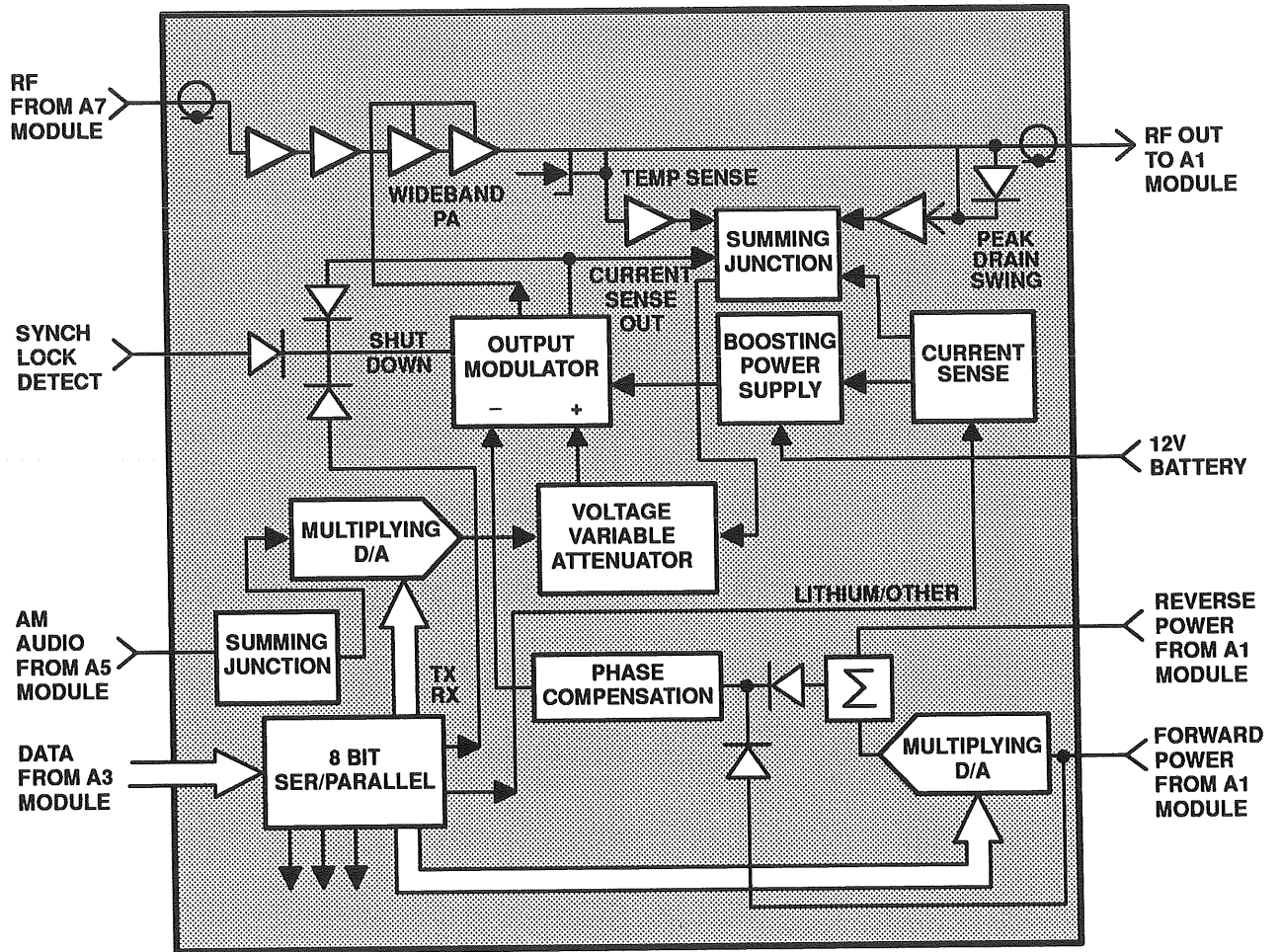


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A9 TRANSMITTER MODULE

1. GENERAL DESCRIPTION

Transmit carrier signals and FM modulation originate in the Frequency Synthesizer Module A7. FM signals are then amplified by the Transmitter Module A9. In AM mode Transmitter Module A9 also provides high level modulation of the amplified carrier signal. All power control, under normal and adverse conditions, is implemented via the high level modulator.

