MOTOROLA

TEST EQUIPMENT

R-2670 FDMA Digital Communications System Analyzer ASTRO 25 Option

OPERATOR'S MANUAL

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Project 25 is the creation of the Association of Public Safety Communications Officials (APCO). Project 25 brings together representatives of federal, state, and local government agencies. These agencies and other user organizations evaluate basic technologies in advanced land mobile radio to find solutions that best serve the needs of the public safety marketplace. The committee has encouraged participation by many international public safety organizations. The National Association of State Telecommunications Directors (NASTD), National Communications Systems (NCS), National Telecommunications & Information Agency (NTIA) and the Department of Defense (DOD) are all actively involved in the development of these user-driven standards.

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Section 1
INTRODUCTION

1-1 INTRODUCTION

This manual contains information regarding operation of the R-2670 ASTRO 25 features. ASTRO 25 provides unique testing features for communications equipment using ASTRO 25 encoding and modulation principles. The additional ASTRO 25 test capabilities are accessed via the LCD display, screen-defined softkeys, numeric keypad, cursor movement keys, and optical tuning knob. Some of the ASTRO 25 functions may also be accessed via the remote control interface port.

1-2 CAPABILITIES

The ASTRO 25 feature set gives the R-2670 the capability of monitoring and generating ASTRO 25 signals. An ASTRO 25 signal relates to the Association of Public-Safety Communications Officials International (APCO) Project 25 digital standard Common Air Interface (CAI) signaling scheme in which a serial bit stream is encoded, mapped into one of four corresponding amplitudes, filtered digitally, and then modulated onto an RF carrier.

Voice Mode System Testing

Voice mode provides ASTRO 25-compatible modulation and demodulation with Improved Multi-Band Excitation (IMBE) vocoding. The ASTRO 25 Option generate and monitor modes support actual functional voice testing in both the unencrypted and encrypted modes. In the encrypted mode, either a test key or an operator key loaded from a separate compatible keyloader can be used.

Bit Error Rate (BER) Testing

A 1011 Hz Tone Test pattern can be selected to modulate the R-2670 generator for BER testing. A 1011 Hz Tone Test pattern can likewise be decoded by the R-2670 in monitor mode and a BER computed from a comparison with a stored version of the expected pattern.

Dedicated Test Screens

Dedicated ASTRO 25 test screens are zoned with RF and Modulation control screens to simultaneously display test results along with their test conditions. Dedicated test screens can be setup as a start-up default condition or as a programmable test set-up.

Clear Scope Display

The display provides a graphic image of the audio clear signal. This clear signal is selectable at either the vocoder input in generate mode or the vocoder output in monitor mode.

1-3 ASTRO 25 CONNECTORS

The R-2670 has two connectors as shown in Figure 1-1. Both connectors are located on the side of the housing. The KVL connector provides a receptacle for loading an external encryption key. The other connector is an interface port.

KEY VARIABLE LOADER (KVL) PORT

The KVL port allows the analyzer to be preloaded with a user-selected encryption key from any compatible KVL keyloader. ASTRO 25 is compatible with DX compatable key loaders.

INTERFACE PORT (25 pin)

The interface port is provided for future capability.

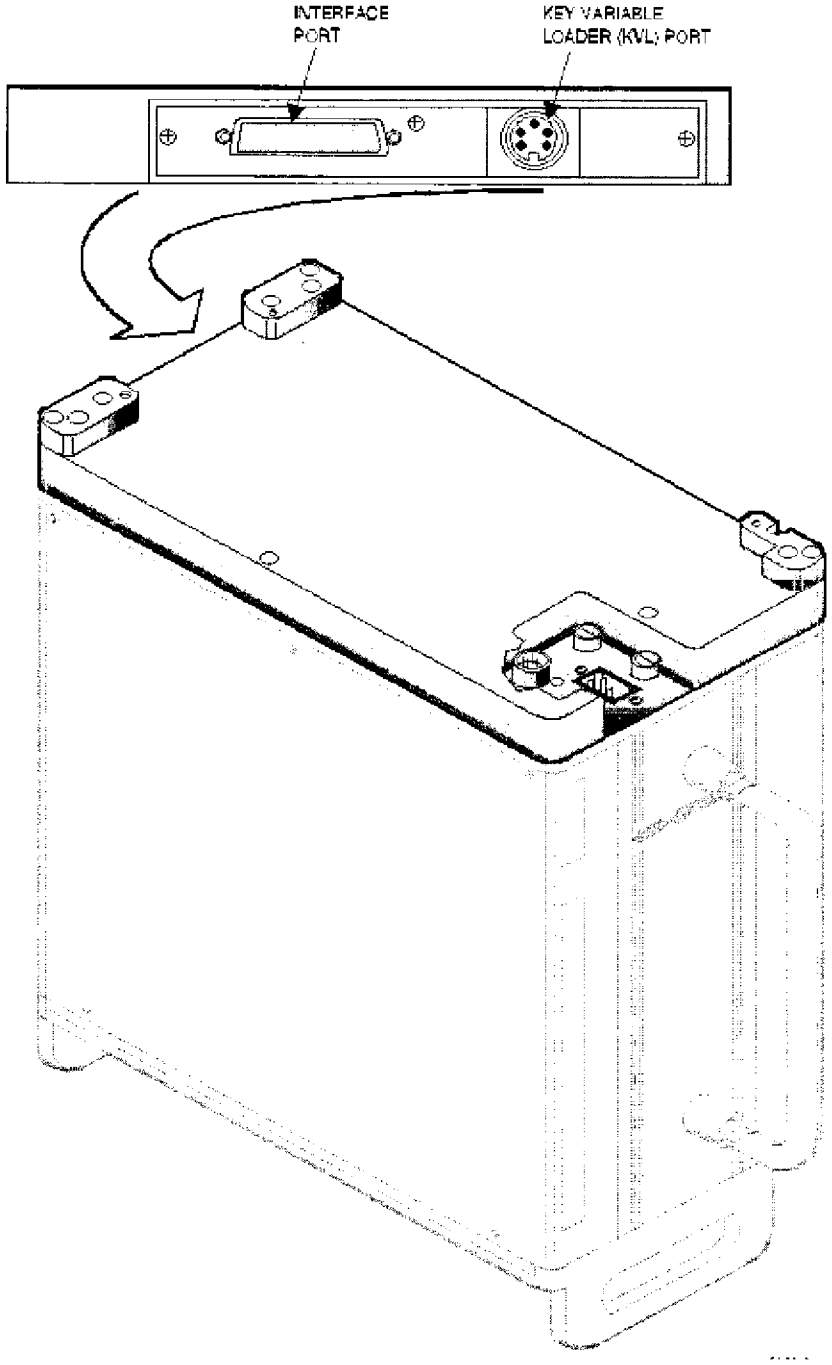

Figure 1-1. Bottom of R-2670

Section 2
DESCRIPTION

2-1 INTRODUCTION

The ASTRO 25 features extend the standard functions of the R-2670 to provide an all-in-one servicing instrument for ASTRO 25 digital radio systems.

2-2 BASIC OPERATION

The R-2670 can emulate the same digital environment used by ASTRO 25 radios in clear and secure mode. This capability allows the analyzer to interoperate with conventional ASTRO 25 radios. Standard test equipment is unable to decrypt secure audio transmissions from ASTRO 25 radios because the audio signals are converted from their native analog format to a digital, ciphered representation prior to transmission.

An ASTRO 25 digital radio provides for both clear and secure voice and data. When operated in secure mode, the radio encrypts communications prior to their transmission. Only intended subscribers, with compatible hardware plus matching security keys, can decrypt the message. In this way, users of a system can be partitioned into groups, each with their own security key. The R-2670 will accept an external operating key from any compatible keyloader.

In its ASTRO 25 mode, the R-2670 provides display screens for monitoring bit error rate characteristics of a radio under test and also generates bit error rate test patterns to support this mode of operation.

The R-2670 provides a clear scope display of audio signals, either the input to the vocoder (generate mode) or the output from the vocoder (monitor mode).

2-3 TEST CONSIDERATIONS

ASTRO 25 digital radio systems encrypted communications have a need to maintain even higher standards of RF signal quality than normal FM radio systems. Encryption subjects the ASTRO 25 signals to additional processing. In order to work reliably, the radios must be tuned to preserve critical factors such as operating frequency response and transmitter deviation.

Operating in secure or standard mode, the R-2670 bundles a wide assortment of sophisticated test features in a single instrument.

2-4 SPECIAL TERMS

The following list contains brief definitions of special terms that are used in association with ASTRO 25 radios and test equipment:

algorithm - In secure systems, an algorithm is a distinct method for translating clear information (input) to a secure version of the information (output). The same algorithm is used to interpret the message. ASTRO 25 systems use the following algorithm:

DES-OFB

DES-XL

DVP-XL

DVI-XL

BER test - In generate mode, the analyzer modulates the RF carrier with a 1011 Hz tone test pattern to test the Unit Under Test receiver. The test pattern received by the Unit Under Test will be compared in the unit under test with a stored version of the test pattern to compute a

BER. This will only be possible if the Unit Under Test has this test mode capability.

In monitor mode, the analyzer monitors the received 1011 Hz tone test pattern, compares it with a stored version, and provides a metering display of bits received, number of bits expected, and bit error rate percentage.

cipher - to convert information to a seemingly random pattern for transmission or wireline delivery in order to protect sensitive information. Ciphered voice and data can only be understood by means of a special key.

IMBE vocoding - Improved Multi-Band Excitation technique used in ASTRO 25 radios and test equipment to code digitized analog voice signals before transmission and to reconstruct analog voice signals on the receiving end.

decryption - process of converting cipher text to plain text

encryption - process of converting plain text to cipher text

key - a sequence of bits stored electronically in the encryption and decryption modules.

key loader (KVL) - a device used to load an electronic encryption key into a radio or other device.

Section 3
OPERATING INSTRUCTIONS

CAUTION

When testing a radio, observe the following precautions:

***Do not** use an antenna on the analyzer for over-the-air testing.*

***Use** double-shielded cables on the analyzer to carry signals to and from the radio.*

***Locate** the analyzer at least thirty five feet from the antenna of a unit that is working in the same system that the analyzer is testing.*

***Adjust** the squelch to where the LED indicator for squelch just turns off or is closed. When the signal from the radio is present, the squelch LED will illuminate indicating that squelch has been detected and there is a signal present.*

3-1 INTRODUCTION

The ASTRO 25 features are an enhancement to the R-2670 Communications System Analyzer. Refer to sections 1, 2, and 3 under the General Operation tab in this manual for general installation information, a description of the control functions, and general operational information. The following sections of this manual contain information on how to connect ASTRO 25 radios under test to the analyzer and how to set controls and indicators to obtain the correct screen display.

Error/Warning Messages

Refer to the Appendix for a listing and description of error and warning messages related to the ASTRO 25 test mode. Messages common to all test modes are described in paragraph 3-4 under the General Operation tab in this manual.

3-2 SOFTWARE VERSION SCREEN

To view the software version of the R-2670 Analyzer, turn power on and wait for the display to appear on the screen. Press the **SPF** hard key, and move the cursor to "VERSION". Select the **display table** softkey. This will configure the analyzer to generate a screen that displays the ASTRO 25 software version (Figure 3-1).

Move the cursor to the ASTRO 25 position and select the **view options** softkey. A screen similar to Figure 3-2 will be displayed and indicates the analyzer options installed and encryption algorithms available.

Select the **return** softkey twice to return to the ASTRO 25 mode screen.

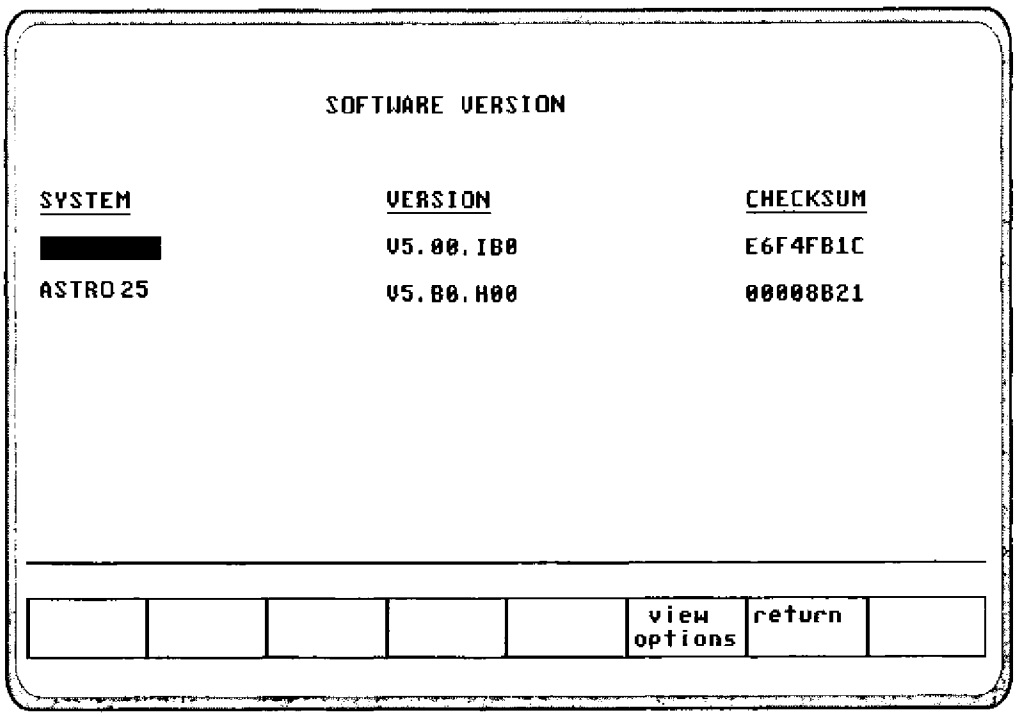

Figure 3-1. ASTRO 25 Version Screen

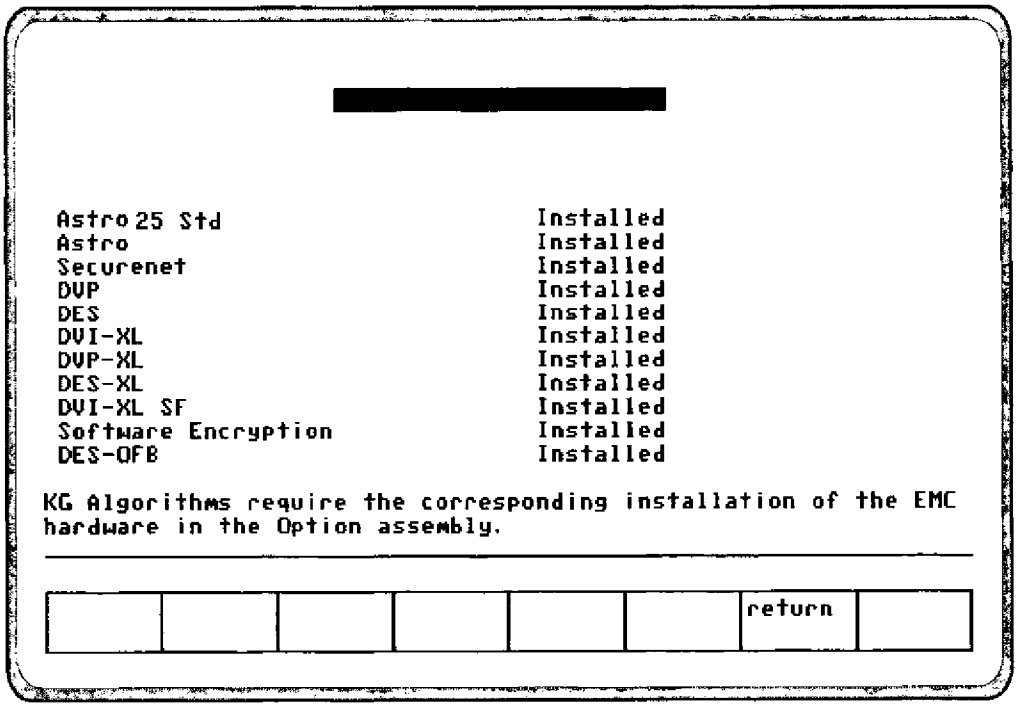

Figure 3-2. ASTRO 25 Options Screen

3-3 BASIC OPERATION

Control of the unit and selection of data to be displayed are done through the use of three main windows which simultaneously appear on the screen: the Display Zone, the RF Zone, and the Audio Zone. These three zones are shown in Figure 3-3. The Display Zone displays data related to the radio under test. The RF Zone is used for selection of RF mode, selection of frequency band, I/O port selection and for control of RF signal level at the input/output port. The Audio Zone is used to select the modulation format, and the signal source and deviation level when generate mode has been selected.

