



**MOTOROLA**

TEST EQUIPMENT

**R-2670 FDMA Digital  
Communications System Analyzer  
ASTRO Option**

**OPERATOR'S MANUAL**

**Motorola Test Equipment Products**

P.O. Box 1417  
Scottsdale, Arizona  
85252-1417

Motorola 1997, 2000  
All Rights Reserved  
Printed in U.S.A.

Pub #68-P30945C Rev. (A)



## Table of Contents

<u>Topic</u>		<u>Page</u>
<b>Section 1</b>		
<b>INTRODUCTION</b>		
1-1	INTRODUCTION.....	1
1-2	CAPABILITIES.....	1
1-3	SERVICE.....	1
1-4	REPLACEMENT PARTS ORDERS .....	1
1-5	ASTRO OPTION HOUSING.....	2
1-5.1	Description .....	2
1-5.2	Connectors.....	2
<b>Section 2</b>		
<b>DESCRIPTION</b>		
2-1	INTRODUCTION.....	5
2-2	BASIC OPERATION .....	5
2-3	TEST CONSIDERATIONS .....	5
2-4	SPECIAL TERMS .....	5
<b>Section 3</b>		
<b>OPERATING INSTRUCTIONS</b>		
3-1	INTRODUCTION.....	7
3-2	SOFTWARE VERSION SCREEN .....	8
3-3	BASIC OPERATION .....	9
3-3.1	Display Screens .....	9
3-3.2	Manual Operation .....	9
3-3.3	Expanded Display.....	10
3-3.4	Dedicated Keys.....	10
3-3.5	Remote Operation.....	11
3-3.6	HELP .....	11
3-4	ENCRYPTION CAPABILITIES .....	11
3-5	TEST SETUP .....	12
3-6	ACCESSING ASTRO MODE .....	13

## Table of Contents (Cont)

<u>Topic</u>	<u>Page</u>
3-7 ASTRO ENCRYPTION SET UP .....	14
3-7.1 SET UP Encrypter Display .....	14
3-7.1.1 Encrypt .....	14
3-7.1.2 Algorithm Select .....	14
3-7.1.3 Key Type .....	16
3-7.1.4 Encrypt Self Test.....	17
3-7.2 Using the Test Key .....	17
3-7.3 Programming with External Key.....	17
3-7.3.1 Connecting the KVL .....	18
3-7.3.2 Loading External Key .....	18
3-7.3.3 Erasing External Key .....	18
3-8 ASTRO RF OPERATING MODES .....	18
3-8.1 Monitor Mode.....	18
3-8.2 Generate Mode .....	20
3-8.3 Duplex Mode.....	22
3-9 ASTRO AUDIO/MODULATION CONTROL .....	23
3-9.1 Modulation Sources .....	23
3-9.1.1 Fixed 1 kHz.....	23
3-9.1.2 External.....	23
3-9.2 Voice Frame .....	23
3-9.2.1 Monitor Mode .....	23
3-9.2.2 Generate Mode .....	24
3-9.2.3 Voice Frame Embedded Signaling (Generate).....	25
3-9.3 BER.....	27
3-9.3.1 Monitor Mode .....	27
3-9.3.2 Generate Mode .....	27
3-9.3.3 Duplex Mode .....	27
3-10 ASTRO METER AND DISPLAY CONTROL .....	28
3-10.1 ASTRO BER Meter.....	28
3-10.1.1 Enabling the BER Test .....	29
3-10.1.2 Resetting the BER Test.....	29
3-10.2 CLEAR SCOPE Display.....	29
3-10.2.1 Monitor Mode .....	29
3-10.2.2 Generate Mode .....	31
3-10.2.3 Duplex Mode .....	31

## Table of Contents (Cont)

<u>Topic</u>	<u>Page</u>
3-10.3 Voice Frame Decode .....	32
3-10.3.1 Embedded Signaling .....	32

### Section 4 APPLICATIONS

4-1	BASIC ASTRO RADIO TESTING .....	35
4-1.1	Monitor Mode Testing .....	35
4-1.2	Generate Mode Testing .....	35
4-2	ASTRO RADIO TRANSMIT TESTS .....	36
4-2.1	ASTRO Voice .....	36
4-2.2	ASTRO Embedded Data .....	36
4-3	ASTRO RADIO RECEIVE TESTS .....	37
4-4	BER TESTING THE RADIO RECEIVER (Generate Mode) .....	37
4-5	BER TESTING THE RADIO TRANSMITTER (Monitor Mode) .....	38
4-6	BER TESTING USING DUPLEX MODE .....	40
4-7	RADIOS WITH BER TEST CAPABILITY AND REPEATERS .....	41
4-8	MONITORING RECEIVED AUDIO WITH CLEAR SCOPE .....	41
4-9	MONITORING TRANSMITTED AUDIO WITH CLEAR SCOPE .....	43

## LIST OF FIGURES

Figure 1-1. R-2670 with ASTRO Option Housing .....	3
Figure 3-1. ASTRO Version Screen .....	8
Figure 3-2. ASTRO Options Screen .....	9
Figure 3-3. Screen Zone Arrangement.....	10
Figure 3-4. Radio to Analyzer Test Setup.....	12
Figure 3-5. ASTRO Mode Screen .....	13
Figure 3-6. SET UP Display Screen .....	14
Figure 3-7. Encryption Select Display.....	15
Figure 3-8. Algorithm Select Display.....	15
Figure 3-9. Test Key Programming Display .....	16
Figure 3-10. External Key Programming Display .....	17
Figure 3-11. Monitor Mode - RF Zone.....	19
Figure 3-12. Generate Mode - RF Zone.....	21
Figure 3-13. Duplex Mode - Display Zone.....	22
Figure 3-14. ASTRO Audio Zone - Voice Generate Mode .....	25
Figure 3-15. Voice Frame Encode - Generate .....	26
Figure 3-16. ASTRO Audio Zone - BER Generate Mode.....	27
Figure 3-17. ASTRO BER Meter .....	28
Figure 3-18. ASTRO Clear Scope Display.....	30
Figure 3-19. Clear Scope Markers.....	31
Figure 3-20. Voice Frame Decode Display .....	33
Figure 4-1. Radio (BER Test Mode) Audio Zone .....	39
Figure 4-2. Radio (BER Test Mode) BER Meter.....	39
Figure 4-3. Transmit BER .....	40
Figure 4-4. Receive BER.....	40
Figure 4-5. ASTRO CLEAR SCOPE Display of Recovered Audio.....	42
Figure 4-6. ASTRO CLEAR SCOPE Display of Output Modulation .....	44

## APPENDIX

ERROR AND WARNING MESSAGES .....	45
----------------------------------	----

## MOTOROLA TEST EQUIPMENT PRODUCTS

### LIMITED WARRANTY

(EXCLUDES EXPORT SHIPMENTS)

Motorola Test Equipment Products (herein the "product") that are manufactured or distributed by Motorola Communications Group Parts Department are warranted by Motorola for a period of one (1) year from date of shipment against defects in material and workmanship.

This express warranty is extended to the original purchaser only. In the event of a defect, malfunction, or failure during the period of warranty, Motorola, at its option, will either repair, or replace the product providing Motorola receives written notice specifying the nature of the defect during the period of warranty, and the defective product is returned to Motorola at 1313 East Algonquin Road, Schaumburg, IL 60196 transportation prepaid. Proof of purchase and evidence of date of shipment (packing list or invoice) must accompany the return of the defective product. Transportation charges for the return of the product to Purchaser shall be prepaid by Motorola.

This warranty is void, as determined in the reasonable judgment of Motorola, if:

- (a) The product has not been operated in accordance with the procedures described in the operating instruction;
- (b) The seals on non-user serviceable components or modules are broken;
- (c) The product has been subject to misuse, abuse, damage, accident, negligence, repair or alteration.

In no event shall Motorola be liable for any special, incidental, or consequential damages.

In the event Motorola elects to repair a defective product by replacing a module or subassembly, Motorola, at its option, may replace such defective module or subassembly with a new or reconditioned replacement module or subassembly. Only the unexpired warranty of the warranty product will remain in force on the replacement module or subassembly. **EXCEPT AS SPECIFICALLY SET FORTH HEREIN, ALL WARRANTIES EXPRESS OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY, ARE EXCLUDED.**

## COMPUTER SOFTWARE COPYRIGHTS

The Motorola products described in this instruction manual include copyrighted Motorola computer programs stored in semiconductor memories or other media. Laws in the United States and other countries preserve for Motorola certain exclusive rights for copyrighted computer programs, including the exclusive right to copy or reproduce in any form the copyrighted computer program. Accordingly, any copyrighted Motorola computer programs contained in the Motorola products described in this instruction manual may not be copied or reproduced in any manner without the express written permission of Motorola. Furthermore, the purchase of Motorola products shall not be deemed to grant either directly or by implication, estoppel, or otherwise, any license under the copyrights, patents or patent applications of Motorola, except for the normal non-exclusive, royalty free license to use that arises by operation of law in the sale of a product.

This product contains silicon software designed by Ready Systems Corp. ©1989 Ready Systems Corp. All rights reserved. Unpublished-rights reserved under the copyright laws of the United States.

### RESTRICTED RIGHTS LEGEND

Use, duplication or disclosure by the Government is subject to restrictions as set forth in subparagraph (c)(1)(ii) of the Rights in Technical Data & Computer Software clause at DFARS 252.227-7013.

READY SYSTEMS, 470 POTRERO AVENUE, SUNNYVALE, CA 94086

Specifications subject to change without notice.

Motorola, ASTRO, DVP, DVP-XL, DVI-XL and DES-XL are trademarks of Motorola, Inc. Vertex, RSC, Ready Systems Corp. are trademarks of Ready Systems Corporation.

Printed in U.S.A. ©1995 Motorola Inc.



## **Section 1**

### **INTRODUCTION**

#### **1-1 INTRODUCTION**

This manual contains information for using the R-2670 FDMA Digital Communications System Analyzer with ASTRO Options. The ASTRO Option provides unique testing features for communications equipment using ASTRO encoding and modulation principles. Standard R-2670 capabilities are retained. The additional ASTRO test sequences are accessed via the LCD display, screen-defined softkeys, numeric keypad, cursor movement keys, and optical tuning knob. The ASTRO Option functions may also be accessed via the remote control interface port.

