GENERAL DYNAMICS
SATCOM Technologies

R8000 SERIES
COMMUNICATIONS SYSTEM ANALYZER
OPERATOR'S MANUAL

CG-1365 REV D

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GENERAL DYNAMICS TEST EQUIPMENT PRODUCTS
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1   PRE-OPERATION OVERVIEW

1.1   SCOPE OF MANUAL

This manual contains information for R8000 Series Communications System Analyzer. The R8000 incorporates many devices and functions, permitting a technician to completely monitor and service radio communications equipment in the shop and in the field.

1.2   SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service and repair of this equipment. Failure to comply with these precautions or warnings violates safety standards of design, manufacture, and intended use of the equipment. General Dynamics assumes no liability for the customer's failure to comply with these requirements.

The safety precautions and warnings listed below represent warnings of certain dangers of which General Dynamics is aware. You as the user of the product should follow these warnings and all other safety precautions necessary for the safe operation of the equipment in your operating environment.

1.2.1   Analyzer Grounding

The R8000 is powered by a provided AC to DC converter connected to a grounded 3 wire AC outlet. The negative (or "-") output of the converter is internally connected to AC ground. Since the R8000 uses the converter's DC negative as system ground the analyzer is also connected to AC ground at the power outlet. As a result most of the external connectors on the R8000 chassis are also at AC ground potential. ***Warning: To minimize shock hazard it is critical to operate the R8000 with the provided converter and three wire AC power cable. The power cable must be plugged into an approved three-contact electrical outlet.*** If the unit is not operated from a properly grounded AC power source, any voltage potential between it and earth ground may cause an electrical shock.

1.2.2   Unit is Live When Plugged In

Internal circuits are live when the DC power cable is plugged in even when the R8000 has been placed in a non-operating mode using the front panel Power switch. To completely remove power from the analyzer internal circuits the DC power plug is the disconnect device. Do not position the equipment such that it is difficult to remove the DC power plug.

1.2.3   Keep Away From Live Circuits

Operating personnel must not remove equipment covers. Only Factory and Authorized Service Personnel may remove equipment covers for internal subassembly, component replacement, or any internal adjustment. Disconnect Analyzer from all voltage sources before removing covers for adjustments, maintenance or repairs. Capacitors inside may still be charged even if the Analyzer is disconnected from the voltage source.

1.2.4   Explosive Atmosphere

Do not operate the equipment in the presence of flammable gases or fumes. Operation of any electrical equipment in such an environment constitutes a definite safety hazard.

1.3   WARNINGS AND CAUTIONS

You should observe several precautions when handling this equipment.

WARNING

The R8000 analyzer is designed to operate with a provided power adapter connected to a properly grounded 3 wire AC power source.   This configuration provides an earth ground connection to the R8000 internal ground and chassis. If the unit is not operated with the above configuration any voltage potential between it and earth ground may cause an electrical shock.

⚠ **CAUTION**

This equipment contains internal parts that are subject to damage by static electricity (ESDS sensitive). Factory and authorized service personnel must follow proper ESDS precautions when handling internal components during repair or calibration.

1.3.1   Analyzer Operating Voltage

The R8000 is powered by 24 VDC and operates from a three wire AC outlet using an AC to DC adapter. *Warning: it is critical that only the adapter provided by General Dynamics and shipped with the analyzer is used to power the R8000. Do not substitute other adapters without first consulting General Dynamics support personnel or a factory authorized service center.*   Make certain to plug the adapter into a properly grounded three wire AC outlet.

1.3.2   DC Power Source

The DC power input can be connected to an optional Battery Pack accessory. For operation from a 12 Volt vehicle battery an optional power converter is available to step the vehicle voltage up to 24 VDC. *Warning: Connecting the Analyzer DC input to an external Power Supply can, in the event of a power supply fault, cause hazardous voltages to be present on the low voltage circuits of the Analyzer.*

1.3.3   Maximum Meter In Voltages

⚠ **CAUTION**

To ensure the safety of the user the Meter In port should not be used to measure equipment containing mains voltages.

The maximum input levels are:

70 VAC RMS /100 VDC (R8000 input impedance set to 1 MΩ).

15 VAC RMS /24 VDC (R8000 input impedance set to 600 Ω).

1.3.4   Replacement Fuses

There are no user serviceable fuses on the R8000. The unit is internally protected against overloads and risk of fire. If the R8000 fails to operate return it to the factory or an authorized repair center for diagnosis and repair.

The R8000 Generate Output Port provides port protection against RF power input up to 5 W continuous. Power levels above 5 W may damage the port if applied for a significant amount of time. If the operator

desires further port protection the 50RF-038 fuse may be obtained from JFW Industries and attached to the Generate Output Port.

1.3.5 Other Cautions

Other cautions relating to the operation of the Analyzer are stated in *Italics* throughout this manual.

⚠ **CAUTION – HOT SURFACES**

The RF I/O Port connector may become hot when inputting power. Exercise caution when removing cabling from the RF I/O Port.

1.3.6 Replacement and Disposal of Batteries

Should the batteries contained in the Battery pack ever need replacing, this work should be performed by Factory Authorized Service personnel only. Replacement batteries should be of the same type and rating. The batteries contain toxic materials and therefore must be handled with care and transported to a disposal or recycling center.

1.3.7 User Maintenance of exterior surfaces

Clean only with a damp cloth and a mild detergent. Do not use abrasives, solvents or alcohol. If the Analyzer is used in a relatively dust free environment, no other periodic maintenance should be required.

1.4 SERVICE

All R8000 Series Communications System Analyzers are calibrated and repaired at the General Dynamics factory:

GENERAL DYNAMICS

Communications Test Equipment
3750 West Loop 281
Longview Texas 75604 USA
Tel: +1-903-295-1480 Fax: +1-903-295-1479

1.5 REPLACEMENT PARTS ORDERS

Send orders for user serviceable replacement parts to the General Dynamics factory listed in section 1.4. Be sure to include the complete identification number located on the equipment.

1.6 INSTALLATION

1.6.1 Packing

Foam pieces protect the Analyzer, which is packed inside a carton. Save the packing container and materials for future use.

1.6.2 Initial Set-up

1. Place the Analyzer on a workbench in the shop or mobile repair unit.

2. Flip out the two lever actuated foot extensions underneath the front of the unit to raise the Analyzer for easier viewing.

3. Take the power cord of the AC to DC adapter and connect to a 3-wire 100-240 VAC power source. Attach the cord's DC plug to the mating connector on the R8000 side panel.

4. Remove accessories from the soft carry case (if provided).

5. Insert the whip antenna into the ANT port, located to the right of the tuning knob on the front panel.

6. Press the Power switch ON and allow the R8000 to boot up. The Analyzer is now ready for use. Before operating the Analyzer, review the operating procedures described in this manual.

CAUTION

When installing the Analyzer in a vehicle it is preferable to operate the R8000 from a fused accessory outlet. If wiring direct to the vehicle's battery place a 10 Amp fuse on the DC supply line close to the battery. Internal circuits protect the R8000 against overload but do not protect the vehicle electrical system.

2 ANALYZER OVERVIEW

2.1 DESCRIPTION

The R8000 Communication System Analyzer is a portable test instrument designed to monitor and service radio communications equipment over the frequency range of 250 kHz to 3 GHz. The analyzer's controls, indicators and connectors are shown in Figures 2.1-1 and 2.1-2. A description of each feature is presented in section 2.3. The R8000 generates and receives signals, measures modulation and frequency, and performs a variety of tests normally associated with the following equipment:

- RF Signal Generator
- Sensitive Measurement Receiver
- Spectrum Analyzer
- Duplex Offset Generator
- Oscilloscope
- Frequency Counter
- AC/DC Voltmeter

- RF Wattmeter
- Sweep Generator
- Signaling Encoder/Decoder
- Signal Strength Meter
- SINAD Meter
- Distortion Analyzer

Figure 2.1-1   Front Panel Controls, Indicators, and Connectors

Figure 2.1-2   Left and Right Sides of the R8000

2.2   TECHNICAL SPECIFICATIONS

Specifications for the AC Adapter

Input Voltage:	100-240 VAC
Input Current:	2.5A Max
Input Frequency:	50-60 Hz

Terminal Specifications

Demod Out:	±8V PK
Mod In:	1V PK REF, ±8V PK
Mod Out:	±8V PK
Meter In:	70 VAC RMS / 100 VDC (1MOhm), 15 VAC RMS / 24 VDC (600Ohm)
RF Gen Out:	Do Not Input Power, +5 dBm Max Out, 250 kHz – 3 GHz
RF In:	50W Cont. / 150W Max, 250 kHz – 3 GHz
RF Out:	-30 dBm Max Out, 250 kHz – 3 GHz
Antenna:	0 dBm Max, 250 kHz – 3 GHz

Mechanical Specifications

Weight:	< 14 lbs (6.4 kg)
Operating Temp:	0° to 50° C
Storage Temp:	-30° to 80° C

For additional technical specifications of the R8000, refer to the R8000 Brochure. **Click here** to open the R8000 Brochure PDF included with this CD manual.

2.3   OPERATOR INTERFACE AND CONTROLS

The R8000 was designed to be intuitive and easy to operate. A large LCD display screen shows the current operating mode along with associated settings, readings, and additional test submenus. Information about monitor settings and test results is visually grouped in outlined panels. The panels are highlighted when active for accepting data entries or changes in settings. Test results are shown numerically in labeled text fields and/or displayed graphically when appropriate.

Most commonly used adjustments can be made with a few simple keystrokes. The primary operating modes of the R8000 are Monitor, Generator, Duplex, Instrument, Test, and Settings. Dedicated keys near the main tuning knob on the front panel provide direct access to the R8000 operating modes (see Figure 2.1-1). Several methods are available for entering numeric values and adjusting user settings. These include:

Function keys - Two groups of non-dedicated (soft) keys are located at the bottom and right side of the main LCD display. The current key function is shown in the adjacent screen area and changes with the operating mode of the R8000 and the specific test in progress. Pressing a soft key executes one of several possible actions. These include: opening a numeric data entry field; providing additional

selections for user settings; activating new submenus; or performing a single measurement task (peak search, etc). Multiple presses of the same key will toggle through all available selections for the setting.

Direct Entry - Numeric values can be entered directly using the digital keypad when a data entry window is shown on the display. Existing values are modified using the Left/Right (◄►) keys to move a highlighted cursor over the desired number. The cursor automatically steps to the right after a keypress. Pressing Enter completes the entry while the Esc key cancels the change. In the case of entering an RF frequency, pressing a scaling unit key (like "kHz") also completes the numeric entry. *Note: You can also adjust highlighted values using the Up/Down keys (▲▼) and tuning knob, but the R8000 will respond in real time as the changes are made.*

Tuning (Spin) Knob - A separate tuning knob allows real time rotational adjustment of numeric values, simulating the smooth continuous operation of an analog tuning control. For example, you can manually scan an RF frequency segment for an unknown carrier. The spin knob adjusts whichever digit is highlighted in the data entry window by the Left/Right (◄►) keys. Continuous rotation of the knob provides a step change equal to the smallest value of the highlighted digit. The knob also cycles through the selections available when a soft key activates a window that displays user determined settings. Selections can also be chosen using the Up/Down (▲▼) keys..

2.3.1   Front Panel Control Keys

Power Switch

Press ON to energize all circuitry and cycle the R8000 through the boot-up sequence.

Navigation (function select) Keys (Monitor, Generate, Duplex, Instrument, Test, Settings)

These keys determine the operating mode of the R8000. The current operating mode is displayed at the bottom left of the screen next to the test mode. The current navigation location is displayed at the top left of menu screens.

Soft Keys (unlabeled groups of 6 buttons to the right of and 7 buttons below the LCD display)

Each key function is determined by the operating mode of the R8000 and the specific test in progress as indicated by an adjacent label on the LCD display.

Numeric Key Pad Area

For entering and controlling the format of alphanumeric data used by the R8000. Specific key functions are as follows:

Keys (0-9) and (shifted letters A–Z).

These keys enter alphanumeric information into the analyzer. Pressing a key during data entry places a new value into the highlighted symbol or number on the analyzer screen. The analyzer then reacts to the new information just entered. If an invalid entry is attempted, the key press is ignored and the numeral on the screen remains unchanged.

"Hot keys" 1, 2, 4/5, & 7/8 also serve as shortcuts that directly activate the 4 "Operating Zones" used for settings and metering in the R8000 Monitor, Generator, and Duplex modes.   The zone

displays are arranged on the R8000 main screen just like the outline around the hot keys. Pressing the hot key activates the zone and displays the associated settings submenu. The hot keys allow jumping from one zone to another while in Monitor, Generator, or Duplex mode without navigating back to the main screen.

+/- Key

Toggles the numeric sign from its present value to the negative of its present value.

Bksp Key

Moves the display highlight to a previously entered alphanumeric entry to allow editing.

Shift Key

Changes the function of some numeric keys on the R8000 to alpha or letter designation (A-Z). May also activate a special function on analyzer when appropriate.

GHz, MHz, KHz, Hz Keys

Apply the indicated scaling units to numeric RF frequency entries.

Enter Key

Equivalent to an "execute" key. It completes an entry from the alphanumeric keypad or a setting change so the R8000 will operate with the new value..

Esc Key

Cancels an action before it is completed or returns to a previous menu. For example, pressing Esc while entering a value with the numeric keypad closes the direct entry window and leaves the original value unchanged. Esc also returns to previous modes or windows when navigating the R8000's operational menus.

▲▼ (Up/Down), and ◄► (Left/Right) Keys

The arrow keys move a highlighted cursor over the alphanumeric digits in data entry windows to allow changes. They also step through the available selections in windows that display user determined settings. The R8000 responds in real time to changes made by the arrow keys.

RF On/Off Key

Disconnects the internal RF Generator from the RF In/Out and RF Gen Out ports. The current RF state is displayed at the bottom right of the screen next to the message bar. The key does not function in the Monitor operational mode.

2.3.2   Control Knobs

Tuning (Spin) Knob

Incrementally changes the value of the highlighted digit in an alphanumeric entry field. Clockwise rotation increases the value, counter-clockwise rotation decreases the value. The Tuning Knob affects

the R8000 in real time, so this provides the equivalent of an analog rotational control at the cursor location for a numeric entry. The knob also cycles through the selections available when a soft key activates a window that displays user determined settings.

Sql. Knob

Squelch control. Clockwise rotation increases the receiver signal threshold level required to open the squelch. The level in dBm is displayed in the lower right corner of the main display. For signals below the threshold speaker audio is muted and the Frequency Error and Deviation readings are blanked out.

Vol. Knob

Controls volume of the speaker audio. A clockwise rotation increases the volume.

2.3.3   DISPLAY and INDICATORS

LCD Display

8.4 inch diagonal bit-mapped LCD. Provides operational status, data, soft key driven menu based operating controls, and instructional information. Displays in digital, analog, and bar graph forms.

NOTE

The LCD has a screen/power saver feature that reduces intensity after approximately 30 minutes of inactivity. Press any key to restore the display.

LED Indicators

The status of certain ports and controls is displayed by an adjacent LED indicator. An illuminated indicator means the port is active and is either accepting an input or providing an output signal. This applies to the **Antenna, Demod Out, Mod In/Out, Meter In, RF In/Out,** and **RF Gen Out** ports**.** In addition an LED indicator next to the Sql. knob illuminates when the RF input signal to the R8000 is above the set squelch threshold.

2.3.4   Connectors

2.3.4.1   Front Panel Connectors

Antenna

Low level RF input port for the sensitive receiver monitor on the R8000. Used for off-the-air and other low level measurements.

WARNING

Do not apply RF Power to this port.

RF Gen Out

A high level generator RF output port isolated from the Monitor input.

WARNING

Do not apply RF Power to this port.

RF In/Out

Bidirectional port that routes RF input signals to the analyzer's internal monitor or output signals from the analyzer's internal generator. Also provides combined input/output in Duplex mode. Contains the RF wattmeter load. **Note: This is the only front panel connector to which RF power may be applied.**

Meter In

Combined input port for oscilloscope vertical, SINAD meter, Distortion meter, and DVM/counter functions,

MOD In/Out

When configured as an output, this port provides a composite sum of all internally generated modulation signals applied to the R8000 RF carrier. When set as an input, audio signals external to the R8000 can be used to modulate the RF carrier. The audio signals must not exceed $1V_{pk}$ to provide a reference for accurate display of the applied modulation level.

Demod Out

Provides the demodulated (recovered) audio output from a received carrier when the R8000 is in Monitor or Duplex mode.

USB (2)

Serial ports for external peripheral devices such as keyboard, mouse, etc.

Mic In

Connector for external accessory microphone.

2.3.4.2   Side Panel Connectors

VGA Out

Provides a 15 pin connection to external VGA format color monitor.

USB (2)

USB ports for external peripheral devices such as keyboard, mouse, etc.

Ethernet

10/100 Mbps LAN port for computer network connection.

Ref. In/Out

BNC connector provides input/output for 10 MHz reference frequency. Input impedance is 50 Ω. Input level requirement is 70 mV to 1V RMS. Output level is approximately 250mV RMS.

DC Power

*Primary DC power input port. **Note:** The R8000 requires 24 VDC – connect only the AC to DC adapter provided by General Dynamics to this port. Do not substitute other adapters without first consulting General Dynamics support personnel or a factory authorized service center.*

3   OPERATION

3.1   OVERVIEW

The R8000 is operated using an intuitive and easy to navigate system of front panel keys and menu driven display interface. Dedicated navigation keys on the front panel enable the primary operating modes. Functions within the main operating modes have an associated display area where important operational settings and measurements are grouped for easy viewing (see figure 3.1.1-1). The groupings include the RF Zone, Audio Zone, Display Zone and Meter Zone. These "Operating Zones" are highlighted when active for user entry as shown in figure 3.1.1-2 for the RF Zone. Menus next to the soft keys on the right and bottom of the display show the Zone settings available for adjustment. Pressing a soft key menu brings up a data entry window or additional submenus as required.

The primary operating modes of the R8000 are controlled by the following navigation buttons left of the ANTENNA port on the front panel:

Monitor

RF receiver mode with frequency coverage from 250 kHz to 3 GHz. Provides signal strength, frequency accuracy, and other metering results while decoding the modulation content of incoming RF carriers to produce a recovered baseband signal. Additional analysis provided by spectrum analyzer and modulation scopes.

Generate

RF generator mode with frequency coverage from 250 kHz to 3 GHz. Produces an RF carrier with user selected output level, modulation type (AM, FM, PM, etc), and tone encoding formats.

Duplex

Duplex mode allowing simultaneous operation and independent control of the generator and receiver.

Instrument

Directly accesses a full screen version of graphically displayed test functions such as the spectrum analyzer, tracking generator and oscilloscope.

Test

Recall or save operator preset analyzer settings and access application specific test functions.

Settings

System configuration mode for viewing and entering general operating parameters for the R8000 such as the date/time, network/port settings for remote control, etc.

3.1.1   Basic navigation and operator control

Pressing a navigation button places the R8000 into the labeled operating mode and presents related information on the display. Figure 3.1.1-1 shows the R8000 in Monitor mode after pressing the Monitor navigation button (Monitor mode is indicated in the lower left display area). The RF Zone

upper left display area shows the RF settings and measured results during monitor operation. This includes the frequency of operation (Mon Freq), the signal input port (Mon Port), the input Attenuation, and other relevant data.
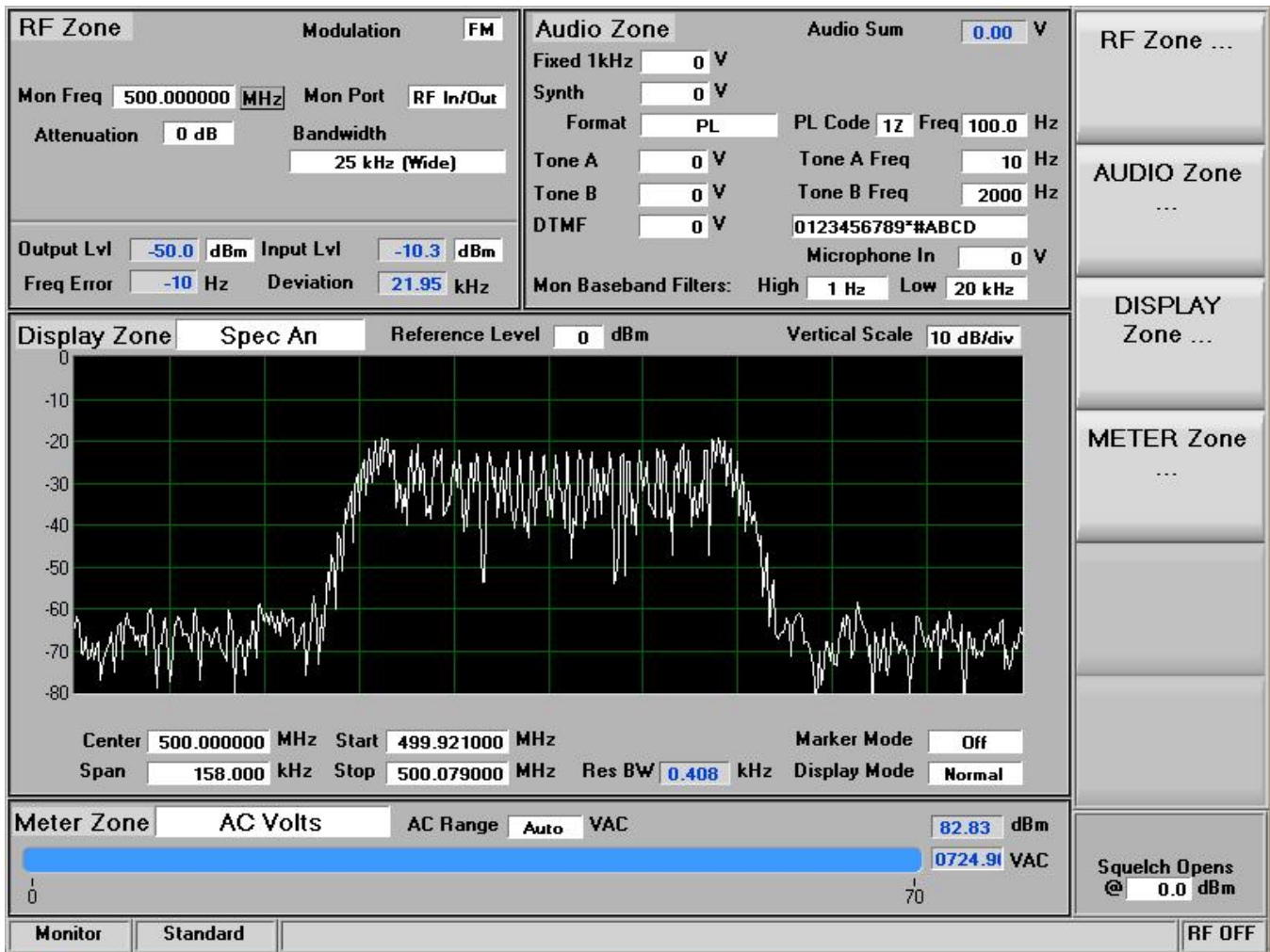
Figure 3.1.1-1   Main screen in Monitor mode showing related information in grouped display zones