3-3.1 Display Screens

The three main windows, or cursor zones, are accessed through a cluster of three CURSOR ZONE keys at the top center of the unit. The location where the cursor rests within each zone is called a cursor field. To control the unit and enter data, all operator inputs are made at highlighted cursor fields (brighter-face type).

Below the screen are softkeys. These softkeys, with customized on-screen labels, interact with the screen to provide a unique menu of entry options for each cursor field. This greatly reduces the number of keys and eliminates having to search through unrelated controls to find the one that's needed.

3-3.2 Manual Operation

To control the cursor location and input information by (manual control):

- Use the CURSOR ZONE keys to move the cursor among the three zones.
- Use the CURSOR POSITION keys to move the cursor from field to field within a zone.
- Once at the desired field, use either the TUNING knob or the numeric keys to enter numeric information. Use the softkeys for other menu selections.

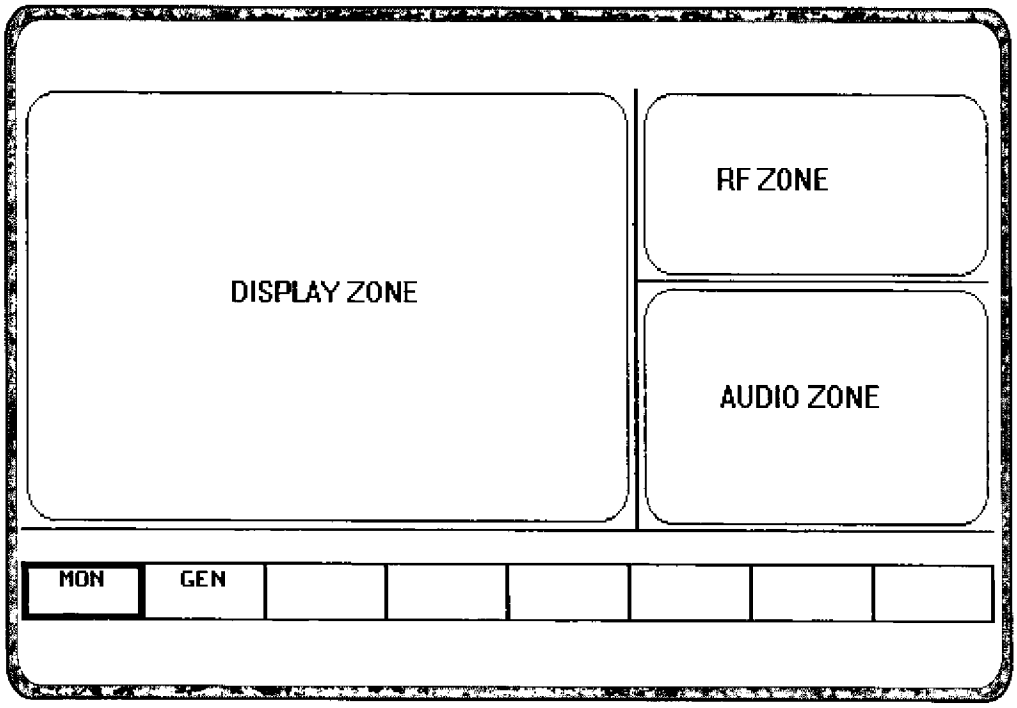

Figure 3-3. Screen Zone Arrangement

3-3.3 Expanded Display

Some fields have the ability to expand their contents to fill the entire screen. These fields consist of the following:

- Spectrum analyzer, clear scope, mod scope, ext scope, bargraph displays
- Encode tables
- Dedicated keys

3-3.4 Dedicated Keys

Refer to paragraph 3-8 under the General Operation tab in this manual for an explanation of the HELP, MEM, SPF, and CAL keys.

3-3.5 Remote Operation

The R-2670 Communications System Analyzer is equipped with a standard RS-232 interface. This interface may be used to remotely control the analyzer using a set of commands, queries, and responses that are defined in the Motorola R-2600 Series Communications System Analyzer Programming Reference Manual (68-80309E55).

3-3.6 HELP

The analyzer provides on-screen operating instructions via the dedicated HELP key. Help screens are organized such that each display area has an associated help screen pertaining to that area of the screen. System help is available via a softkey within each help screen. Use the **return** softkey to return to the function in progress.

3-4 ENCRYPTION CAPABILITIES

When in the ASTRO 25 mode, the R-2670 can operate in clear or hardware encrypted modes. ASTRO 25 equipment converts normal speech patterns to their digital equivalent and then uses an encryption algorithm to encrypt data f transmission. A receiving radio, using the san algorithm and a matching key, automatically reverses the process so you can hear a normal audio message.

A set of either U.S. or International encryption algorithms is available with the ASTRO 25. Algorithms include: Data Encryption System (DES) – a U.S. Federal Government encryption standard, and Digital Voice Protection (DVP) – a Motorola Proprietary encryption algorithm, and DVI – a Motorola Proprietary encryption algorithm for international use. Within a set, each algorithm is individually selectable:

Domestic: DES-OFB, DES-XL or DVP-XL

International: DVI-XL, DVP-XL

3-5 TEST SETUP

Connecting a Radio

Use a 50 ohm BNC cable and an N to BNC adapter to connect from the RF I/O port of th R-2670 analyzer to the antenna port of the rad as shown in Figure 3-4.

CAUTION

When in Monitor mode, adjust the squelch to where the LED indicator for squelch just turns off or is closed. When the signal from the radio is present, the squelch LED will illuminate indicating that squelch has been detected and there is a signal present.

CAUTION

Observe the input power ratings and warnings of the analyzer to insure that no damage occurs to the analyzer.

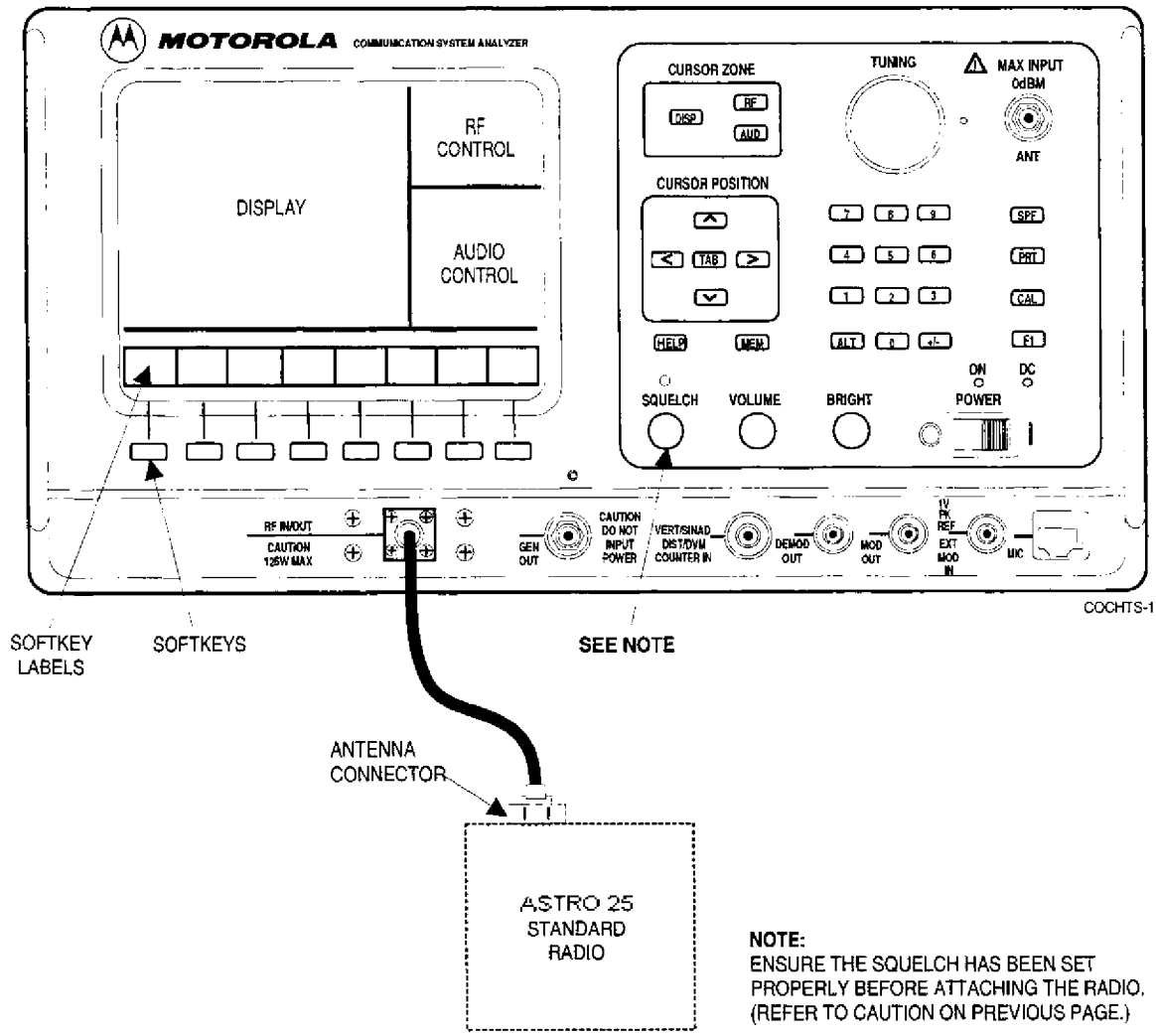

Figure 3-4. Radio to Analyzer Test Setup

3-6 ACCESSING ASTRO 25 MODE

Select the ASTRO 25 mode by placing the cursor in the "Mode:" field in the Display Zone located at the top of the screen. Use the ASTRO 25 softkey to select the ASTRO 25 mode. A screen similar to Figure 3-5 appears.

When the display zone "Mode:" is set to ASTRO 25, the R-2670 will configure itself to generate and monitor ASTRO 25 signals.

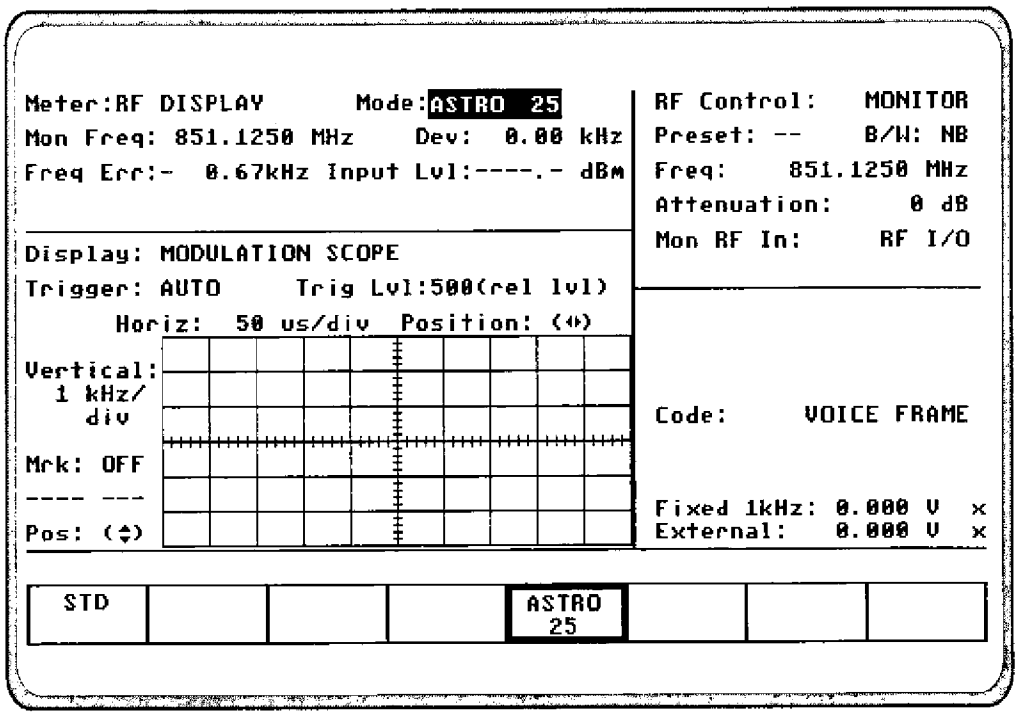

Figure 3-5. ASTRO 25 Mode Screen

3-7 ASTRO 25 ENCRYPTION SET UP

3-7.1 SET UP Encryption Display

The SET UP display places the analyzer in encryption setup mode and allows the operator to select the desired algorithm. The SET UP display is accessed from the Display Zone. To use SET UP display, move the cursor to the "Display:" field and select SET UP using the **SET UP** softkey. The Display Zone will show a menu of SET UP options as shown in Figure 3-6.

3-7.1.1 Encrypt

The analyzer operates in either clear or encrypted modes. In the Display Zone, scroll the cursor to the "Encrypt:" field and select ON as shown in Figure 3-7 for encrypted ASTRO 25, or OFF for clear ASTRO 25 operation.

3-7.1.2 Algorithm Select

Within the SET UP display, the type of algorith. can be selected. Algorithm is a term that describes the method of coding data or audio so that only equipment having the same algorithm selected and the same key are able to exchange voice and data information.. The analyzer includes several algorithms recognized by radios using ASTRO 25. You will need to select these algorithms to use for processing messages.

In the Display Zone, move the cursor to the "Algorithm Sel:" field as shown in Figure 3-8. A softkeys will provide for selection of the available algorithms. Select the appropriate algorithm. Refer to Section 3-4 for a description of the U.S. and International encryption algorithms.