#### **1-2 CAPABILITIES**

The ASTRO Option gives the R-2670 the capability of monitoring and generating ASTRO signals. An ASTRO signal relates to a Motorola proprietary signaling scheme in which a serial bit stream is Grey-encoded into one of four corresponding amplitudes, filtered digitally, and then modulated onto an RF carrier. Most of the ASTRO user interface operates exactly like that of the standard R-2670. Several new features were added to test the unique requirements of user ASTRO equipment.

##### **Voice Mode System Testing**

Voice mode provides ASTRO-compatible modulation and demodulation with vocoding. The ASTRO Option generate and monitor modes support actual functional voice testing in encrypted mode using either a test key or an operator key from a separate compatible keyloader.

##### **Bit Error Rate (BER) Testing**

A BER test pattern can be selected to modulate the R-2670 generator section. A BER test pattern can likewise be decoded by the R-2670 in monitor mode. BER tests can also be conducted in duplex mode.

##### **Dedicated Test Screens**

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

##### **Baseband Audio Scope Display**

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

#### **1-3 SERVICE**

Motorola Test Equipment Service Centers service all test equipment supplied by the Motorola Communications Sector. Refer to Section 1 of the R-2600 Series Communications System Analyzer Operator's Manual for service information.

#### **1-4 REPLACEMENT PARTS ORDERS**

Send orders for replacement parts to the nearest Motorola Test Equipment Service Center. Refer to Section 1 of the R-2600 Series Communications System Analyzer Operator's Manual for replacement parts ordering information.

## **1-5 ASTRO OPTION HOUSING**

### **1-5.1 Description**

The ASTRO Option housing (Figure 1-1) is an external module containing circuitry and connectors to support ASTRO functions. The ASTRO Option housing attaches to the rear of the R-2670 analyzer. In some instances the Option housing may be attached along with another option housing or in conjunction with the R-2670 battery pack (optional). The battery pack, if used, mounts on the back of the final option housing.

### **1-5.2 Connectors**

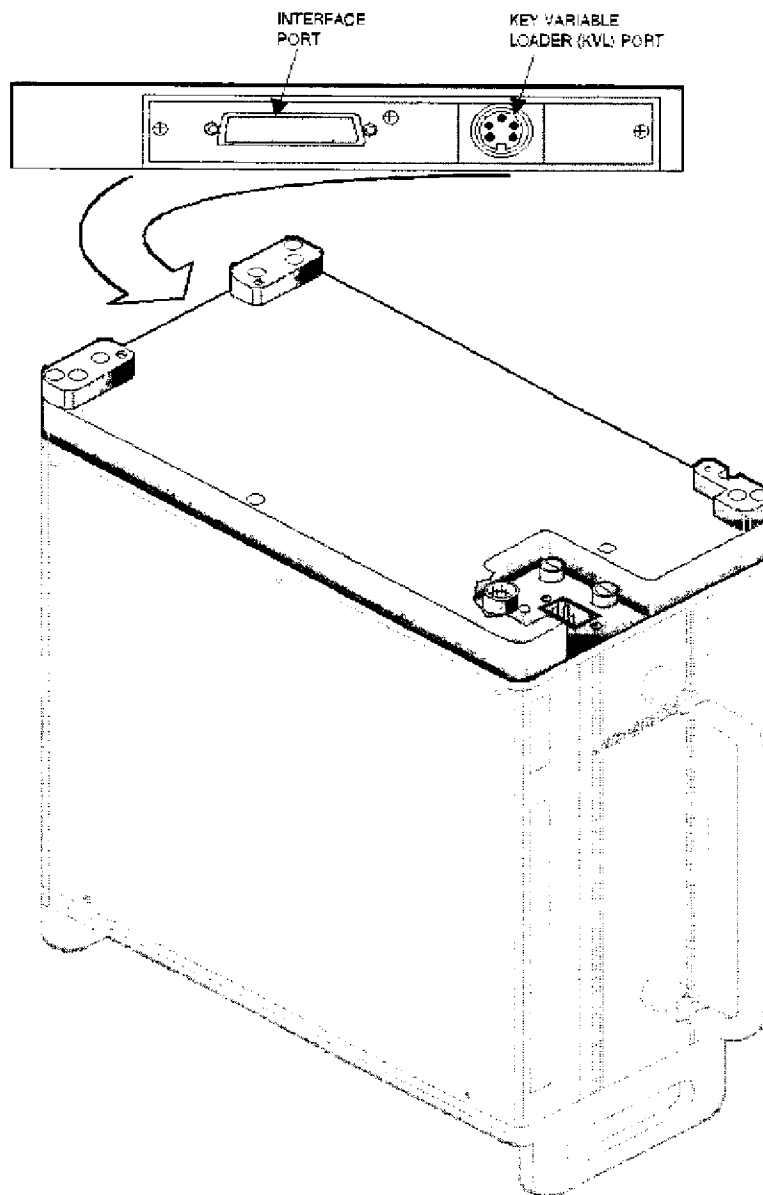
The ASTRO Option housing has two connectors as shown in Figure 1-1. Both connectors are located on the side of the housing. The KVL connector provides a receptacle for loading an external encryption key. The other connector is an interface port.

#### *KEY VARIABLE LOADER (KVL) PORT*

The KVL port allows the analyzer to be preloaded with a user-selected encryption key from any compatible keyloader (key inserter). The R-2670 with ASTRO Option is compatible with the following Motorola key inserters: T3010DX, T3011DX, T3012DX, T3013DX, and T3014DX.

#### *SERIAL PORT (25 PIN)*

The serial interface port is multiplexed to provide the future addition of an HDLC wireline serial data interface or an RS-232 interface for data communications.



*Figure 1-1. Bottom of 2-2670*

[This page intentionally left blank]

## Section 2

### DESCRIPTION

#### 2-1 INTRODUCTION

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

#### 2-2 BASIC OPERATION

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

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

In its ASTRO 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 with ASTRO Option, provides a clear scope display of baseband signals, either

the input to the vocoder (generate mode) or the output from the vocoder (monitor mode).

#### 2-3 TEST CONSIDERATIONS

ASTRO digital radio systems encrypted communications have a need to maintain even higher standards on RF signal quality than normal FM radio systems. Encryption subjects the ASTRO 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. Individual test meters and generators compound the effects of multiple RF paths and wirelines in the test environment, resulting in degraded signals and less accurate measurements.

Operating in secure or standard mode, the R-2670 with ASTRO Option 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 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 systems use the following algorithms:

- DVP-XL
- DES-XL
- DVI-XL

BER test - In generate mode, the analyzer modulates the RF carrier with Bit Error Rate test pattern to test the radio receiver. This BER test pattern consists of a free running, pseudo-random bit pattern. In monitor mode, the analyzer monitors the BER test pattern input 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. Ciphred voice and data can only be understood by means of a special key.

VSELP modulation - Vector Sum Excited Linear Predictive technique used in ASTRO

radios and test equipment to digitize analog signals before transmission and to reconstruct analog 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. Once the key has been loaded, it trains the internal encryption/decryption circuits.

key inserter - a device used to load an electronic encryption key into a radio or other device. Also called a key loader.

## 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 R-2670 FDMA Digital Communications System Analyzer with ASTRO Option is an enhancement of the R-2600 Series Communications System Analyzer. Refer to sections 1, 2, and 3 of the R-2600 Series Communications System Analyzer Operator's Manual (68-P80386B72) 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 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. Messages common to all the R-2600 Series equipment are described in paragraph 3-4 of the R-2600 Series Communications System Analyzer Operators Manual (68-P80386B72).

### 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 software version (figure 3-1).

Move the cursor to the ASTRO 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 **return** softkey twice to return to the ASTRO mode screen.

SOFTWARE VERSION							
<u>SYSTEM</u>		<u>VERSION</u>		<u>CHECKSUM</u>			
██████████		V3.10.A01		AF529168			
ASTRO/SECURENET		V3.10.H00		000063B3			

Figure 3-1. ASTRO Version Screen



TRACK GENERATOR	Installed
CABLE FAULT	Installed
C-MSG FILTER/600-OHM DUM INPUT	Installed
CCITT FILTER/600-OHM DUM INPUT	Installed
PHASE MODULATION	Installed
GRAPHICS PRINTOUT	Installed
ENHANCED SPECTRUM ANALYZER/MARKERS	Installed
FULL TEST SETUPS	Installed
IEEE488	Installed

---

						return	
--	--	--	--	--	--	--------	--

(these are Standard options)

Figure 3-2. ASTRO 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 top portion of Display Zone displays the status and selections for the current test sequence. The bottom portion of the Display Zone displays the data about the radio under test. The RF Zone is used for selection of RF mode, for selection of frequency band, for port selection and for control of RF signal level at the input/output port. The audio section is unchanged from the standard system except that, in ASTRO mode, modulation options are limited.

#### 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.

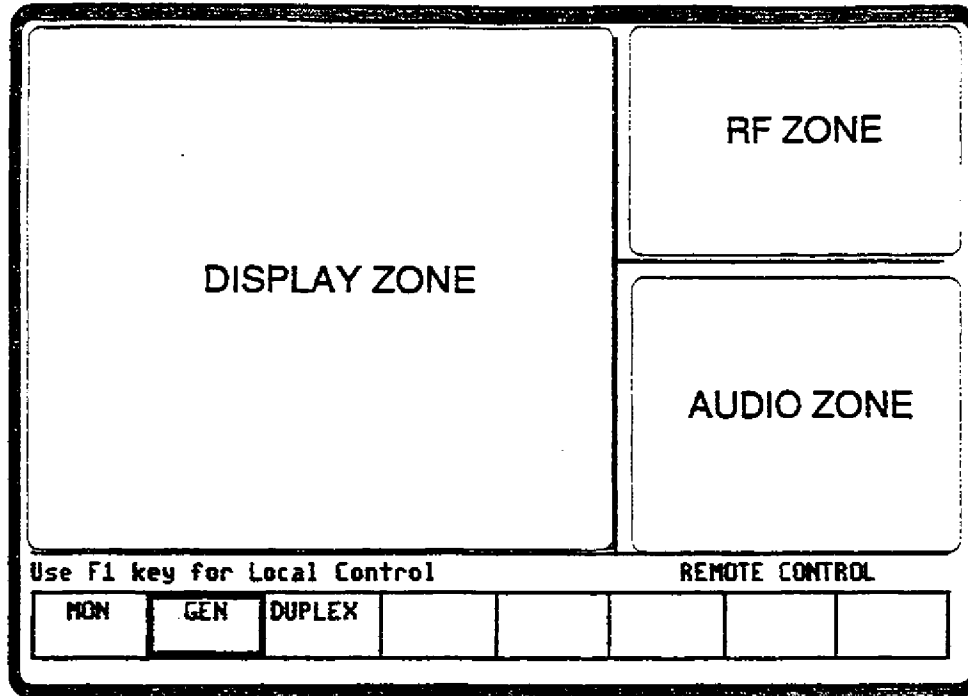


Figure 3-3. Screen Zone Arrangement

### 3-3.3 Expanded Display

Some fields have the ability to expand their contents and overwrite other display areas. These consist of the following:

- Spectrum analyzer, scope waveforms, bargraph displays
- Decode tables
- Encode tables
- Dedicated keys

### 3-3.4 Dedicated Keys

Refer to the Other Functions portion of the R-2600 Series Communications System Analyzer Operator's Manual (paragraph 3-8) for an explanation of expanded screens in the HELP, MEM, SPF, and CAL modes.