Six soft keys to the right enable selection and adjustment of monitor specific modes and parameters. Figure 3.1.1-2 shows the R8000 display after pressing the RF Zone soft key while in Monitor mode – note the RF Zone section is highlighted. This indicates it is active for user entry and a new submenu with related selections appears next to the soft keys. Pressing the Esc key returns the R8000 to the previous menu.
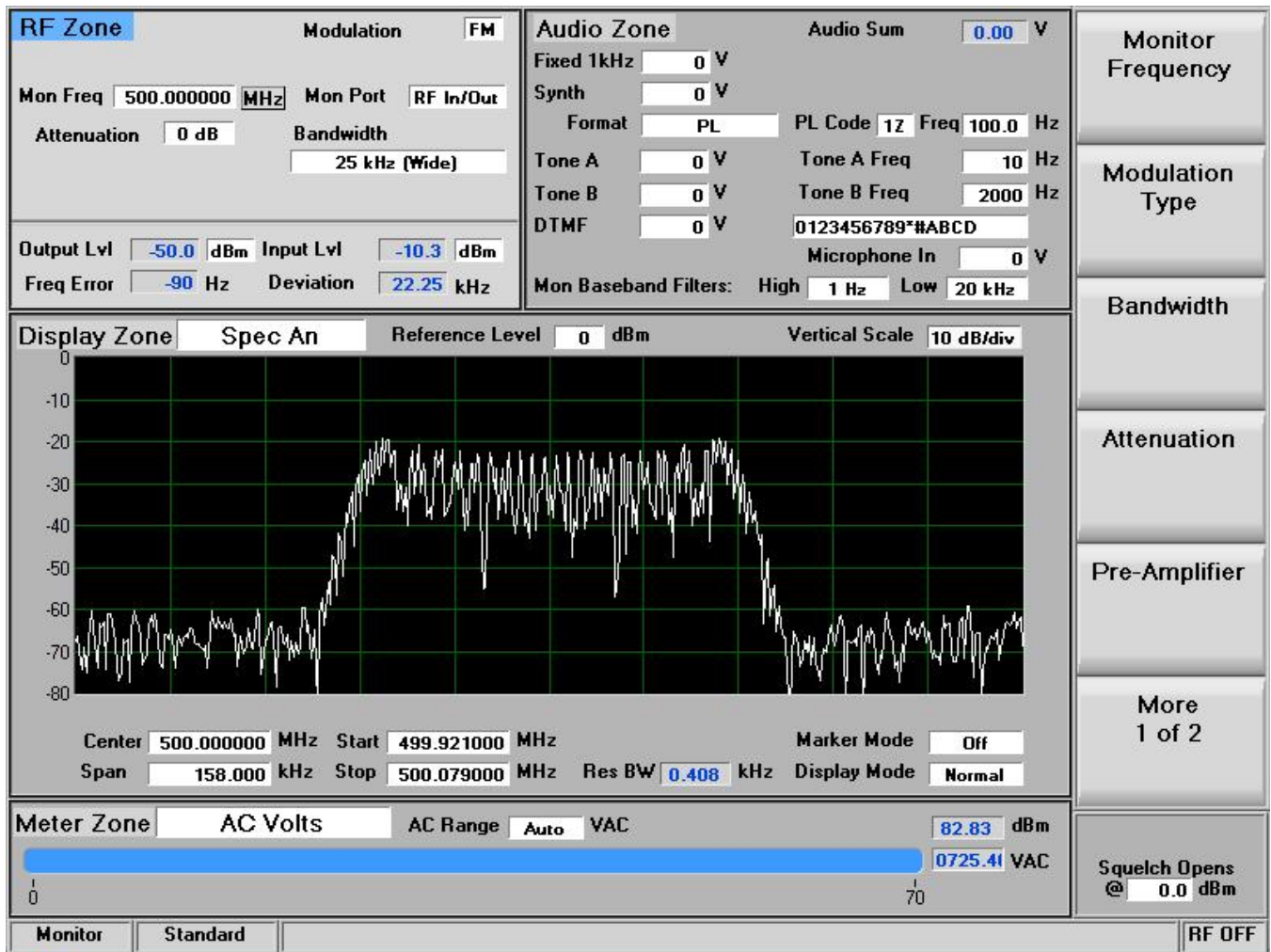
Figure 3.1.1-2   Soft key submenu in Monitor mode after RF Zone key press

RF Zone Modulation FM

Mon Freq 403.000000 MHz Mon Port RF In/Out
Attenuation 0 dB Bandwidth
  25 kHz (Wide)

Output Lvl -50.0 dBm Input Lvl -11.0 dBm
Freq Error 89.98 Hz Deviation 21.23 kHz

Audio Zone Audio Sum 0.00 V
Fixed 1kHz 0.5 V
Synth 0 V
  Format PL PL Code 1Z Freq 100.0 Hz
Tone A 0 V Tone A Freq 1000 Hz
Tone B 0 V Tone B Freq 2000 Hz
DTMF 0 V 0123456789*#ABCD
  Microphone In 0 V
Mon Baseband Filters: High 1 Hz Low 20 kHz

Display Zone Spec An Reference Level 0 dBm Vertical Scale 10 dB/div

Center 403.000000 MHz Start 402.921000 MHz Marker Mode Off
Span 158.000 kHz Stop 403.079000 MHz Res B/W 0.408 kHz Display Mode Normal

Meter Zone AC Volts AC Range Auto VAC 82.85 dBm
  0760.09 VAC
0 70

Monitor Standard RF OFF

Fixed 1kHz Level

Fixed 1kHz Mode

Synth Level

Format

Synth Mode

More 1 of 4

Figure 3.1.1-3   Submenu in Audio Zone after soft key press

Figure 3.1.1-3 shows the R8000 display after pressing the Audio Zone soft key from the main menu. Pressing the Fixed 1kHz Level soft key brings up a data entry box for user entered data as shown in Figure 3.1.1-4. The value can be adjusted with the front panel keypad and tuning controls. The Left/Right (◄►) keys move the highlight over the desired number field. Numeric changes are entered directly via the keypad, or in steps using the Up/Down (▲▼) keys or Tuning Knob.
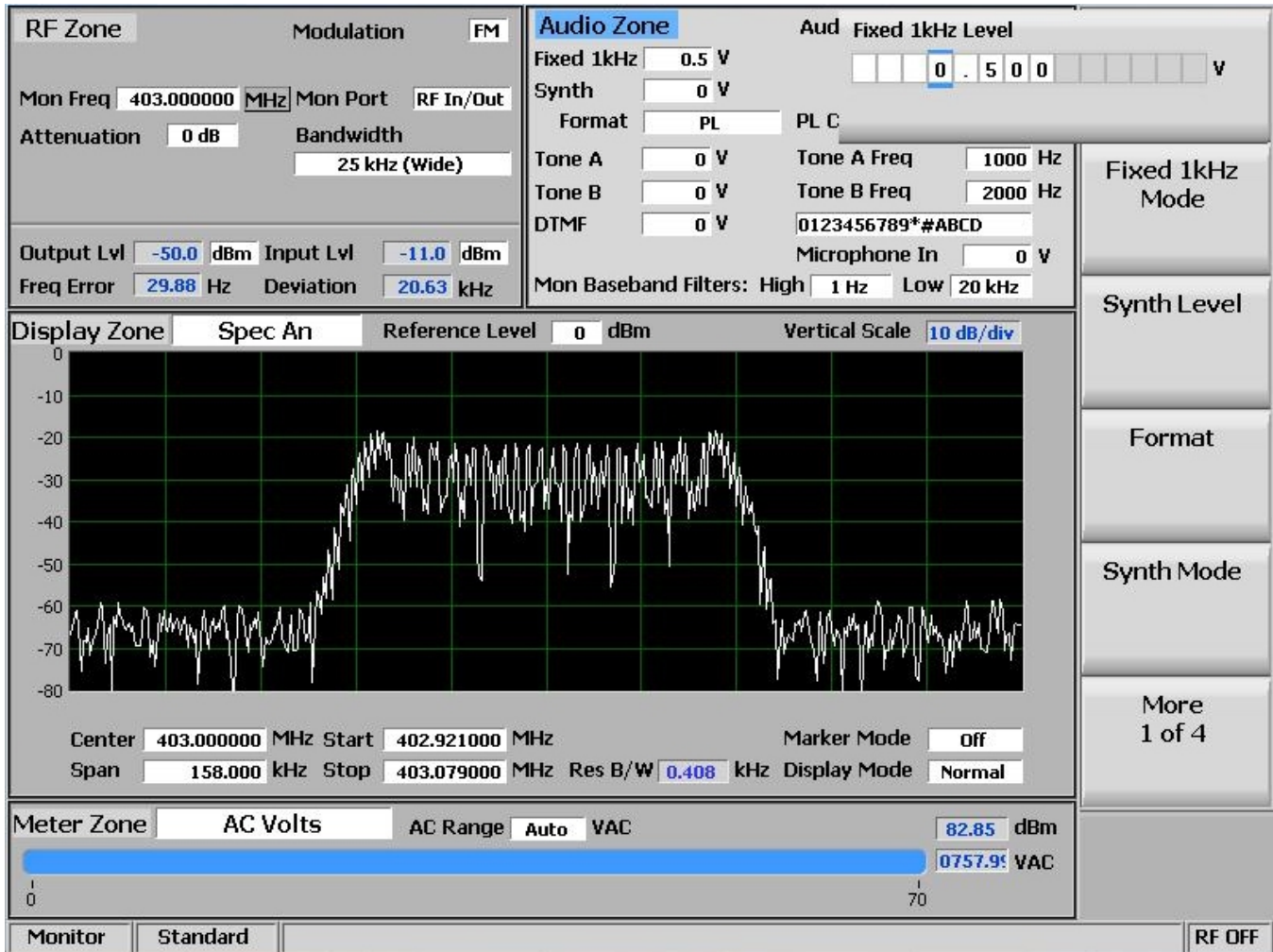
Figure 3.1.1-4   Audio Zone data entry for Fixed 1 kHz Level

Data entry windows always start with the left most numeric field highlighted. Entering a value with the numeric keypad automatically steps the highlight to the right to speed the entry process. Pressing the Up/Down (▲ ▼) keys or rotating the Tuning Knob adjusts the value in step increments. If the value in the numeric field rises above 9 or goes below zero the excess is rolled over into the base number. The R8000 stops accepting numeric changes when the value reaches the maximum or minimum allowed for that parameter. During the entry process pressing Enter completes the entry and pressing Esc cancels the input.

3.1.2   Hot keys for fast Operating Zone navigation in Monitor, Generate, and Duplex modes

"Hot keys" 1, 2, 4/5, & 7/8 on the numeric keypad are shortcuts that directly activate the 4 "Operating Zones" used for settings and metering in the R8000 Monitor, Generator, and Duplex modes. The outline around the hot keys is drawn to match the arrangement of the Operating Zone displays on the R8000 main screen – see Figure 3.1.2-1.

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Pressing a hot key directly activates the Operating Zone and displays its associated settings submenu. This allows jumping from one zone to another while in Monitor, Generator, or Duplex mode without navigating back to the main screen. The hot keys activate the respective zones and submenu as follows:

RF Zone – Press numeric hot key 1

Audio Zone – Press numeric hot key 2

Display Zone – Press numeric hot key 4 or 5

Meter Zone – Press numeric hot key 7 or 8

Figure 3.1.2-1   Outline around Numeric Keypad Hot Keys

Note: Hot keys are inactive whenever there is a data entry window open or the horizontal soft key menu below the display is shown. Press the Esc key to close data entry windows or horizontal soft key menus before using hot keys in Monitor, Generator, or Duplex mode.

3.2   OPERATING INSTRUCTIONS

The main operating modes of the R8000 are oriented towards testing 2-way radios and related infrastructure. So for a majority of applications the R8000 will either receive or generate an RF carrier and display carrier specific information such as power level, modulation content, spectral content, etc. The description of R8000 operation will initially focus on basic use as a receiver and generator then expand into more detail on associated functions.

3.2.1   Monitor Mode

The R8000 Monitor mode provides the analyzer's receiver function used for testing radio transmitters. It is capable of monitoring over the air (OTA) RF signals through its ANTENNA port or with a direct connection to the transmitter at the RF In/Out port. The operating frequency range is from 250 kHz to 3.0 GHz in 1 Hz increments with selectable bandwidths between 6.25 kHz and 200 kHz. The analyzer processes AM and FM modulated carriers and a variety of audio encoding formats. Once set to an RF carrier's center frequency the R8000 accurately determines the frequency error, power level, and modulation characteristics. Figure 3.2.1-1 shows the R8000 in Monitor mode in the RF Zone section of the main display.

Figure 3.2.1-1   RF Zone display area showing Monitor Mode data

To enable the R8000 Monitor mode press the **Monitor** navigation button from within any menu and confirm that "Monitor" is indicated in the lower left corner of the R8000 main display. Then press the **Esc** button repeatedly until the soft keys to the right of the display area indicate RF Zone, AUDIO Zone, DISPLAY Zone, and METER Zone. This places the R8000 at the entry point for adjusting basic Monitor mode settings such as frequency, modulation type etc. *Note: In Monitor mode you can bypass standard menu navigation and jump directly to a Zone and its settings submenu with the appropriate hot key - see paragraph 3.1.2.*

Setting the Monitor's RF operating parameters in the RF Zone

To adjust the RF settings press the RF Zone soft key or hot key 1. The RF Zone area of the display highlights and the soft key submenu shown in Figure 3.2.1-2 appears with the following selections:

Figure 3.2.1-2   Monitor Mode submenu after RF Zone soft key press

Monitor Frequency

Sets the desired monitor frequency in a data entry window from 250 kHz to 3 GHZ using the arrow keys, keypad, or tuning knob. Pressing Enter completes the change and Esc cancels the entry.

Modulation Type

Activates a horizontal submenu with selections for the signal detection mode of the R8000 receiver – either FM or AM.

Bandwidth

Selects the IF detection bandwidth via horizontal soft keys from 6.25 kHz (narrow) to 200 kHz (wide).

Note: *For best measurement quality always set an IF bandwidth no wider than necessary for the signal carrier of interest. Example: A typical channel spacing for modern narrowband 2-way radio is 12.5 kHz. Monitor IF bandwidths that are wider than necessary allow more noise in the measurement and degrade the quality of readings for deviation, frequency error, SINAD, etc.*

Attenuation

Adjusts the RF input signal attenuation in 2 dB steps from 0 to 90 dB in a selection table window using the Up/Down (▲▼) keys or tuning knob.

Pre-Amplifier

*Enables a supplementary input amplifier that extends the sensitivity of the RF Monitor by improving the S/N ratio for low signal levels. **Note:** To avoid input overload and erroneous readings use the pre-amplifier only under the following conditions:*

Input Port	Maximum input level for using pre-amplifier
Antenna	(Input signal in dBm – Attenuator setting) is equal or less than -40 dBm
RF In/Out	(Input signal in dBm – Attenuator setting) is equal or less than -10 dBm

Mon Port

Monitors the RF input signal from either the ANTENNA or the RF In/Out front panel connectors. Choose in a selection table window using the Up/Down (▲▼) keys or tuning knob.

CAUTION

Do not apply input power to the ANT input port. In the event RF power is inadvertently applied, the port is protected to some degree by overload detection circuitry.

Input Level Units

Selects the measuring units for the RF Zone input level display (Input Lvl) via horizontal soft keys. Choices are Volts, Watts, or dBm.

Direct entry example:

Figures 3.2.1-3 and 3.2.1-4 show the data entry and RF Zone windows after pressing the Monitor Frequency soft key and entering 501.234567 MHz via the numeric keypad. The data entry window starts with the left most numeric field highlighted. As the value is entered on the keypad the highlight automatically steps to the right. Pressing Enter or a units key (MHz, etc) completes the change while Esc cancels the entry.

Figure 3.2.1-3   Data entry window before and after Monitor frequency change
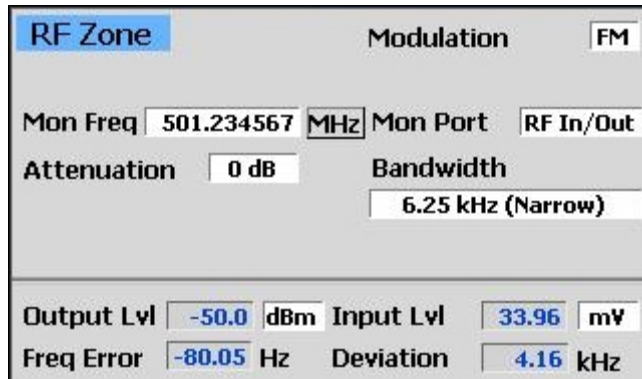
Figure 3.2.1-4   RF Zone display area after Monitor frequency change

Real time adjustments using the tuning knob and arrow keys.

The frequency entry adjustment in Monitor mode is an example of where the R8000 responds directly to a parameter change before the Enter key is pressed. This permits an operator to use the tuning (spin) knob to manually scan an RF frequency segment for an unknown carrier with the smooth action associated with an analog control. The spin knob adjusts whichever digit is highlighted in the data entry field by the Left/Right (◄►) cursor control buttons. Continuous rotation of the knob steps the frequency adjustment by the smallest value of the highlighted digit. Moving the highlight to a different field allows coarse (faster) or fine (slower) tuning as desired. The Up/Down (▲▼) keys provide precise step changes for final adjustment after the R8000 is quickly dialed close to the desired frequency.

3.2.2   Generate Mode

The R8000 Generator mode is the analyzer's transmitter function used for testing radio receivers. The RF carrier is accessible through the RF Gen Out or RF In/Out ports for over the air (OTA) operation or direct coupling into a receiver over a frequency range of 250 kHz to 3.0 GHz in 1 Hz increments. The output level is adjustable from -95 dBm to +5 dBm on the RF Gen Out port and -130 dBm to -30 dBm on the RF In/Out port. A variety of modulation formats are available for the RF carrier. Figure 3.2.2-1 shows the R8000 in the generate mode in the RF Zone section of the main display.
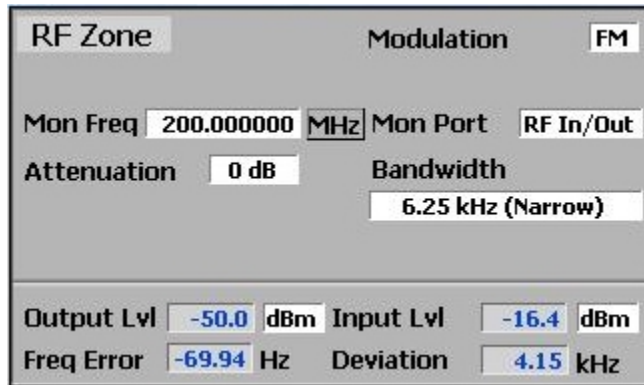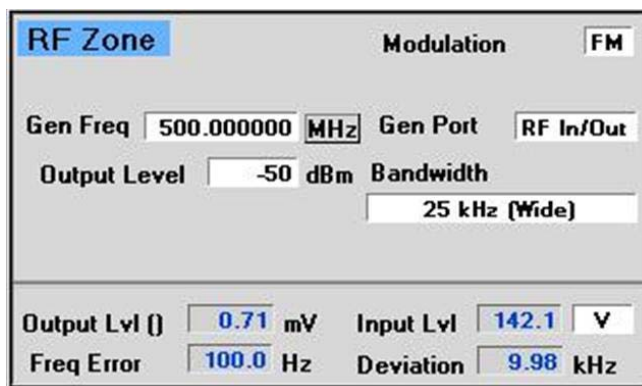

Figure 3.2.2-1   RF Zone display area showing Generator Mode data

To enable the R8000 Generate mode press the **Generate** navigation button from within any menu and confirm that "Generate" is indicated in the lower left corner of the R8000 main display. Then press the **Esc** button repeatedly until the soft keys to the right of the display area indicate RF Zone, AUDIO Zone, DISPLAY Zone, and METER Zone. This places the R8000 at the entry point for adjusting basic Generate mode settings such as frequency, modulation type etc. *Note: In Generate mode you can bypass standard menu navigation and jump directly to a Zone and its settings submenu with the appropriate hot key – see paragraph 3.1.2.*