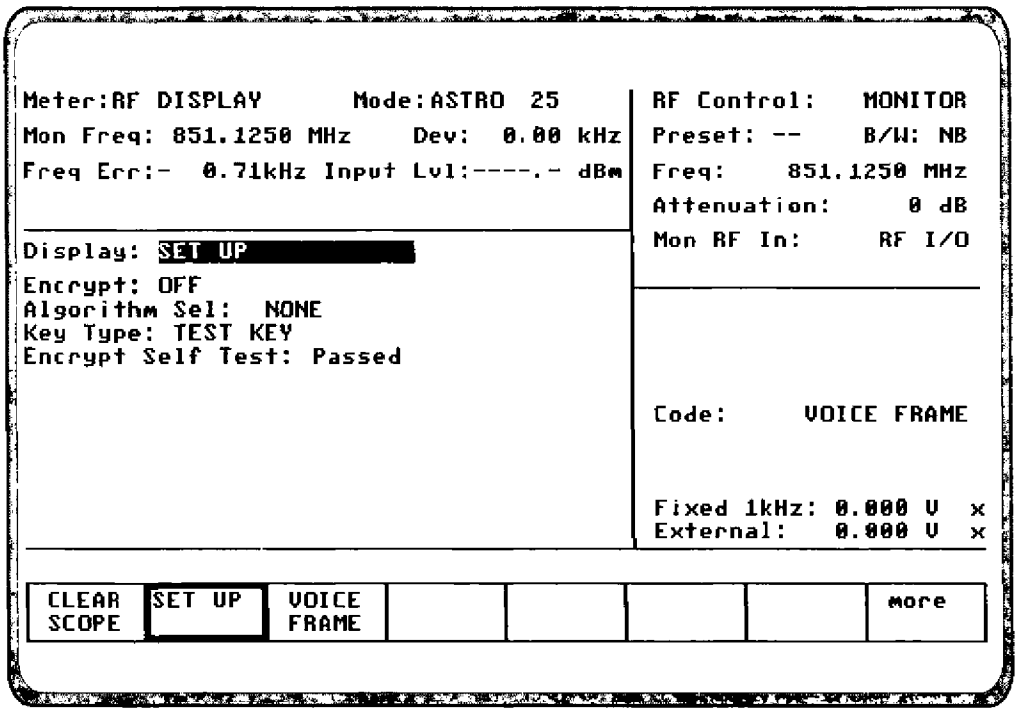

Figure 3-6. SET UP Display Screen

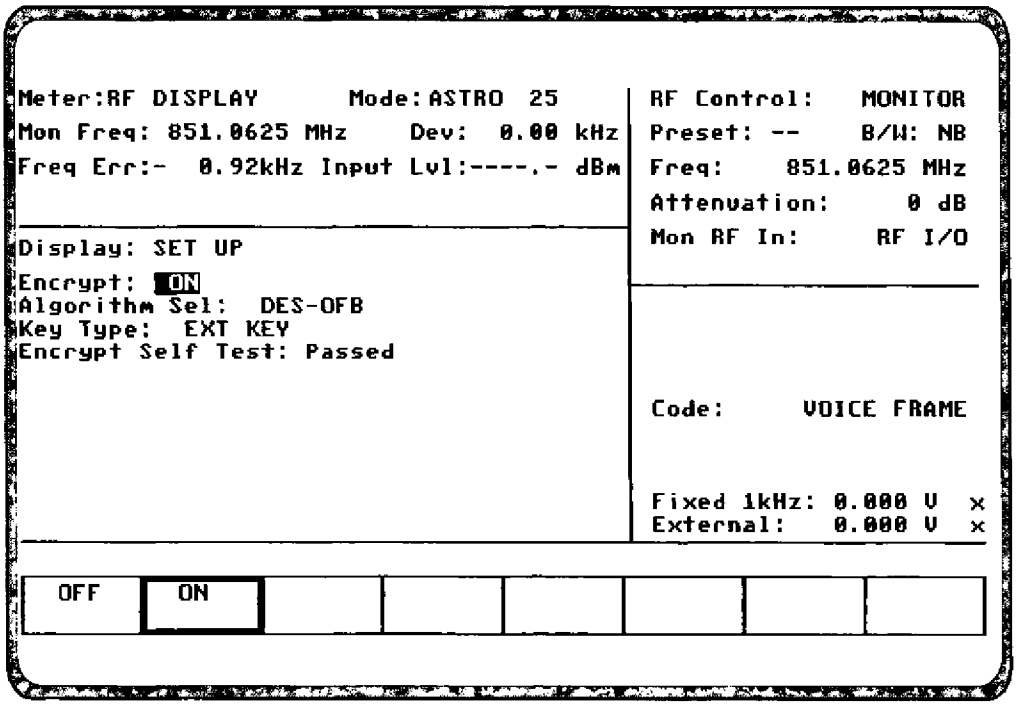

Figure 3-7. Encryption Select Display

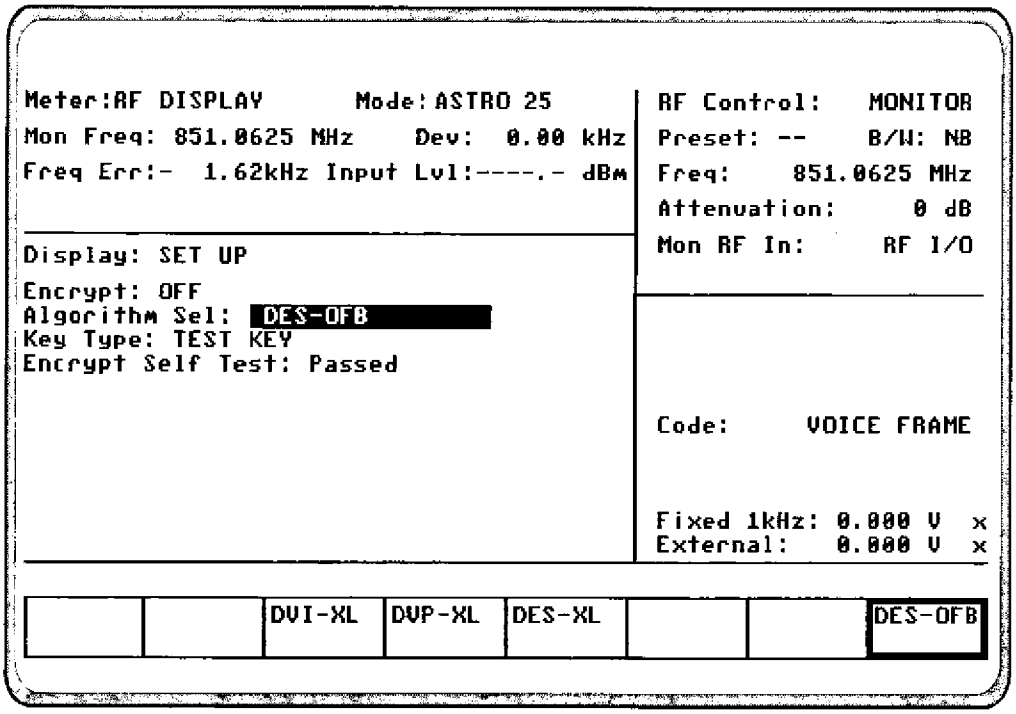

Figure 3-8. Algorithm Select Display

3-7.1.3 Key Type

An encryption key is needed when testing in the encryption mode. There are two encryption key types that can be selected, either a Test Key or an External Key. The Test Key is the default and is used to support most ASTRO 25 testing. The Test Key is a predefined key that is programmed into the analyzer for testing purposes only. In order to prevent compromised security, the Test Key should never be used for sending secure radio communications (all ASTRO 25 analyzers use the same Test Key). The External Key is a key that has been loaded from a KVL. In order to test secure communications the keys in both the Unit Under Test and the analyzer must be the same. The analyzer provides these softkey selections:

TEST KEY

This softkey selects the Test Key saved in the analyzer's key storage memory.

EXT KEY

This softkey selects the External Key saved in the analyzer' storage memory for the selected algorithm. This key is defined by the customer and must first be loaded into the analyzer by a KVL.

erase ext key

This softkey erases from the analyzer's key storage memory any External Key saved for the current algorithm.

load ext key

This softkey starts the sequence of programming the analyzer with an External Key for the algorithm selected from a Key Variable Loader (KVL). This procedure requires a key loading cable and a KVL.

3-7.1.4 Encrypt Self Test

A self test of the encryption functions is performed at power up. The "Encrypt Self Test:" field in the SET UP display (Figure 3-6) indicates the results of the self test, passed or failed.

3-7.2 Using the Test Key

The analyzer can be used to test radios using the internal Test Key (707070.....hex). To select the Test Key, place the cursor in the "Display:" field

in the Display Zone. Select SET Up using the **SET UP** softkey. This will access the SET UP display screen (Figure 3-6).

Move the cursor to the "Encrypt:" field and select the **ON** softkey (Figure 3-7). Move the cursor to the "Algorithm Sel:" field and select the desired algorithm using softkeys (figure 3-8). Move the cursor to the "Key Type:" field and select the **TEST Key** softkey (Figure 3-9). The analyzer is now programmed with the Test Key.

ASTRO 25 radios may also have an internal Test Key which is the same as the analyzer's. Refer to the radio service manual to determine if this key can be activated in your particular radio. If the internal Test Key cannot be activated, it must be loaded from a KVL.

Follow the procedure in the KVL instruction manual to load the 707070....hex key into the radio. The radio encrypter is now keyed to match the analyzer.

3-7.3 Programming with External Key

You can use a customer key to program the analyzer and operate in secure mode with a keyed radio. The customer (external) key, once loaded, is saved in memory by the analyzer until the operator erases it. The key is stored in non-volatile memory and will be retained even if power to the analyzer is turned off.

3-7.3.1 Connecting the KVL

The KVL plugs into the KVL port (Figure 1-1) on the side of the analyzer opposite the carrying handle. Connect the KVL to the analyzer and then use the following instructions to load the External Key.

CAUTION

Use DX key loaders only. Other types of key loaders (AX, BX or CX) may cause the encryption hardware to malfunction. To recover, press the ***encrypt reset*** *softkey under the "Special Functions" (SPF) menu.*

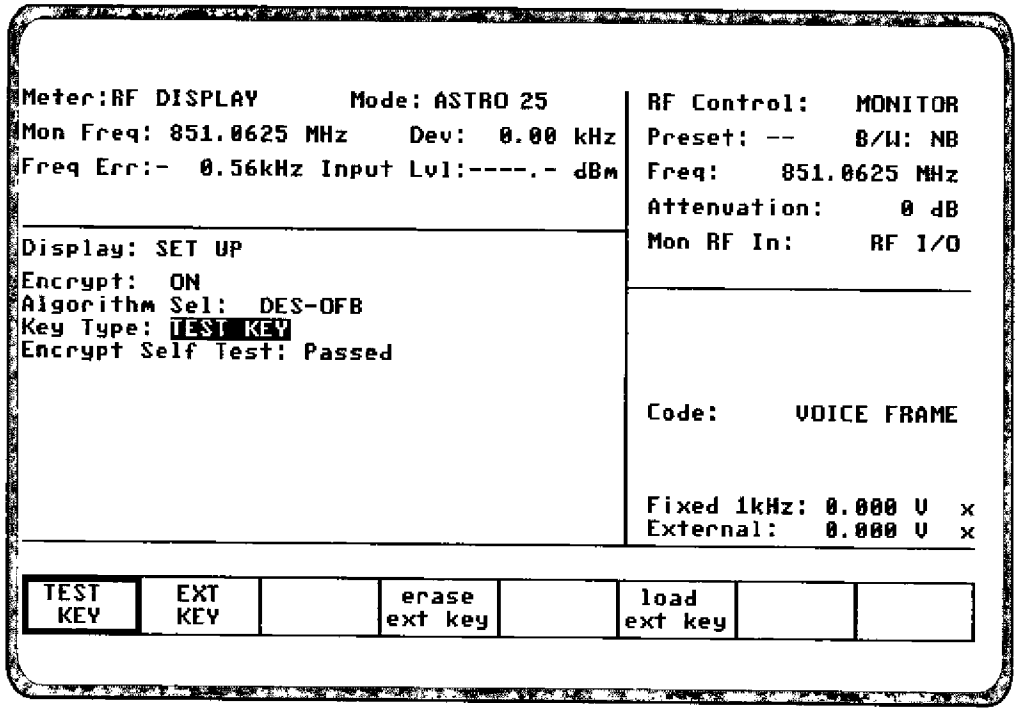

Figure 3-9. Test Key Programming Display

3-7.3.2 Loading External Key

To initiate loading an External Key, place cursor in "Display:" field in the Display Zone and select SET UP mode display using the **SET UP** softkey.

Move cursor to "Algorithm Sel:" field and select desired algorithm using softkeys (Figure 3-8).

Move cursor to "Key Type:" field.

Press the **load ext key** softkey to initiate the key load sequence.

Push the switch on the KVL to begin loading. This activates the programming function. When programming is complete, the KVL displays "pass" if the key load procedure was successful. The analyzer displays a message, "Ext key passed". If the key load procedure was unsuccessful, the KVL displays "fail".

If key load procedure was successfi disconnect the KVL. Be sure to press the **EX KEY** softkey after loading an External Key from the KVL in order to use the key. This completes External Key loading. You can exit the SET UP screen at this time.

3-7.3.3 Erasing External Key

To erase an External Key, place cursor in "Display:" field in the Display Zone and select **SET UP** softkey. This will access the SET UP display screen (Figure 3-6).

Move cursor to "Algorithm Sel:" field. Using softkey, select the algorithm associated with the External Key you want to erase.

Move cursor to "Key Type:" field and press **erase ext key** softkey (Figure 3-10). The analyzer will erase the stored External Key and display "key erased" in the message area.

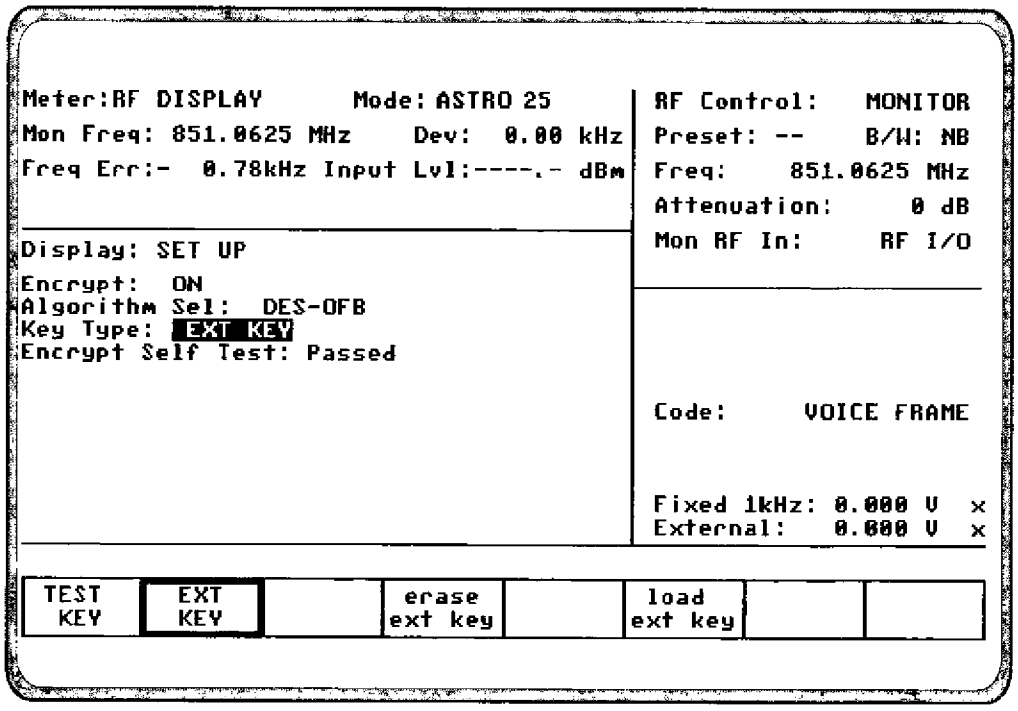

Figure 3-10. External Key Programming Display

3-8 ASTRO 25 RF OPERATING MODES

Select the RF operating mode by placing the cursor in the "RF Control:" field in the RF Zone. Use the desired softkey to select MONITOR or GENERATE.

3-8.1 Monitor mode

The Monitor mode (Figure 3-11) provides the analyzer's test receiver function which is used in the testing of radio transmitters. In ASTRO 25 Monitor mode, the RF Zone is similar to the RF Zone in standard mode. It is capable of setting up the analyzer to monitor RF input through its antenna or a direct connection to the transmitter.

The RF Zone in Monitor mode contains fields for choosing the monitor bandwidth, frequency, attenuation, and source of the ASTRO 25 RF signal.

The specific entry fields are as follows.

Preset

Refer to Section 3-8.5 Memory Screens under the General Operation tab in this manual for information on this field.