### **3-3.5 Remote Operation**

All R-2600 Series Communications System Analyzers are equipped with a standard RS-232 interface. Optionally, the R-2670 is equipped with an IEEE 488 interface. Either of these interfaces 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 mode, the R2670 can operate in clear, hardware encrypted or software encrypted modes. ASTRO equipment converts normal speech patterns to their digital equivalent and then uses an encryption algorithm to encrypt data for transmission. A receiving radio, using the same 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 are available with the ASTRO Option. Algorithms include Data-Encryption System (DES) - a U.S. Federal Government encryption standard, Digital Voice Protection (DVP) - a Motorola Proprietary encryption algorithm, and DVI - a Motorola Proprietary encryption algorithm for international use only. Within a set, each algorithm is individually selectable:

Domestic: DES-XL, 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 the R-2670 analyzer to the antenna port of the radio 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.*

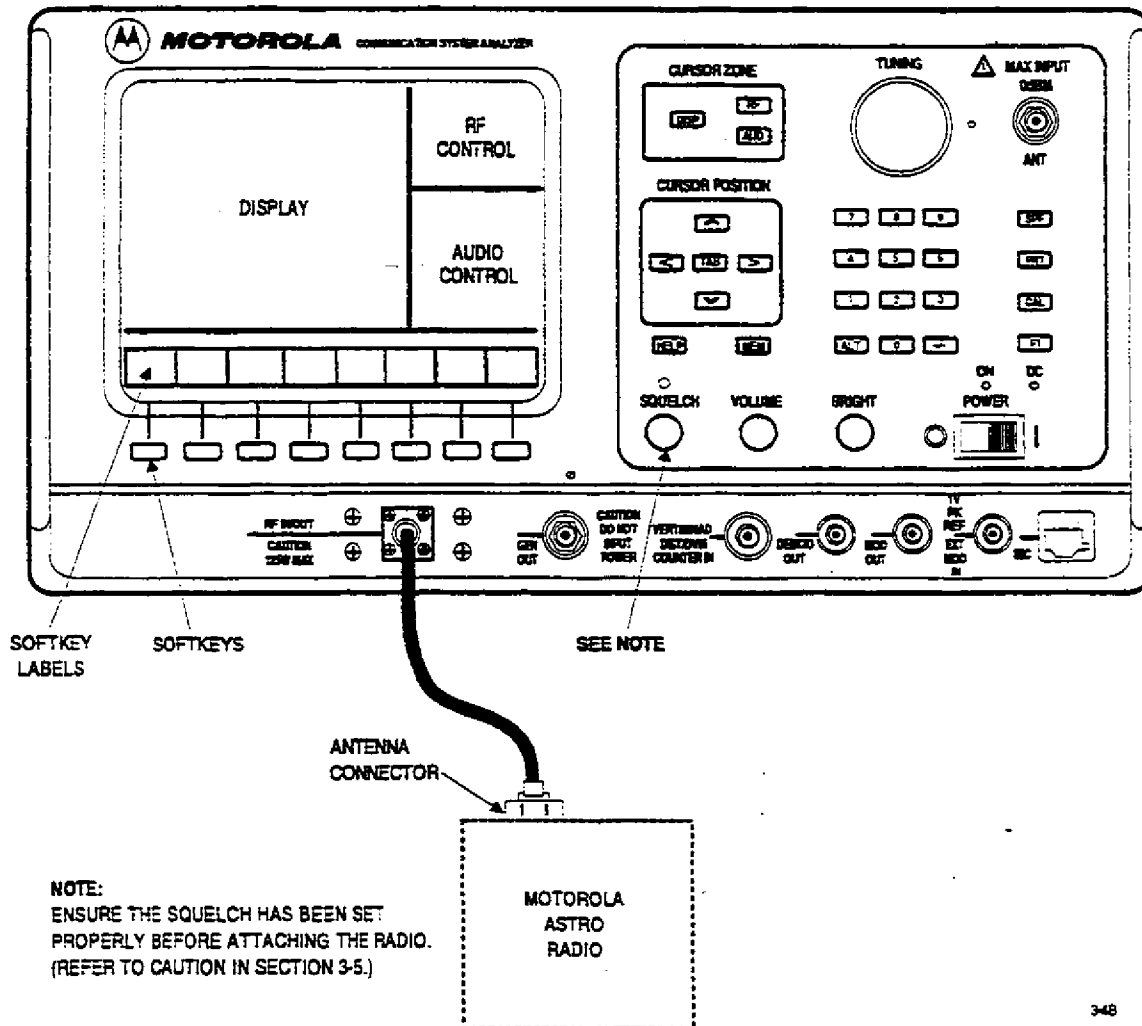


Figure 3-4. Radio to Analyzer Test Setup

### 3-6 ACCESSING ASTRO MODE

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

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

Meter: RF DISPLAY		Mode: <b>ASTRO</b>		RF Control: MONITOR	
Mon Freq: 181.5000 MHz		Dev: 0.00 kHz		Preset: -- B/W: NB	
Freq Err: - 200 Hz		Input Lvl: --- dBm		Freq: 181.5000 MHz	
				Attenuation: 0 dB	
				Mon RF In: RF I/O	
Display: MODULATION SCOPE					
Trigger: AUTO		Trig Lvl: 500 (rel lvl)			
Horiz: 50 us/div		Position: (←)			
Vertical:					
1 kHz/div					
Mrk: OFF					
Pos: (→)					
		Code: VOICE FRAME			
		Fixed 1kHz: 0.000 V x			
		External: 0.000 V x			
STD		SECURE NET	ASTRO		

Figure 3-5. ASTRO Mode Screen

### 3-7 ASTRO 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, or OFF for clear ASTRO operation.

#### 3-7.1.2 Algorithm Select

Within the SET UP display, the type of algorithm 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 intelligible information. The analyzer includes several algorithms recognized by radios using ASTRO. You will need to select one of 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. The softkeys will provide a menu of the available algorithms. Select the appropriate algorithm. Refer to section 3-4 for a description of the U.S. and International encryption algorithms.

Meter: RF DISPLAY      Mode: ASTRO		RF Control:    MONITOR	
Mon Freq: 851.8625 MHz    Dev: 0.00 kHz		Preset: --    B/U: NB	
Freq Err: -155 Hz    Input Lvl: ----. - dBm		Freq: 851.8625 MHz	
Display: SET UP		Attenuation: 0 dB	
Encrypt: ON		Mon RF In:    RF I/O	
Algorithm Sel: DES-XL		Code:    VOICE FRAME	
Key Type: TEST KEY		Fixed 1kHz: 0.000 U x	
Encrypt Self Test: Passed		External: 0.000 U x	
CLEAR SCOPE	SET UP	VOICE FRAME	more

Figure 3-6. SET UP Display Screen

Meter: RF DISPLAY      Mode: ASTRO		RF Control:    MONITOR	
Mon Freq: 851.0625 MHz    Dev: 0.00 kHz		Preset: --    B/W: NB	
Freq Err: -    235 Hz Input Lvl: ----, - dBm		Freq:    851.0625 MHz	
		Attenuation:    0 dB	
		Mon RF In:    RF I/O	
Display: SET UP			
Encrypt: <b>ON</b>			
Algorithm Sel: DES-XL			
Key Type: TEST KEY			
Encrypt Self Test: Passed			
		Code:    VOICE FRAME	
		Fixed 1kHz: 0.000 U x	
		External: 0.000 U x	
<input checked="" type="checkbox"/> ON	<input type="checkbox"/> OFF	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Figure 3-7. Encryption Select Display

Meter: RF DISPLAY      Mode: ASTRO		RF Control:    MONITOR	
Mon Freq: 851.0625 MHz    Dev: 0.00 kHz		Preset: --    B/W: NB	
Freq Err: -    241 Hz Input Lvl: ----, - dBm		Freq:    851.0625 MHz	
		Attenuation:    0 dB	
		Mon RF In:    RF I/O	
Display: SET UP			
Encrypt: ON			
Algorithm Sel: <b>DES-XL</b>			
Key Type: TEST KEY			
Encrypt Self Test: Passed			
		Code:    VOICE FRAME	
		Fixed 1kHz: 0.000 U x	
		External: 0.000 U x	
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/> DES-XL	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Figure 3-8. Algorithm Select Display

### 3-7.1.3 Key Type

Each algorithm is associated with one particular key type: either a Test Key or an External Key. Test Key is the default and is used to support most ASTRO testing. The Test Key is a dummy key which is programmed into the radio and the analyzer for maintenance purposes only. The Test Key should never be used for sending private radio communications. Its security is compromised (all ASTRO Option analyzers use the same Test Key). The analyzer provides these softkey selections:

#### TEST KEY

This softkey selects the Test Key saved in the analyzer's key storage memory. The Test Key will then be used for testing.

#### EXT KEY

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

#### 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. If the software encryption algorithm had been selected (section 3-7.1.2), then selecting load ext key softkey puts a "Key" field on the display. The key is entered using the softkeys or numeric keypad. Press **STORE KEY** softkey to load.