Setting the Generator's RF operating parameters in the RF Zone

To adjust the RF settings press the RF Zone soft key or hot key 1. The RF Zone area of the display highlights and a new soft key submenu appears as shown in Figure 3.2.2-2. The soft key selections are as follows:
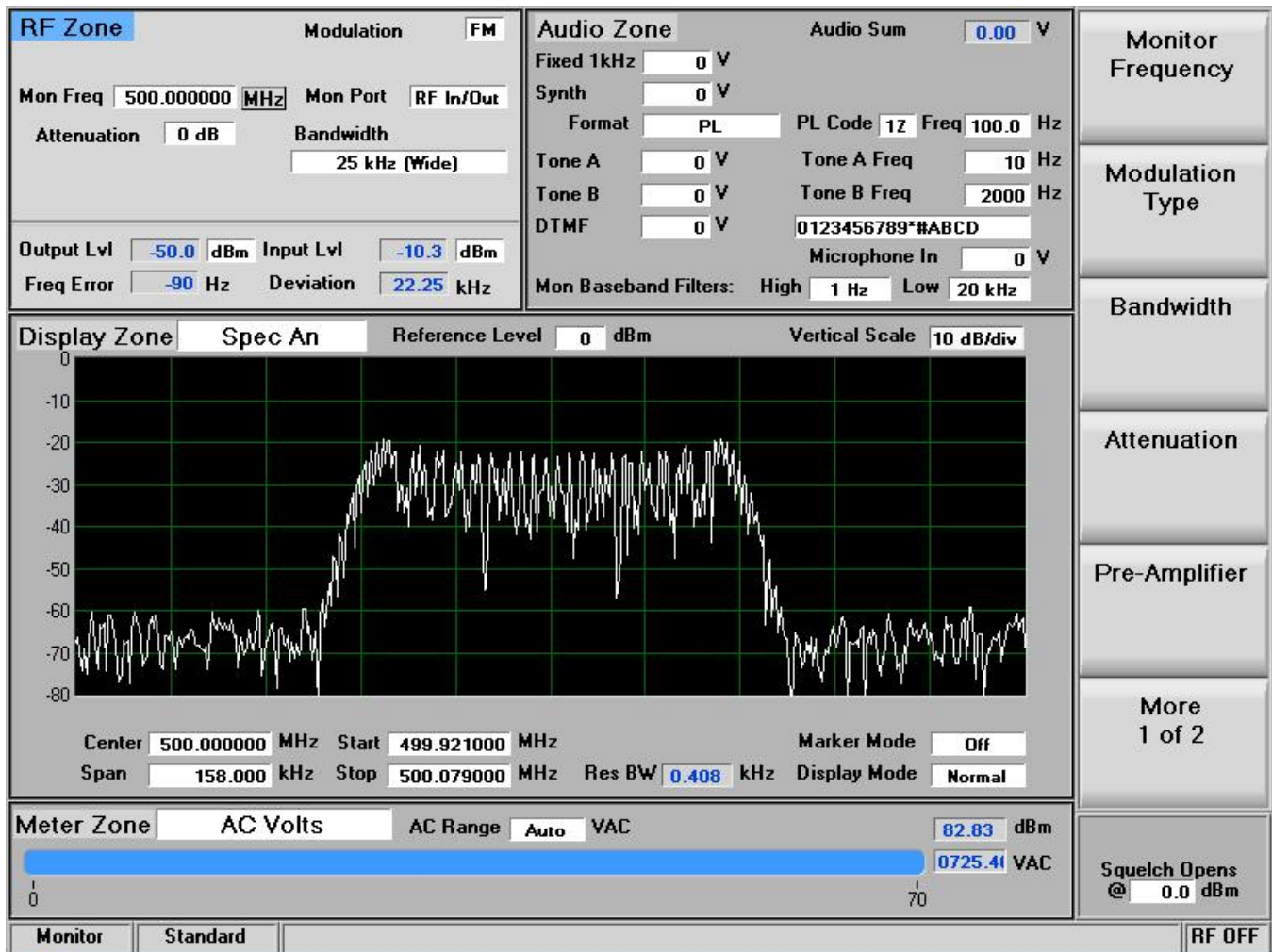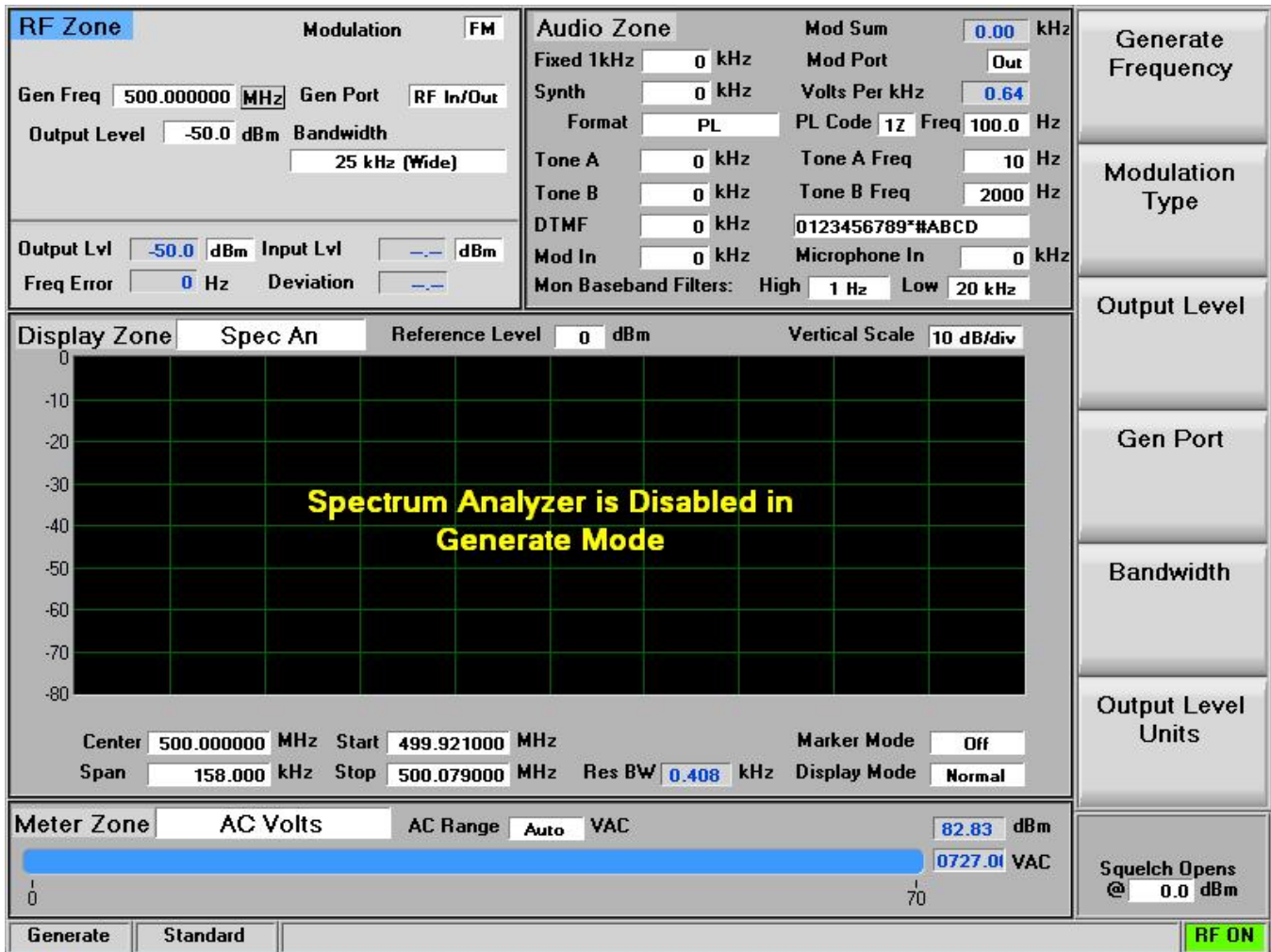

Figure 3.2.2-2   Generator Mode submenu after RF Zone soft key press

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Generator Frequency

Sets the desired monitor frequency in a data entry window from 250 kHz to 3 GHZ using the arrow keys, keypad, or tuning knob. Pressing Enter completes the change and Esc cancels the entry.

Modulation Type

Activates a horizontal submenu with selections for the carrier modulation mode of the R8000 – either FM or AM. For AM, the Output Level upper limits are reduced to accommodate peak power levels.

Output Level

Adjusts the RF level of the transmitted carrier for the selected output port. Range is from -95 dBm to +5 dBm on the RF Gen Out port and -130 dBm to -30 dBm on the RF In/Out port. When Modulation Type is AM, the upper limits are -1 dBm and -36 dBm respectively.

Gen Port

Choose the active port (RF In/Out or Gen Out) for the R8000 carrier output in a selection table using the Up/Down (▲▼) keys or tuning knob.

Bandwidth

Sets the maximum occupied bandwidth in kHz for the R8000's carrier via a set of horizontal soft keys. The range is from 6.25 kHz (narrow) to 200 kHz (wide).

3.2.3   Duplex Mode

The R8000 Duplex mode provides simultaneous generator and monitor operation for testing radio transceivers with full duplex capability, or radio systems with offset transmit and receive frequencies. All RF parameters of the R8000 generator and monitor are independently adjustable during Duplex operation except the shared functions of modulation type and bandwidth. Duplex mode permits offset frequency operation of the generator and monitor over the full frequency range of the R8000. Figure 3.2.3-1 shows Duplex operation of the R8000 in the RF Zone section of the main display.
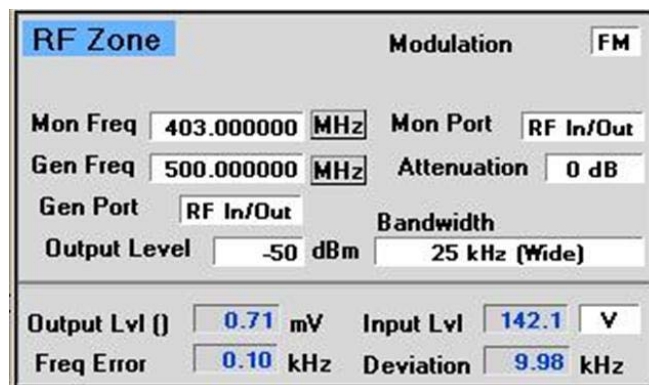
Figure 3.2.3-1   RF Zone display after Duplex key press

To enable the R8000 Generate mode press the **Duplex** navigation button from within any menu and confirm that "Generate" is indicated in the lower left corner of the R8000 main display. Then press the **Esc** button repeatedly until the soft keys to the right of the display area indicate RF Zone, AUDIO Zone, DISPLAY Zone, and METER Zone. This places the R8000 at the entry point for adjusting basic Duplex mode settings such as frequency, modulation type etc. *Note: In Duplex mode you can bypass standard menu navigation and jump directly to a Zone and its settings submenu with the appropriate hot key – see paragraph 3.1.2.*

Setting RF operating parameters in Duplex mode in the RF Zone

To adjust the RF settings press the RF Zone soft key or hot key1. The RF Zone area of the display highlights and the soft key submenu shown in Figure 3.2.3-2 appears. Most of the soft keys duplicate the independent generator and monitor adjustments described in sections 3.2.1 and 3.2.2. The Modulation Type and Bandwidth settings are common and simultaneously applied to the generator and monitor.
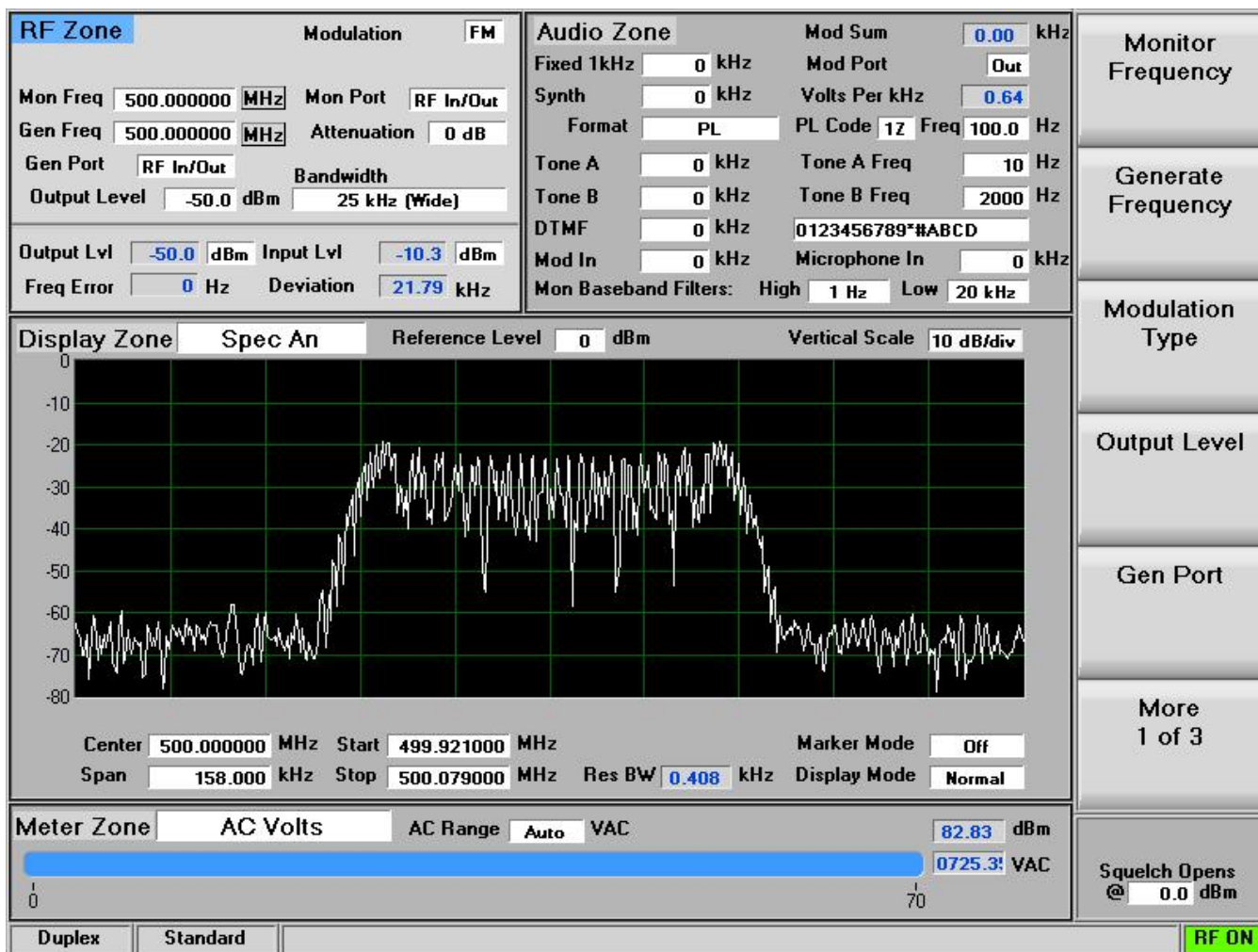
Figure 3.2.3-2   Duplex Mode submenu after RF Zone soft key press

3.2.4   Audio Zone

The R8000 Generate and Monitor modes have a variety of audio settings and encoding/decoding features. Most of these are associated with modulation of the carrier transmitted from the R8000. The audio/modulation sources include a fixed 1 kHz tone generator, independent variable frequency Tone A/Tone B generators, a dedicated DTMF (Dual Tone Multi-Frequency) generator, and a synthesizer for generating various other encoding formats used in 2-way radio testing. The Audio Zone also has the baseband filter settings for the R8000 Monitor mode. Other decoding functions for the carrier recovered audio are primarily located in the Meter Zone.

The display presentation for the Audio Zone on the R0000 main screen changes depending on the R8000 mode. Figure 3.2.4-1 shows the Audio Zone display area with the R8000 in Generate mode. Note the field description of "Mod Sum" towards the upper right, and that the level is in kHz. In Generate mode this synthesizer generated composite audio modulates the internally generated RF carrier on the R8000. The carrier modulation level is indicated in units of deviation for FM (kHz) or percent for AM. The composite audio modulation is also available on the Mod In/Out connector.
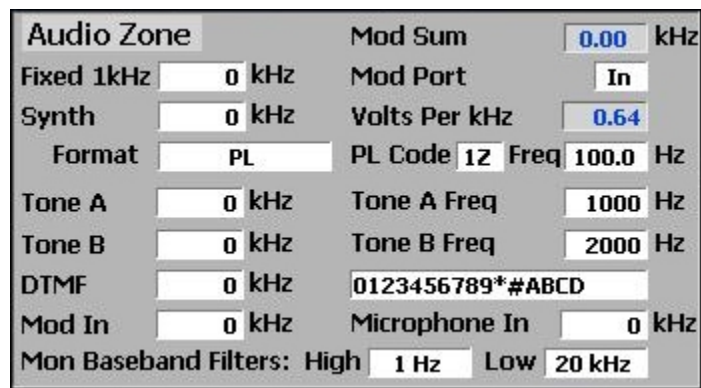
Figure 3.2.4-1   Audio Zone display with the R8000 in Generate mode

Figure 3.2.4-2 shows the Audio Zone display area with the R8000 in Monitor mode. In Monitor mode the audio synthesizers operate like a standalone audio generator since they're not modulating a carrier internal to the R8000. Note the field description of "Audio Sum" towards the upper right and that the level is in Volts (V). This level is the composite sum of all audio sources enabled. The composite audio signal is available on the Mod In/Out connector.
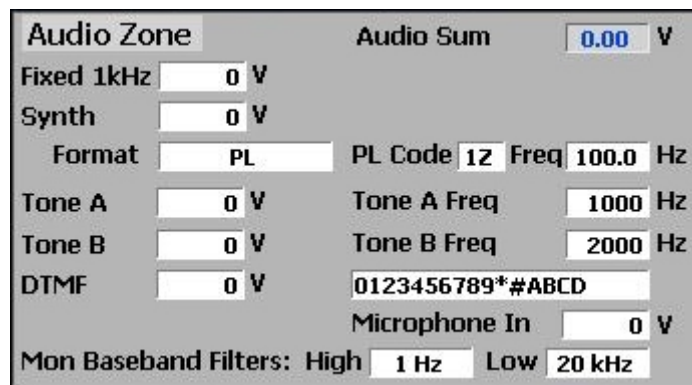
Figure 3.2.4-2   Audio Zone display with the R8000 in Monitor mode

3.2.4.1   Setting audio operating parameters in Monitor mode

Figure 3.2.4.1-1 shows page 1 of the Audio Zone submenu in Monitor mode after the soft key press. Recall that the R8000 audio synthesizers operate like a standalone audio generator in this mode and the signal is directed to the Mod In/Out connector. This is the first of several menu pages with settings mainly associated with the audio synthesizer. The last page of the Audio Zone submenu also contains the baseband filter settings for the R8000 Monitor mode.

Note: An important point regarding the Audio Zone submenu screen pages. They display common settings along with menu choices that change to reflect the Format (signal type) chosen for the audio synthesizer. Different submenu screens and settings appear when other encoding types such as DPL, A/B Sequence, or 5/6 Tone are selected with the Format soft key. The following sections will first describe the common settings, followed by the alternate settings specific to each encoding format.
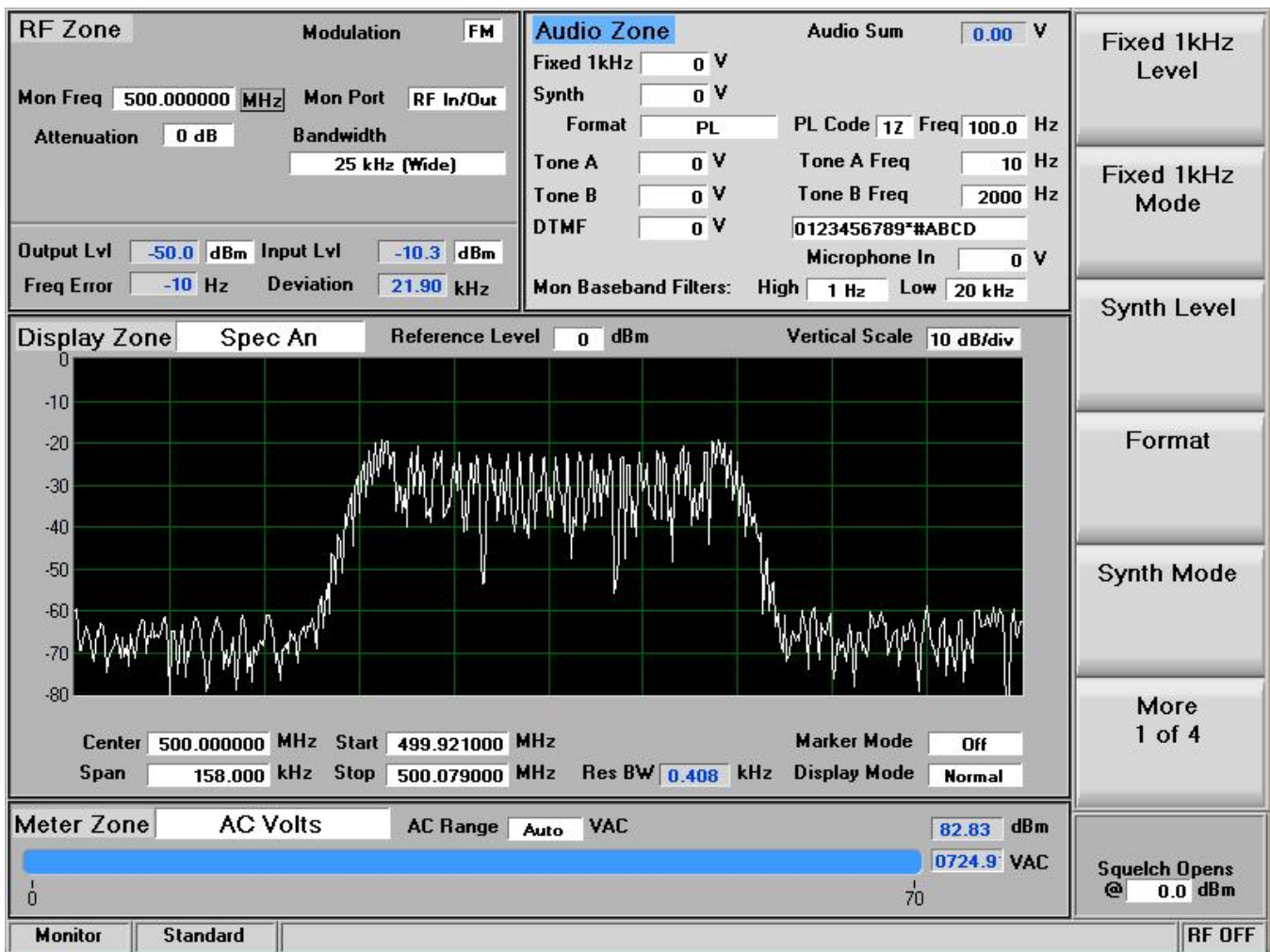
Figure 3.2.4-1   Audio Zone submenu in Monitor mode

3.2.4.2   Common Audio Settings for the Audio Zone submenu

Fixed 1kHz Level

Adjusts the fixed 1 kHz tone generator amplitude from 0 to 0.795V RMS in a data entry window using the arrow keys, keypad, or tuning knob. Pressing Enter completes the change and Esc cancels the entry.

Fixed 1 kHz Mode

Activates a horizontal submenu with an Off or Continuous selection for the 1 kHz tone generator. When the tone is activated the Fixed 1kHz field is highlighted in green.

Synth Level

Adjusts the synthesized audio generator amplitude from 0 to 0.795V RMS in a data entry window using the arrow keys, keypad, or tuning knob. This is an independent generator used for encoded audio such as PL, DPL, A/B Sequence, etc.