2. PHYSICAL CHARACTERISTICS

Figure 1 shows Transmitter Module A9. Figure 2 shows the A9 module position in the R/T Assembly chassis. As shown in figure 2, three cables connect to this module. These cables are color coded and can be described as follows:

- No Color – Forward/reflected power detect from Antenna Tuner/Filter Module A1
- Black – RF drive from Frequency Synthesizer Module A7
- Blue – VHF/UHF PA power out to Antenna Tuner/Filter Module A1

The backplane connector of this module is marked A09. For positive identification, locate the following numbers on A9 module printed wiring boards:

- 10369-4110
- 10369-4120
- 10369-4130
- 10369-4210
- 10369-4220
- 10369-4240

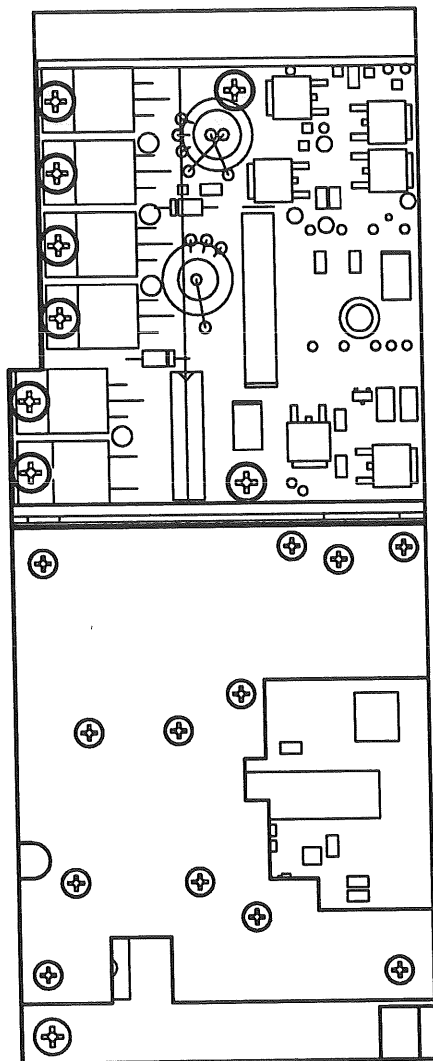
3. OPERATION

FM modulation is developed on the Frequency Synthesizer Module A7 and is part of the drive signal. A functional block diagram of the Transmitter Module A9 is located on the front cover of this section. The Transmitter Module A9 contains a wideband VHF/UHF PA, the protective circuitry for the PA, AM modulation and power control circuits, power supply circuits (boosts battery 12V to 33 V), and battery current limit circuits (lithium mode).

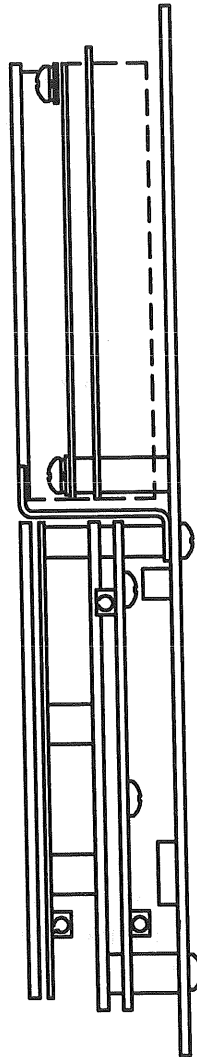
The synthesizer frequency goes to the wideband PA. The PA output passes via coax cable to Antenna Tuner/Filter Module A1.

In AM, the modulating audio/data signal from the Audio Module A5 goes through a summing junction, digital-to-analog converter, and a variable voltage attenuator. The signal then goes through a switching modulator that controls the supply voltage to the wideband VHF/UHF. The modulator senses voltage levels from the forward/reflected detectors (A1), temperature, battery, and PA current sense circuitry. The sense circuitry acts to reduce the carrier and AM power levels under adverse conditions.