Meter: RF DISPLAY      Mode: ASTRO		RF Control: MONITOR	
Mon Freq: 851.0625 MHz      Dev: 0.00 kHz		Preset: --      B/W: NB	
Freq Err: -241 Hz Input Lvl: ----. dBm		Freq: 851.0625 MHz	
		Attenuation: 0 dB	
Display: SET UP		Mon RF In: RF I/O	
Encrypt: ON			
Algorithm Sel: DES-XL			
Key Type: TEST KEY			
Encrypt Self Test: Passed			
		Code: VOICE FRAME	
		Fixed 1kHz: 0.000 U x	
		External: 0.000 U x	
TEST KEY	EXT KEY	erase ext key	load ext key

Figure 3-9. Test Key Programming Display



Meter: RF DISPLAY      Mode: ASTRO		RF Control:    MONITOR	
Mon Freq: 851.8625 MHz    Dev:    0.00 kHz		Preset: --    B/U: MB	
Freq Err: -    229 Hz Input Lvl: ----, - dBm		Freq:    851.8625 MHz	
		Attenuation:    0 dB	
		Mon RF In:    RF I/O	
Display: SET UP			
Encrypt: ON			
Algorithm Sel: DES-XL			
Key Type: <b>EXT KEY</b>			
Encrypt Self Test: Passed			
		Code:    VOICE FRAME	
		Fixed 1kHz: 0.000 U    x	
		External:    0.000 U    x	
TEST KEY	EXT KEY		erase ext key
			load ext key

Figure 3-10. External Key Programming Display

#### 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 radios 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 private 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.

When software encryption is selected, the External Key is not saved when the analyzer is turned off. For all algorithms except software

encryption, a KVL is required to load an External Key.

### 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.*

### 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.

If the Software Algorithm was selected, the "Key:" field will be displayed and a key can be entered using the softkeys for alpha characters and the keypad for numerics. Press the STORE KEY softkey to load. For the other algorithms (DES-XL, DVP-XL or DVI-XL), the External Key must be loaded from a KVL.

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 successful, disconnect the KVL. Be sure to press the EXT KEY softkey after loading an External Key from the KVL to transfer the External Key into the analyzer's key storage memory. 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.

## 3-8 ASTRO 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, GENERATE, or DUPLEX.

### 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 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 RF signal. All of these fields operate as described in the R-2600 Series Operator's Manual except the Modulation Type field is not required.

Meter: RF DISPLAY		Mode: ASTRO		RF Control: <b>MONITOR</b>	
Mon Freq: 851.0625 MHz		Dev: --. -- kHz		Preset: -- B/W: NB	
Freq Err: ----. -- kHz		Input Lvl: ----. - dBm		Freq: 851.0625 MHz	
				Attenuation: 0 dB	
				Mon RF In: RF I/O	
Display: MODULATION SCOPE					
Trigger: AUTO		Trig Lvl: 500 (rel lvl)			
		Horiz: 50 us/div Position: (←)			
Vertical:					
1 kHz/div					
Mrk: OFF					
Pos: (←)					
		Code: .VOICE FRAME			
		Fixed 1kHz: 0.000 V x			
		External: 0.000 V x			
MON	GEN	DUPLEX			

Figure 3-11. Monitor Mode - RF Zone

The specific entry fields are as follows.

#### **Preset**

The preset entry field provides a convenient way to enter a bandwidth, frequency, and other information for the unit by recalling preset data from nonvolatile memory. If a preset is not to be used, enter the desired information at each of the fields.

#### **NOTE**

*If a preset had been selected and changes are made to any of the preset values, the "Preset:" field will have dashes through it, indicating the preset is no longer selected.*

#### **B/W**

Selects either wide or narrow IF bandwidth of the unit via softkey selection.

#### **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.

#### **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. Refer to paragraph 2-2.4.1 in the R-2600 Series Operator's Manual for additional detail.*

#### **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 radio receiver testing. In ASTRO 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 RF signal. All of these fields operate as described in the R-2600 Series Operator's Manual except the Modulation Type field is not required.

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

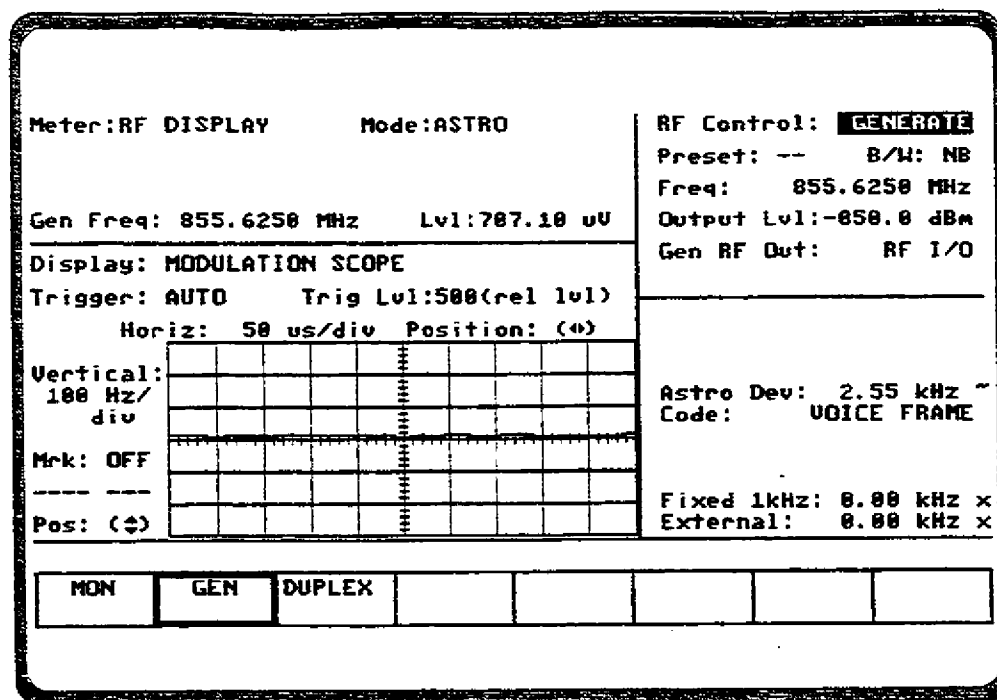


Figure 3-12. Generate Mode - RF Zone

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.

#### **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.*

### 3-8.3 Duplex Mode

The Duplex mode (figure 3-12) provides a simultaneous RF generator BER pattern output that is offset in frequency from the monitor center frequency and fully adjustable in output level.

This capability provides for servicing full duplex radio equipment as well as repeaters and radios operating with offset transmit and receive frequencies. The Display zone provides softkey selections for generated or monitored clear baseband signals as shown in figure 3-12.

Specific controls which further configure the Duplex mode are located within the RF Zone when DUPLEX is first selected.

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.

#### Mon Freq

Enter the desired monitor frequency using keypad or tuning knob.

#### Offset

Enter the generator frequency offset relative to the monitor frequency entered. Offset frequencies of + or -0 to 55 MHz are allowed. The offset frequency is set in 5 kHz steps.

#### Mon

This field actually contains two separate fields, one for monitor input attenuation and one for monitor port selection. Refer to the Monitor mode description for further details.

#### Gen

This field actually contains two separate fields, one for generate output level and one for generate output port selection. Refer to the Generate mode description for further details.

Meter: RF DISPLAY		Mode: <b>ASTRO</b>		RF Control: <b>DUPLEX</b>	
Mon Freq: 851.8625 MHz		Dev: --. -- kHz		Preset: -- B/U: NB	
Freq Err: ----. -- kHz		Input Lvl: ----. -- dBm		Mon Freq: 851.8625 MHz	
Gen Freq: 896.8625 MHz		Lvl: 707.10 uV		Offset: +45.000 MHz	
Display: MODULATION SCOPE		Select: MON		Mon: 8 dB RF I/O	
Trigger: AUTO		Trig Lvl: 500 (rel lvl)		Gen: -858.8 dBm RF I/O	
Horiz: 50 us/div		Position: (←)			
Vertical:					
1 kHz/div					
Mrk: OFF					
Pos: (←)					
Astro Dev: 2.55 kHz ~					
Code: BER					
STD		SECURE NET	ASTRO		

Figure 3-13. Duplex Mode - Display Zone

### 3-9 ASTRO AUDIO/ MODULATION CONTROL

The Audio Zone, located at the lower right of the screen (Figure 3-14), 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 mode are Voice Frame and Bit Error Rate (BER). Many of the features available in standard mode are not available in ASTRO mode. The Audio Zone has been changed to accommodate testing of ASTRO 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 and BER, there are two other modulation sources selectable in the Audio Zone, Fixed 1 kHz and External.

##### 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 selection of Voice Frame or BER pattern. 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 RF transmissions.

##### 3-9.2.1 Monitor Mode

Voice Frame decode is not selectable in the Audio Zone in Monitor mode. 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 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 can generate ASTRO voice patterns when placed in the Generate mode. The ASTRO signal can be clear or encrypted with one of the hardware or software 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 is 2.55 kHz.



Meter: RF DISPLAY		Mode: ASTRO		RF Control: GENERATE	
Gen Freq: 851.0625 MHz		Lvl: 707.10 uV		Preset: -- B/W: NB	
Display: MODULATION SCOPE		Trigger: AUTO Trig Lvl: 500 (rel lvl)		Freq: 851.0625 MHz	
Horiz: 50 us/div Position: (0)				Output Lvl: -050.0 dBm	
Vertical: 100 Hz/div				Gen RF Out: RF I/O	
Mrk: OFF				Astro Dev: 2.55 kHz x	
Pos: (0)				Code: VOICE FRAME	
				Fixed 1kHz: 0.00 kHz x	
				External: 0.00 kHz x	
BER	VOICE FRAME			display table	

Figure 3-14. ASTRO Audio Zone - Voice Generate Mode

### 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 3-15. The following information is encoded by the ASTRO option:

Embedded Information	Size (bits)
Link Control Field (LCF)	60
Presentation Address (PA)	56
Key ID	16
Network ID	12
Busy Bits	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 Format Identifier	Value (binary)
System/ Announcement/ Talkgroup	%0000
System Talkgroup Activity Update with Channel Numbers	%0001
System Talkgroup Activity Update	%0010
Selective Call	%0011
System Individual-Activity Update with Channel Numbers	%0100
System Individual Activity Update	%0101
System Status	%0110
Encrypted PTT ID	%1110
Expansion, includes Received Signal Quality Indicator	%1111

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

Mnemonic	Default Value
Link Control Field	0
Selective Call Variable Octet	N/A
Talkgroup ID	0
Channel	0
Source ID	0
Destination ID	0
Emergency	0
Acknowledge	0
Power Level	0
Bit Error Rate	0
RF Level	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 to verify the network ID to be displayed.