Synth Format

*Activates a horizontal submenu with selections for the Synth encoding format – PL, DPL, DPL Invert, and A/B Sequence – see Figure 3.2.4.2-1. Selecting the format makes it the active encoding type for the audio synthesizer. **Note:** See paragraph 3.2.4.3 for specific submenu selections for these formats.*
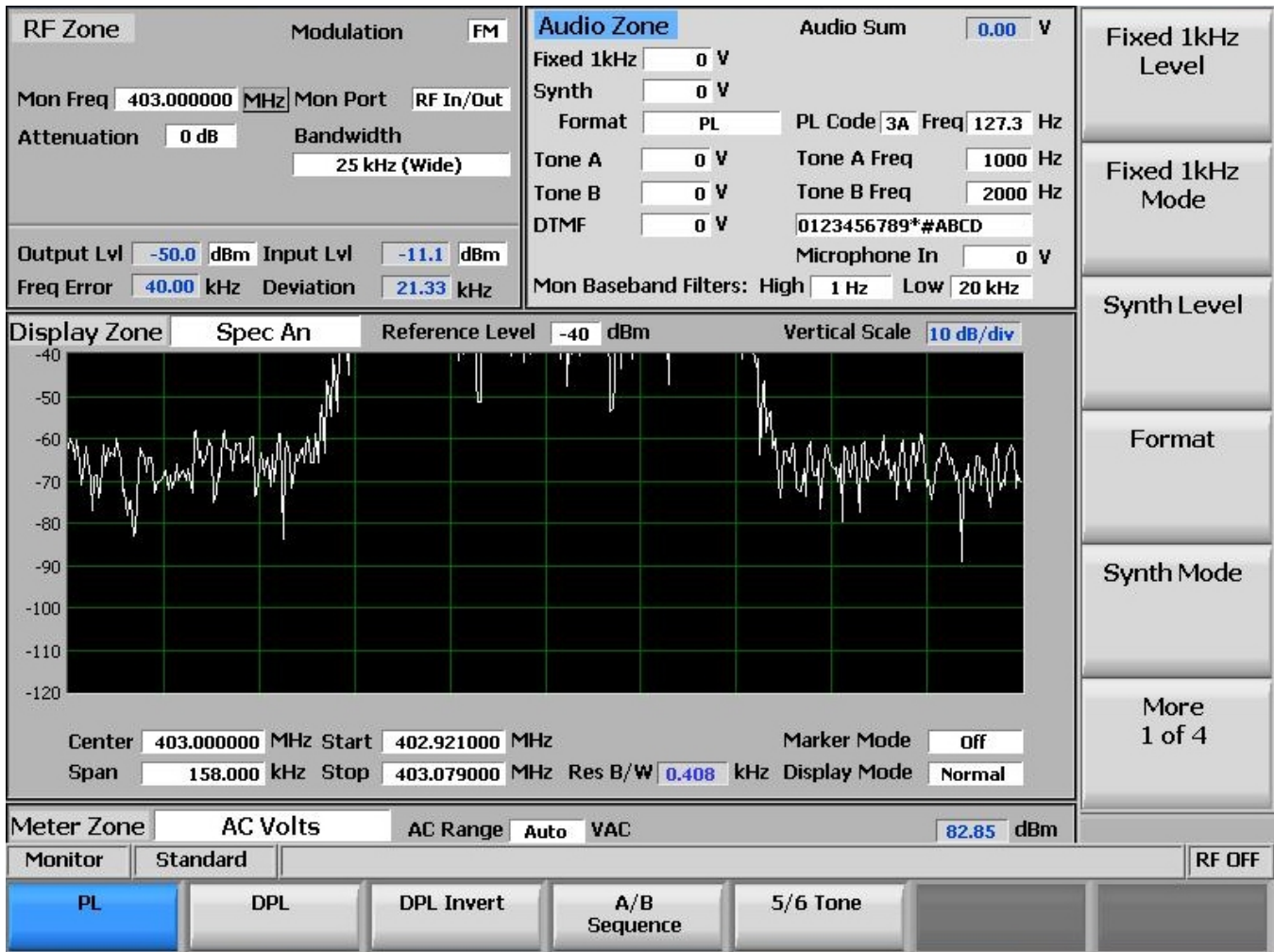
Figure 3.2.4.2-1   Format submenu in Audio Zone

Synth Mode

Activates a horizontal submenu with an Off or Continuous selection for the Synth generator.

Tone A Level

Adjusts the "A" variable tone generator amplitude from 0 to 0.795V RMS in a data entry window using the arrow keys, keypad, or tuning knob. Pressing Enter completes the change and Esc cancels the entry.

Tone A Frequency

Adjusts the "A" variable tone generator frequency from 0 to 19999 Hz in a data entry window using the arrow keys, keypad, or tuning knob. Pressing Enter completes the change and Esc cancels the entry.

Tone A Mode

Activates a horizontal submenu with an Off or Continuous selection for the Tone A generator.

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Tone B Level

Adjusts the "B" variable tone generator amplitude from 0 to 0.795V RMS in a data entry window using the arrow keys, keypad, or tuning knob. Pressing Enter completes the change and Esc cancels the entry.

Tone B Frequency

Adjusts the "B" variable tone generator frequency from 0 to 19999 Hz in a data entry window using the arrow keys, keypad, or tuning knob. Pressing Enter completes the change and Esc cancels the entry.

Tone B Mode

Activates a horizontal submenu with an Off or Continuous selection the Tone B generator.

DTMF Level

Adjusts the DTMF (Dual Tone Multi-frequency) tone generator amplitude from 0 to 0.795V RMS in a data entry window using the arrow keys, keypad, or tuning knob. Pressing Enter completes the change and Esc cancels the entry. DTMF is used for testing telephone interfaced systems.

DTMF Mode

Activates a horizontal submenu with an Off, Continuous, or Burst selection for the DTMF tone generator.

DTMF Code

Enters a DTMF Code sequence in a data entry window using the alphanumeric keypad. The Left/Right (◄►) keys move the highlight to the desired field. The code is entered either of several ways. The Up/Down (▲▼) keys or tuning knob cycles the highlighted field through the entire DTMF Code table. Pressing the alphanumeric keypad allows direct numeric entry and alpha characters are entered by cycling through repeated presses of the appropriate numeric key.

DTMF Table

Activates soft keys and a table that provide more control when generating a DTMF Code sequence. In addition to the data entry window there are selections permitting adjustment of the Tone Duration and Inter-digit Delay. A Single Digit mode also allows single key press tone generation similar to a telephone keypad.

Mod In Port Mode

Activates a horizontal submenu with an Off or Continuous selection for the external signal applied to the Mod In/Out port on the front panel.

High Pass Filter

Activates a horizontal submenu with audio filter selections that determine the high pass frequency for the R8000's baseband response to recovered audio. The "cut-on" frequency selections are 5 Hz, 300

Hz, and 3 kHz. This setting is used in conjunction with the Low Pass Filter to determine the audio pass band for the R8000 baseband circuitry.

Low Pass Filter

Activates a horizontal submenu with audio filter selections that determine the low pass frequency for the R8000's baseband response to recovered audio. The "cut-off" frequency selections are 300 Hz, 3 kHz, and 20 kHz. This setting is used in conjunction with the High Pass Filter to determine the audio pass band for the R8000 baseband circuitry.

Note: For best audio and measurement quality always set an audio pass band no wider than necessary for the signal of interest.   Example: A typical 2-way radio audio pass band is 300 Hz to 3 kHz. Pass bands wider than necessary allow more noise in the measurement and degrade the audio quality and the readings for deviation, frequency error, SINAD, etc.

3.2.4.3   Settings for PL, DPL, DPL Invert A/B Sequence, 5/6 Tone Formats

The following settings appear in Audio Zone submenu pages when specific encoding formats are chosen in the Format horizontal menu - see Figure 3.2.4.2-1.

PL Table (displayed in Audio Zone submenu when synthesizer Format selected is PL)

Activates a selection table Motorola Private-Line tone coded squelch signaling and provides a listing of valid codes/frequencies – see Figure 3.2.4.3-1. The codes and associated frequencies are selected using the Up/Down (▲▼) and Left/Right (◄►) keys to scroll through the table and pressing Enter to complete the entry. Choosing a blank field removes PL coding from the Audio Sum. For valid codes see Table B-3 in Appendix B.
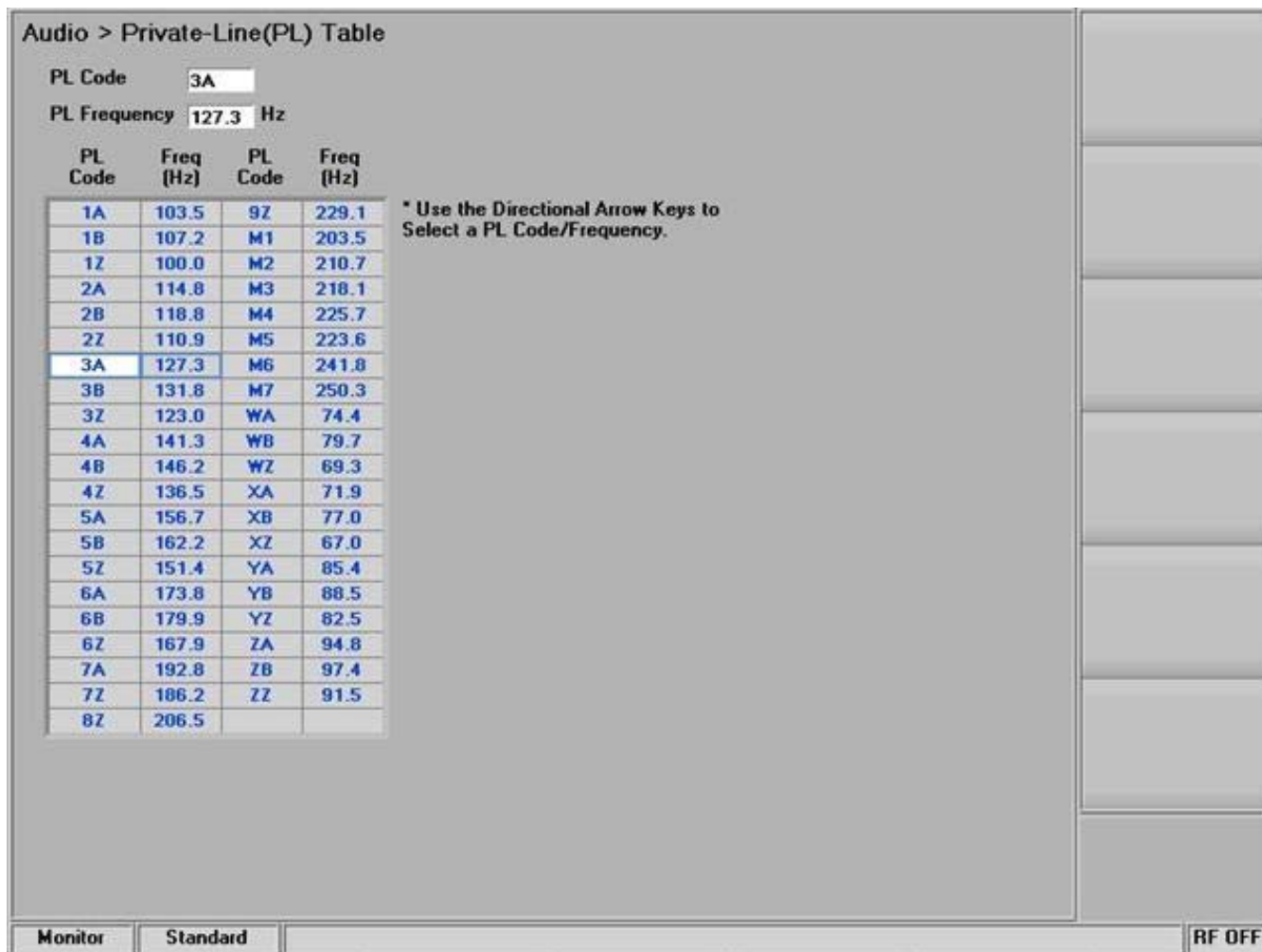
Figure 3.2.4.3-1   PL Table showing highlighted entry code.

DPL Code (displayed when synthesizer Format selected is DPL or DPL Invert)

Activates a data entry window to enter codes for the Motorola Digital Private-Line coded squelch signaling format. Code entries are made via a data entry box with the cursor control, numeric keypad, and tuning knob. See Table B-5 in Appendix B for a selection table with a listing of valid DPL codes.

A/B (displayed when synthesizer Format selected is A/B Sequence)

This short-cut key brings up a horizontal menu to select one of 4 timing sequences for the two-tone sequential paging format. The sequences are programmed and appear in the A/B Sequence Table – see next setting.

A/B Sequence Table (displayed when synthesizer Format selected is A/B Sequence)

Activates a programming table for the two-tone sequential paging format – see Figure 3.2.4.3-2, The A/B Sequence encoding mode uses the Tone A and Tone B generators and one of four selectable timing sequences determined by the Sequence soft key. Sequences 1 and 2 utilize fixed timing for standard "tone" and "tone/voice" pagers, while sequences 3 and 4 may be customized through numeric entries by

the user.   When the Up/Down (▲▼) keys highlight the programmable sequences (3 and 4) a new submenu appears as shown in Figure 3.2.4.3-3. The tone frequencies, durations and delays are entered using this submenu.
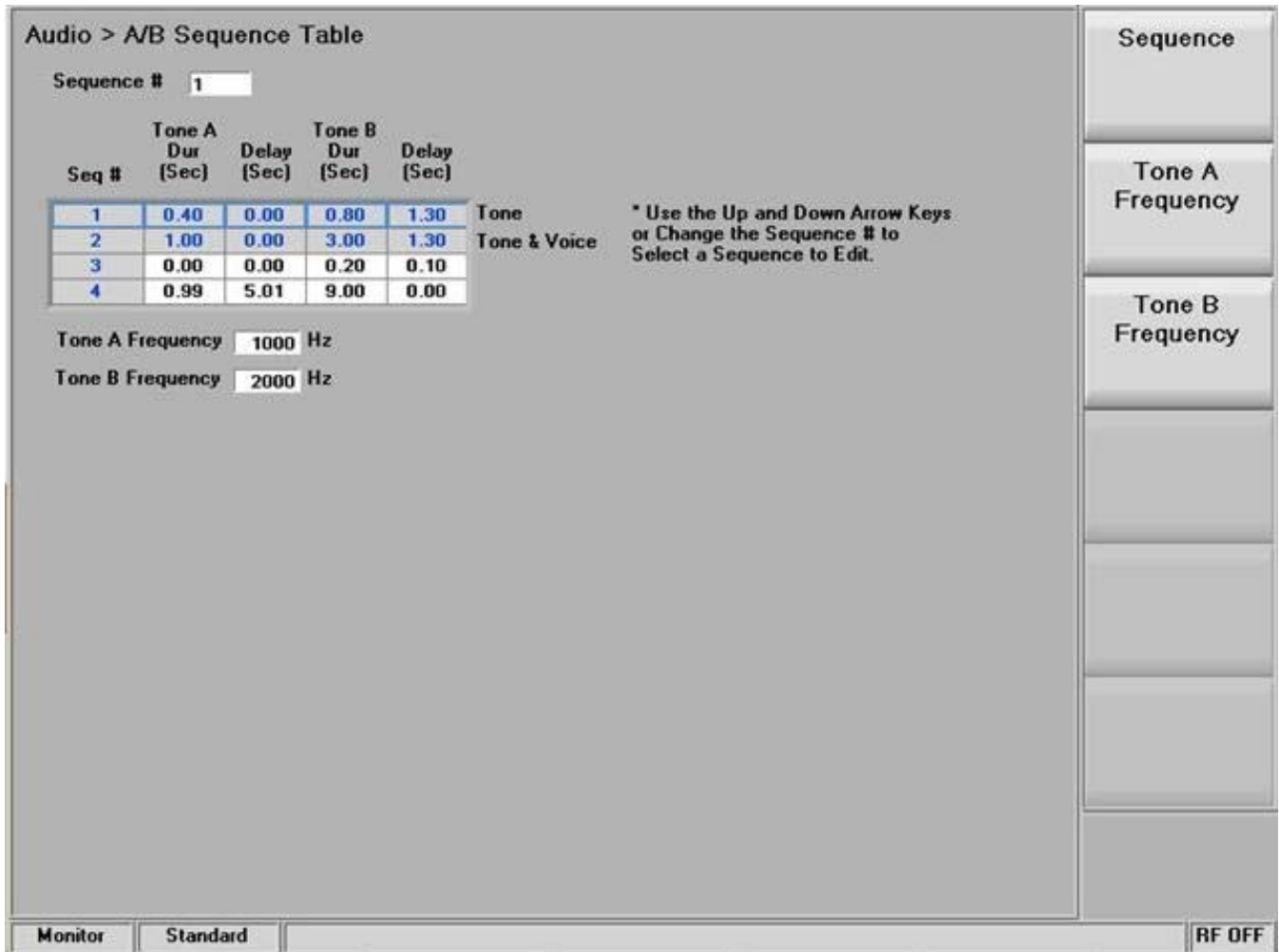
Figure 3.2.4.3-2   A/B Sequence table showing highlighted sequence.
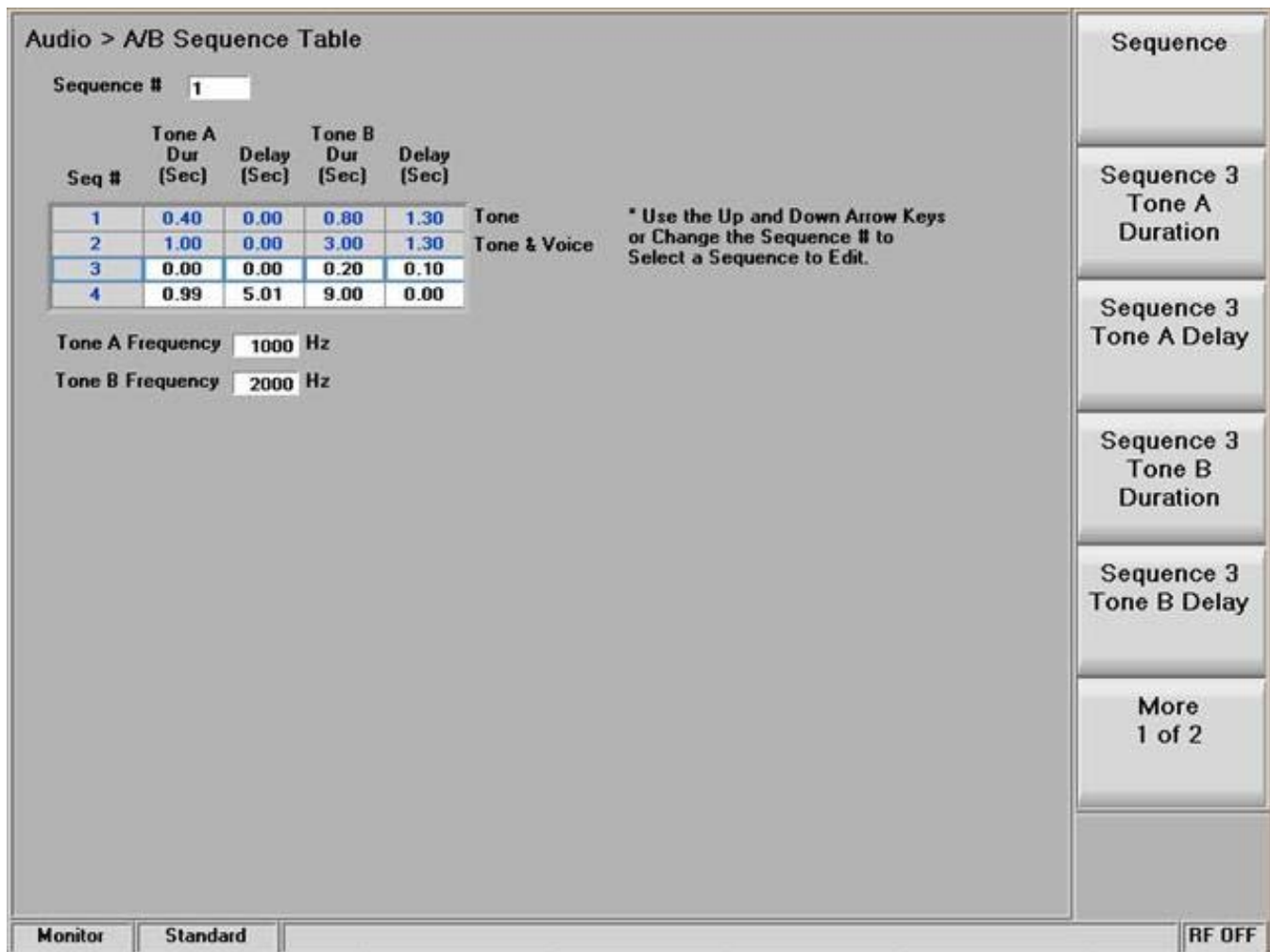
Figure 3.2.4.3-3   A/B Sequence submenu for user programmable entries

5/6 Tone (displayed when synthesizer Format selected is 5/6 Tone)

Activates a data entry window and horizontal menu to enter codes for the 5/6 Tone paging format – See Figure 3.2.4.3-4. Code entries are made via a data entry box with the cursor control, numeric keypad, and tuning knob. See Table B-4 in Appendix B for a selection table with a listing of valid 5/6 Tone codes.

The first digit preceding the hyphen is the preamble tone for activating one of ten battery-saver groups. The R-Repeat key or "R" tone is used in place of a repeated digit – when this tone is heard it is assumed the prior digit is being transmitted again. If the digit is repeated a third time the original tone is transmitted.   A sixth or "X" tone is optional for pagers that support this function. The "X" tone indicates a different beep pattern is used in place of that used for the standard 5 tone response. Pressing the 6-Tone soft key adds the "X" tone to the transmission.