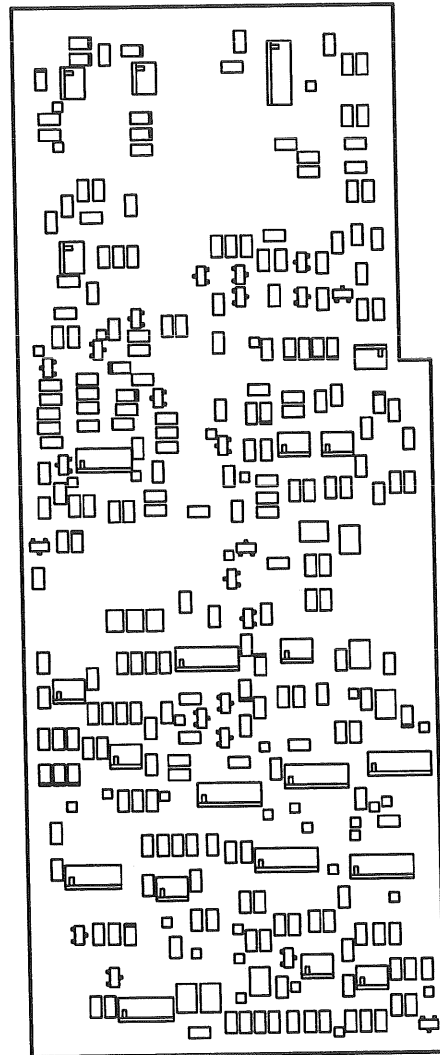
In FM, audio paths in the transmitter are muted. The modulator continues to control and reduce power under normal and adverse load conditions in these modes. Microprocessor Module A3 sets the modulation mode, PA selection, power level, battery current limit mode (lithium) and state (TX or RX) of the transmitter, and reads the self-test status.



VIEW OF LEFT SIDE



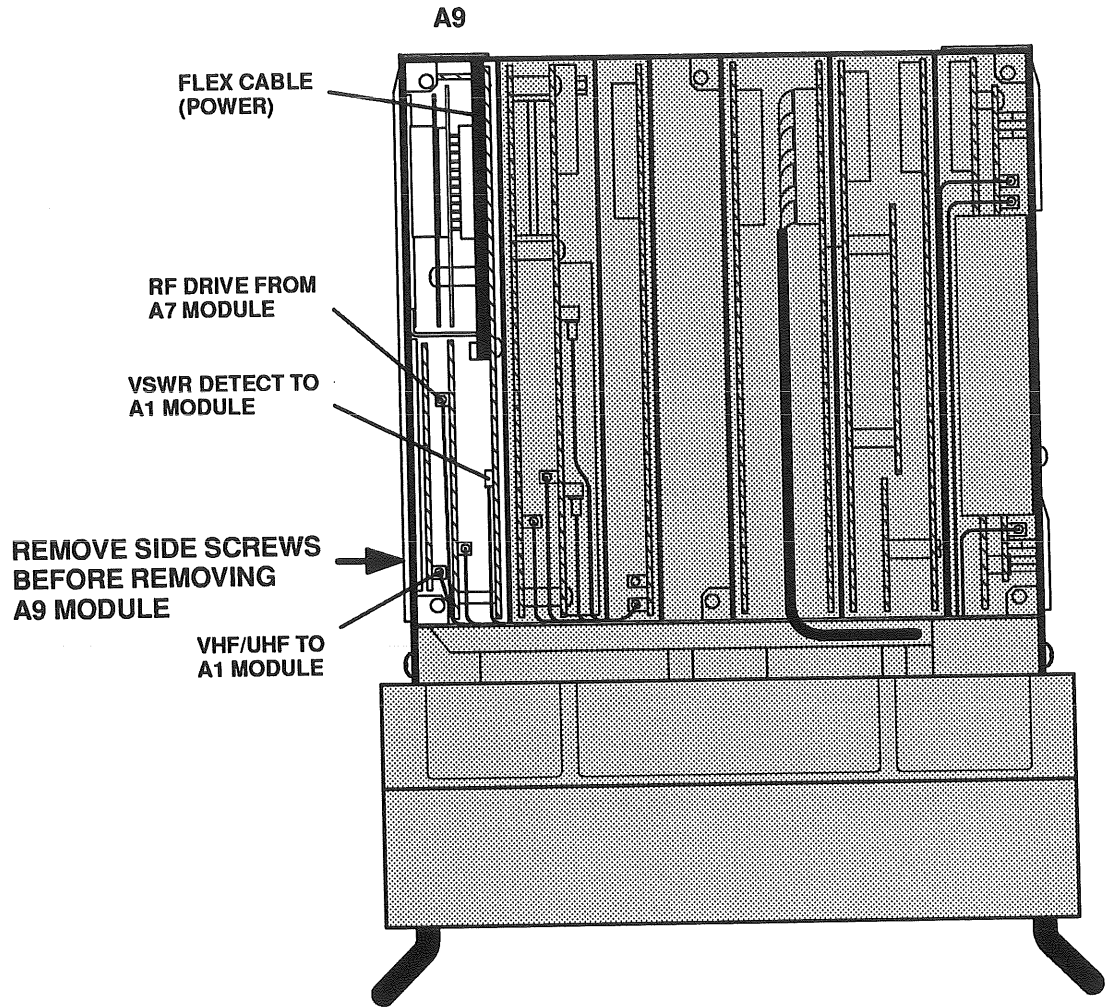
TOP VIEW
(VIEWED FROM
TOP OF RADIO)