B/W

Selects either wide or narrow IF bandwidth of the unit via softkey selection. Narrow bandwidth is typically used for ASTRO 25.

Freq

Enter the desired monitor frequency using keypad or TUNING knob.

Attenuation

Selects the amount of attenuation at the RF input to the monitor receiver using softkeys. Selectable input attenuation is useful in adjusting displays for a wide range of input levels, as well as for use in high RF field environments where intermodulation may cause desensitization of the receiver.

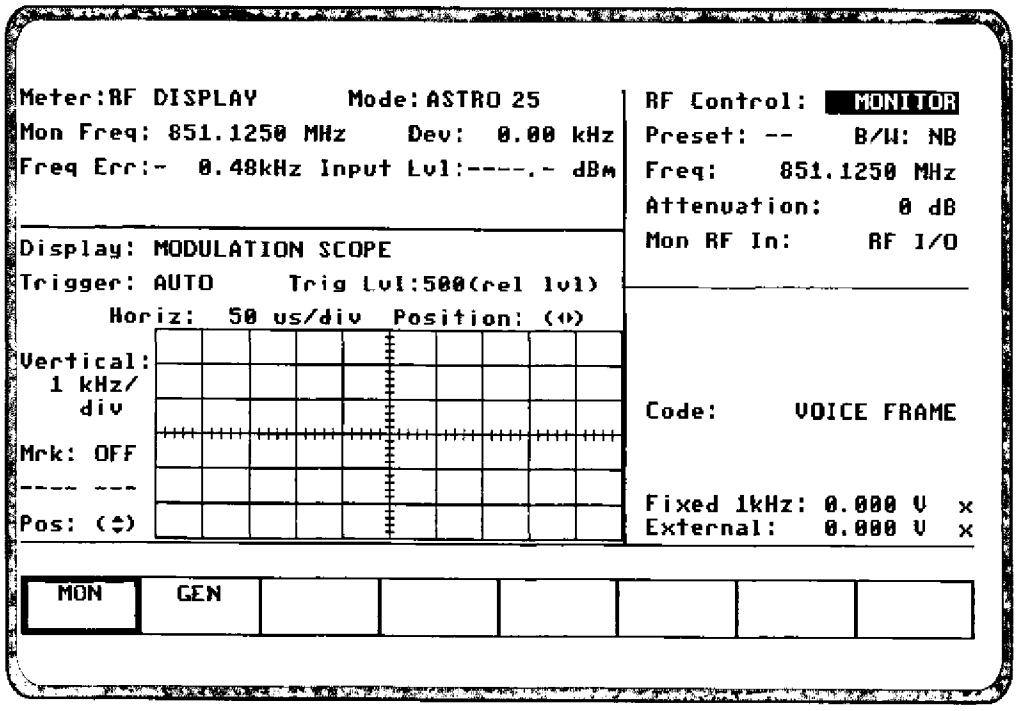

Figure 3-11. Monitor Mode - RF Zone

Mon RF In

Selects the RF input port via softkeys. The RF I/O port contains an RF load and should be used for direct connection to the radio under test. The ANT port accesses the unit's sensitive receiver and should be used with an antenna for "off-the-air" reception. Selection of the ANT port is indicated by a red LED next to the ANT connector.

CAUTION

Do not apply input power to the ANT input port. In the event RF power is inadvertently applied, the port is protected by an in-line RF fuse. This fuse may be accessed by unscrewing the front of the BNC connector out of the front panel.

3-8.2 Generate Mode

The Generate mode (Figure 3-12) configures the Analyzer to generate an RF signal at a controlled output level. The Generate mode thus provides for ASTRO 25 radio receiver testing. In ASTRO 25 Generate mode, the RF Zone is similar to the RF Zone in standard mode. It is capable of setting up the analyzer to generate RF output through its RF I/O port or through the Generator Output (GEN OUT) port. The RF Zone contains fields for choosing the generator bandwidth, frequency, output level, and output connector of the ASTRO 25 RF signal.

Specific controls which further configure the Generate mode are located within the RF Control Zone when GENERATE is first selected.

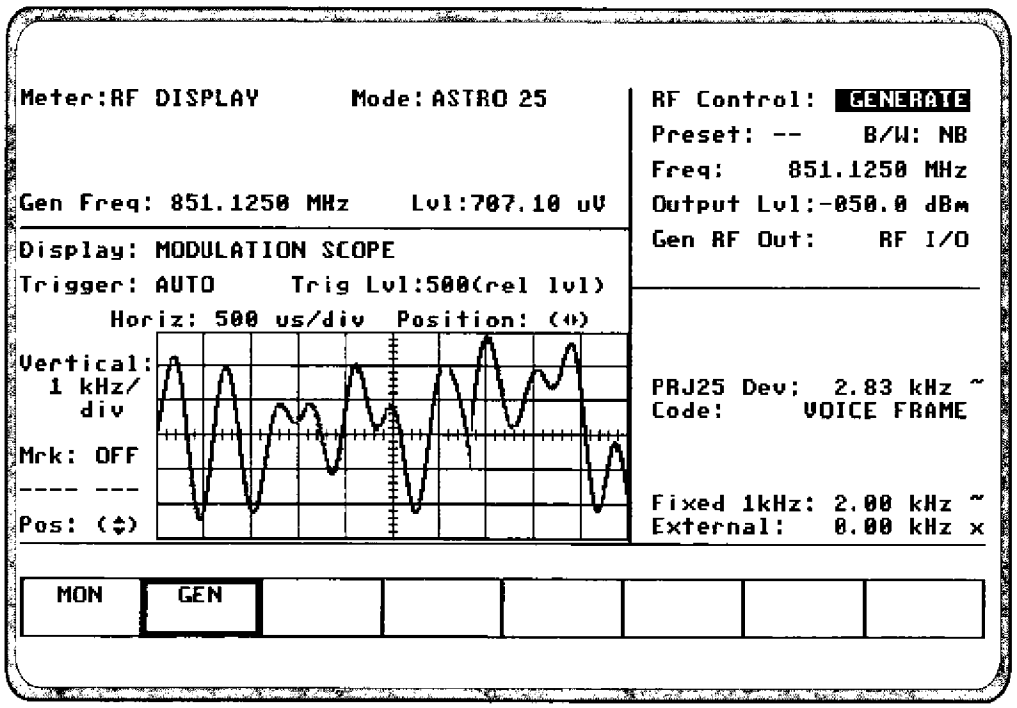

Figure 3-12. Generate Mode - RF Zone

The specific entry fields are as follows:

Preset

The preset function is the same as in the Monitor mode.

B/W

Selects either wide or narrow bandwidth of the unit via softkey selection. Narrow bandwidth is typically used for ASTRO 25.

Freq

Enter the desired generate RF frequency using keypad or TUNING knob.

Output Lvl

Selects generator output level in 0.1 dBm steps over the range of -130 dBm to 0 dBm. An alternate display of generate level in microvolts is available in the "Meter:" area of the Display Zone. Output level is available in two ranges depending upon which output port is selected:

- The range of -80 dBm to 0 dBm is available when the high level GEN OUT port is selected.
- The range of -130 dBm to -50 dBm is available when the RF I/O output port is selected.

Gen RF Out

Selects the RF output port via softkeys. The RF I/O port is recommended for most applications. GEN and MON ports are combined for a single connection to the radio under test. The GEN port is recommended where higher levels are needed. Selection of the GEN port is indicated by a red LED adjacent to the GEN OUT connector.

CAUTION

Do not apply input power to the GEN OUT port. In the event RF power is inadvertently applied, the port is protected by an in-line RF fuse. This fuse may be accessed by unscrewing the front of the BNC connector out of the front panel.

3-9 ASTRO 25 AUDIO/ MODULATION CONTROL

The Audio Zone, located at the lower right of the screen (Figure 3-13), is used to control the multipurpose audio synthesizer section of the unit. Signals generated by the audio synthesizer are coupled internally to the generator modulation input as well as to the MOD OUT connector on the front panel. The primary categories of modulation in ASTRO 25 mode are Voice Frame, 1011 Hz tone test pattern, calibration test pattern, and silence pattern. Many of the features available in standard mode are not available in ASTRO 25 mode. The Audio Zone has been changed to accommodate testing of ASTRO 25 radios and equipment.

Each modulation signal has a cursor field for entering its desired level. Use the keypad or TUNING knob to enter the desired level.

An additional cursor field, adjacent to each level entry, is used to enable or switch each selection on and off using softkeys. This field is located at the extreme right side of the zone. There are two possible conditions for this softkey selection.

CONT activates continuous ON condition, or continuous cycling if a sequence has been selected. A "~" symbol is indicated at the extreme right, adjacent to the level to indicate continuous ON.

OFF switches off the modulation source. Off is indicated by an "X" at the extreme right, adjacent to the level.

3-9.1 Modulation Sources

In addition to Voice Frame, 1011 Hz tone test pattern, calibration test pattern, and silence pattern, there are two other modulation sources selectable in the Audio Zone, a Fixed 1 kHz tone and an External signal.

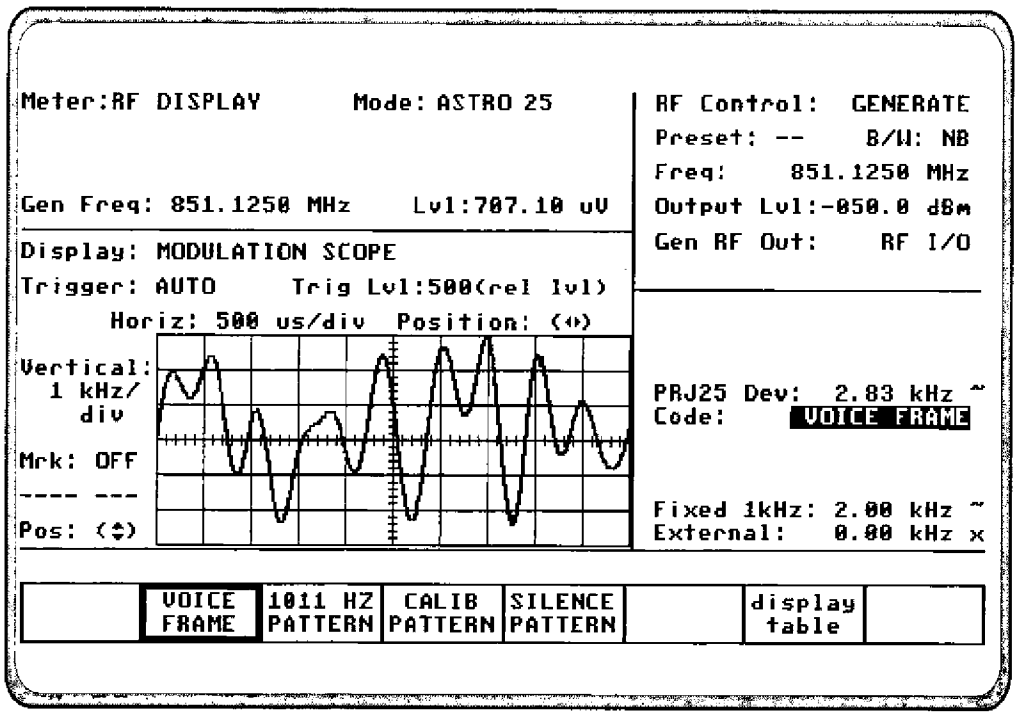

Figure 3-13. ASTRO 25 Audio Zone - Voice Generate Mode

3-9.1.1 Fixed 1 kHz

The analyzer contains a fixed 1 kHz modulation source, which can be selected independently from the other audio synthesizers. Level control and on-off selection is described above.

3-9.1.2 External

External modulation is applied to the external modulation input (EXT MOD IN) connector on the front panel. When external modulation source is selected, the modulation input is summed with the microphone input. Level control and on-off selection for an external modulation source are selectable via softkey or the TUNING knob.

3-9.2 Voice Frame

The Audio Zone provides for audio source selection. In generate mode, controls are provided for both signal level and frequency deviation settings of the voice baseband signal that is used to modulate the ASTRO 25 RF transmissions.

3-9.2.1 Monitor Mode

Voice Frame decode is selectable from the Display Zone.To display Voice Frame decoded data, refer to section 3-10.3. Be sure Monitor is selected in the RF Control Zone in the upper right section of the display. Move cursor to the Audio Zone and place the cursor in the "Code:" field. Select Voice modulation using the **VOICE FRAME** softkey. Selection of Monitor Voice allows for the addition of the following audio sources:

External + microphone, or

1 kHz tone.

These inputs are selected by using the off and continuous switches and the level is adjusted using the keypad or tuning knob. The level range varies depending on whether the bandwidth (in the RF Zone) is set to narrow or wide.

BW Setting	Audio level Range
Narrow	0.000 to 0.795 volt maximum, in 0.001 volt increments
Wide	0.00 to 7.95 volt maximum, in 0.01 volt increments

3-9.2.2 Generate Mode

The analyzer generates ASTRO 25 voice patterns when placed in the Generate mode. The ASTRO 25 signal can be clear or encrypted with one of the hardware algorithms.

Be sure GENERATE is selected in the RF Control Zone in the upper right section of display. Move cursor to the Audio Zone and place the cursor in the "Code:" field. Select Voice modulation using the **VOICE FRAME** softkey.

When code VOICE FRAME is selected in the Audio Zone (Figure 3-14), the analyzer allows audio inputs to the modulator to be selected from two sources:

External + microphone, or

1 kHz tone.

Controls for each modulating input consist of a switch with values of Off and Continuous. Move cursor to the appropriate switch field and turn the modulating input on "~" or off "X" using the softkeys.

The audio inputs also include a level control for precisely setting the audio input to the modulator. Use the keypad or TUNING knob to enter the desired level. The level range varies depending on whether the bandwidth (in the RF Zone) is set to narrow or wide.

BW Setting	Audio Level Range
Narrow	0.00 to 9.95 kHz maximum, in 0.01 kHz increments
Wide	00.0 to 99.5 kHz maximum, in 0.1 kHz increments

In Generate mode, Deviation control is available in the Audio Zone consisting of a switch with values of Off and Continuous, and a level control. Move cursor to the switch field and turn deviation on "~" or off "X" using the softkeys.

Use the keypad or TUNING knob to enter the desired deviation. The deviation range varies depending on whether the bandwidth (in the RF Zone) is set to narrow or wide.

BW Setting	Deviation Range
Narrow	0.00 to 5.00 kHz maximum, in 0.01 kHz increments
Wide	00.0 to 50.0 kHz maximum, in 0.10 kHz increments

The default deviation setting for ASTRO 25 is 2.83 kHz.