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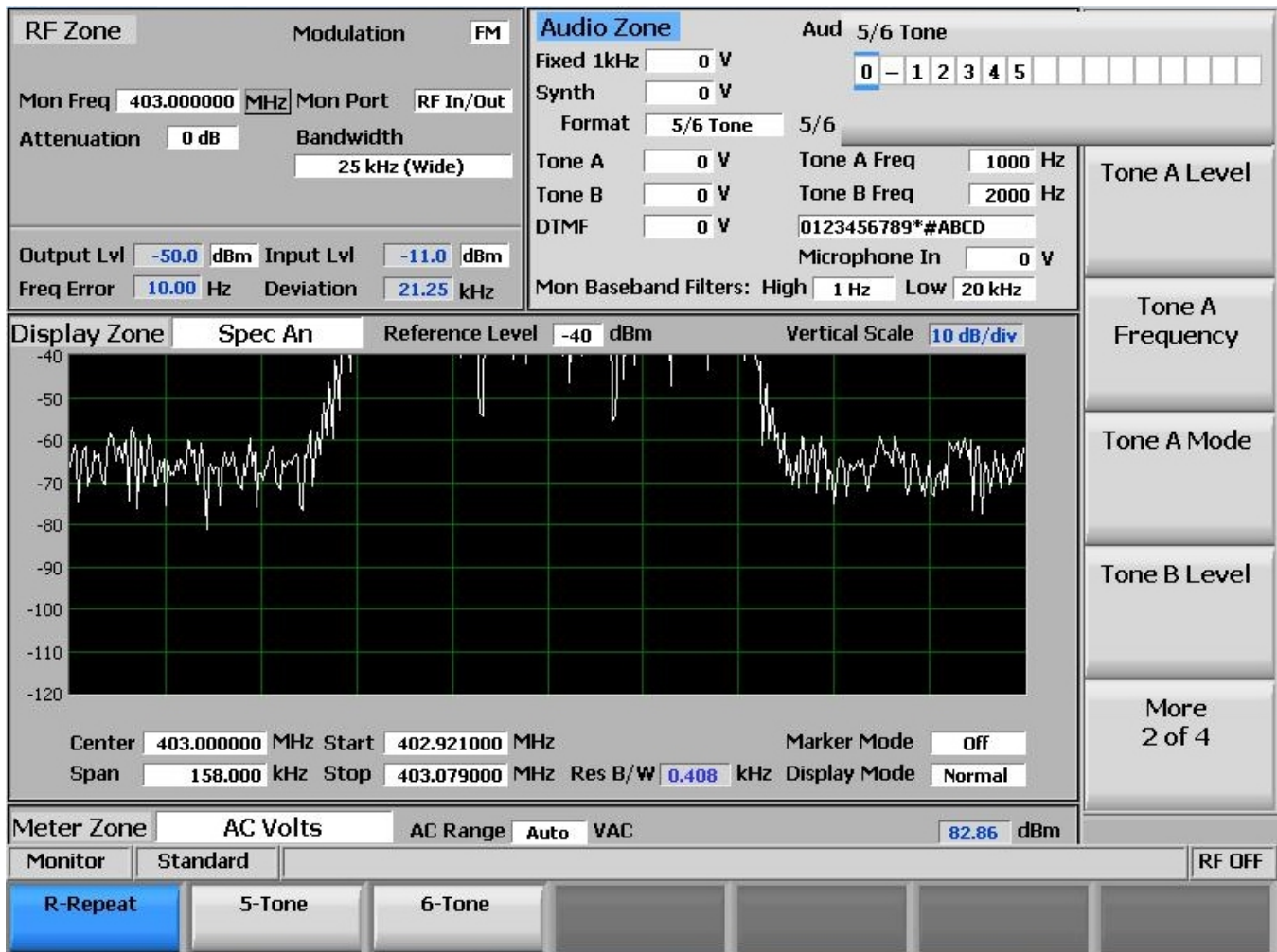
Figure 3.2.4.3-4   5/6 Tone entry submenu

3.2.4.4   Setting audio operating parameters in Generator mode

The audio settings in Generator mode replicate those in Monitor mode with two key differences.   In Generator mode the audio signal is simultaneously applied as a modulation to the RF carrier and the Mod In/Out connector. Also, Mod Sum level is shown in units of FM deviation (kHz) or AM modulation depth (%), depending on the Modulation Type setting in the RF Zone. See Figure 3.2.4.4-1
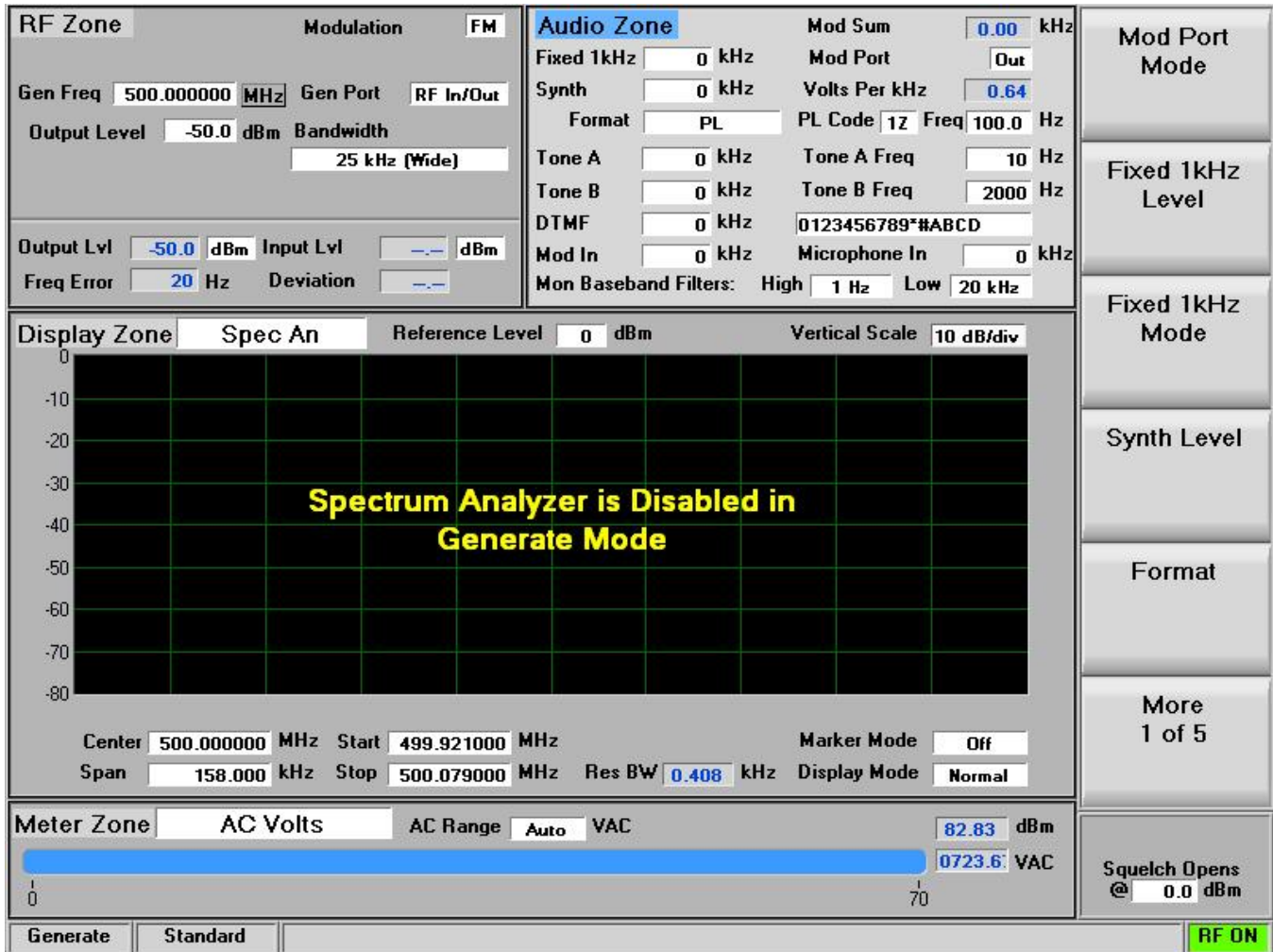
Figure 3.2.4.4-1   Audio Zone submenu in Generator mode

The additional submenu choices for the Audio Zone in Generate mode are as follows:

Mod Port Mode

This soft key determines the signal routing for the Mod In/Out port on the front panel. Choosing In routes an externally applied signal to the modulation circuitry of the R8000. When switched to Out, the internal audio modulation is routed to the Mod In/Out port for use by an external radio or instrument.

Microphone Level

Sets the modulation level for the external microphone attached to the R8000. The displayed units reflect the modulation mode chosen in the RF Zone, either deviation in kHz for FM or % modulation for AM.

Mod In Port Level

Sets the modulation level for the external signal applied to the MOD In/Out port on the R8000. The displayed units reflect the modulation mode chosen in the RF Zone, either deviation in kHz for FM, or % modulation for AM.

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Mod In Port Mode

Activates a horizontal submenu with an Off or Continuous selection for the external signal applied to the Mod In/Out port on the front panel.

3.2.5   Display Zone

The R8000 has several graphical displays providing a visual presentation of received RF signals and recovered audio, along with internally generated and externally measured audio signals. They are accessed from the main menu with the Display Zone soft key. The displays include a Spectrum Analyzer, Modulation Scope, Oscilloscope, along with Bar Graphs for RF signal deviation, frequency error and input level. Figure 3.2.5-1 shows the submenu after a Display Zone soft key press. Note the submenu selections below the "Select Display" soft key. These selections change depending on the chosen display - in this case the Spectrum Analyzer.
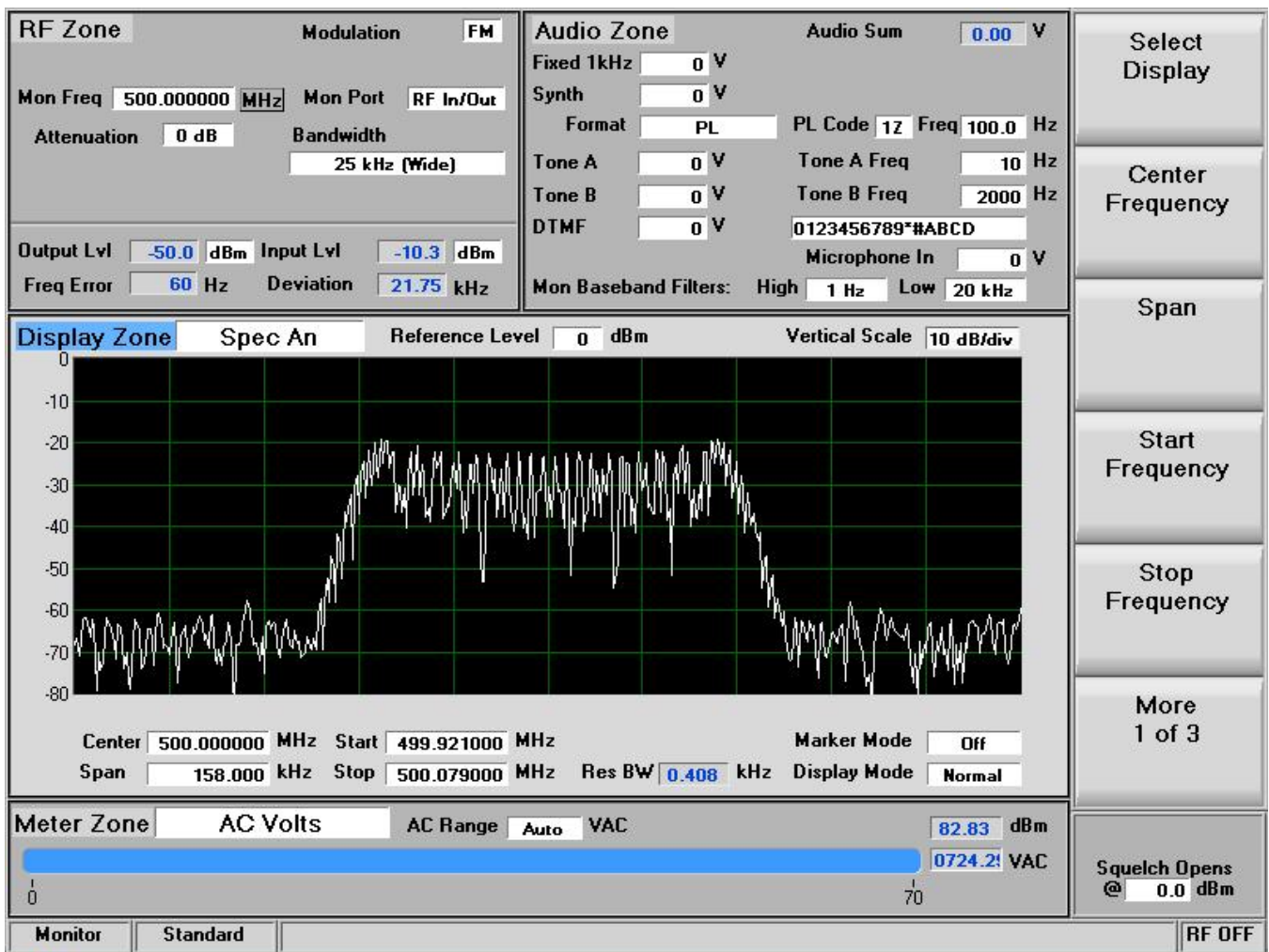
Figure 3.2.5-1   Display Zone submenu after soft key press

Figure 3.2.5-2 shows the horizontal menu after a "Select Display" soft key press. The highlight on the "Spec An" soft key selection indicates that display is in use. The vertical soft key menu has several pages of Spectrum Analyzer settings including Center Frequency, Span, Start and Stop frequencies, etc.
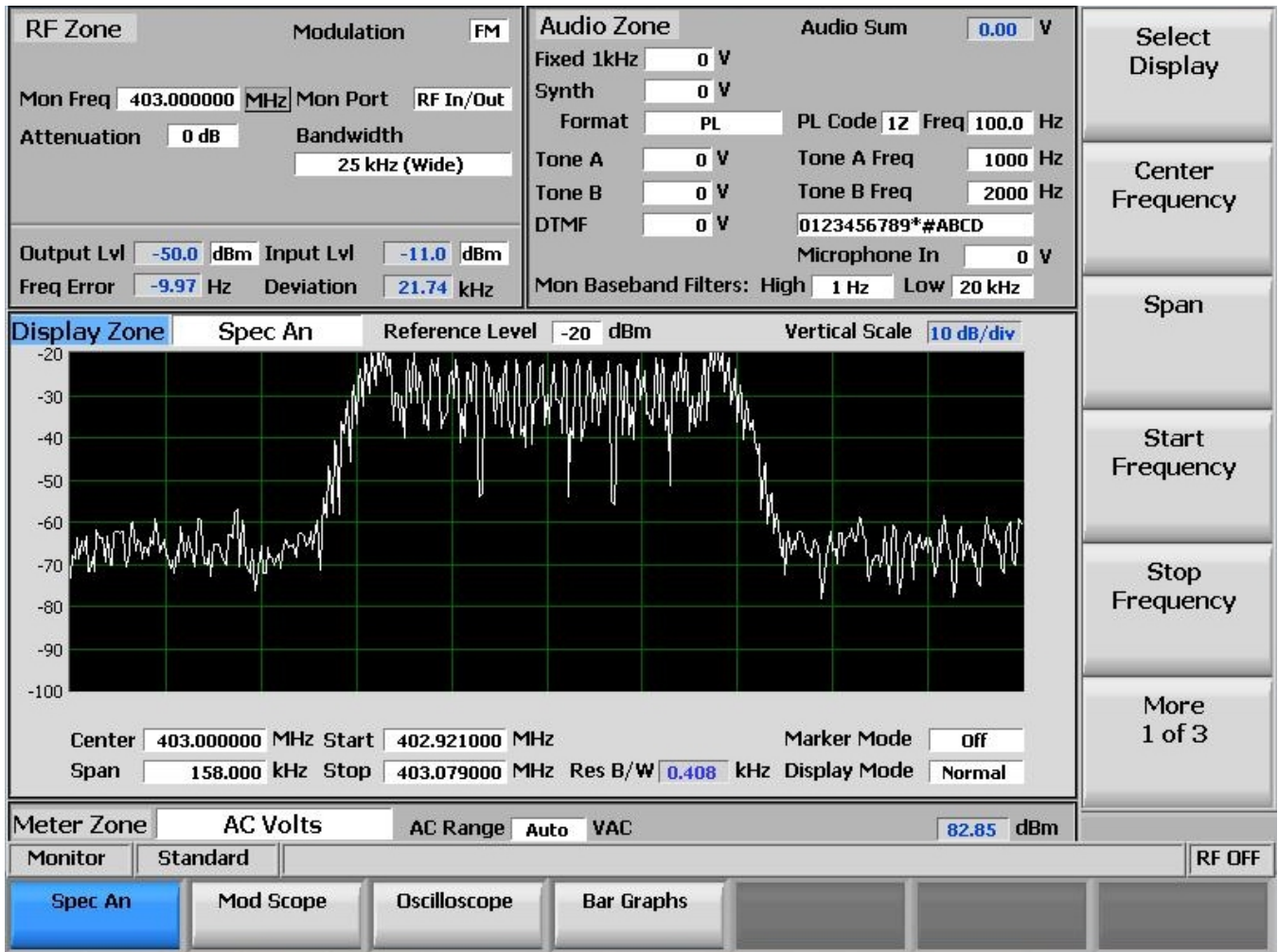
Figure 3.2.5-2   Submenu after Select Display soft key press

Figure 3.2.5-3 shows the Display Zone submenu after selecting the Mod Scope display. The vertical soft key menu now presents modulation scope settings for Monitor mode.

RF Zone   Modulation   FM

Mon Freq   500.000000   MHz   Mon Port   RF In/Out

Attenuation   0 dB   Bandwidth

25 kHz (Wide)

Output Lvl   -50.0   dBm   Input Lvl   -10.3   dBm

Freq Error   20   Hz   Deviation   17.49   kHz

Audio Zone   Audio Sum   0.00   V

Fixed 1kHz   0 V

Synth   0 V

Format   PL   PL Code   1Z   Freq   100.0   Hz

Tone A   0 V   Tone A Freq   10   Hz

Tone B   0 V   Tone B Freq   2000   Hz

DTMF   0 V   0123456789*#ABCD

Microphone In   0 V

Mon Baseband Filters: High   300 Hz   Low   3 kHz

Display Zone   Mod Scope   Horizontal Scale   1 ms   /div   Vertical Scale   10 kHz   /div

Marker Mode   Off

Trigger Mode   Auto   Trigger Level   100   kHz   Edge   Rising

Meter Zone   AC Volts   AC Range   Auto   VAC   81.71   dBm

0432.40 VAC

0   70

Monitor   Standard

Select Display

Horizontal Scale

Vertical Scale

Marker Mode

Toggle Marker

More 1 of 2

Squelch Opens @   0.0   dBm

RF OFF

Figure 3.2.5-3   Display Zone submenu for the Mod Scope

The following sections detail the submenu and soft key selections for the graphical displays on the R8000 analyzer.

3.2.5.1   Spectrum Analyzer settings

Access the Spectrum Analyzer using the Select Display soft key to bring up the horizontal submenu display choices. The available adjustments are as follows:

Center Frequency

Sets the center frequency from 250 kHz to 3 GHz for the Spectrum Analyzer in a data entry window using the arrow keys, keypad, or tuning knob. Pressing Enter completes the change and Esc cancels the entry.

Span

Sets the total frequency window displayed on the Spectrum Analyzer in MHz. The Span entry total is automatically split on each side of the current center frequency.

Start Frequency

Sets the display start frequency in MHz. Use with the Stop Frequency to establish a desired frequency range for the Spectrum Analyzer display. The R8000 automatically centers the frequency display midway between Start and Stop frequencies.

Stop Frequency

Sets the display stop frequency in MHz. Use with the Start Frequency to establish a desired frequency range for the Spectrum Analyzer display. The R8000 automatically centers the frequency display midway between Start and Stop frequencies

Resolution Bandwidth

Selects the RF bandwidth of the Spectrum analyzer from 300 Hz to 1 MHz via a horizontal soft key menu. Narrower bandwidths permit separation of closely spaced carriers but with slower display updates. Wider bandwidths provide quick display updates but with lower frequency resolution.

Reference Level

Adjusts the maximum level for the vertical scale of the display (top line) from -50 dBm to + 50 dBm in 1 dB increments.

Vertical Scale

Selects the vertical scale resolution for the display's major grid lines from 1 dB/div to 10 dB/div via a horizontal soft key menu.

Display Mode

Selects the display presentation using a horizontal menu with the following choices:

Normal – The display updates continuously.

Freeze – Provides a snapshot of the current display indication and stops additional updates. ***Note:*** *In Freeze mode the R8000 reacquires data and updates the display whenever "Center Marker" or "Center Peak" is pressed.*

Max Hold – The display retains the highest peak signal amplitudes measured during successive sweeps.

Average – The displayed signal amplitudes are a rolling average of the peak amplitudes measured on each successive sweep. The default setting is 5 averages.

Center Peak

Centers the operating frequency and display of the R8000 Spectrum Analyzer around the highest peak signal within the display range.

Marker Mode

Provides display marker control via a horizontal soft key menu. Markers can be turned off or on with a choice of numeric readout for the signal measurements. "Absolute" provides actual peak readings while "Delta" measures the relative difference between peaks.

Toggle Marker

Cycles through and highlights the available markers to select the active one for positional adjustment on the display. The active marker is moved using the Left/Right (◄►) cursor control buttons.

Center Marker

Centers the operating frequency and display of the R8000 Spectrum Analyzer around the frequency of the active marker.

Find Peak

Moves the cursor to the highest signal peak in the display window and provides a numeric readout of the amplitude and frequency.

3 dB Marker

Frequency - *Places a marker above and below center frequency where the signal is -3 dB below the peak amplitude measured at center frequency. The upper and lower frequencies are shown on the display.*

Delta - *Places a marker above and below center frequency where the signal is -3 dB below the peak amplitude measured at center frequency. The difference between these two frequencies is shown on the display.*

3.2.5.2 Modulation Scope settings

The Modulation Scope displays the internal modulation waveforms. It automatically switches between generator or monitor modulation depending on which mode is selected.

Access the Modulation Scope using the Select Display soft key to bring up the horizontal submenu display choices. The available adjustments are as follows:

Vertical Scale

Selects the vertical scale resolution for the display's major grid lines via a horizontal submenu. The display units presented are dependent on the R8000's modulation setting in the RF Zone. For FM mode the units are in Hz and kHz deviation, ranging from 100 Hz/div to 50 kHz/div. In AM mode the units are in % modulation depth and range from 1%/div to 50%/div.

Horizontal Scale

Selects the horizontal time scale resolution for the display's major grid lines in a dialog entry box using the Up/Down (▲▼) keys or tuning knob. The units range from 20 uS/div to 1 sec/div.

Marker Mode

Provides display marker control via a horizontal soft key menu. Markers can be turned off or on with a choice of numeric readout for the signal measurements as follows:

<u>*Delta V*</u> *– The numeric reading shows the difference in amplitude between marker positions.*

<u>*Delta T*</u> *– The numeric reading shows the difference in time between marker positions.*

<u>*1/DeltaT*</u> *– The numeric reading shows the inverse of the time difference between markers which can be used to determine the frequency of a repetitive waveform.*

Toggle Marker

Cycles through and highlights the available markers to select the active one for positional adjustment on the display. The active marker is moved using the Left/Right (◄►) cursor control buttons.