**VOICE FRAME ENCODE**

```

Raw:  0 000000 00000000
LCF:  0 (Sys Announcement Talkgroup )
TID 1: 000    2: 000    3: 000    4: 000
CHN 1: 0000    2: 0000
SID 1: 000000 2: 000000
DID:  000000  ENG: 0      ACK: 0
PWR LVL: 00 (+ 0 dBm)
BER: 0 ( 0.07% A) RF LVL: 0 (S--- dBm U)

Network ID: 000    Busy Bits: 0 (Un Tlk)
Key ID: 0000  PA: 000000 00000000

```

default frame						return	
---------------	--	--	--	--	--	--------	--

Figure 3-15. Voice Frame Encode - Generate

### 3-9.3 BER

The Audio Zone provides for selection of Voice Frame or BER pattern. In generate mode, controls are provided for both signal level and frequency deviation settings of the BER baseband signal that is used to modulate the ASTRO RF transmissions.

#### 3-9.3.1 Monitor Mode

When MONITOR is selected in the RF Zone and code BER is selected in the Audio Zone, the analyzer is configured to receive a BER pattern. The received BER pattern can be displayed and measured in the Display Zone.

#### 3-9.3.2 Generate Mode

The analyzer can generate ASTRO BER patterns when placed in the Generate mode. The Audio Zone provides the "Code:" field to select BER generation.

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

- RF I/O port, or
- GEN OUT port.

In Generate mode, Deviation control is available consisting of a switch with values of Off and Continuous, and a level control in the Audio Zone. 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	0.50 to 5.00 kHz maximum, in 0.05 kHz increments
Wide	05.0 to 50.0 kHz maximum, in 0.50 kHz increments

#### 3-9.3.3 Duplex Mode

The analyzer can generate ASTRO BER patterns when placed in the Duplex mode. The Audio Zone user interface is the same as in Generate mode.

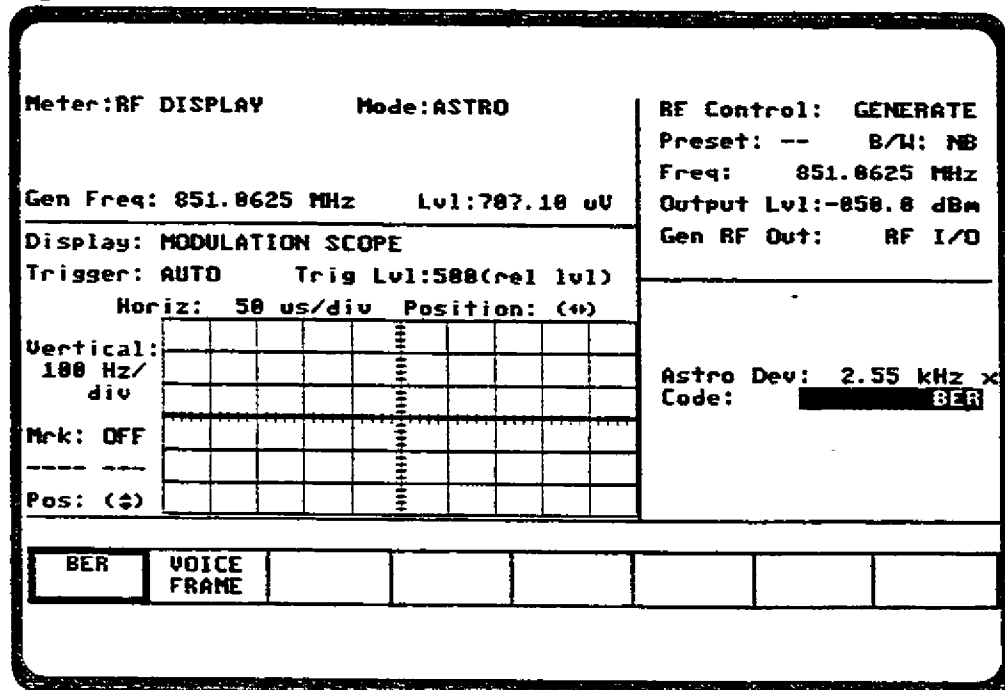


Figure 3-16. ASTRO Audio Zone - BER Generate Mode

### 3-10 ASTRO METER AND DISPLAY CONTROL

ASTRO meter and Display Zone is similar to the standard mode. Many of the softkey selections are available, however, some of the selections will return a "not available in ASTRO mode" message. See section 3-7.1 in the R-2600 Series Operator's Manual for a description of the functionality of meter and Display Zone selections that are still available in ASTRO mode. The Display Zone is slightly modified to accommodate testing of ASTRO radio equipment. A BER meter is added to the metering functions in the Display Zone. VOICE FRAME, CLEAR SCOPE and SET UP display functions have also been added to the Display Zone. Functions that have been added are described in the following paragraphs. Description of the other displays can be found in section 3-7.2 of the R-2600 Series Operator's Manual.

#### 3-10.1 ASTRO BER Meter

The BER Meter is available only during BER Monitor or Duplex Testing. The BER Meter is used to verify the performance of test signals generated by ASTRO 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 3-17.

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

RF Control: Monitor (or Duplex)  
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 3-17).

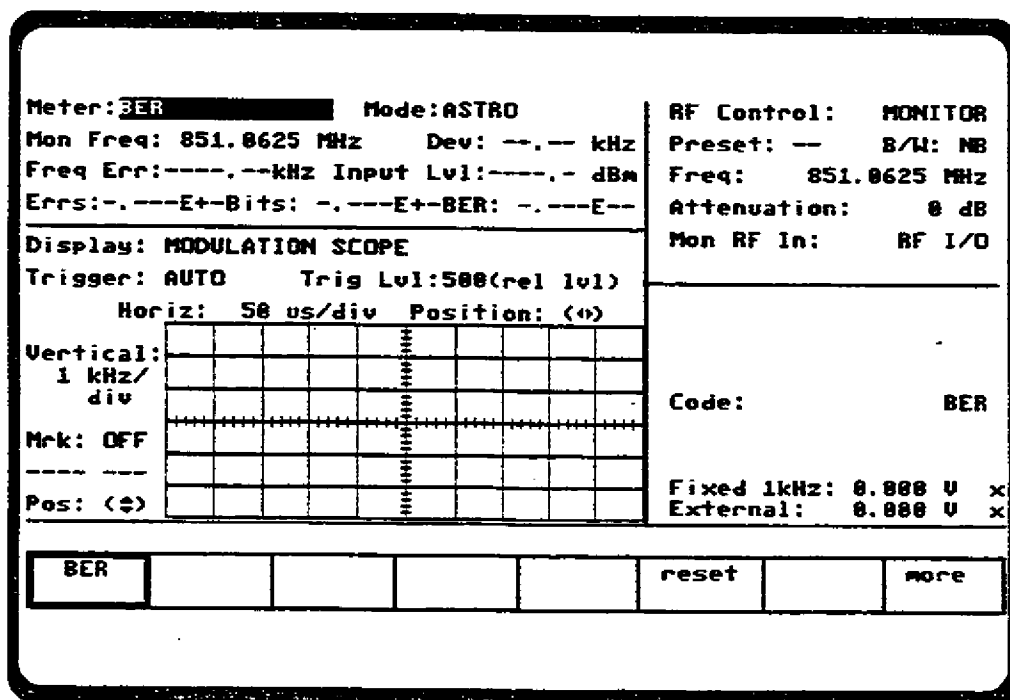


Figure 3-17. ASTRO BER Meter

**Mon Freq**

Display of the actual monitored frequency.

**Dev**

Display of the frequency deviation in kHz.

**Freq Err**

The acquisition frequency error range is  $\pm 1500$  Hz as described for the RF Display.

**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.

**Bits**

Display of the bit count during the test.

**BER**

Display of the ratio of bit errors to bit count determined during the test. BER is displayed as an exponent. The BER for one error in one thousand bits is 0.001E01.

**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 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 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 3-18 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 with the following differences in vertical scale.

10 mV/div	500 mV/div
20 mV/div	1 V/div
50 mV/div	2 V/div
100 mV/div	5 V/div
200 mV/div	10 V/div

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.

### 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 ( $\blacktriangleleft$ ) 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 ( $\blacktriangleup$ ) 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.

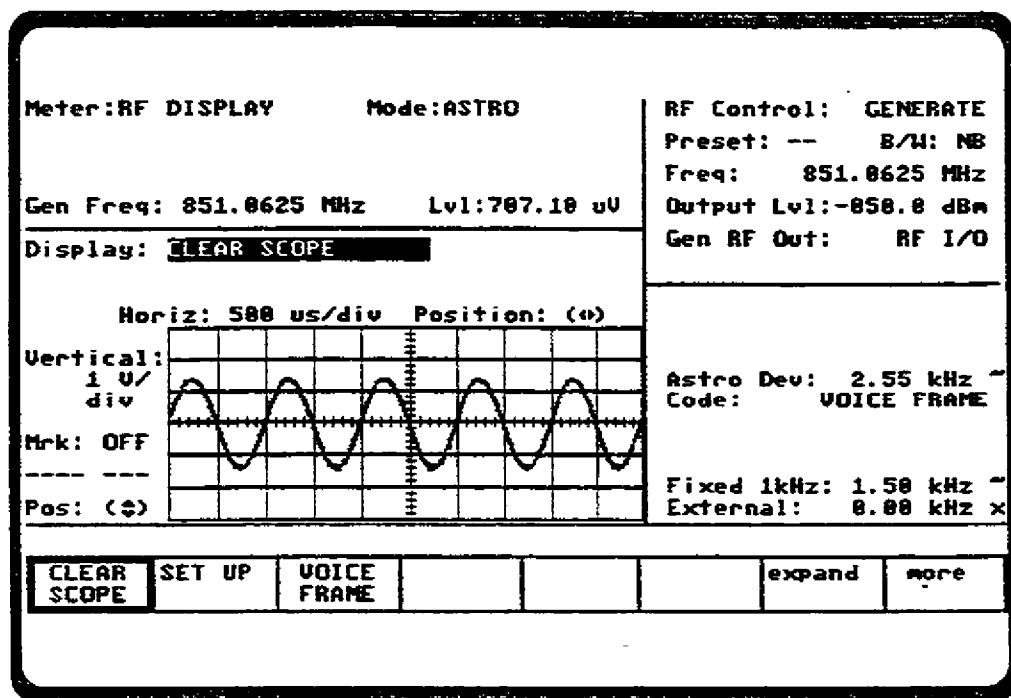


Figure 3-18. ASTRO Clear Scope Display

### Marker (if equipped)

Select marker operation by moving the cursor to the "Mrk:" field, then pressing the desired "delta" softkey ( $\Delta V$ ,  $\Delta T$ , or  $1/\Delta T$ ). Selection provides two markers on the CLEAR SCOPE screen (refer to figure 3-19). Press the **toggle marker** softkey to alternate between markers and use TUNING knob to position markers.