VIEW OF RIGHT SIDE

117D-094

Figure 1. A9 Transmitter Module



TOP VIEW

117D-084 DI

Figure 2. Chassis Position – A9 Transmitter Module

The following information is provided for your reference:

1. The first section of the document contains a list of items.

2. The second section contains a detailed description of the items.

3. The third section contains a list of the items' locations.

4. The fourth section contains a list of the items' dates.

5. The fifth section contains a list of the items' quantities.

6. The sixth section contains a list of the items' values.

7. The seventh section contains a list of the items' owners.

8. The eighth section contains a list of the items' status.

9. The ninth section contains a list of the items' notes.

10. The tenth section contains a list of the items' comments.

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A10 FRONT PANEL ASSEMBLY

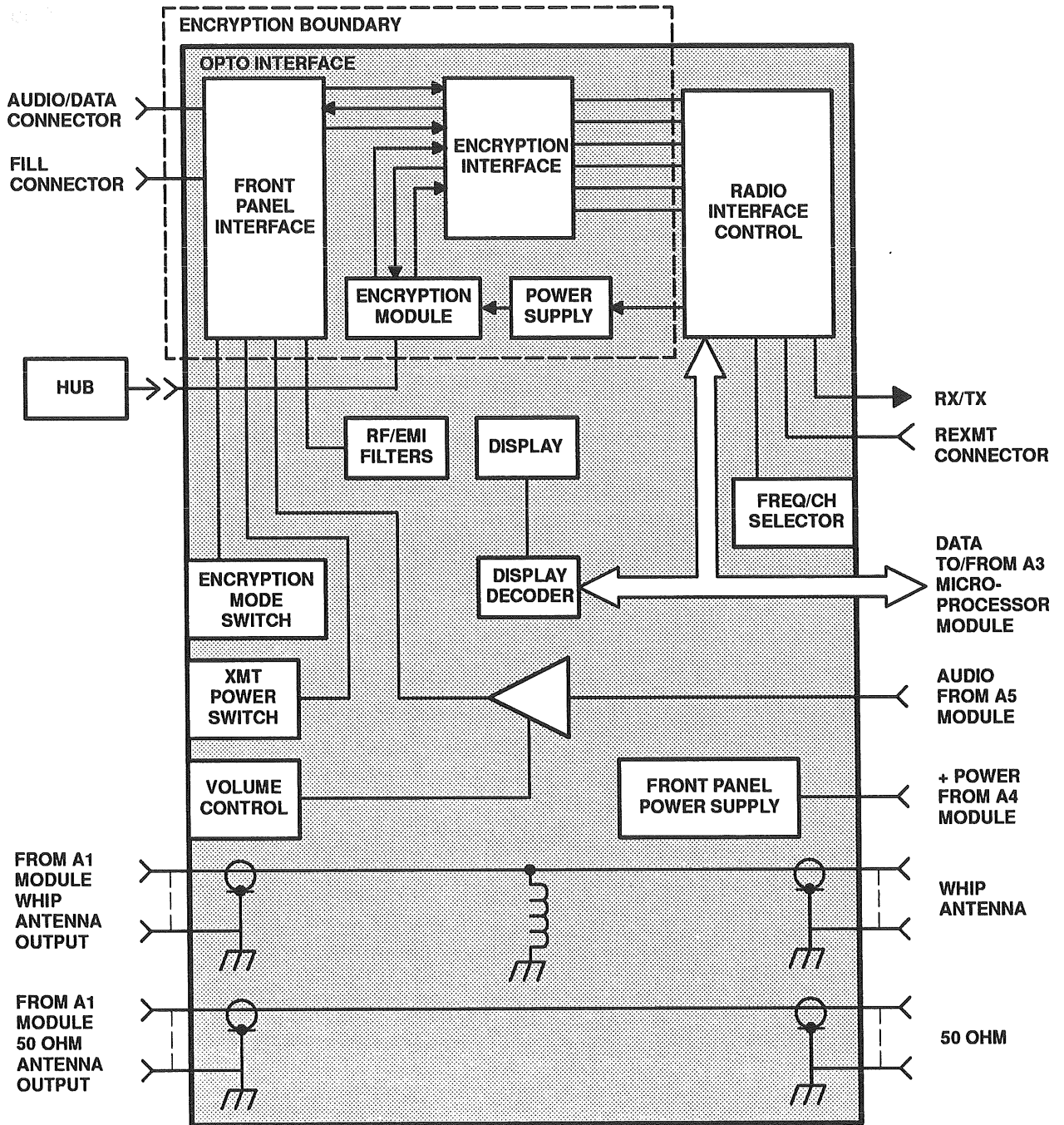


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A10 FRONT PANEL ASSEMBLY

1. GENERAL DESCRIPTION

The A10 Front Panel Assembly provides all operator controls, connectors for handset and manpack antenna, and the LED display. The following functions of this assembly are:

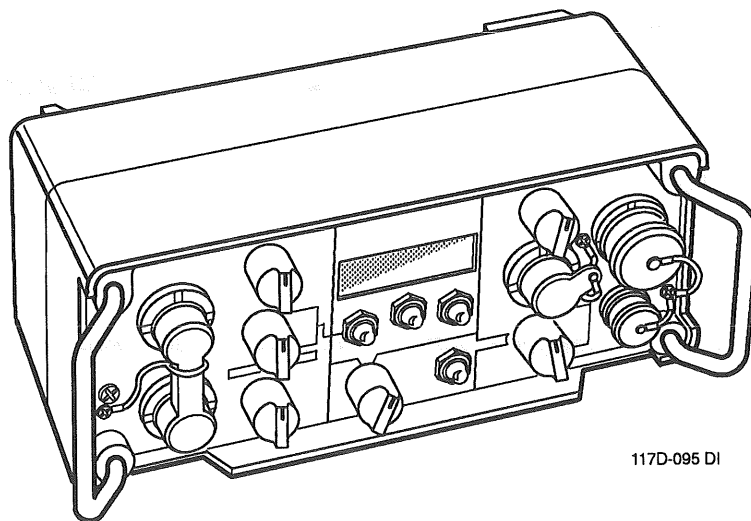
- Controls display brightness and audio levels
- Converts switch positions to digital data for the microprocessor
- Provides encryption functions

2. PHYSICAL CHARACTERISTICS

Figure 1 shows Front Panel Assembly A10. Figure 2 shows the A10 Assembly position in the R/T chassis. As shown in figure 2, one cable connects to this module. This cable is color coded and can be described as follows:

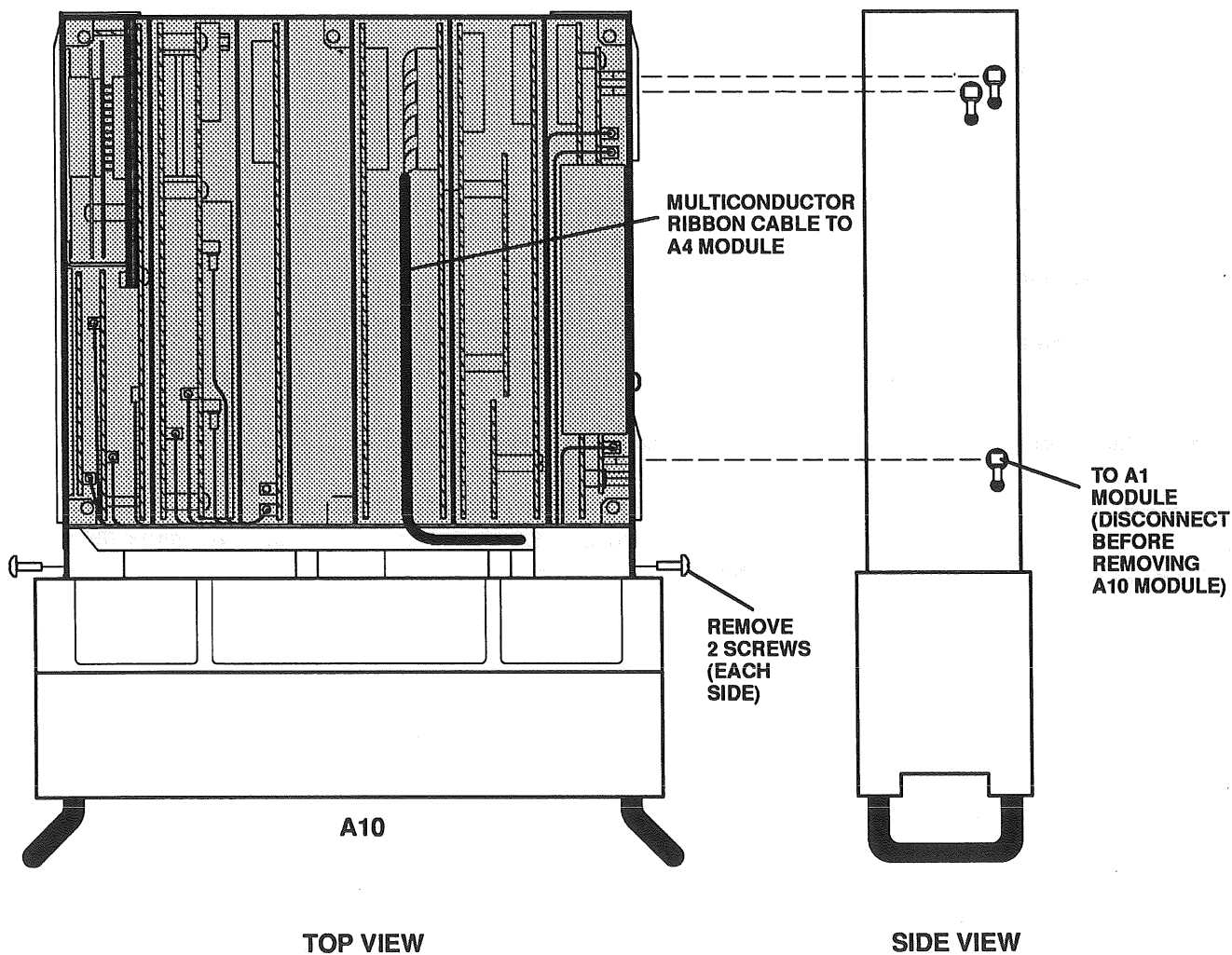
- Black – RF from 50 ohm connector to Antenna Tuner/Filter Module A1

To remove the front panel assembly from the chassis, first disconnect the RF cable from the A1 module. To disconnect the front panel, remove the multiconductor ribbon cable from the A4 module, then remove the screws on each side of the assembly, as indicated in figure 2.



117D-095 DI

Figure 1. A10 Front Panel Assembly



117D-085 DI

Figure 2. Chassis Position – A10 Front Panel Assembly

3. OPERATION

A functional block diagram of the front panel assembly is located on the front cover of this section.

The front panel interface circuitry takes care of most operator controls. One exception is the VOLUME control which is tied directly into the audio amplifier. The front panel interface ties into the Encryption Interface circuitry.

The Encryption Interface circuitry basically performs two functions. The first function is the interface to the encryption module. The second function is the Interface to the Radio Interface Control circuitry. A dedicated power supply circuit provides power to the encryption functions.

The Radio Interface Control circuitry is the link between the front panel and the rest of the radio. The most important link is the data lines to Microprocessor Module A3. The second link is the RX/TX line which tells the radio to transmit or receive. Unlike AUDIO/DATA and FILL, the RXMT connector ties into the Radio Interface Control circuitry. The frequency/channel selection switch is also tied into this circuitry with the generated data going to the data lines.

Also tied into the data lines is the display decoder. This decoder takes the data generated from Microprocessor Module A3 based on the frequency/channel selections. The decoded signal then goes to the display where frequency, channel, mode, and fault indications are displayed.