Trigger Mode

Selects the trigger mode for the horizontal sweep via a submenu. The choices are as follows:

<u>*Auto*</u> *– If a signal satisfying the Trigger Edge and Trigger Level settings is present the display will sweep as in Normal mode. If no signal satisfying the Trigger Edge and Trigger Level settings is present then the display sweeps continuously until a signal satisfying the settings is acquired.*

<u>*Normal*</u> *– The display sweeps only when the input signal satisfies the Trigger Edge and Trigger Level settings.*

<u>*Single*</u> *– The display sweeps once after a key press is performed on the Single soft key.*

Trigger Level

Adjusts the signal threshold at which a horizontal sweep is initiated. The soft key activates a numeric entry box and the Left/Right (◄►) keys move the highlight over the desired number field. Numeric changes are entered directly using the keypad, or in steps with the Up/Down (▲▼) keys or Tuning Knob.

Trigger Position

Adjusts the amount of pre-trigger waveform displayed on the screen via selections on a horizontal submenu. The choices are 10%, 50%, or 90% of the display allocated to the waveform preceding the trigger threshold.

Trigger Edge

Determines which waveform edge is used to trigger the modulation scope sweep via selections on a horizontal submenu. The selections are Rising, Falling, or Either.

Vertical Position

Adjusts the vertical position of the waveform on the display using a horizontal submenu. Pressing the Move Up and Move Down soft keys shifts the waveform position by fixed increments.

3.2.5.3   Oscilloscope settings

The R8000 analyzer provides a general purpose oscilloscope with calibrated vertical input sensitivities and automatic or triggered horizontal sweep rates. Use the scope to analyze waveforms, detect asymmetric modulation or audio distortion, trace signals, and troubleshoot subsystems or circuits. The Meter In port serves as the vertical input for the Oscilloscope.

Access the external Oscilloscope using the Select Display soft key to bring up the horizontal submenu display choices shown in Figure 3.2.5.3-1. The available adjustments are as follows:
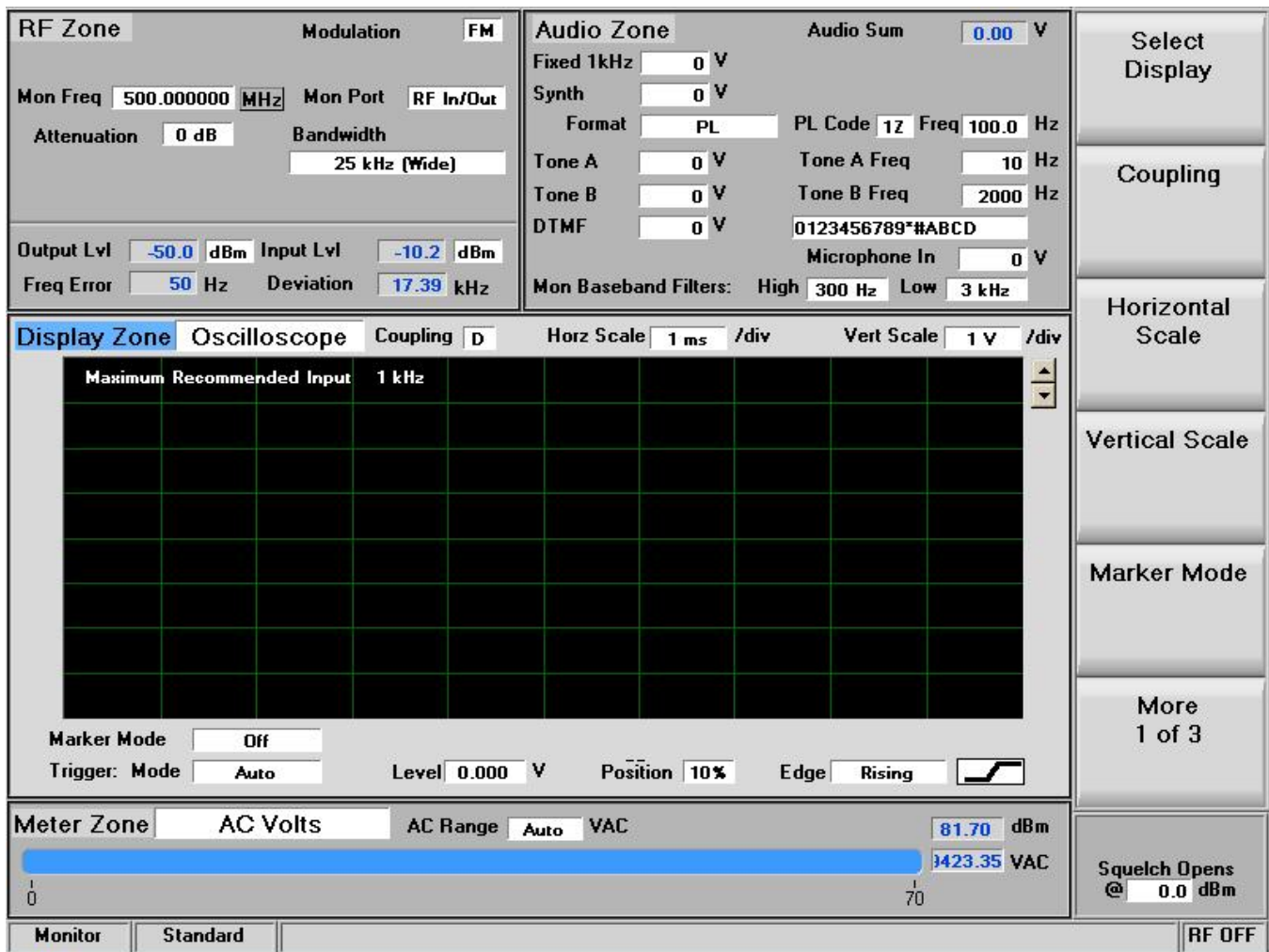
Figure 3.2.5.3-1   Display Zone submenu for the Oscilloscope

Coupling

Selects the input coupling for the external signal applied to the Meter In port with a user entry window. Choose DC or AC coupling by pressing the Coupling soft key, the Up/Down (▲▼) keys, or rotating the Tuning Knob.

Vertical Scale

Selects the vertical scale resolution for the display's major grid lines with a user entry window. The available selections range from 10 mV/div to 25 V/div and can be changed by pressing the Vertical Scale soft key, the Up/Down cursor keys, or rotating the Tuning Knob.

Horizontal Scale

Selects the horizontal time scale resolution for the display's major grid lines in a dialog entry box using the Up/Down (▲▼) keys or tuning knob. The units range from 20 uS/div to 1 sec/div.

Note: Digital oscilloscopes are susceptible to aliasing which can cause inaccurate signal reconstruction. The Maximum Recommended Input frequency for each horizontal scale setting is shown in the display area. For best results follow the guidelines shown in the table below:

Horizontal Scale	Maximum Signal Frequency	Maximum Recommended Signal Frequency
20 us	50000 Hz	50000 Hz
50 us	50000 Hz	20000 Hz
100 us	50000 Hz	10000 Hz
200 us	25000 Hz	5000 Hz
500 us	10000 Hz	2000 Hz
1 ms	5000 Hz	1000 Hz
2 ms	2500 Hz	500 Hz
5 ms	1000 Hz	200 Hz
10 ms	500 Hz	100 Hz
20 ms	250 Hz	50 Hz
50 ms	100 Hz	20 Hz
100 ms	50 Hz	10 Hz
200 ms	25 Hz	5 Hz
500 ms	10 Hz	2 Hz
1 s	5 Hz	1 Hz

Marker Mode

Provides display marker control with a horizontal soft key menu. Markers can be turned off or on with a choice of numeric readout for the signal measurements as follows:

Delta V – The numeric reading shows the difference in amplitude between marker positions.

Delta T – The numeric reading shows the difference in time between marker positions.

1/DeltaT – The numeric reading shows the inverse of the time difference between markers which can be used to determine the frequency of a repetitive waveform.

Absolute – The numeric reading shows the absolute amplitude at the marker position

Toggle Marker

Cycles through and highlights the available markers to select the active one for positional adjustment on the display. The active marker is moved with the Left/Right (◄►) keys

Trigger Mode

Submenu selections for the horizontal sweep trigger mode. The choices are as follows:

Auto – If a signal satisfying the Trigger Edge and Trigger Level settings is present the display will sweep as in Normal mode. If no signal satisfying the Trigger Edge and Trigger Level settings is present then the display sweeps continuously until a signal satisfying the settings is acquired.

Normal – The display sweeps only when the input signal satisfies the Trigger Edge and Trigger Level settings.

Single – The display sweeps once after a key press is performed on the Single soft key.

Freeze – The display sweeps stop, allowing further analysis of the captured input signal.

Trigger Level

Adjusts the signal threshold at which a horizontal sweep is initiated. The soft key activates a numeric entry box and the Left/Right (◄►) keys move the highlight over the desired number field. Numeric changes are entered directly with the keypad, or in steps using the Up/Down (▲▼) keys or Tuning Knob.

Trigger Position

Submenu selections for the amount of pre-trigger waveform displayed on the screen. The choices are 10%, 50%, or 90% of the display allocated to the waveform preceding the trigger threshold.

Trigger Edge

Submenu for choosing which waveform edge triggers the modulation scope sweep. The selections are Rising, Falling, or Either.

Vertical Position

Adjusts the vertical position of the waveform on the display using a horizontal submenu. Pressing the Move Up and Move Down soft keys shifts the waveform position by fixed increments.

3.2.5.4   Settings for the Bar Graphs

The R8000 Bar Graph display provides a simultaneous analog and digital readout of critical signal characteristics. The analog display facilitates real time tuning adjustments of 2-way radios while the digital reading provides precision in the measured result. Access the Bar Graphs using the Select Display soft key to bring up the horizontal submenu display choices. Three bar graphs are displayed for the received carrier while in Monitor mode (see Figure 3.2.5.4-1):

Monitor Deviation – *Displays the FM deviation of a modulated carrier in kHz.*

Frequency Error – *Shows the frequency difference (error) between the input carrier and programmed frequency of the R8000.*

Input Level – *Displays the RF input level of the carrier. Indicated units are Volts, Watts or dBm as set with "Input Level Units" soft key in the RF Zone.*
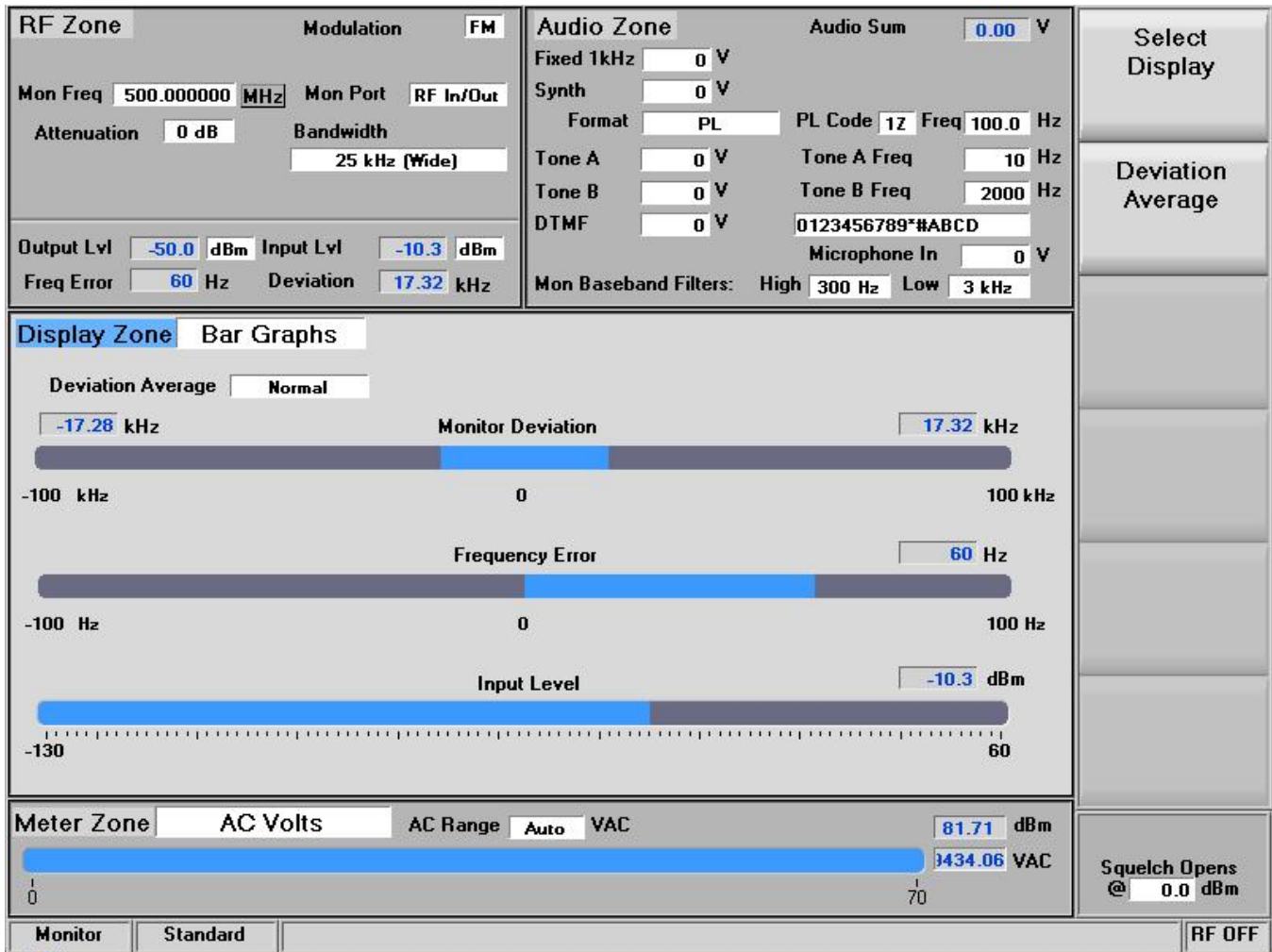
Figure 3.2.5.4-1   Bar Graphs screen in Display Zone

The Bar Graph display response can be adjusted using horizontal submenu selections activated with the Deviation Average soft key on the vertical menu. The Deviation Average settings are:

Normal – *No smoothing is engaged, which provides the quickest measurement response.*

Peak Average – *The deviation peaks are averaged over a time window which smoothes the reading but slows the response.*

RMS Average – The deviation peaks are processed with an RMS converter. Narrow deviation spikes and noise are significantly reduced while providing a speed of response similar to the normal mode. Calibration is only valid for repetitive sine wave modulation.

3.2.6   Meter Zone

The R8000 has several metering functions consisting of general purpose and specialized instruments providing detailed analysis of the recovered baseband content from RF signals. They are accessed from the main menu with the Meter Zone soft key and displayed in a dedicated area on the main screen below the Display Zone – see Figure 3.2.6-1 which shows the RF Scan meter.
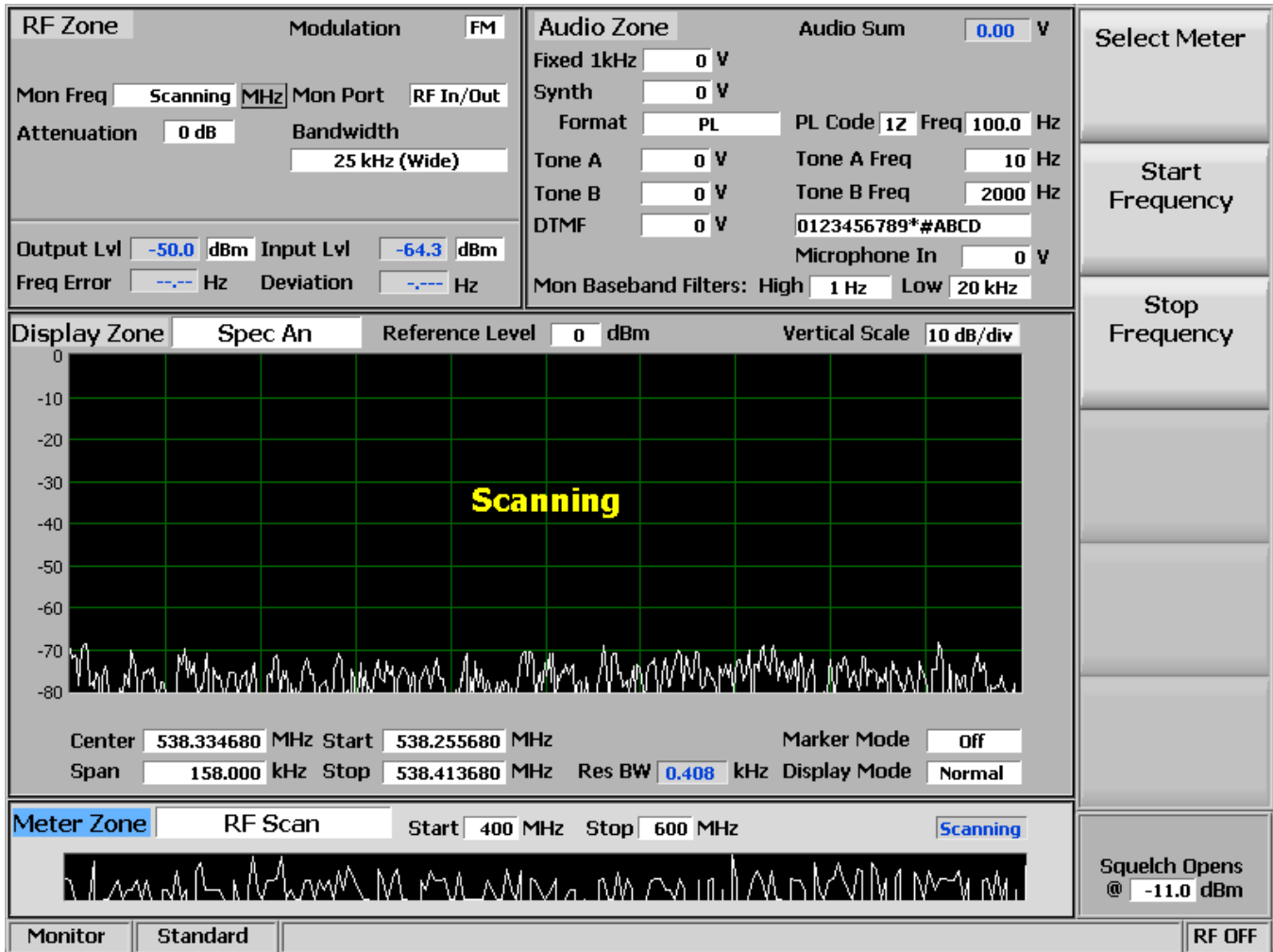
Figure 3.2.6-1   Meter Zone submenu showing RF Scan meter

Pressing the Select Meter soft key displays the available metering functions on a horizontal submenu (see Figure 3.2.6-2). They include RF Scan, AC Volts, DC Volts, Internal Distortion, SINAD, PL/Period Counter, DPL Decode, DTMF Decode, 2-Tone Decode, 5/6 Tone Decode, Frequency Counter, and a Power Meter.