3-9.2.3 Voice Frame Embedded Signaling (Generate)

When the audio source is selected to Voice Frame, a **display table** user selection is available which provides access to the embedded signaling information contained in voice frames. The display table presentation is shown in Figure 3-14. The following information is encoded by the ASTRO 25:

Embedded Information	Size (bits)
Link Control Format (LCF) (Raw)	72
Network Access Code (NAC)	12
Low Speed Data (LSD)	96
Status Symbol	2

The LCF information is further decomposed to allow entry of specific LCF data units. Encoding of the following LCFs is supported from the user interface:

Link Control Opcode Identifier	Value (binary)
Group Voice Chan User	%000000
Unit to Unit Voice Chan User	%000011
Adaptive Power Control	%001111

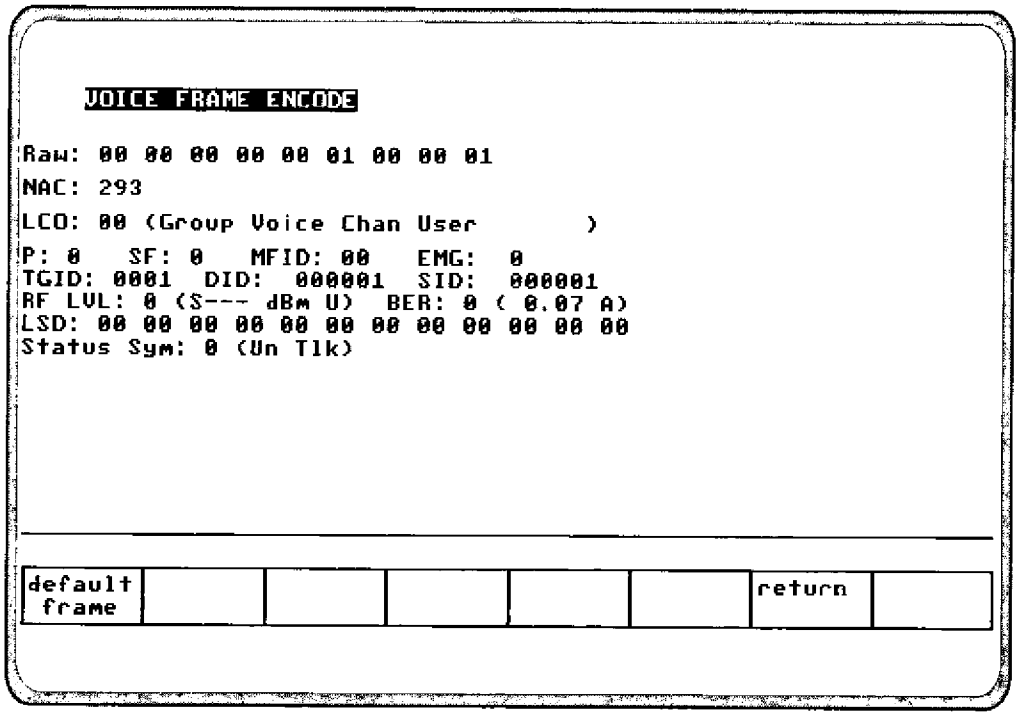

Figure 3-14. Voice Frame Encode - Generate

The embedded information associated with a particular Link Control Opcode Identifier is available for encoding from the user interface:

Mnemonic	Default Value
Link Control Opcode (LCO)	0
Priority (P)	0
Standard Format (SF)	0
Manufacture ID (MFID)	0
Emergency Bit (EMG)	0
Talkgroup ID	1
Destination ID (DID)	1
Source ID (SID)	1
RF Lvl	0
Bit Error Rate (BER)	0

The user interface provides entry of the embedded signaling information as hexadecimal numbers. A softkey that sets the encoded embedded signaling information to a default frame is provided. Default values are shown in the table above.

Selection of the default embedded signaling values causes an information message verify the network ID to be displayed.

3-9.3 1011 Hz Tone Test Pattern

The Audio Zone provides for selection of a 1011 Hz Tone Test pattern. In generate mode, control is provided for setting the frequency deviation of the 1011 Hz Tone Test Pattern baseband signal that is used to modulate the ASTRO 25 RF transmissions.

3-9.3.1 Monitor Mode

When MONITOR is selected in the RF Zone and the 1011 Hz Tone Test pattern is selected for the Audio Zone code field, the analyzer is configured to receive a 1011 Hz Tone Test pattern. The received 1011 Hz Tone Test pattern will be compared with a stored version of the pattern and a BER will be computed. The computed BER can be displayed in the Display Zone when BER is selected for the Meter field in the Display Zone.

NOTE

The Monitor mode must be selected to compute BER

3-9.3.2 Generate Mode

The analyzer generates a 1011 Hz Tone Test pattern when Generate mode is selected in the RF Zone and the 1011 Hz Tone Test pattern is selected for the code field in the Audio Zone.

When code 1011 Hz Tone Test pattern is selected in the Audio Zone (Figure 3-15), the analyzer modulates the 1011 Hz Tone Test pattern on the carrier at either of two output ports:

RF I/O port, or
GEN OUT port.

Both deviation level control and a deviation switch are provided in the Audio Zone for deviation control of the generated signal.

The deviation level control can be set by either the keypad or the TUNING knob to enter the desired deviation. The deviation range varies depending on whether the bandwidth (in the RF Zone) is set to narrow or wide.

BW Setting	Deviation Range
Narrow	0.50 to 5.00 kHz maximum, in 0.05 kHz increments
Wide	05.0 to 50.0 kHz maximum, in 0.50 kHz increments

The deviation switch with values of Off and Continuous is located to the right of the deviation level control field. Move the cursor to the switch field and turn deviation on "~" or off "X" using the softkeys.

The generated 1011 Hz Tone Test pattern can be used to measure the received BER of the radio under test. If the 1011 Hz Tone Test pattern is received without error, the BER detected by the unit under test will be zero. These measurements will only be possible for radios that are capable of computing a BER when the received signal is compared with a stored 1011 Hz Tone Test pattern and having the necessary radio test mode software.

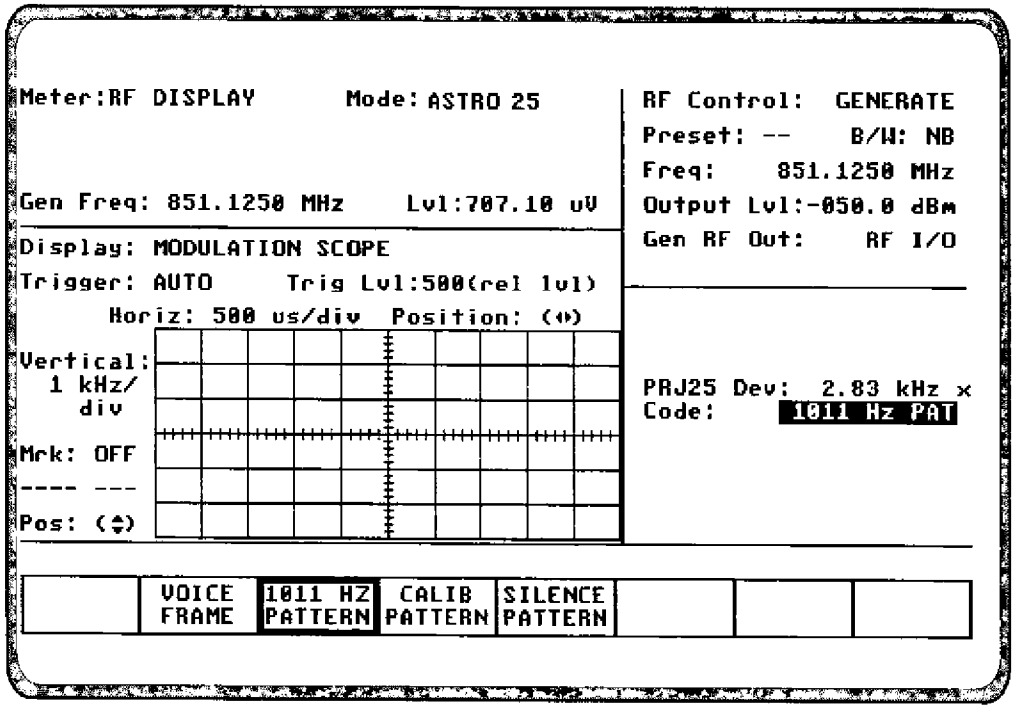

Figure 3-15. ASTRO 25 Audio Zone - BER Generate Mode

3-9.4 Calibration Test Pattern

The Audio Zone provides for selection of a Calibration Test Pattern when the GENERATE mode is selected in the RF Zone. This pattern is the same as the 1011 Hz Tone Test pattern with every 20th bit inverted, to yield 172 errors out of 3456 bits. When this pattern is compared with a 1011 Hz tone test pattern, a 4.977% BER will result. This pattern conforms to the calibration test pattern specified in the Digital C4FM/CQPSK Transceiver Measurement Methods Document TIA/EIA IS-102.CAAA for the Project 25 system.

3-9.4.1 Generate Mode

The analyzer generates a Calibration Test Pattern when Generate mode is selected in the RF Zone and the Calibration Test Pattern is selected for the code field in the Audio Zone.

When code Calibration Test Pattern is selected in the Audio Zone (Figure 3-16), the analyzer modulates the Calibration Test Pattern on the carrier at either of two output ports:

RF I/O port, or
GEN OUT port.

Both deviation level control and a deviation switch are provided in the Audio Zone for deviation control of the generated signal.

The deviation level control can be set by either the keypad or the TUNING knob to enter the desired deviation. The deviation range varies depending on whether the bandwidth (in the RF Zone) is set to narrow or wide.

BW Setting	Deviation Range
Narrow	0.50 to 5.00 kHz maximum, in 0.05 kHz increments
Wide	05.0 to 50.0 kHz maximum, in 0.50 kHz increments

The deviation switch with values of Off and Continuous is located to the right of the deviation level control field. Move the cursor to the switch field and turn deviation on "~" or off "X" using the softkeys.

The generated Calibration Test Pattern can be used to determine if the unit under test receiver is operating correctly. This is done by computing t' BER for the received calibration test pattern wh compared against a 1011 Hz tone test pattern in the unit under test. If the Calibration Test Pattern is received correctly, the measured BER will be 4.977%. These measurements will only be possible for radios that are capable of computing a BER when the received signal is compared with a stored 1011 Hz Tone Test pattern and having the necessary radio test mode software.

3-9.5 Silence Pattern

The Audio Zone provides for selection of a Silence Pattern when the GENERATE mode is selected in the RF Zone. This pattern will produce silence in the radio under test.

3-9.5.1 Generate Mode

The analyzer generates a Silence Pattern when Generate mode is selected in the RF Zone and the Silence Pattern is selected for the code field in the Audio Zone.

When code Silence Pattern is selected in the Aud Zone (Figure 3-15), the analyzer modulates t Silence Pattern on the carrier at either of two output ports:

RF I/O port, or
GEN OUT port.

Both deviation level control and a deviation switch are provided in the Audio Zone for deviation control of the generated signal.

The deviation level control can be set by either the keypad or the TUNING knob to enter the desired deviation. The deviation range varies depending on whether the bandwidth (in the RF Zone) is set to narrow or wide.

BW Setting	Deviation Range
Narrow	0.50 to 5.00 kHz maximum, in 0.05 kHz increments
Wide	05.0 to 50.0 kHz maximum, in 0.50 kHz increments

The deviation switch with values of Off and Continuous is located to the right of the deviation level control field. Move the cursor to the switch field and turn deviation on "~" or off "X" using the softkeys.

3-10 ASTRO 25 METER AND DISPLAY CONTROL

ASTRO 25 meter and display fields in the Display Zone are similar to the standard mode. Many of the softkey selections are available: however, some of the selections will return a "not available in ASTRO 25 mode" message. Refer to Section 3-7 under the General Operation tab in this manual for a general description of the functionality of meter and display field selections. To accommodate testing of ASTRO 25 radio equipment, several additional selections have been added for these fields. A BER meter is added to the metering functions in the Display Zone. VOICE FRAME, CLEAR SCOPE and SET UP selections have been added to the display functions in the Display Zone. The selections that have been added are described in the following paragraphs. Description of the standard selections can be found in section 3-7 under the General Operation tab in this manual.

3-10.1 ASTRO 25 BER Meter

The BER Meter is used to verify the performance of test signals generated by ASTRO 25 radios. The BER Meter provides display of bit error rate, frequency error and input power level as well as monitor frequency and deviation. An example of a BER Meter is shown in Figure 3-16. The BER Meter is available only when Monitor "RF Control:" mode has been selected.

To activate the BER test, set controls in the RF Zone as follows:

RF Control:	Monitor
Frequency:	Same as radio transmit frequency
Attenuation:	0 dB
Mon RF In:	RF I/O

The BER Meter is accessed by placing the cursor in the Display Zone's "Meter:" field and pressing the **more** softkey until the **BER** softkey is presented. Select the **BER** softkey to access the BER Meter (Figure 3-16).

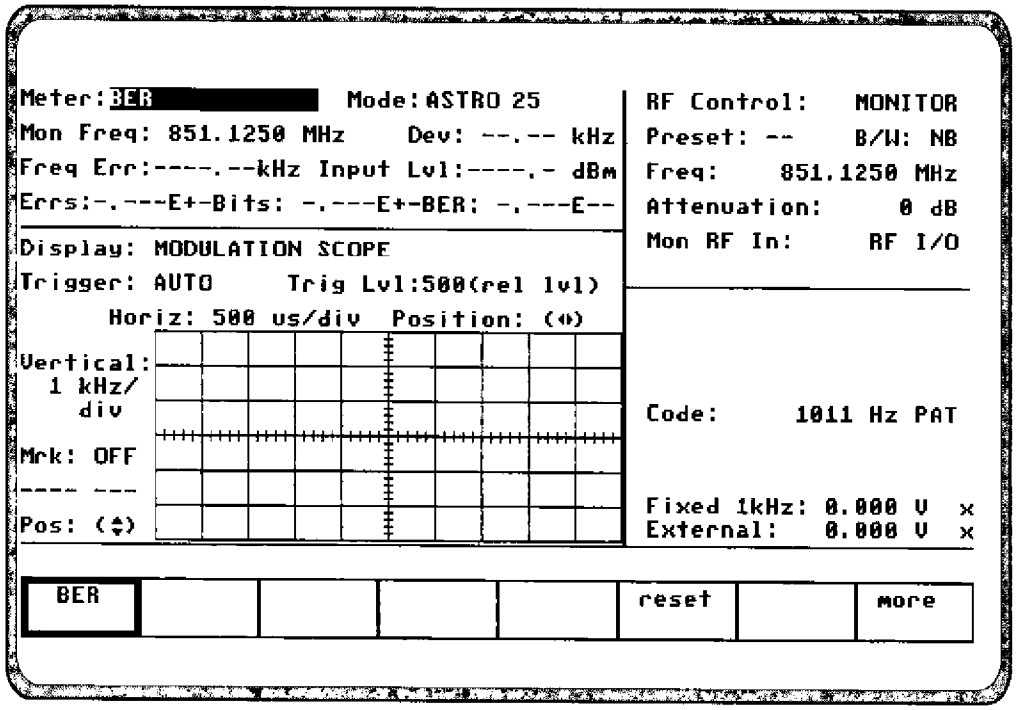

Figure 3-16. ASTRO 25 BER Meter

Mon Freq

Monitor frequency for the radio under test as entered in the RF Control Zone.

Dev

Display of the frequency deviation in kHz.

Freq Err

The error in frequency between the received frequency and the frequency entered in the RF Control Zone.

Input Lvl

Displays the signal level received at the selected front panel connector. A single cursor field at this location allows selection by softkey of either microvolts/watt or dBm units of display.

Errs

Display of the bit error count detected during the test. This display is in exponential notation.

Bits

Display of the bit count during the test. This display is in exponential notation.

BER

Display of the ratio of bit errors to bits sampled during the test. **BER** is displayed in exponential notation. The BER for one error in one thousand bits or 0.1% will be displayed as 1.000E-3.

NOTE

BER Meter measurement is accurate up to 20 percent bit errors.

3-10.1.1 Enabling the BER Test

The BER test begins when BER meter is selected in the Display Zone "Meter:" field.

3-10.1.2 Resetting the BER Test

To reset the BER test, move cursor to the "Meter:" field in the Display Zone and press more until reset is displayed. Press reset and the BER count is started over from zero.