Two RF signal paths are also present on the front panel assembly. One path is the 50-ohm path. The other is the whip antenna path. The whip antenna path is used only when operating at a VHF-Lo frequency and a VHF-Lo whip is installed. The 50-ohm path is used in all other cases.

NOTE

An exception is multiband scan when VHF-Lo frequencies are included. See section 3.12 for clarification.)

Front Panel Assembly A10 has its own power supply, as shown in the block diagram. Functions, such as ENCRYP Zeroize and radio on or off, can be performed while the rest of the radio is off.



GLOSSARY

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GLOSSARY

-A-

A, AMP	Ampere(s)
ac, AC	Alternating Current
Address, Addr, ADDR	Address
AF	Audio Frequency
AGC	Automatic Gain Control
AK	Automatic Rekey
ALC	Automatic Level Control
AM	Amplitude Modulation
Amp, AMP	Ampere(s), Amplifier
Ant., ANT	Antenna
Approx.	Approximately
Assy(s)	Assembly, Assemblies
Async	Asynchronous
AUD	Audio
Auto, AUTO	Automatic
Aux, AUX	Auxiliary

GLOSSARY (Cont.)

-B-

batt., BATT	Battery
BER (Bit Error Rate)	Bit Error Rate; An evaluation of the ability of a channel to pass error-free data information.
BLK	Black, Block
BLU	Blue
BNC	Baby N Connector (bayonet type)
bps	Bits Per Second (number of discrete signal elements per second)
BRN	Brown
BW	Bandwidth

-C-

C	Degrees Celsius; Clear
CB	Circuit Breaker
CCW or ccw	Counterclockwise
Channel, Ch, CH., CHAN	Channel; A programmed combination of frequency and mode of transmission
CKT	Circuit
CLR	Clear
cm	Centimeter
CMOS	Complimentary-Metal-Oxide-Semiconductor
Conn	Connector, Connection
CTRL	Control
CW	Continuous Wave

GLOSSARY (Cont.)

-D-

D/A	Digital-to-Analog
dB	Decibel(s)
dBc	Decibels relative to carrier
dBm	Decibels above or below 1 milliwatt (or decibels referenced to 1 milliwatt)
dc, DC	Direct Current
Demod	Demodulated
Diff	Differential
Dip, DIP	Dual In-Line Package
DLY	Delay
DVM	Digital Volt Meter (or Digital Voltmeter)

-E-

Eb/N0	Energy per Bit in Noise (noise in 1 Hz)
ECCM	Electronic Counter-Countermeasure(s) (or Electronic Counter-Counter Measure(s))
EEPROM	Electrically Erasable Programmable Read-Only Memory
EEROM	Electrically Erasable Read Only Memory
EIA	Electronic Industries Association
EMI	Electromagnetic Interference
EPROM	Erasable Programmable Read-Only Memory
EQ., Equip.	Equipment
ERASE	Erase all encryption variables
EXT	External

-F-

f	Frequency
Fig.	Figure
FM	Frequency Modulation
FSK	Frequency Shift Keying
FWD	Forward

GLOSSARY (Cont.)

-G-

g	Gram
Gnd, GND	Ground
GRN	Green
GRY	Gray

-H-

HD	Half Duplex
HDBK	Handbook
HF	High Frequency (from about 3 to 30 MHz)
Hz	Hertz
HUB	Hold-Up-Battery

-I-

IC	Integrated Circuit
ID	Identification
I/F	Interface
IF	Intermediate Frequency
I/O	Input/Output

-J-

J	Jack (connector) Designation
----------	------------------------------

-K-

k	Thousand
K	Thousand; Relay Designation
Kbyte (also KB)	Kilobyte
KEY	Keyline
kg	Kilogram
kHz	Kilohertz
km, KM	Kilometer(s)
Kohm	Kilohm(s)
kW	Kilowatt(s)

GLOSSARY (Cont.)