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Figure 3.2.6-2   Meter Zone submenu after Select Meter soft key press

RF Scan

*Searches for the strongest RF signal on the selected RF input port that is above the Squelch Opens @ setting. The R8000 locks onto and automatically centers its operating frequency on this carrier (Figure 3.2.6-3).   The search frequency range is entered using Start Frequency and Stop Frequency soft keys (Figure 3.2.6-1). The meter graph displays an automatically-scaled spectrum of the entire scan range. Once a signal is acquired the RF Scan meter stays locked on that frequency while the carrier is present. It resumes scanning once the carrier disappears. The RF Scan meter operates only when it is highlighted; otherwise it becomes inactive. **Note:** To maintain frequency lock for further analysis exit the RF Scan meter while the carrier is present.*
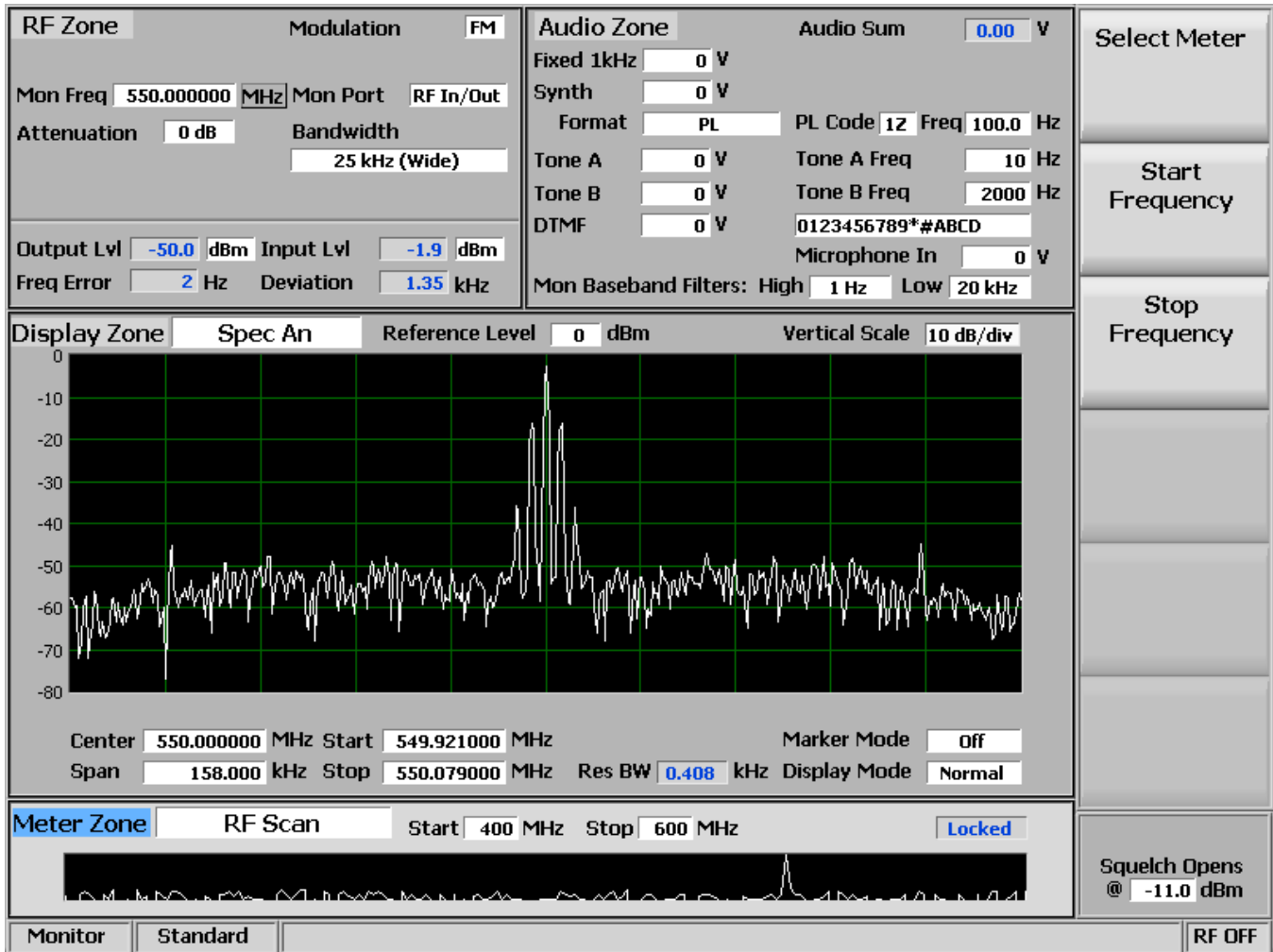
Figure 3.2.6-3   RF Scan display

AC Volts

Measures AC voltage applied to the Meter In port with selections for the full scale AC Range via a horizontal submenu (Figure 3.2.6-4). Choices include Auto (auto-ranging), 1 Volt, 10 Volts, and 70 Volts RMS.
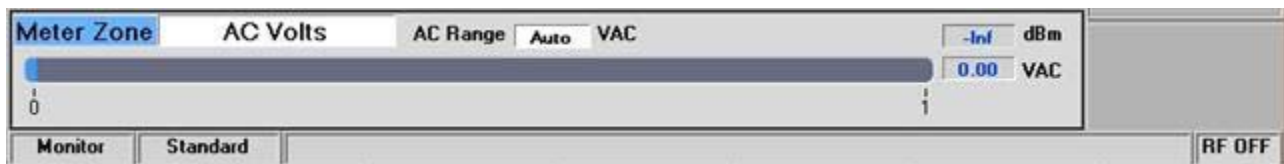
Figure 3.2.6-4   AC Volts display

DC Volts

Measures DC voltage applied to the Meter In port with selections for the full scale range via a horizontal submenu (Figure 3.2.6-5). Choices include Auto (auto-ranging), 1 Volt, 10 Volts, 100 Volts and the Battery voltage if that option is installed.
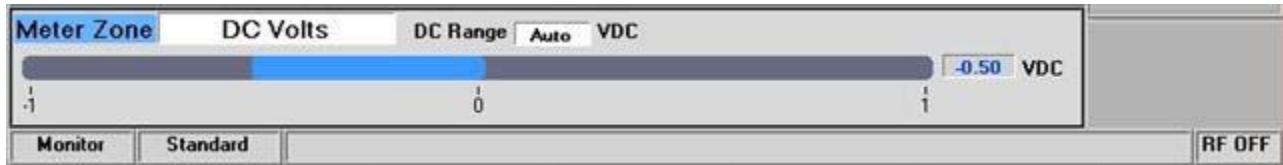
Figure 3.2.6-5   DC Volts display

Internal Distortion

Measures the distortion in percent of the recovered audio from a received RF carrier when the R8000 is in Monitor mode (Figure 3.2.6-6).

Figure 3.2.6-6   Internal Distortion display

External Distortion

Measures the distortion in percent of the audio signal applied to the Meter In port (Figure 3.2.6-7).

Figure 3.2.6-7   External Distortion display

SINAD

Provides a Signal in Noise and Distortion measurement of the recovered audio from a radio under test when a 1 kHz modulated RF carrier is applied to a radio's antenna port by the R8000 (Figure 3.2.6-8). The RF level is adjusted in the RF Zone while monitoring the SINAD meter to determine the receiver sensitivity per EIA and other standards. See 5.2.3 SINAD Measurement.

Figure 3.2.6-8   SINAD display

PL/Period Counter

Displays the frequency and numeric code of the recovered audio from a radio modulated using the Motorola Private-Line (PL) format (Figure 3.2.6-9). The period counter also allows rapid high resolution measurements of non-PL low frequency modulation without the long gate times associated with frequency counting. A vertical submenu permits adjustment of the meter Sensitivity and the Low and High Pass filters to reduce noise for more accurate measurements.

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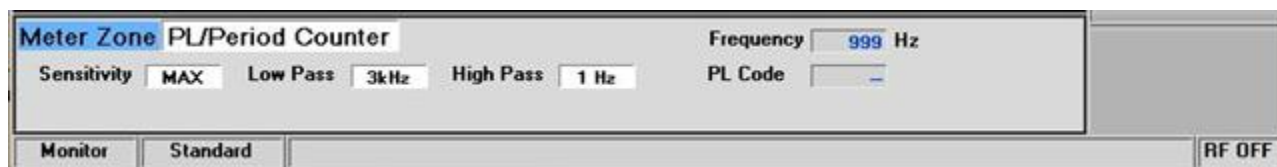
Figure 3.2.6-9   PL/Period Counter screen

DPL Decode

Provides a numeric code readout from the recovered audio of a radio modulated using Motorola Digital Private-Line (DPL) format (Figure 3.2.6-10). A vertical submenu permits adjustment of the meter Sensitivity and the Low and High Pass filters to reduce noise for more accurate measurements.

Figure 3.2.6-10   DPL Decode screen

DTMF Decode

Provides a means of decoding DTMF (Dual Tone Multi Frequency) signals used in testing telephone interfaced systems (Figure 3.2.6-11). A vertical submenu permits adjustment of the meter Sensitivity and the Low and High Pass filters to reduce noise for more accurate measurements.

Figure 3.2.6-11   DTMF Decode screen

2-Tone Decode

Provides a means of decoding the two-tone sequential paging format. The meter displays the Tone A/Tone B (Tone 1 and Tone 2) frequencies and durations (Figure 3.2.6-12). A vertical submenu permits adjustment of the meter Sensitivity and the Low and High Pass filters to reduce noise for more accurate measurements.
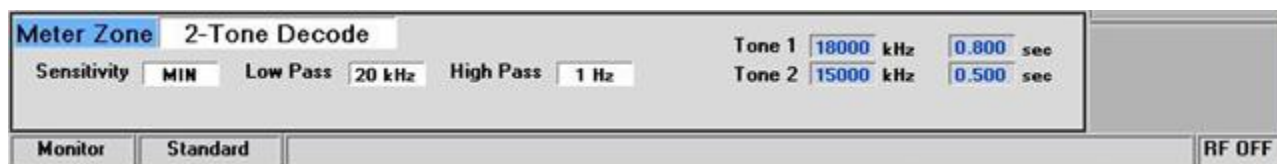
Figure 3.2.6-12   2-Tone Decode screen

5/6 Tone Decode

Provides a means of decoding the 5/6 tone sequential paging format (Figure 3.2.6-13). The meter displays a table with the decoded cap code along with the individual tone frequencies and durations. A

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vertical submenu allows selection of the meter sensitivity from MIN to MAX via the Tuning knob, Up/Down (▲▼) keys, or repeated presses of the Sensitivity soft key. The vertical submenu also has selections for the Low and High Pass baseband filters which are displayed on a horizontal submenu after the specific key press.
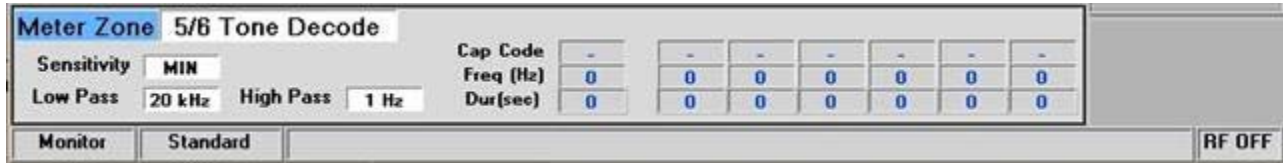
Figure 3.2.6-13   5/6-Tone Decode screen

Frequency Counter

In Monitor mode this soft key enables a general purpose frequency counter for the recovered baseband audio or IF frequency displayed in the modulation scope (Figure 3.2.6-14). In Generator mode the counter measures the frequency of the internal or external modulation applied to the RF carrier. In External Scope mode the counter measures the frequency of signals applied to the Meter In port.

The Resolution soft key activates a horizontal submenu with selections for the counter resolution. The choices include Auto (auto-ranging), 0.1 Hz, 1.0 Hz, and 10 Hz resolution.
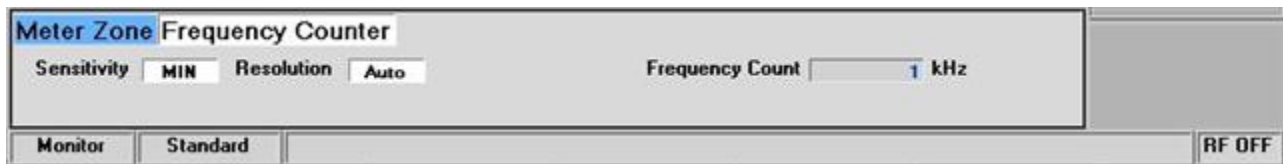
Figure 3.2.6-14   Frequency Counter screen

Power Meter

Provides a bar graph display and numeric readout in dBm of the broadband input power applied to the RF/IO port (Figure 3.2.6-15).

Figure 3.2.6-15   Frequency Counter screen

3.2.7   Instrument Mode with full screen displays

In the Instrument mode several of the measurement functions on the R8000 are available in a dedicated full screen display. This makes it easier to view smaller waveform details and provide more numeric fields with instrument specific data. Figure 3.2.7-1 shows the submenu after pressing the Instrument navigation button. The vertical soft key submenu lists the instruments available in a full screen display. While the Spectrum Analyzer, Modulation Scope, and Oscilloscope displays are available elsewhere on the R8000, the size is limited in those areas since they are shared with other measuring functions The optional Dual Display, Tracking Generator, and Cable Fault Locator functions are full screen

instruments and only available in Instrument mode. For convenience the other meters on the R8000 such as RF Scan, AC Volts, etc can also be directly accessed in Instrument mode.
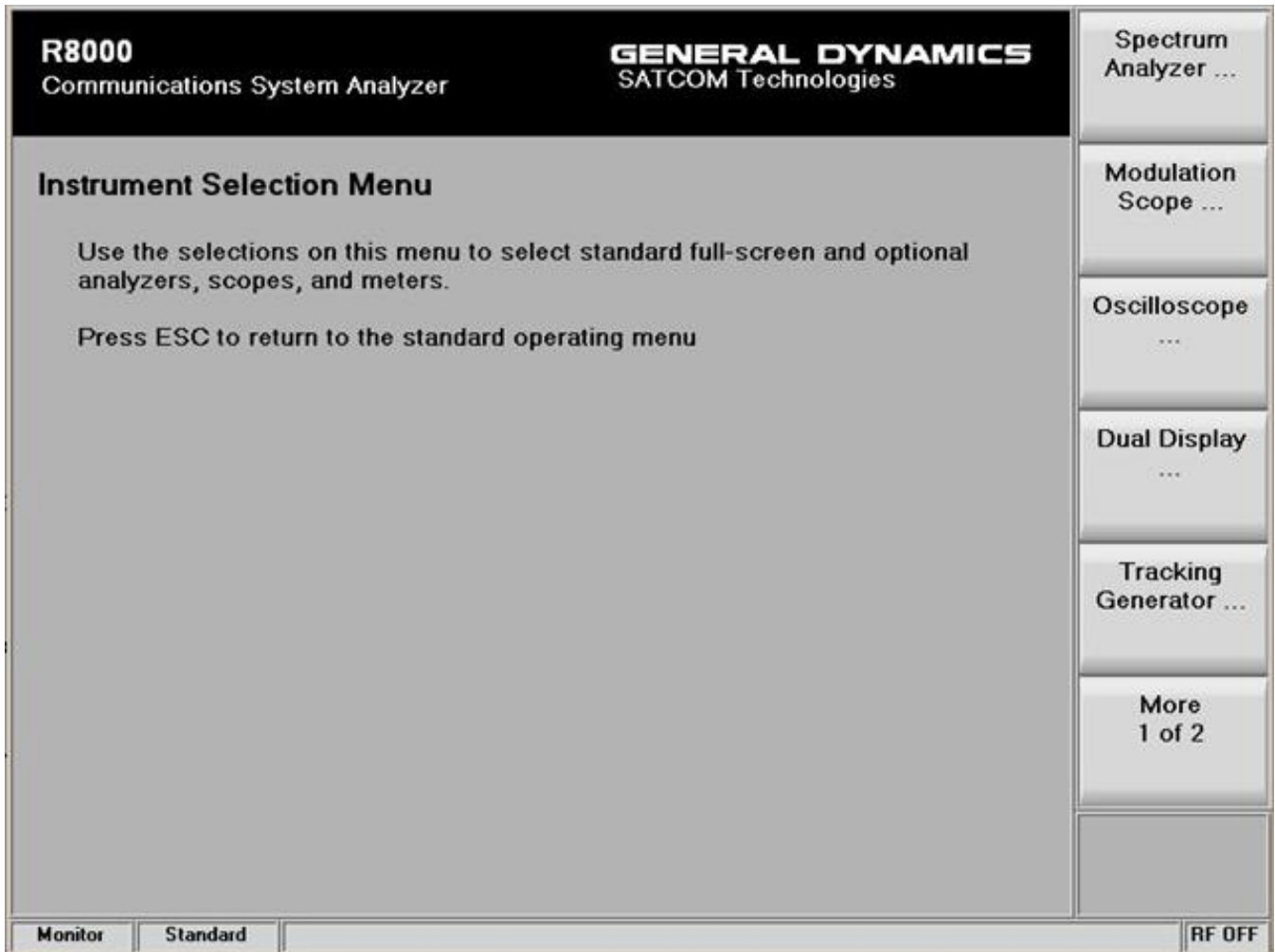
Figure 3.2.7-1   Submenu after pressing Instrument navigation key

The submenus, control, and settings for the full screen instruments duplicate those of the limited screen versions in the Display Zone. Where applicable, additional soft keys appear to exploit the extra display area of the Instrument mode. As an example, 4 markers and associated data can be displayed in the Spectrum Analyzer Instrument mode as shown in Figure 3.2.7-2.
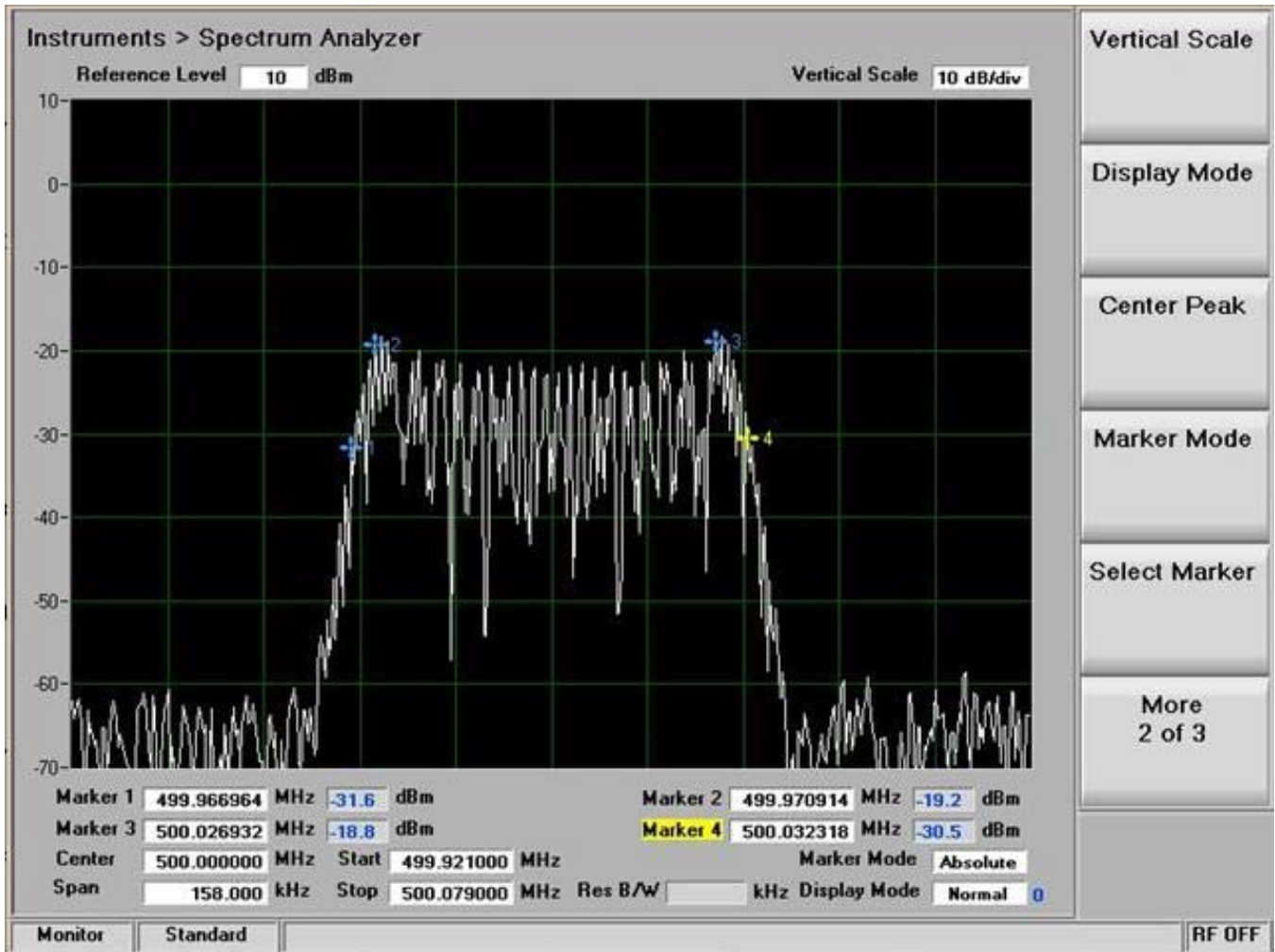
Figure 3.2.7-2   Submenu in Spectrum Analyzer Instrument mode

3.2.7.1   Dual Display mode

The optional Dual Display mode provides a convenient one screen presentation of two analyzer functions that have a graphical display output and are often used together, the Spectrum Analyzer and Modulation scope.   This permits a user to control and simultaneously view the results from both measurement functions. Figure 3.2.7.1-1 shows the R8000 screen after pressing the Dual Display soft key.

Select Instrument

Spectrum Analyzer

Reference Level -10 dBm -10
Vertical Scale 10 dB/div -20
Center Freq 500.000000 MHz -30
Span 158.000 kHz -40
Start Freq 499.921000 MHz -50
Stop Freq 500.079000 MHz -60
Res B/W kHz -70
Display Mode Normal 0 -80
Marker Mode Off -90

Vertical Scale

Horizontal Scale

Marker Mode

Modulation Scope

Vertical Scale 5 kHz /div
Horizontal Scale 1 ms /div
Trigger Mode Auto
Trigger Level 100 kHz

Trigger Edge Rising Edge

Marker Mode Off

Toggle Marker

More 1 of 2

Monitor Standard RF OFF

Figure 3.2.7.1-1   Dual Display mode

In Dual Display mode the submenus, control, and parameter entry are unchanged from the full screen versions of the Spectrum Analyzer and Modulation Scope.

3.2.7.2   Tracking Generator mode

The optional Tracking Generator function sets up the R8000 RF generator in a sweeping mode for simultaneous use with the spectrum analyzer display. This provides a valuable capability for measuring and servicing a wide variety of RF filtering and combining networks. Pressing the Tracking Generator key provides the full screen display shown in Figure 3.2.7.2-1. *Note: Enabling the Tracking Generator suspends the Standard Zone operation of the R8000 (i.e., RF Zone, AUDIO Zone, etc), and special test modes like MOTOTRBO. To restore Standard Zone operation press the appropriate mode key such as Monitor, Generate, Duplex, etc.*
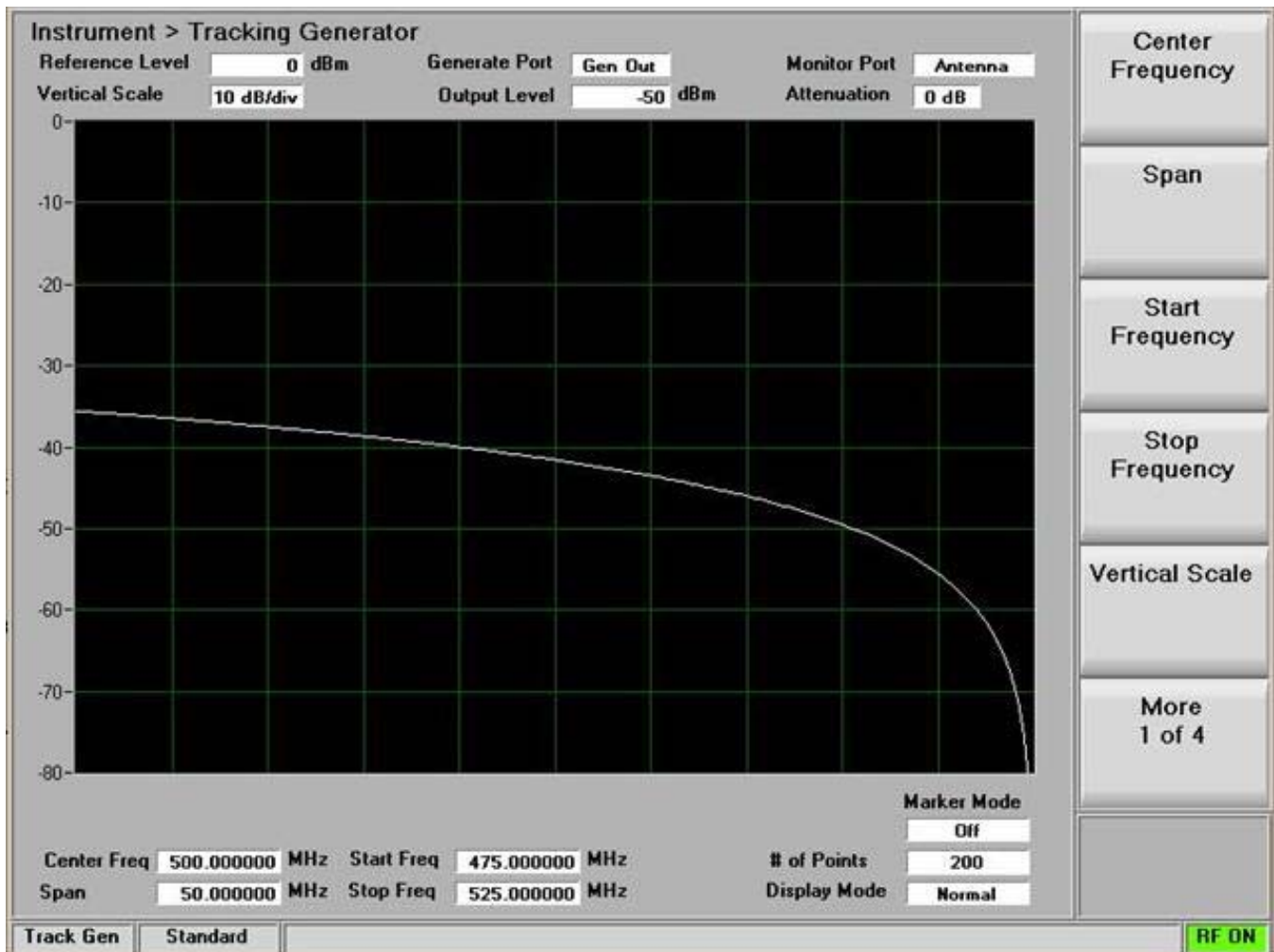
Figure 3.2.7.2-1   Tracking Generator mode

The Tracking Generator settings are similar to those used when operating the RF Generator and Spectrum Analyzer independently. An exception is the frequency setting which is common to both, since the Spectrum analyzer is lock stepped to and tracks the swept RF Generator.