3-10.2 CLEAR SCOPE Display

The CLEAR SCOPE display shows either the received audio signal after it has been converted to analog or the analog transmit signal before it is digitized. To activate the CLEAR SCOPE, place the analyzer in ASTRO 25 mode. The selection of either MONITOR or GENERATE in the RF Zone determines which signal will be displayed on the screen. Press the DISP hardkey, place the cursor on "Display:" field, and select the **CLEAR SCOPE** softkey. The display field in the Display Zone of the screen will indicate CLEAR SCOPE with the input signal displayed in a time-versus-amplitude graph. The operator can adjust the horizontal scale by placing the cursor on "Horiz:" field and selecting the appropriate value from the softkey selections. To change the vertical scale, go to the "Vert:" field and select the appropriate value for the softkey selections. Figure 3-17 shows the display, cursor and associated softkey used for the CLEAR SCOPE.

3-10.2.1 Monitor Mode

In Monitor mode, the CLEAR SCOPE display shows the recovered analog audio signal. The CLEAR SCOPE operational controls are similar to the Standard version MOD SCOPE.

NOTE

The waveform amplitude of this signal is an internal voltage only and does not reflect the deviation of the RF signal.

To change horizontal position, horizontal range, vertical position, or vertical range, use the cursor control keys to highlight the appropriate cursor fields as follows:

Horiz

Press the desired softkey to select the Horizontal Sweep rate (20 us to 1 sec/div). Since all ranges cannot be shown on one screen, press the **more** softkey for additional selections.

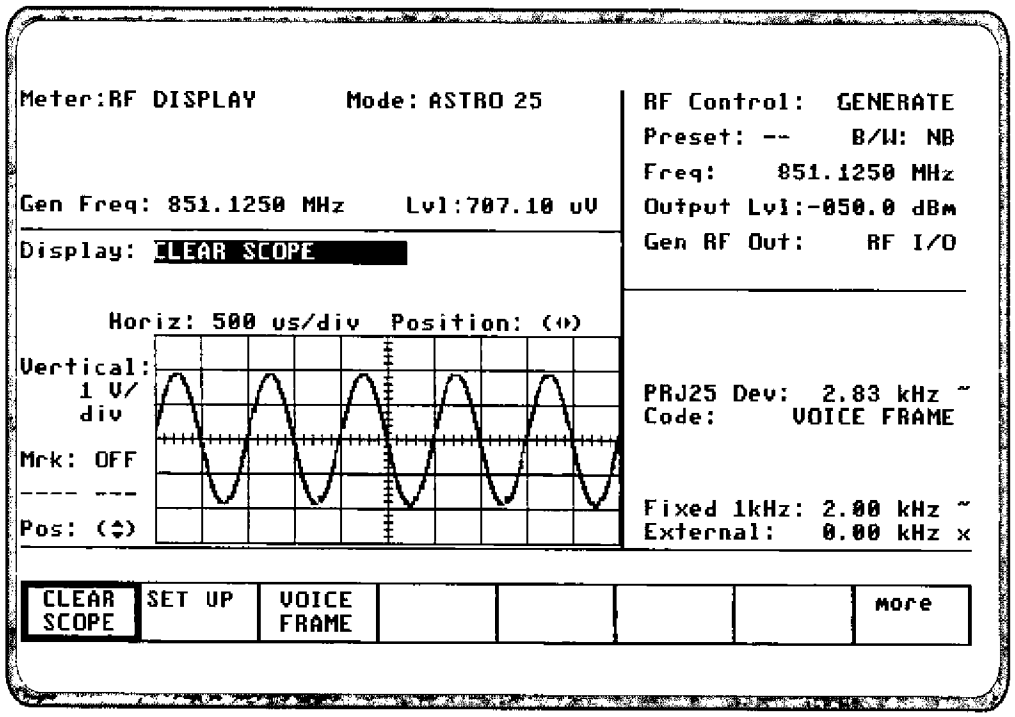

Figure 3-17. ASTRO 25 Clear Scope Display

NOTE

If horizontal sweep rates of greater than 10 msec/div are selected, the update rate will slow down. A good overall setting for most applications is 200 usec per division.

Horizontal Position

Adjust the horizontal position through the (◀▶) cursor field either by using the desired softkey (MOVE LEFT, MOVE RIGHT) or by using the rotary TUNING knob.

Vertical Sensitivity

Press the desired softkey to select the Vertical Sensitivity (10 mV to 10 V per division). When all ranges cannot be shown on one screen, press the **more** softkey for additional selections.

Vertical Position

Adjust the vertical position through the (▲▼) cursor field either by using the desired softkey (MOVE UP, MOVE DOWN) or by using the rotary TUNING knob.

Press the expand softkey from any field in the scope display window to enlarge the display for more detailed analysis. Use the return softkey to get back to the normal size display.

Marker

Select marker operation by moving the cursor to the "Mrk:" field, then pressing the desired "delta" softkey (V, T, or 1/ T). Selection provides two markers on the CLEAR SCOPE screen (refer to Figure 3-18). Press the **toggle marker** softkey to alternate between markers and use TUNING knob to position markers.

V

This softkey selection provides markers that are horizontally located to permit relative readings along the scope vertical axis. The display adjacent to the "Mrk:" field shows the relative voltage difference between the two marker positions.

T

This key selection provides markers that are vertically located to permit relative readings along the scope horizontal axis. The display adjacent to the "Mrk:" field shows the relative horizontal deflection between the two marker positions in units of time.

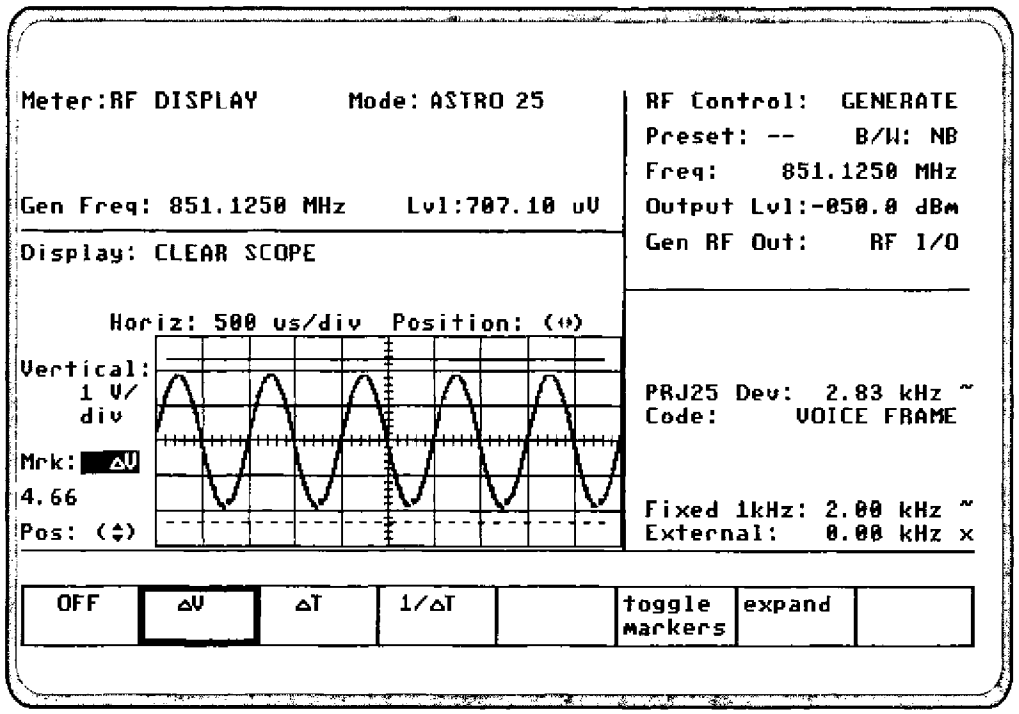

Figure 3-18. Clear Scope Markers

1/ T

This softkey selection provides markers that are also vertically located to permit relative readings along the scope horizontal axis. This selection, however, inverts the time reading and displays the relative difference in terms of frequency.

3-10.2.2. Generate Mode

In Generate mode, the CLEAR SCOPE display shows the generated analog audio signal. The CLEAR SCOPE operational controls are the same as those described for the CLEAR SCOPE in Monitor mode.

3-10.3 Voice Frame Decode

The Voice Frame display is used to decode and view the received embedded data in the link control frame of ASTRO 25 transmissions.

3-10.3.1 Embedded Signaling

The ASTRO 25 provides a user display of decoded embedded signaling (Figure 3-19). It saves the last 30 frames of information on a first-in, first-out (FIFO) basis. User controls are provided to start and stop the data decoding process and to select a specific frame for display.

To monitor the received embedded, voice frame data, move cursor to the RF Control zone. Set th fields as follows:

RF Control:	Monitor
Freq:	(same as transmitting unit)
B/W:	NB
Attenuation:	0 db

Move cursor to the Display Zone. Place cursor in the "Display:" field and press **VOICE FRAME** softkey. Press the **decode start** softkey to select continuous decoding of embedded data. As the analyzer decodes embedded signaling data, the "Frame Counter" counts from 0 to 9999. The last 30 frames of data are stored and can be individually recalled.

To recall a frame, press the **decode stop** softkey and place the cursor on the "Frame:" field. Enter a number from 0 to 29 to recall a frame of data (29 being the most recent). To reset the "Frame Counter" or "Frame Number", press the **frame** softkey.

The "Voice Frame" decode fields are shown in Figure 3-19. The decode fields are the same as described for the encode fields in Section 3-9.2.3 except for the "Raw:" field.

Raw

Field that contains the raw LC data prior to decoding. The data is displayed in hex format.

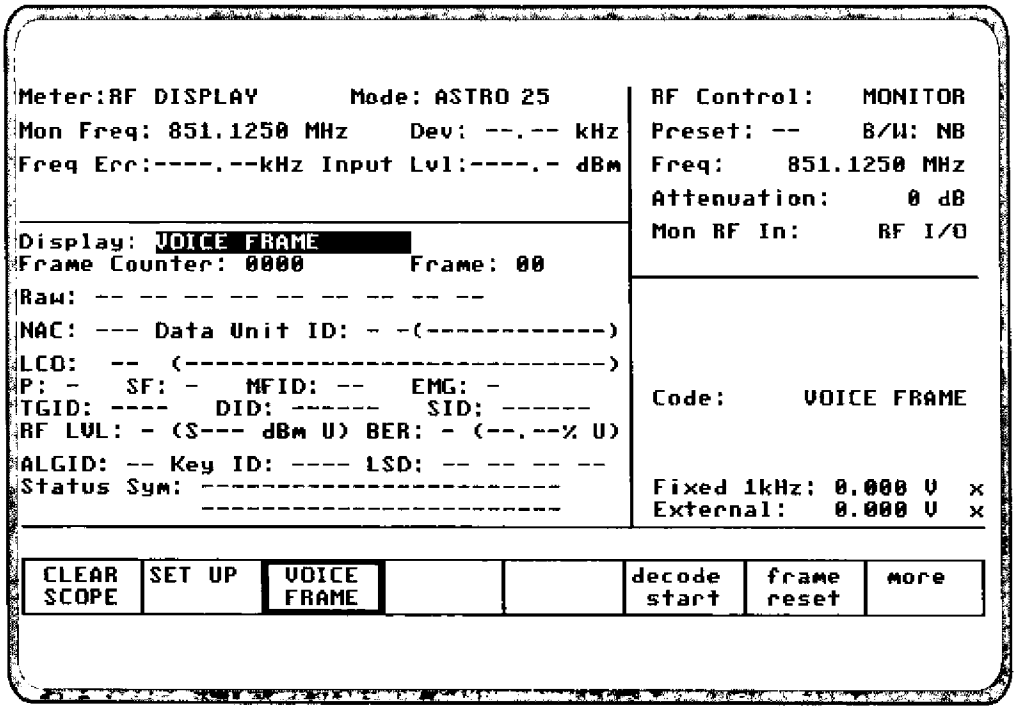

Figure 3-19. Voice Frame Decode Display

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Section 4
APPLICATIONS

CAUTION

When testing a radio, observe the following precautions:

***Use** double-shielded cables on the analyzer to carry signals to and from the radio.*

***Locate** the analyzer at least thirty five feet from the antenna of a unit that is working in the same system that the analyzer is testing.*

***Adjust** the squelch to where the LED indicator for squelch just turns off or is closed. When the signal from the radio is present, the squelch LED will illuminate indicating that squelch has been detected and there is a signal present.*

4-1 General Information

This section contains operational testing examples for testing ASTRO 25 radios.

4-1.1 Configuration for Monitor Mode Testing

To configure the analyzer for Monitor mode testing, first select ASTRO 25 for the "Mode:" field in the Display Zone. Next select Monitor mode for the "RF Control:" field and the appropriate settings for "B/W:", "Freq:", and "Attenuation:" fields in the RF Zone.

The "Mon RF In:" field in the RF Zone has two softkey selections: ANT and RF I/O port. The ANT port accesses the analyzer's sensitive receiver and should be used for "off the air" or low power measurements. If an antenna is used with the ANT port, attach the supplied antenna to the ANT port. The RF I/O port should be used for direct connection to the radio under test. If RF I/O port is used, connect a coaxial cable from the analyzer's input port to the radio's output port.

NOTE

Do not directly apply excessive input power to the ANT port. In the event that excessive RF power is inadvertently applied, the port is protected by in-line RF fuse. This fuse may be accessed by unscrewing the front of the BNC connector out of the front panel.

4-1.2 Configuration for Generate Mode Testing

To configure the analyzer for Generate mode testing, first select ASTRO 25 for the "Mode:" field in the Display Zone. Next select Generate mode for the "RF Control:" field and the appropriate settings for "B/W:", "Freq:", and "Output Lvl:" fields in the RF Zone.

Place the cursor in the Audio Zone and select the desired levels for the summed modulating signal and ASTRO 25 deviation. Remember to enable the switches to the right of the level entry. To transmit anything other than 1011 Hz Tone Test pattern, Calibration Test pattern or silence pattern, the Generate code in the Audio Zone must be set to VOICE FRAME.

Place the cursor on the "Gen RF Out:" field in the RF Zone. This field has two softkey selections: GEN and RF I/O port. The RF I/O port is recommended for most applications

where GEN and MON ports are combined for a single connection to the radio under test. The GEN port is recommended where higher levels of output signal are needed. Connect a coaxial cable from the selected output port to the input of the radio.

NOTE

Do not apply input power to the GEN output port. In the event RF power is inadvertently applied, the port is protected by in-line RF fuse. This fuse may be accessed by unscrewing the front of the BNC connector out of the front panel.

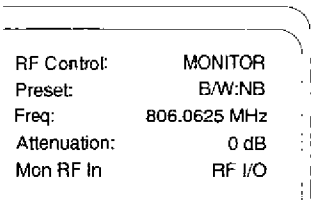
4-2 ASTRO 25 RADIO TRANSMIT TESTS (Monitor Mode)

This section describes the basic test setup for testing ASTRO 25 radio transmitted voice and embedded data.

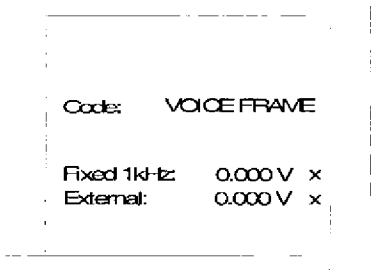
NOTE

If the selected radio channel is encrypted, select the analyzer encryption algorithm and key as described in Section 3-7.

1. Place the cursor in the RF Zone and configure the analyzer in Monitor mode as shown in the example below:



2. Select the desired frequency that matches the radio under test; 806.0625 MHz is used in this example.
3. Connect the RF input/output of the radio under test to the RF I/O port of the analyzer as shown in Figure 3-4.
4. Press the **AUD** hardkey to place the cursor in the Audio Zone and select **VOICE FRAME**.



5. Press the **DISP** hardkey to place the cursor in the Display Zone.

NOTE

If the radio transmit frequency is unknown, it can be determined by turning on the radio, pressing the radio PTT and placing the analyzer in RF Scan mode. Refer to Section 3-7.1.2 under the General Operation tab for a description of the RF Scan function.