#### $\Delta V$

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.

#### $\Delta T$

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.

#### $1/\Delta T$

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 to display 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 similar to the Standard version MOD SCOPE, however, the vertical scale is different as listed above for Monitor mode.

### 3-10.2.3 Duplex Mode

In Duplex mode, the softkeys provide selection of either the recovered analog audio signal or the generated analog audio signal. Otherwise, the CLEAR SCOPE display is the same as in section 3-10.2.1 above.

In Duplex mode, select either generate or monitor CLEAR SCOPE display by first moving the cursor to the "Select:" field within the Display Zone, then pressing the desired softkey, GEN or MON.

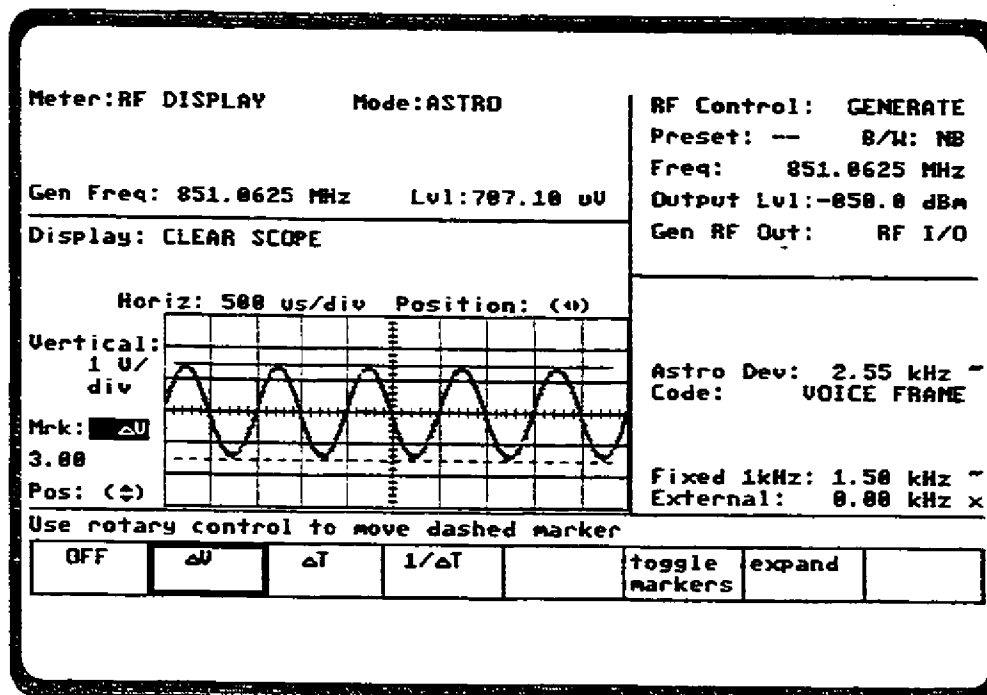


Figure 3-19. Clear Scope Markers

### 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 transmissions.

#### 3-10.3.1 Embedded Signaling

The ASTRO option provides a user display of decoded embedded signaling (Figure 3-20). The ASTRO option 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 the 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 reset** 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 3-9.2.2.2 except for the "Raw:" field.

#### **Raw**

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



Meter: RF DISPLAY		Mode: ASTRO		RF Control: MONITOR	
Mon Freq: 855.6250 MHz		Dev: --, -- kHz		Preset: -- B/W: NB	
Freq Err: ---.---kHz		Input Lvl: + 0.8 dBm		Freq: 855.6250 MHz	
				Attenuation: 0 dB	
				Mon RF In: RF I/O	
Display: VOICE FRAME					
Frame Counter: 0000		Frame: 00			
Raw: -----					
LCF: - (-----)					
TID 1: --- 2: --- 3: --- 4: ---					
CHN 1: --- 2: ---					
SID 1: --- 2: ---					
DID: --- EMG: - ACK: -					
PMR LVL: --- (--- dBm)					
BER: - (---% U) RF LVL: - (S--- dBm U)					
Network ID: --- Busy Bits: - (-----)					
Key ID: --- PA: -----					
Code: VOICE FRAME					
Fixed 1kHz: 0.000 U x					
External: 0.000 U x					
CLEAR SCOPE	SET UP	VOICE FRAME		decode start	frame reset
more					

**Figure 3-20. Voice Frame Decode Display**

[This page intentionally left blank]

## Section 4

### APPLICATIONS

---

#### 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.*
- 

#### 4-1 BASIC ASTRO RADIO TESTING

This section of the manual contains information on how to connect equipment under test to the R-2670 Analyzer. It is a supplement to sections 3 and 4 of the R-2600 Operator's Manual.

##### 4-1.1 Monitor Mode Testing

To setup for Monitor mode testing, put the analyzer in ASTRO mode, and in the RF Zone select Monitor mode. Select the desired settings for each cursor position in the RF Zone. Select the corresponding softkey for the Mon RF In cursor location. There are two choices: ANT and RF I/O port. The ANT port accesses the analyzer's sensitive receiver and should be used strictly for "off the air" measurements. If ANT is used, 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.

Select the desired meter and display needed to perform the test. See the R-2600 Series Operator's Manual and other sections in this

manual for more details about the analyzer's Monitor functions.

#### 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. Refer to section 2-2.4 in the R-2600 Series Operator's Manual for more details.*

##### 4-1.2 Generate Mode Testing

To setup for Generate mode testing, put the analyzer in ASTRO mode, and in the RF Zone select Generate mode. Select the desired settings for each cursor position in the RF Zone. Also select the desired levels in the Audio Zone for the summed modulating signal and ASTRO deviation. Remember to enable the switches. To transmit anything other than BER, the Generate code in the Audio Zone must be set to VOICE FRAME.

In the RF Zone, select the appropriate softkey for the Gen RF Out cursor location. There are two choices: 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. See the R-2600 Series Operator's Manual and other sections in this manual for more details about the analyzer's Generate functions.

### 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. Refer to section 2-2.4 in the R-2600 Series Operator's Manual for more details.*

## 4-2 ASTRO RADIO TRANSMIT TESTS

This section contains the basic test setup for testing ASTRO radio transmitted voice and embedded data. If the selected radio channel is encrypted, select the analyzer encryption algorithm and key as described in section 3-7. Place the analyzer in Monitor mode as shown in the below example. Select the appropriate frequency that matches the radio under test; 806.0625 MHz is used in this example.

1. Place the cursor in the RF Zone and configure each field as follows:

RF Control	MONITOR
Preset	BW:NB
Freq	806.0625 MHz
Attenuation	0 dB
Mon RF In	RF I/O

2. 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.
3. Press the AUD hardkey to place the cursor in the Audio Zone and select **VOICE FRAME**.

Code	VOICE FRAME
Fixed 1kHz:	0.000 V x
External:	0.000 V x

4. Press the **DISP** hardkey to place the cursor in the Display Zone. 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 for a description of the RF Scan function. After the RF frequency is captured, place the cursor in the "Meter:" field and select **RF DISPLAY**. The scanned frequency, deviation, frequency error and input power level are all displayed in the Display Zone.

### 4-2.1 ASTRO Voice

Move the cursor to the "Display:" field and select **MOD SCOPE**. Note that when the radio PTT is pressed, the ASTRO modulated waveform appears on the scope in the Display Zone. Turn up the volume on the analyzer and with the radio PTT pressed, speak into the radio microphone. If the radio is operating, the transmitted voice will be heard from the speaker of the analyzer.

### 4-2.2 ASTRO Embedded Data

Move the cursor to the "Display:" field and select **VOICE FRAME**. The Voice Frame decode table will be displayed as shown in figure 3-20. 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 all of the captured data for a single frame in hex format.

### 4-3 ASTRO RADIO RECEIVE TESTS

This section contains the basic test setup for testing ASTRO radio received voice and embedded data. If the selected radio channel is encrypted, select the analyzer encryption algorithm and key as described in section 3-7. Place the analyzer in Generate mode as shown in the below example. Select the appropriate frequency that matches the radio under test; 806.0625 MHz is used in this example.

1. Place the cursor in the RF Zone and configure each field as follows:

RF Control:	GENERATE
Preset:	BAW:NB
Freq:	806.0625 MHz
Output Level	-50.0 dBm
Gen RF Out	RF I/O

2. 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.
3. 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.

Astro Dev:	2.55 kHz -
Code:	VOICE FRAME

Fixed 1kHz:	0.00 kHz x
External:	9.95 kHz -

4. Place the cursor on **VOICE FRAME** in the Audio Zone, and press the **display table** softkey. The **VOICE FRAME ENCODE** screen shown in figure 3-15 will be displayed.
5. Insert the desired 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).
6. Press the **return** softkey from the **VOICE FRAME ENCODE** screen.
7. Press the **DISP** hardkey then move the cursor to the "Display:" field and select the **MOD SCOPE** softkey.
8. Connect a microphone to the analyzer and press the **PTT**. Note that when the microphone **PTT** is pressed, the **ASTRO** modulated waveform appears on the 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.