-L-

LD	Load
LED	Light-Emitting Diode
LOS	Line Of Sight
LP	Low Pass
LSB	Lower Sideband

-M-

M	Mile, when used with a unit of measure; Mega (one million)
m	Meter, when used with a unit of measure; Milli (one thousandth)
mA	Milliampere(s)
Maint	Maintenance
Max.	Maximum
MDM	Modem
MHz	Megahertz
MIC	Microphone
MIL	Military
MIL-STD	Military Standard
mm, MM	Millimeter(s)
Mod	Modification, Modulated
Modem	Modulator-Demodulator
MON, MON.	Monitor
MOS	Metal Oxide Semiconductor
MOSFET	Metal Oxide Semiconductor Field Effect Transistor
ms, msec	Millisecond
MTBF	Mean Time Between Failure
MTBR	Mean Time Between Replacement
mV	Millivolt
mW	Milliwatt

GLOSSARY (Cont.)

-N-

n	Nano
NB	Narrowband
NC, N.C.	Normally Closed
N/C	Not Connected
Neg	Negative
Ni-Cd	Nickel Cadmium
NO, N.O.	Normally Open
No.	Number

-O-

O.C.	Open Circuit or Open Collector
Op Amp	Operational Amplifier
ORG	Orange

-P-

p	Pico (millionth-millionth or milli-milli)
P	Plug (connector) designation; Power; Plain
PA	Power Amplifier
PCB, pcb	Printed Circuit Board
PEP	Peak Envelope Power
pF	Picofarad
PLL	Phase-Locked Loop
P/N	Part Number
P/O	Part of
POS.	Position
P-P	Peak-to-Peak
PRGM	Program
Prog.	Programmable

GLOSSARY (Cont.)

-P- (Cont.)

PS	Power Supply
PSK	Phase Shift Keying
PTT	Push-to-Talk
PWB	Printed Wiring Board
PWR	Power

-Q-

QTY	Quantity
------------	----------

-R-

RAM	Random Access Memory
RCV, RX	Receive
RCVR	Receiver
REC.	Receptacle
Ref	Reference
Ref. Desig.	Reference Designator
Rev.	Revision
RF	Radio Frequency
RFI	Radio-Frequency Interference
rms, RMS	Root Mean Square
R/T	Receive/Transmit; Receiver/Transmitter
RX	Receive
RXD	Receive Data

GLOSSARY (Cont.)

-S-

S	Switch Designation
SAE	Stand-Alone Encryption
SEC	Secure
Sh	Sheet
SHLD	Shield
Sig	Signal
SINAD	A ratio of (signal + noise + distortion) to (noise + distortion) used to measure the signal quality of a communication channel. SINAD is commonly used to evaluate the ability of a channel to pass voice traffic.
SINCGARS	Single Channel Ground and Airborne Radio System
Sip, SIP	Single In-Line Package
SP	Single Pole
SPDT	Single-Pole, Double-Throw
SPKR	Speaker
SSB	Single Sideband
STD	Standard
SW, SW.	Switch
SYNC	Synchronized

-T-

TCXO	Temperature Controlled Xtal (Crystal) Oscillator
TDPSK	Time Differential Phase Shift Keying
Term.	Terminal
T/R	Transmit/Receive
TX	Transmit

GLOSSARY (Cont.)

-U-

u	Micro (one millionth)
UHF	Ultra High Frequency
USB	Upper Sideband
uW	Microwave

-V-

V	Volt
Var.	Variable
VCA	Voltage Controlled Attenuator
VCO	Voltage Controlled Oscillator
VCXO	Voltage Controlled Xtal (Crystal) Oscillator
VDC, Vdc	Volts, Direct Current
VFO	Variable Frequency Oscillator
VHF	Very High Frequency
VIO	Violet (color)
VOM	Volt-Ohm-Milliammeter
VOX	Voice Operated Transmitter
vs	Versus
VSWR	Voltage Standing Wave Ratio

-W-

W	Cable Designation, Watt(s), Wire
WB	Wideband
WHT	White
WSPR	Whisper (Pre-amp is used on microphone)

GLOSSARY (Cont.)

-X-

XCVR	Transceiver
XMT	Transmit
XMIT	Transmit
XMTR	Transmitter

-Y-

YEL	Yellow
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-Z-

Zeroize (Radio Zeroize)	A command sequence which erases all programmed channel parameters and option settings.
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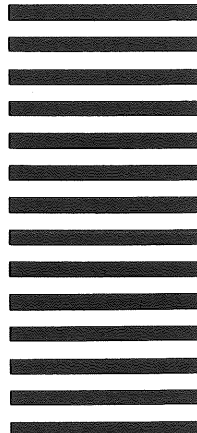
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