Place the cursor in the "Meter:" field and select **RF DISPLAY**. The monitored frequency, deviation, frequency error and input power level are all displayed in the Display Zone.

4-2.1 ASTRO 25 Voice

To display the voice analog waveform move the cursor to the "Display:" field in the Display Zone and select **CLEAR SCOPE**. Press the radio PTT, speak into the radio microphone, and turn up the volume on the analyzer. If the radio is operating, the transmitted voice will be heard from the speaker of the analyzer.

4-2.2 ASTRO 25 Voice Frame Embedded Data

To display the voice frame embedded data, move the cursor to the "Display:" field in the Display Zone and select **VOICE FRAME**. The Voice Frame decode table will be displayed as shown in Figure 3-19. Press the **decode start** softkey then press the PTT on the radio to display the embedded data. As each frame is captured, the number displayed in the "Frame Counter:" field will be incremented. Press the **decode stop** softkey to discontinue capturing frames.

The last 30 frames of data from the radio are stored and can be recalled for further analysis. To recall a frame, enter a number from 0 to 29 in the "Frame:" field (29 being the most recent), and the selected frame will be displayed. To reset the "Frame:" and "Frame Counter:" fields, press the **frame reset** softkey.

The "Raw:" field displays the captured link control format data for a single frame in hex format.

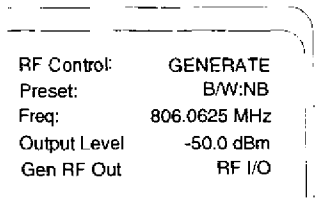
4-3 ASTRO 25 RADIO RECEIVE TESTS (Generate Mode)

This section describes the basic test setup for testing ASTRO 25 radio received voice and embedded data.

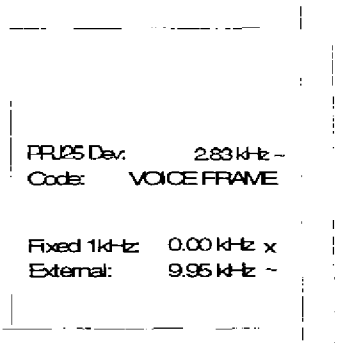
NOTE

If the selected radio channel is encrypted, select the analyzer encryption algorithm and key as described in Section 3-7.

1. Place the cursor in the RF Zone and configure the analyzer in Generate mode as shown in the example below:



2. Select the desired frequency that matches the radio under test; 806.0625 MHz is used in this example.
3. Connect the RF input/output of the radio under test to the RF I/O port of the analyzer as shown in Figure 3-4.
4. Press the **AUD** hardkey to place the cursor in the Audio Zone and make the selections shown below. External must be set to a value and turned on with ~ to enable the input from the microphone of the analyzer.



5. Place the cursor on VOICE FRAME in the Audio Zone, and press the **display table** softkey. The VOICE FRAME ENCODE screen shown in Figure 3-14 will be displayed.
6. Insert the appropriate values into each of the fields of the VOICE FRAME ENCODE table or press the **default frame** softkey to enter pre-programmed values. It is essential to enter the correct Network ID code that matches the radio. This can be determined from the VOICE FRAME DECODE table when monitoring the transmitted voice frames from the radio (refer to Section 4-2).
7. Press the **return** softkey from the VOICE FRAME ENCODE screen.
8. Press the **DISP** hardkey then move the cursor to the "Display:" field and select the **CLEAR SCOPE** softkey.
9. Connect a microphone to the analyzer and press the PTT. Note that when the microphone PTT is pressed, the ASTRO 25 analog voice can be observed on the CLEAR SCOPE in the Display Zone. Turn on the radio and talk into the microphone of the analyzer. If the radio is operating, the received voice will be heard from the speaker of the radio.

4-4 BER TESTING THE RADIO RECEIVER (Generate Mode)

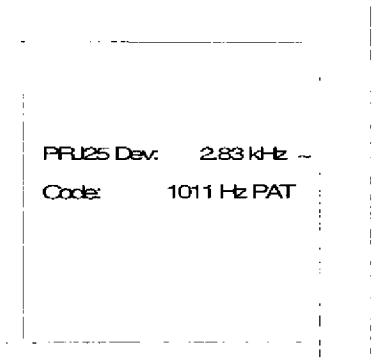
This application example describes the receiver test for radios that have BER test capability. The receiver must have the capability of comparing an unencrypted received signal with a stored 1011 Hz Tone Test Pattern. Performance of this test

requires the analyzer to operate in Generate mode with either 1011 Hz Tone Test Pattern or Calibration Test Pattern selected for the code field in the Audio Zone. In this mode the analyzer generates a test signal and the radio monitors the signal. When testing the receiver, the radio under test measures the BER of the received signal and displays the result to the operator. When a 1011 Hz Tone Test Pattern has been selected for the output signal, the output level of the analyzer is reduced until the radio BER threshold is determined. Consult the radio maintenance manual to determine the BER threshold percentage to be used in testing. When a Calibration Test Pattern has been selected for the output signal, the measured BER should be 4.977%

NOTE

Test frequencies may be specified for BER test of your equipment. Consult the radio maintenance manual.

1. Connect the RF Input port of the radio under test to the GEN OUT port of the analyzer. Consult the radio maintenance manual to determine the appropriate test port.
2. Place the cursor on the "Code:" field in the Audio Zone (Figure 4-1) and select the **1011 Hz PAT** softkey. This will generate a 1011 Hz tone test pattern. If this pattern is received correctly by the unit under test, the BER measured be the unit under test should be zero.
3. Set the deviation in the Audio Zone as below:



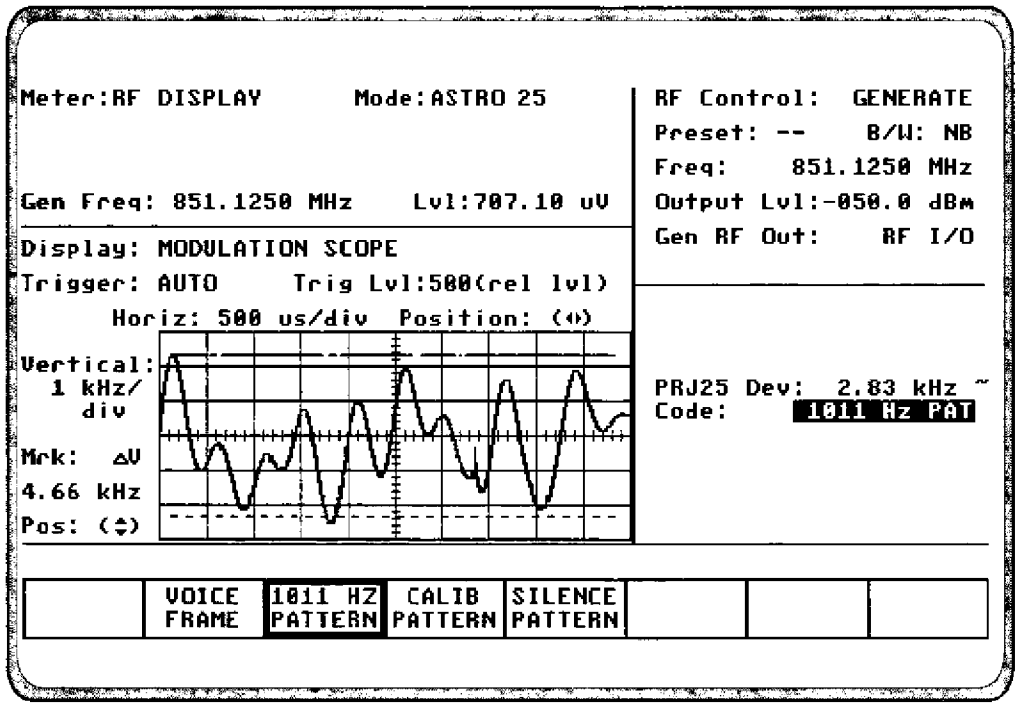
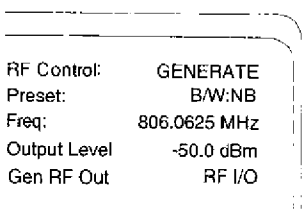


Figure 4-1. Radio (BER Test Mode) Audio Zone

4. Place the cursor in the RF Zone and configure the analyzer in Generate mode as shown in the example below:



5. Select the desired frequency that matches the radio under test; 806.0625 MHz is used in this example.
6. Configure the radio under test to the BER Test mode. Consult your radio maintenance manual for specific instructions.
7. Monitor the radio's received BER. Reduce the analyzer's output level until the radio measures a BER corresponding to the sensitivity threshold. Consult your radio maintenance manual for the receiver sensitivity specification.

4-5 BER TESTING THE RADIO TRANSMITTER (Monitor Mode)

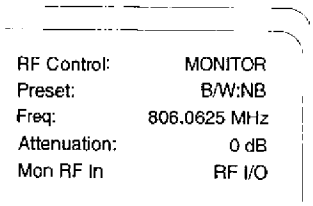
This application example describes the transmitter test for radios that have BER test capability. The transmitter must have the capability of transmitting an unencrypted 1011 Hz Tone Test Pattern. Performance of this test requires the analyzer to operate in monitor mode, while monitoring a test signal transmitted by the radio under test.

When testing the transmitter, the radio generates a test signal. The analyzer measures the transmitted BER, frequency error, and power level of the signal transmitted by the radio.

NOTE

Consult the radio maintenance manual, as specific test frequencies may be specified for BER test of your equipment.

1. Connect the RF input/output of the radio under test to the RF I/O port of the analyzer as shown in Figure 3-4. Consult the radio maintenance manual to determine the appropriate test port.
2. Place the cursor within the Audio Zone and place the cursor on the "Code:" field (Figure 4-1). With the cursor on the "Code:" field, select the **1011 Hz PAT** softkey.
3. Place the cursor in the RF Zone and configure the analyzer in Monitor mode as shown in the example below:



4. Select the desired frequency that matches the radio under test; 806.0625 MHz is used in this example.
5. Configure the radio under test to transmit an 1011 Hz Tone Test Pattern. Consult your radio maintenance manual for specific instructions.
6. Turn on the transmitter of the radio. Consult your radio maintenance manual for instructions.
7. Access the BER Meter by placing the cursor in the Display Zone's "Meter:" field and pressing the **more** softkey until the **BER** softkey is presented. Select BER via the softkey to display the BER Meter. A screen similar to Figure 4-2 appears.
8. BER measurements will be terminated at the end of transmission or when switching out of Monitor Mode.

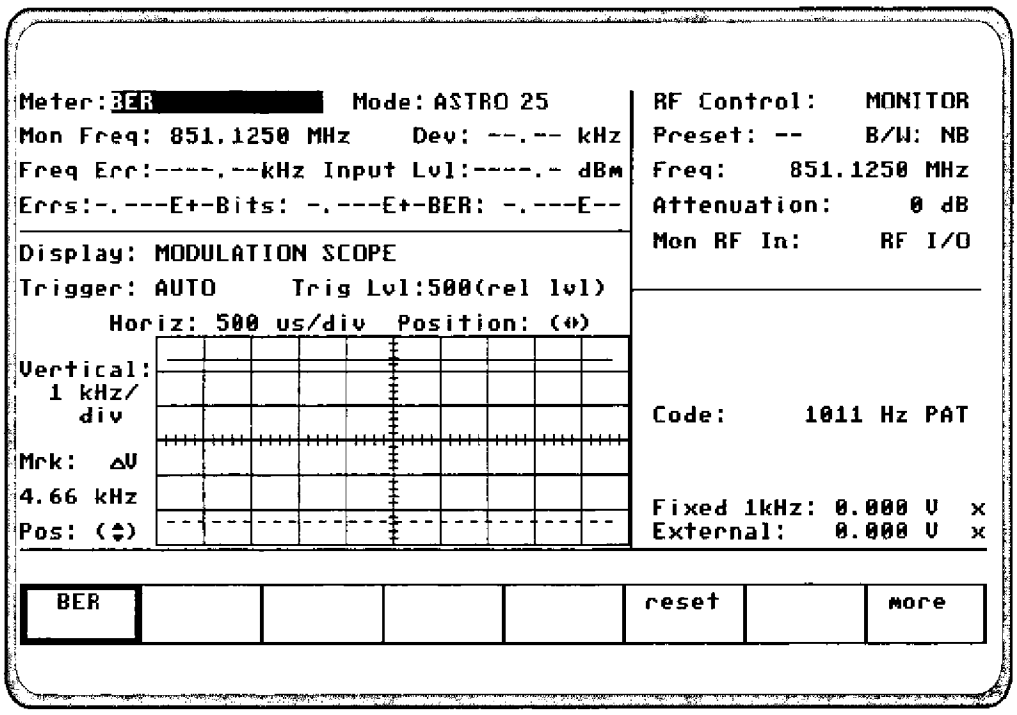
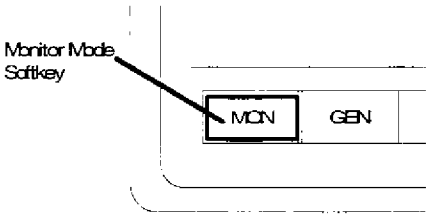


Figure 4-2. Radio (BER Test Mode) BER Meter

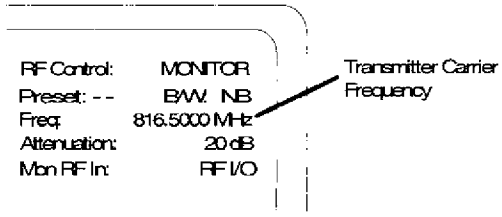
4-6 MONITORING RECEIVED AUDIO WITH CLEAR SCOPE

This section of the manual contains information on using the Clear Scope function to monitor an audio signal that has been transmitted by an ASTRO 25 radio and then recovered by the analyzer.

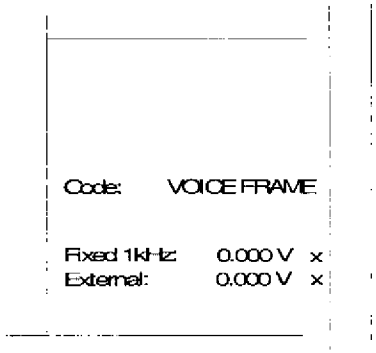
1. Place the cursor within the RF Zone in "RF Control:" field. Press the **MON** softkey to place the analyzer into its Monitor mode of operation.



2. Within the RF Zone, set as follows:



3. Connect the analyzer's RF I/O port to the RF output of the transmitter under test.
4. Set the SQUELCH control on analyzer to threshold.
5. Press **AUD** hardkey and select **VOICE FRAME**.



6. Press **DISP** hardkey to move the cursor to the Display Zone.
7. Place cursor in the "Display:" field and press **CLEAR SCOPE** softkey. The CLEAR SCOPE screen should appear similar to Figure 4-3. No waveform is present until the transmitter is turned on.
8. Turn on the Project 25 radio and press PTT.

CAUTION

The analyzer's built-in RF load dissipates up to 50 W for three minutes and up to 125 W for one minute. If a high-power transmitter is keyed into the analyzer for a time long enough to threaten overheating the power measuring circuitry, the analyzer's audible alarm sounds and the display changes to the ***RF LOAD OVERTEMPERATURE*** *warning, signaling the operator to unkey.*

9. Move the cursor to "Horiz:" field and select the desired scale.
10. Move the cursor to "Vert:" field and select the desired scale.
11. Move the cursor to "Vert Position:" field. Use **move up/move down** softkeys or rotary control to position the recovered audio waveform on a convenient graticule.
12. Move the cursor to "Horiz Position:" field. Use **move left/move right** softkeys or rotary control to position the recovered audio waveform on a convenient graticule.
13. Move the cursor to "Mrk:" field.