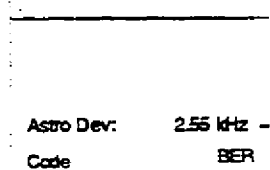
### 4-4 BER TESTING THE RADIO RECEIVER (Generate Mode)

This application example describes the receiver test for radios that have BER test capability. The receiver must have the capability of receiving an unencrypted V.52 BER test pattern. Performance of this test requires the analyzer to operate in Generate BER Test mode. 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. 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.

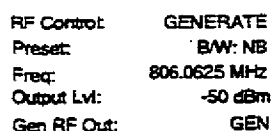
Test frequencies may be specified for BER test of your equipment. Consult the radio maintenance manual.

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. Select the ASTRO BER Test mode by placing the cursor in the "Code:" field in the Audio Zone (Figure 4-1). With the cursor in the "Code:" field, select the BER softkey.
3. Set controls in the Audio Zone as follows.



Astro Dev: 2.55 kHz -  
Code: BER

4. Place the cursor within the RF Zone and configure the analyzer as follows:



RF Control: GENERATE  
Preset: B/W: NB  
Freq: 806.0625 MHz  
Output Lvl: -50 dBm  
Gen RF Out: GEN

5. Configure the radio under test to BER Test mode. Consult your radio maintenance manual for specific instructions. Reset the analyzer frequency to the BER Test frequency of the radio.
6. Monitor the radio's received BER. Reduce the analyzer's output level until the radio measures a BER corresponding to 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 V.52 BER test pattern. Performance of this test requires the analyzer to operate in monitor or duplex 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.

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.

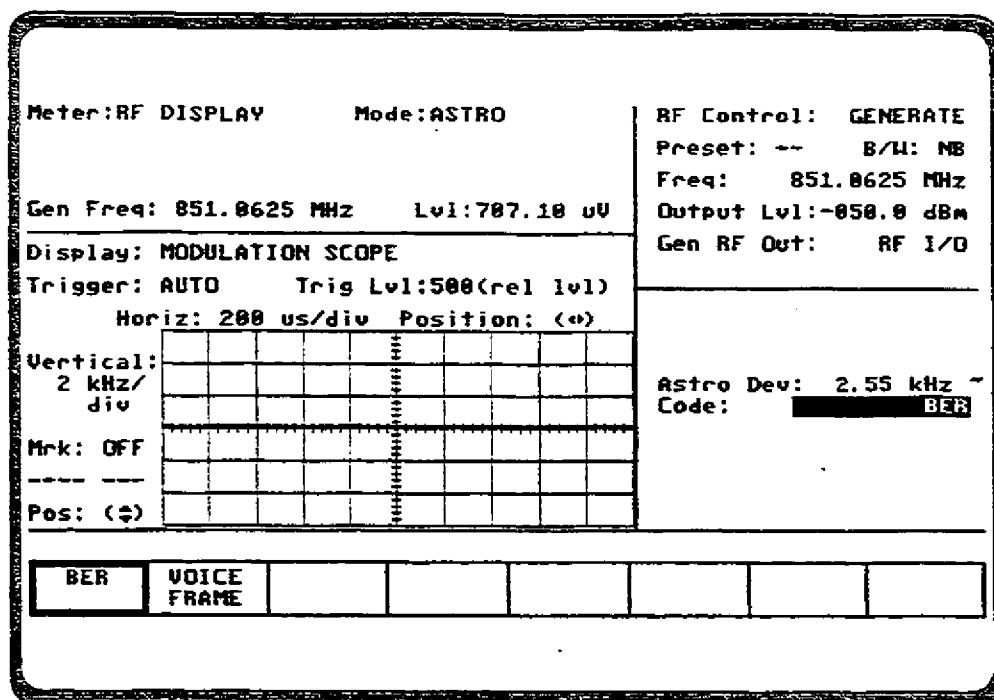


Figure 4-1. Radio (BER Test Mode) Audio Zone

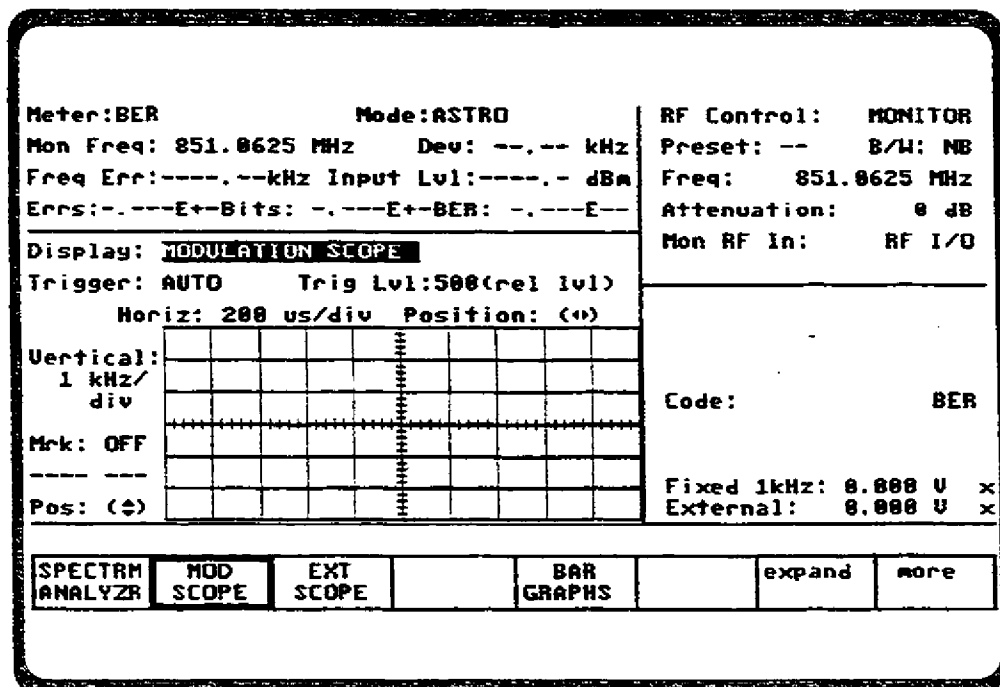


Figure 4-2. Radio (BER Test Mode) BER Meter

- Place the cursor within the RF Zone and configure the analyzer as follows:

RF Control:	MONITOR
Preset:	BW: NB
Freq:	806.0625 MHz
Attenuation:	0 dB
Mon RF In	RF I/O

- Configure the radio under test to BER Test mode. Consult your radio maintenance manual for specific instructions. Reset the frequency of the analyzer to appropriate BER test frequency.
- Turn on the transmitter of the radio. Consult your radio maintenance manual for instructions.

- 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.
- BER measurements will be terminated at end of transmission or when switching out of BER Monitor Mode.

#### 4-6 BER TESTING USING DUPLEX MODE

The analyzer can perform BER testing using RF or Baseband. The analyzer generates a CCITT V.52 standard BER pattern.

Figures 4-3 and 4-4 show where the analyzer BER test pattern is inserted and sampled in the transmit and receive paths.

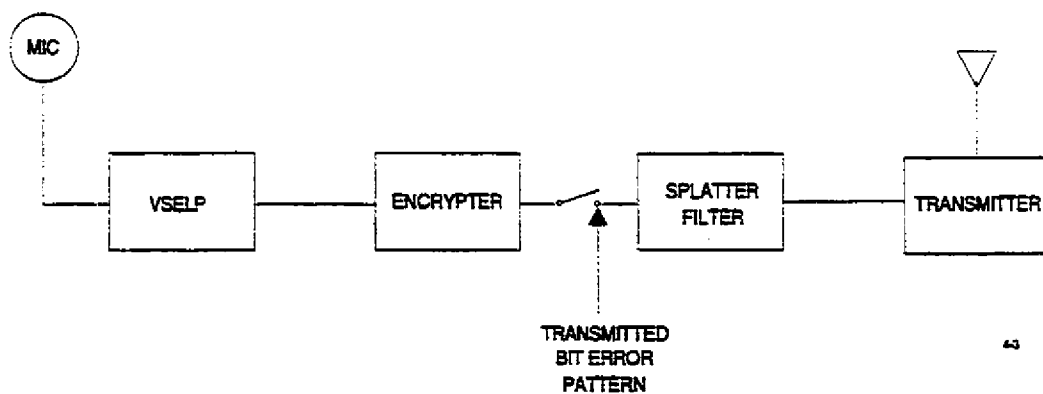


Figure 4-3. Transmit BER

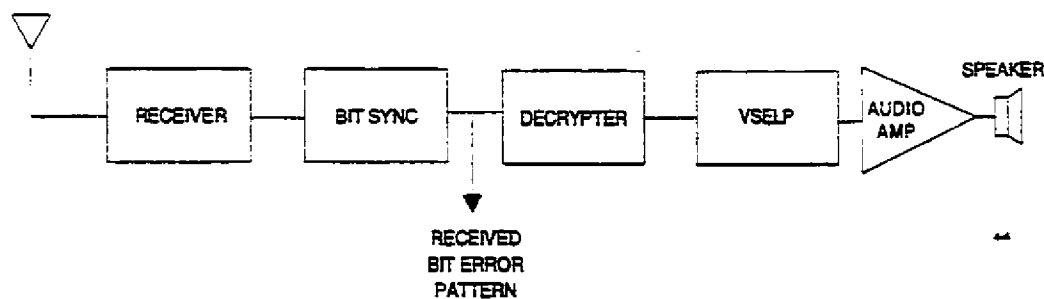


Figure 4-4. Receive BER



#### 4-7 RADIOS WITH BER TEST CAPABILITY AND REPEATERS

Radios with BER capability and repeaters can be tested by the analyzer using the V.52 BER test pattern. In RF mode, the operation of both the radio receiver and transmitter can be evaluated. To set up the analyzer for the BER test, use the following sequence:

1. Connect the RF IN/OUT port of the analyzer to the RF port of the radio under test.
2. Place the cursor in the RF Zone and configure the analyzer as shown below. Set the monitor frequency of the analyzer at the generate frequency of the radio to be tested, and set the analyzer offset frequency to correspond to that of the radio.

RF Control:	Duplex
Preset:	BW: NB
Mon Freq:	800.000 MHz
Offset:	+45.000 MHz
Mon: 0dB	RF I/O
Gen: -050.0 dBm	RF I/O

3. Set the controls in the Audio Zone as follows:
  - ASTRO: 2.55 kHz
  - Code: BER
4. With the cursor on RF Display, press the **more** softkey and select BER. The BER metering will appear in the top left corner of the screen.
5. Press the **reset** softkey to reset the BER measurements.

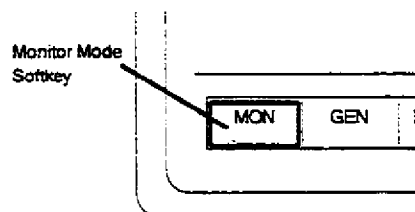
The monitored or generated BIT pattern can be observed by selecting MODULATION SCOPE in the Display Zone.

#### 4-8 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 ASTRO radio and then recovered by the analyzer.

Connect the analyzer's RF I/O port to the RF output of the transmitter under test.

1. Place the analyzer in ASTRO mode. 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:

RF Control:	MONITOR	Transmitter Carrier Frequency
Preset: --	BW: NB	
Freq:	816.5000 MHz	
Attenuation:	-20 dB	
Mon RF In:	RF I/O	

3. Set the SQUELCH control on analyzer to threshold.
4. Press **AUD** hardkey and select **VOICE FRAME**.

Code	VOICE FRAME
Fixed 1kHz:	0.000 V X
External:	0.000 V X

5. Press **DISP** hardkey to move the cursor to the Display Zone.
6. Place cursor in the "Display:" field and press **CLEAR SCOPE** softkey. The CLEAR SCOPE screen should appear similar to Figure 4-5. No

waveform is present until the transmitter is turned on.

7. Turn on the ASTRO 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.*

8. Move the cursor to "Horiz:" field and select the appropriate scale.
9. Move the cursor to "Vert:" field and select the appropriate scale.
10. 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.

11. 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.
12. Move the cursor to "Mrk:" field.
  - Press  $\Delta V$  softkey to display movable markers that measure voltage differential (Vp-p).
  - Press  $\Delta T$  softkey to display movable markers that measure time differential (sec).
  - Press  $\Delta 1/T$  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.

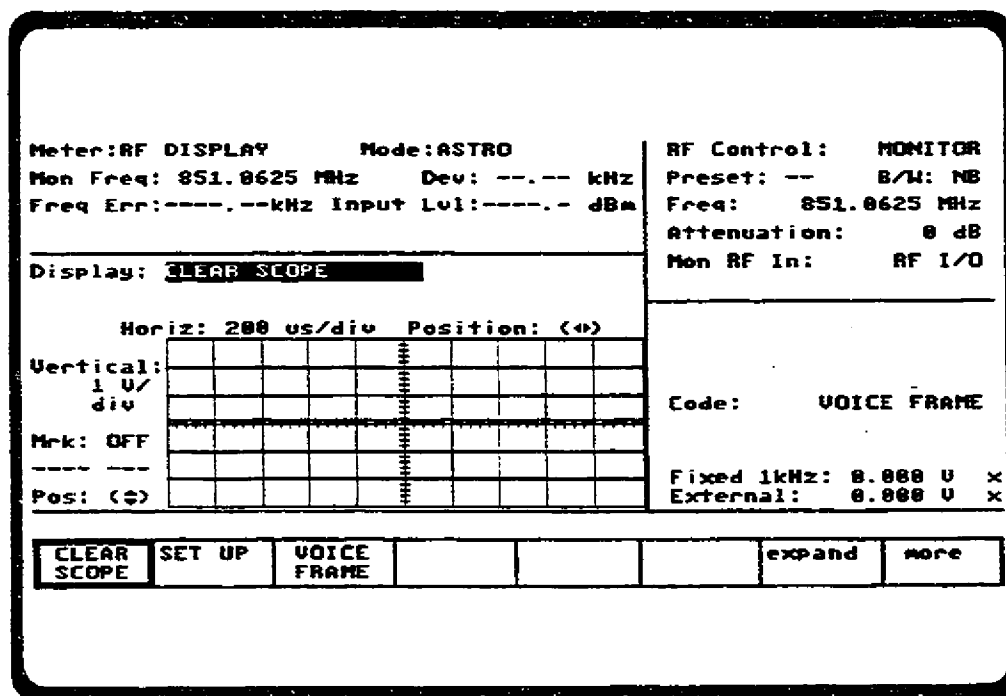


Figure 4-5. ASTRO CLEAR SCOPE Display of Recovered Audio

#### 4-9 MONITORING TRANSMITTED AUDIO WITH CLEAR SCOPE

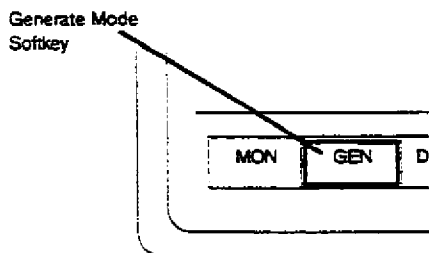
This section of the manual contains information on using the Clear Scope function to analyze the R-2670's raw modulation signal (1 kHz) in ASTRO Generate mode. This analog signal is viewed prior to being digitized and encrypted.

Refer to Figure 4-3. Connect the analyzer's RF I/O port to the radio's antenna connector.

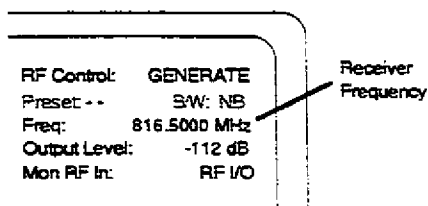
#### NOTE

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

1. Place the analyzer in ASTRO mode. 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.



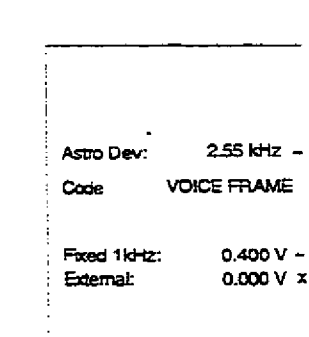
2. Within the RF Zone, set as follows:



#### NOTE

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

3. 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.



4. Turn on the ASTRO receiver and tune receiver and analyzer to the same frequency. Verify receiver locks onto test signal.
5. Use the **CURSOR ZONE** keys on analyzer front panel and move the cursor to the Display Zone.
6. Place cursor in the "Display:" field and press **CLEAR SCOPE** softkey. The **CLEAR SCOPE** screen should appear similar to Figure 4-6.
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  $\Delta V$  softkey to display movable markers that measure voltage differential (Vp-p).
  - Press  $\Delta T$  softkey to display movable markers that measure time differential (sec).

- Press  $\Delta 1/T$  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.

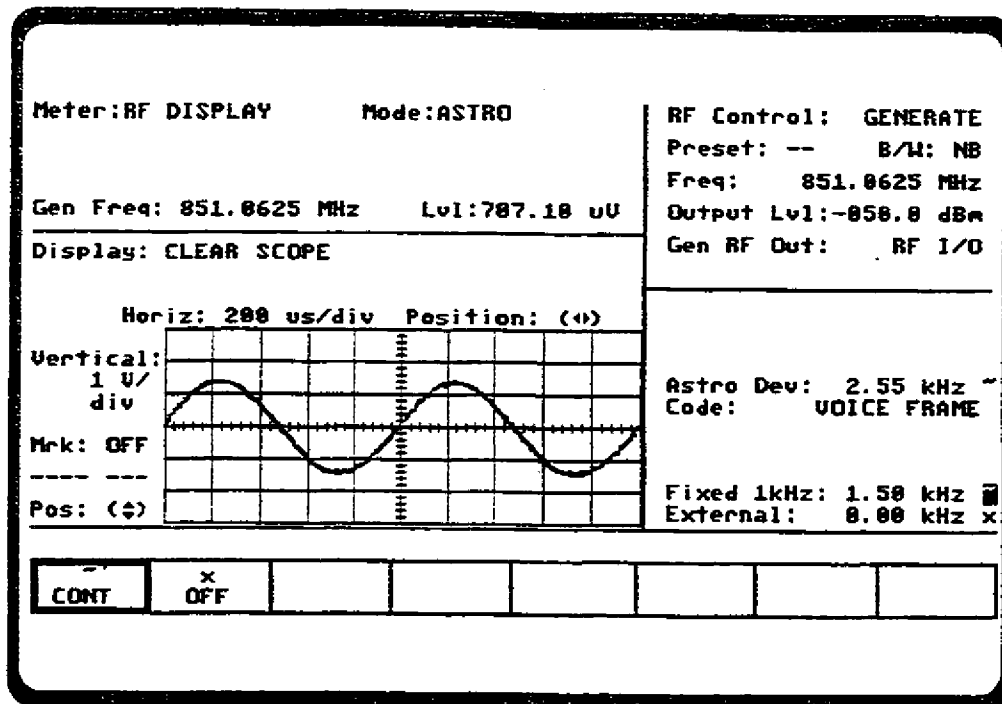


Figure 4-6. ASTRO CLEAR SCOPE Display of Output Modulation

## APPENDIX

### ERROR AND WARNING MESSAGES

#### 1 ERRORS

ASTRO errors fall into two categories: EMC/Encryption Key Errors and ASTRO Option 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 Option 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 R2670. 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 R-2670 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 R-2670 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 R-2670 is generating ASTRO VOICE.

qwdId:

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

## 1.2 ASTRO Option Error Messages

The following three messages are very similar. They are all related to a severe failure of the ASTRO Option. A general discussion of the cause follows, along with a general recommended solution. This solution is basically to reset the R-2670 and restart the powerup sequence.

#### ASTRO Failed. Notify Local Service Rep

#### ASTRO Option - Illegal CP Request

#### ASTRO Option - Bad CP opcode

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

qwdId:

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

#### No Response From Option

The R-2670 has attempted to communicate with the ASTRO Option but has not received a response.

qwdId:

Verify that the ASTRO 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 R-2670. 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 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.

## 2 WARNINGS

ASTRO 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 Informational Warnings

The following ASTRO 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

An External Key has been successfully loaded into the EMC.

#### 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 User Prompt Warnings

#### Verify Correct Network ID

When generating ASTRO 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 R-2670 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.

#### **NOTE**

*Software encryption is different. Either cancel or set the desired key and then press the **STORE KEY** softkey.*

#### 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 are installed in the R-2670 via the Monitor Service Software (MSS) but were not detected on either Encryption Module.

qwdId:

Notify the Service Representative.