    Press **V** softkey to display movable markers that measure voltage differential (Vp-p).

    Press **T** softkey to display movable markers that measure time differential (sec).

    Press **1/T** softkey to display movable markers that measure reciprocal time differential (in Hz).
14. Position the markers as desired using TUNING knob (press **toggle marker** softkey to select marker). The movable marker is indicated by a dashed line. Observe digital readout of marked values below "Mrk:" field.

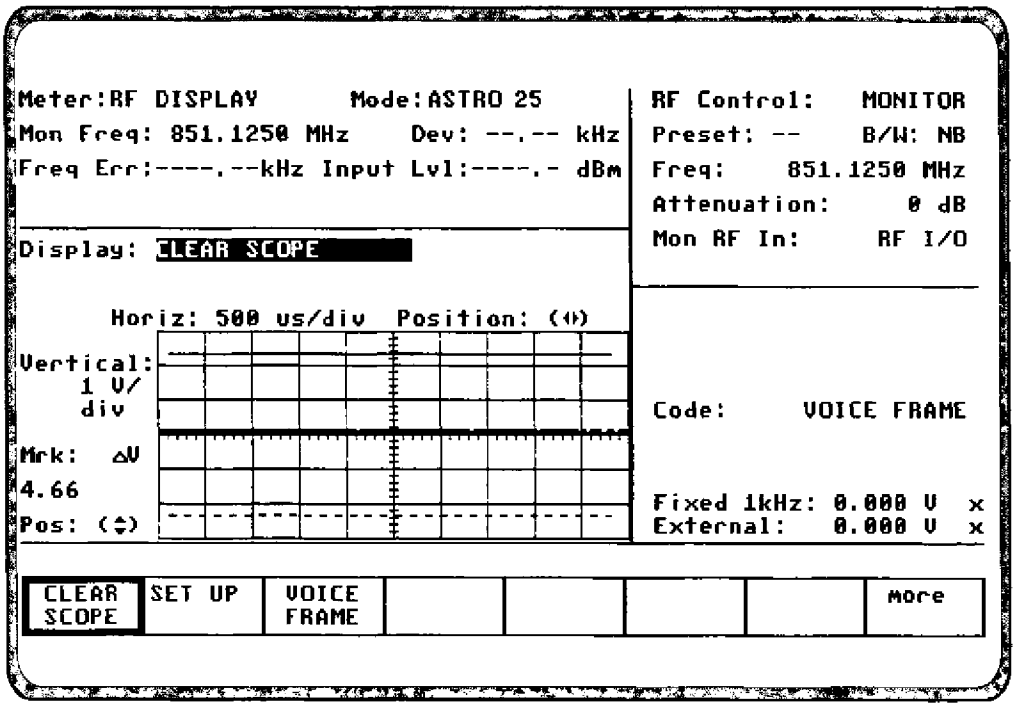


Figure 4-3. ASTRO 25 CLEAR SCOPE Display of Recovered Audio

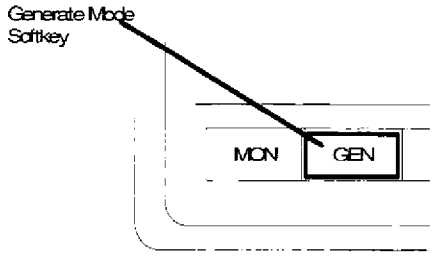
4-7 MONITORING TRANSMITTED AUDIO WITH CLEAR SCOPE

This section of the manual contains information on using the Clear Scope function to analyze the R-2670's raw modulation signal (1 kHz) in ASTRO 25 Generate mode. This analog signal is viewed prior to being digitized and encrypted.

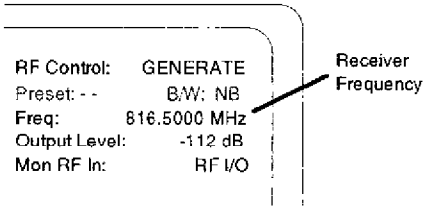
NOTE

It is not necessary to connect the analyzer's DVM port for this application.

1. Place the cursor within the RF Zone in "RF Control:" field. Press the **GEN** softkey to place the analyzer into its Generate mode of operation.



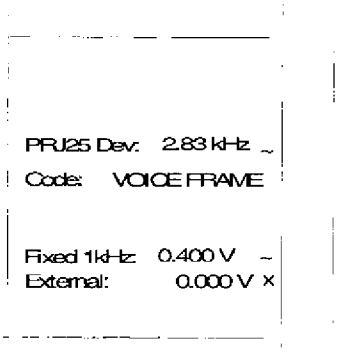
2. Within the RF Zone, set as follows:



NOTE

For setup and distortion measurements, set output level to at least 30 dB above sensitivity threshold (-80 dBm recommended).

3. Connect the analyzer's RF I/O port to the radio's antenna connector.
4. Use the CURSOR ZONE keys to move the cursor to the Audio Zone. Within the Audio Zone, move the cursor to Fixed 1 kHz controls field. Select 1 kHz audio source as the modulating signal (also available from the MOD OUT connector on the front panel) by turning 1 kHz on "~". Set 1 kHz voltage level to 0.4 volt.



5. Turn on the ASTRO 25 receiver and tune receiver and analyzer to the same frequency. Verify receiver locks onto test signal.
6. Use the CURSOR ZONE keys on analyzer front panel and move the cursor to the Display Zone.
7. Place cursor in the "Display:" field and press **CLEAR SCOPE** softkey. The CLEAR SCOPE screen should appear similar to Figure 4-4.
8. Move the cursor to "Horiz:" field and press **200 us** softkey.
9. Move the cursor to "Vert:" field and press **200 mv** softkey.
10. Move the cursor to "Vert Position:" field. Use **move up/move down** softkeys or rotary control to position the modulating 1 kHz waveform on a convenient graticule.
11. Move the cursor to "Horiz Position:" field. Use **move left/move right** softkeys or rotary control to position the modulating 1 kHz waveform on a convenient graticule.
12. Move the cursor to "Mrk:" field.

    Press **V** softkey to display movable markers that measure voltage differential (Vp-p).

    Press **T** softkey to display movable markers that measure time differential (sec).

    Press **1/T** softkey to display movable markers that measure reciprocal time differential (in Hz).
13. Position the markers as desired using TUNING knob (press **toggle marker** softkey to select marker). The movable marker is indicated by a dashed line. Observe digital readout of marked values below "Mrk:" field.

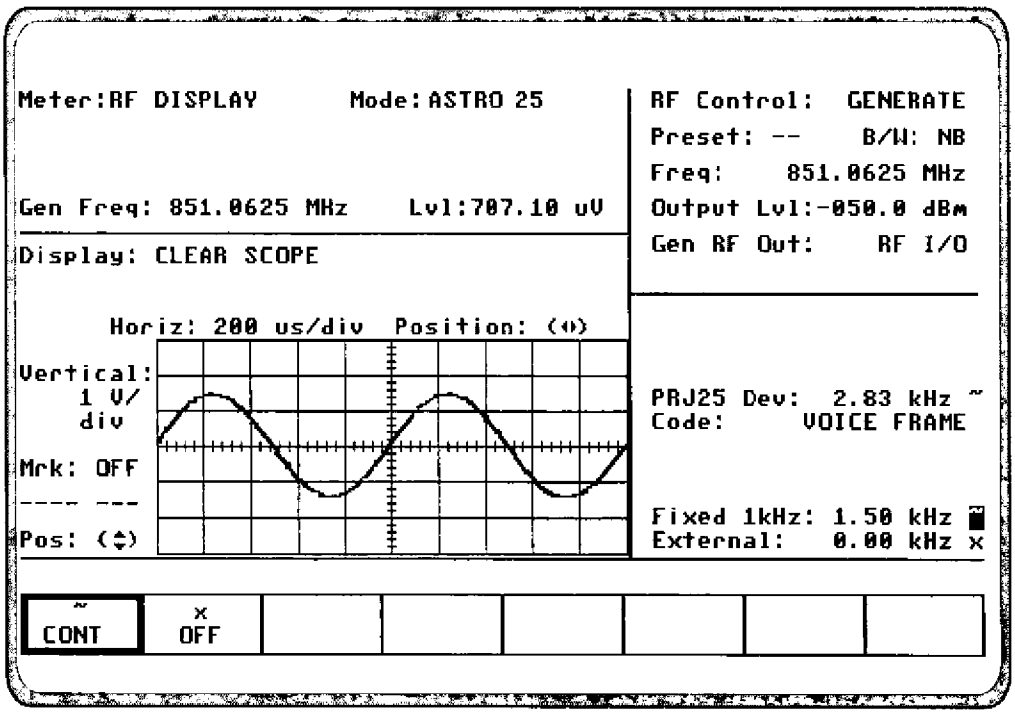


Figure 4-4. ASTRO 25 CLEAR SCOPE Display of Output Modulation

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Appendix
ERROR AND WARNING MESSAGES

1 ERRORS

ASTRO 25 errors fall into two categories: EMC/Encryption Key Errors and ASTRO 25 Errors. Error messages are defined as: "Messages displayed to alert the user to failures which affect system or test functionality." A summary of EMC/ Encryption Key and ASTRO 25 Errors follows.

1.1 EMC/Encryption Error Messages

The following errors occur when there has been an error or failure that prevents encryption decode or encode from operating correctly. The probable cause for the error, along with a recommended solution is presented.

(qwdId: quick, what do I do ?)

Hardware Failure - Perform Encrypt Reset

This message indicates that the Hardware Encryption Modules have failed. The system has either been unable to communicate with one or both of the modules or the module has indicated that it has experienced a startup error.

qwdId:

Perform **encrypt reset** from the Special Function window. If the problem persists, contact the Service Representative.

Warning - External Key Lost

This message is displayed when a Powerup Configuration Failure has occurred. This is most likely due to a Password Validation Failure. In this case, all previously stored keys and passwords have been erased as part of the hardware recovery process.

qwdId:

If an External Key is required, it must be reloaded using a DX type KVL.

Key Invalid - Verify Key Loaded

The user has attempted to use an External Key which is not available for the selected algorithm or encryption type.

qwdId:

This error can be cleared in one of two ways. You can either test using the TEST KEY or you can load an External Key using a DX type key loader. To continue testing using the TEST KEY, select the correct algorithm from the SET UP menu. Select the **TEST KEY** softkey. To test using the External Key in the SET UP menu, select the correct algorithm and then select the **load ext key** softkey. Connect a DX key loader which matches the selected algorithm to the R2625. Enter the desired key into the key loader. When the key is loaded in the key loader, press the PTT on the key loader. The R2625 should respond with the "External Key Loaded" message. If the key does not load, follow instructions in this manual under "External Key Load Failed" message. If the key loads successfully, reselect the **EXT KEY** softkey in the SET UP menu.

External Key Load Failed

An attempt to load an External Key with a key loader has failed.

qwdId:

Observe the SET UP menu in the Display Zone. Verify that the selected algorithm matches the key loader type. For example, if the key loader is a DVP-XL type, verify that the SET UP menu displays "Algorithm Sel: DVP-XL." Also, verify that the selected key type is EXT KEY.

On the back of the key loader, verify that the key loader type is DX. Check the connection from the key loader to the R2625 then retry the key load. If the key load continues to fail, perform an **encrypt reset** from the Special Functions (SPF) menu. After the reset, retry the key load. If the key load still fails, contact the Service Representative.

Entry Field Must Be Made with Mod OFF

An attempt to change the embedded data fields has been made while the R2625 is generating ASTRO 25 VOICE.

qwdId:

In the Audio Zone, turn off the ASTRO 25 signal by changing CONT to OFF before attempting to change the embedded data fields.

Encryption Algorithm Mismatch

An attempt has been made to receive voice in an encryption mode that is different from the encryption mode used for transmitting the voice. (This error only occurs when the analyzer is in monitor mode.)

qwdId:

If the message is displayed and clear voice is heard, then the encryption needs to be turned off on the setup page. If the message is displayed and grabled voice is heard, then the encryption type selected on the setup screen needs to be changed to the same encryption type used for transmitting the voice.

1.2 ASTRO 25 Error Messages

The following three messages are very similar. They are all related to a severe failure of the ASTRO 25. A general discussion of the cause follows, along with a general recommended solution. This solution is basically to reset the R2625 and restart the powerup sequence.

ASTRO 25 Failed, Notify Local Service Rep

ASTRO 25 Option - Illegal CP Request

ASTRO 25 Option - Bad CP opcode

While in the ASTRO 25 mode, the system experiences difficulty when communicating with the ASTRO 25.

qwdId:

First try **encrypt reset**, and if that fails, notify the Service Representative.

No Response From Option

The R2625 has attempted to communicate with the ASTRO 25 Option but has not received a response.

qwdId:

Verify that the ASTRO 25 Option is installed. This can be done by inspecting the Installed Options window from the Special Functions (SPF) page.

If the option is installed, press the **encrypt reset** softkey from the system functions line on the SPF window. This will reset the R2625. Retry the test. If the message is redisplayed, perform the **nvm clear** from the SPF menu. (This function will clear all settings previously input.) Retry the test. If the message is redisplayed, contact the Service Representative.

Option Not Responding To Calibration Msg

A command to start the modulation calibration for the ASTRO 25 Option has been generated but the option is not responding.

qwdId:

Perform an **nvm clear** from the Special Functions (SPF) menu to restart calibration. If the option fails to respond, notify the Service Representative

An External Key has been successfully loaded into the EMC.

Astro Option - Failed DSP SRAM Test

Indicates failure of the DSP powerup test of the three DSP static RAM chips on the option card.

Astro Option - Failed DSP ROM Test

Indicates failure of the DSP powerup test of the DSP program ROM on the option card.

Astro Option - Failed DSP Startup

Indicates failure of the DSP powerup sequence has been detected by the HC11 when the required DSP startup message is not correctly received from the DSP.

ASTRO Option Timed Out

Indicates failure of the option has been detected by the 68k during powerup when the required diagnostic response has not been received from the HC11.

qwdId:

For the above four message, first try to reset the analyzer. If this fails notify the Service Representative.

2 WARNINGS

ASTRO 25 Warnings also fall into two categories Informational Warnings and User Prompt Warnings. Informational Warnings provide feedback to the user, informing the user of results of actions. User Prompt Warnings prompt the user to perform some action to continue.

2.1 ASTRO 25 Informational Warnings

The following ASTRO 25 Informational Messages occur as the result of some user or system action. All of these messages are informational only and do not require any user action.

External Key Load Passed

Keyload In Progress

The operator has selected the **load ext key** softkey and then pressed PTT on the KVL.

External Key Erased

The user has erased a previously loaded External Key.

External Keyload Canceled

The user has chosen to cancel a key load operation. The system has been restored from key load mode back to normal operating mode.

2.2 ASTRO 25 User Prompt Warnings

Verify Correct Network ID

When generating ASTRO 25 VOICE, this message indicates that the user has not entered a valid Network ID.

qwdId:

In the Audio Zone, cursor down to VOICE FRAME. Select **display table**. Change the Network ID to a nonzero value.

Press KVL PTT to Start Keyload

The user has selected **load ext key**. The R2625 is now in key load mode and is awaiting the start of the key loading function from the KVL.

qwdId:

Press the KVL PTT to start the key load or press the **cancel** softkey to terminate the key load.

Secure Mode Failure

User is attempting to run a secure voice scenario but is unable to load an algorithm or key into the Encryption Module.

qwdId:

Press the **encrypt reset** softkey.

Warning - Encryption Hardware Failure

One or more algorithms is installed in the R2625 via the Monitor Service Software (MSS) but were not detected on either Encryption Module.

qwdId:

Notify the Service Representative.