Center Frequency

Sets the tracking generator center frequency from 250 kHz to 3 GHz in a data entry window using the arrow keys, keypad, or tuning knob. Pressing Enter completes the change and Esc cancels the entry.

Span

Sets the total frequency window for tracking generator operation in MHz. The Span entry total is automatically split on each side of the current center frequency.

Start Frequency

Sets the tracking generator start frequency in MHz. Use with the Stop Frequency to establish a desired frequency range for tracking generator operation. The R8000 automatically centers the frequency display midway between Start and Stop frequencies.

Stop Frequency

Sets the tracking generator stop frequency in MHz. Use with the Start Frequency to establish a desired frequency range for tracking generator operation. The R8000 automatically centers the frequency display midway between Start and Stop frequencies.

Reference Level

Adjusts the maximum level (top line) for the vertical scale of the Spectrum Analyzer in Tracking Generator mode from -120 dBm to + 60 dBm in 1 dB increments.

Vertical Scale

Selects the vertical scale resolution for the display's major grid lines from 1 dB/div to 10 dB/div via a horizontal soft key menu.

of Points

Adjusts the number of data points acquired and displayed. Higher settings increase the trace resolution for viewing signal detail but also slow the update rate.

Display Mode

Selects the display presentation using a horizontal menu with the following choices:

<u>Normal</u> – The display updates continuously.

*<u>Freeze</u> – Provides a snapshot of the current display indication and stops additional updates. **Note:** In Freeze mode the R8000 reacquires data and updates the display whenever "Center Marker" or "Center Peak" is pressed.*

<u>Max Hold</u> – The display retains the highest peak signal amplitudes measured during successive sweeps.

<u>Average</u> – The displayed signal amplitudes are a rolling average of the peak amplitudes measured on each successive sweep. The default setting is 5 averages.

Marker Mode

Provides display marker control via a horizontal soft key menu. Markers can be turned off or on with a choice of numeric readout for the signal measurements.

<u>Absolute</u> – Displays the frequency and absolute signal amplitude for each marker selected (total of 4).

<u>Delta</u> – Displays the frequency and amplitude difference between each pair of markers selected (1-2 & 3-4).

Select Marker

Selects 1 of 4 available markers on a horizontal submenu for position adjustment on the display.

Set Marker Frequency

Directly sets the frequency of the selected marker in MHz via a data entry window.

Center Marker

Centers the operating frequency and display of the R8000 Spectrum Analyzer around the frequency of the active marker.

Find Peak

Moves the cursor to the highest signal reading in the display window and provides a numeric readout of the amplitude and frequency

Find Valley

Moves the cursor to the lowest signal reading in the display window and provides a numeric readout of the amplitude and frequency

3 dB Marker

Frequency - Places a marker above and below center frequency where the signal is -3 dB below the peak amplitude measured at center frequency. The upper and lower frequencies are shown on the display.

Delta - Places a marker above and below center frequency where the signal is -3 dB below the peak amplitude measured at center frequency. The difference between these two frequencies is shown on the display.

Output Level

Adjusts the RF level of the tracking generator output at the selected output port. From -95 dBm to 5 dBm on the RF Gen Out port and -130 dBm to -30 dBm on the RF In/Out port.

Attenuation

Adjusts the Monitor Port RF input signal attenuation in 2 dB steps from 0 to 62 dB. Select in a windowed table using the Up/Down (▲▼) keys or tuning knob.

Pre-Amplifier

Enables a supplementary input amplifier that extends the sensitivity of the RF Monitor by improving the S/N ratio for low signal levels. **Note:** To avoid input overload and erroneous readings use the pre-amplifier only under the following conditions:

Input Port	Maximum input level for using pre-amplifier

Antenna	*(Input signal in dBm – Attenuator setting) is equal or less than -40 dBm*
RF In/Out	*(Input signal in dBm – Attenuator setting) is equal or less than -10 dBm*

Gen Port

Selects the active port (RF In/Out or Gen Out) for the swept R8000 tracking generator output in a selection table using the Up/Down (▲▼) keys or tuning knob.

Monitor Port

Selects the port monitored by the Spectrum Analyzer as either the ANTENNA or the RF In/Out front panel connector. Choose in a windowed table using the Up/Down (▲▼) keys or tuning knob.

3.2.7.3   Cable Fault Locator mode

The optional Cable Fault Locator mode uses the R8000 Tracking Generator along with FFT analysis to determine distance to a fault or termination mismatch in RF cables. Pressing the Cable Fault Locator soft key provides the full screen display shown in Figure 3.2.7.3-1. The Cable Fault Locator is used with an optional directional coupler or splitter. *Note: Enabling the Cable Fault Locator mode suspends the Standard Zone operation of the R8000 (i.e., RF Zone, AUDIO Zone, etc), and special test modes like MOTOTRBO. To restore Standard Zone operation press an associated mode key such as Monitor, Generate, Duplex, etc.*
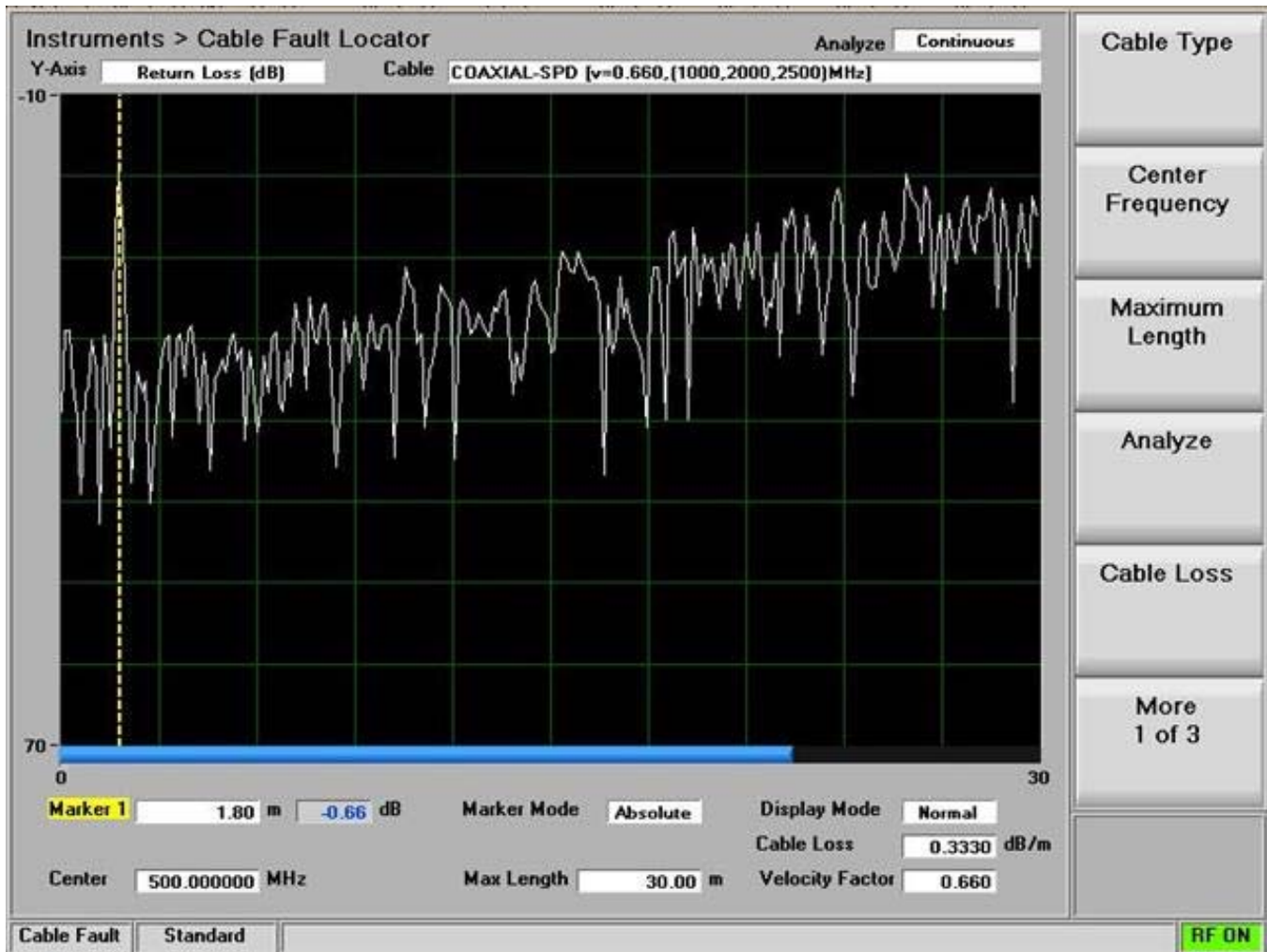
Figure 3.2.7.3-1   Cable Fault Locator mode

The Cable Fault Locator has settings for entering cable parameters and display specifics.   Several standard cable selections provide predetermined settings.   A user can also enter specific data for a cable under test and save these settings for future use. See 5.3   Cable Fault Testing

Cable Type

Choose from factory provided or user saved cable selections.   This automatically populates the Cable Loss and Velocity Factor.   If No Selection is chosen the user should enter the specific data for the cable under test.

Center Frequency

Sets the Cable Fault Locator center frequency from 250 kHz to 1 GHz in a data entry window using the arrow keys, keypad, or tuning knob.   Pressing Enter completes the change and Esc cancels the entry.

Maximum Length

Sets the maximum cable length in a data entry window so that the R8000 can optimize the RF parameters and FFT calculations. The entry units are determined by the setting in the Distance Units submenu.

Analyze

Determines the Cable Fault Locator operating mode with a horizontal soft key menu.

Off – The Cable Fault Locator is disabled to allow parameter entry.

Continuous – The display provides continuous measurement updates.

Single Sweep – The display provides one measurement update after a key press is performed on the Single Sweep soft key.

Calibrate – The Cable Fault Locator performs a calibration to nullify effects from the RF directional coupler/splitter.

Cable Loss

Shows the cable loss in dB per unit length at the Center Frequency for the selected Cable Type in a numeric entry window. Also allows a user to override that value or enter one for the specific cable under test. The entry units are determined by the setting in the Distance Units submenu.

Velocity Factor

Shows the velocity factor for the selected Cable Type in a numeric entry window. Also allows a user to override that value or enter one for the specific cable under test.

Display Mode

Selects the display presentation using a horizontal menu with the following choices:

Normal – The display updates continuously.

*Freeze – Provides a display snapshot of the first measurement sweep started by a Continuous or Single Sweep key press in the Analyze submenu, then stops additional display updates. If a measurement sweep is already in process during the key press, the display updates when complete, and then freezes. **Note:** Measurement sweeps completed and displayed before the Freeze key press are not frozen and will be overwritten by the first subsequent sweep.*

Max Hold – The display retains the highest peak signal amplitudes measured during successive sweeps.

Average – Displays a rolling average of the peak return loss amplitude measured on each successive sweep. The default setting is 5 averages.

Marker Mode

Provides display marker control via a horizontal soft key menu.

Off – *No markers are displayed*

Absolute – *Enables one marker with peak return loss and distance readings.*

Delta – *Enables a second marker with peak return loss and distance readings. The distance between the first and second marker is shown in the main display area.*

Toggle Marker

Cycles through and highlights the available markers to select the active one for positional adjustment on the display. The active marker is moved using the Left/Right (◄►) cursor control buttons.

Find Peak

Moves the cursor to the highest peak in the display window and provides a numeric readout of the distance and return loss.

Distance Units

Select units of distance for cable length in either meters or feet.

Add Cable Type

Allows custom entry of parameters for a user defined cable not on the standard selection list. The soft key activates a new submenu for entering a Cable Description and the associated cable specifications. These include the cable Velocity Factor along with the Nominal Attenuation Units for three frequency points.   Pressing the Next soft key advances the menu to each successive Frequency/Nominal Attenuation entry – see Figure 3.2.7.3-2 . The Back soft key returns to the previous entry menu.

Once the entries are completed for three frequency points, pressing the Save New Cable soft key loads the user defined cable into R8000 memory. The Return key brings the display back to the main Cable Fault Locator menu. The saved cable entry is now available on the Cable Type selection window.
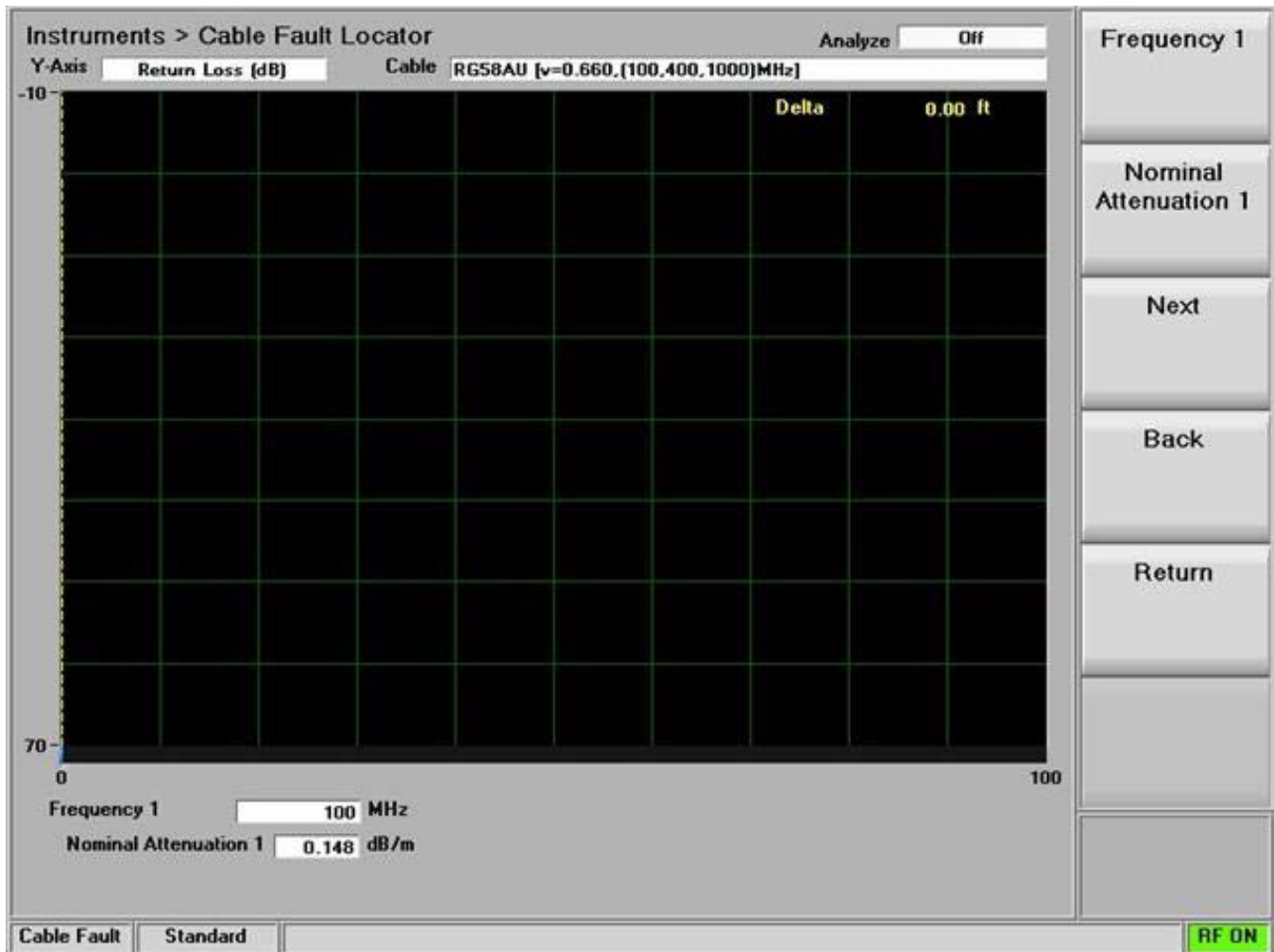
Figure 3.2.7.3-2   Frequency and Attenuation entries in the Add Cable Type submenu

Edit Cable

*Allows parameter changes for the currently selected cable type. **Note:** This function is not available for factory provided selections.*

Delete Cable

Removes the currently selected cable type from R8000 memory if it was stored as a user defined cable.

3.2.7.4   Other Meters

Pressing the "Other Meters" soft key provides a shortcut to the Meter Zone operation of the R8000. The screen displays the same horizontal menu of meter selections shown when the "Select Meter" soft key in the Meter Zone is pressed.

3.2.8   Test Mode

The R8000 Test Mode provides operator presets and dedicated modes for radio or protocol specific tests. The presets permit storage or recall of R8000 operational settings allowing an operator to quickly

recreate specific test conditions. In addition, dedicated test modes provide the ability to perform testing on various advanced transmission protocols. See 3.2.8.2   Test Mode submenu for the supported protocols. Figure 3.2.8-1 shows the submenu screen after pressing the dedicated Test navigation key.
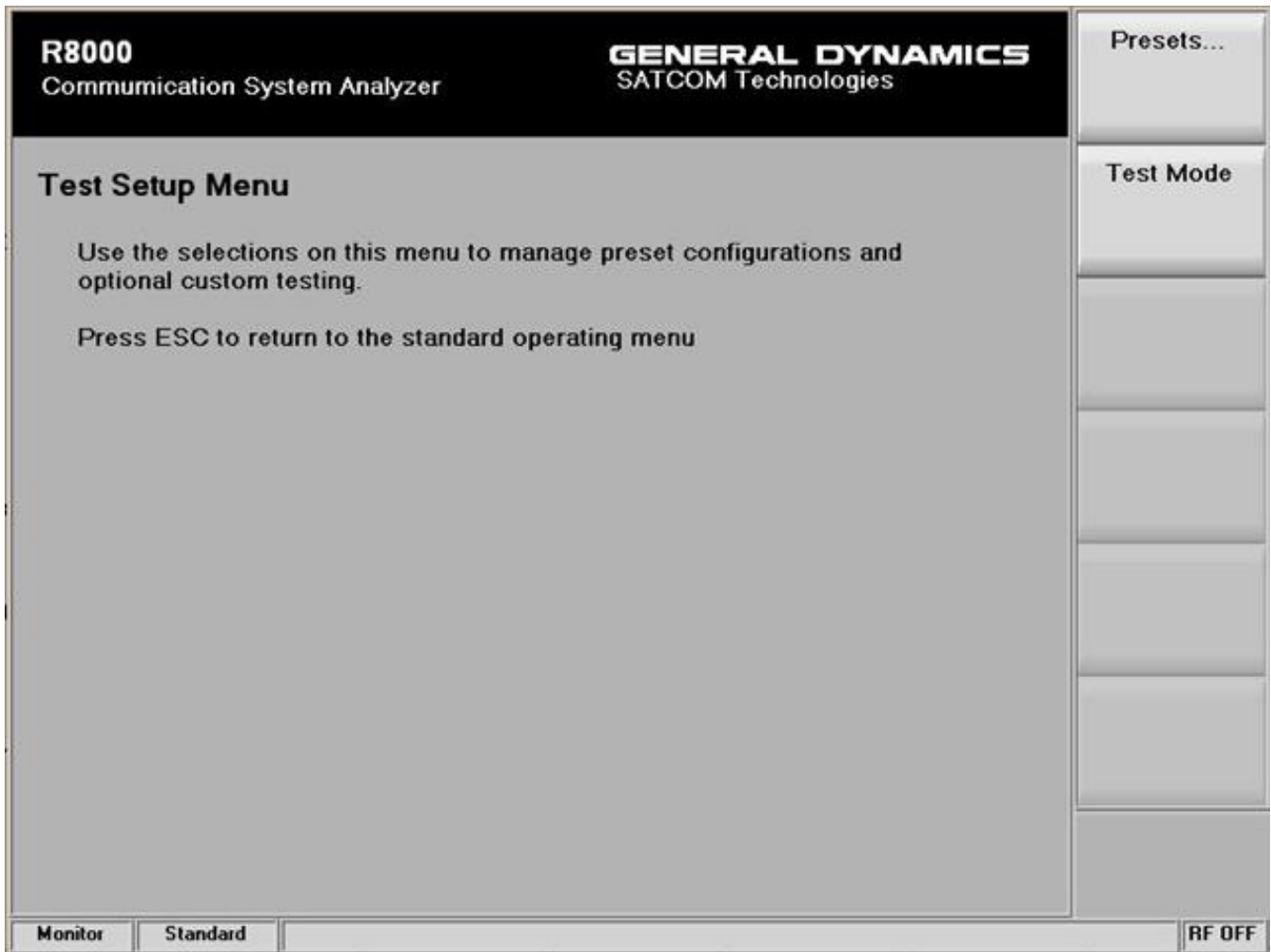
Figure 3.2.8-1   Submenu after pressing Test navigation key

3.2.8.1   Presets

Presets are a convenient tool for storing and recalling R8000 operational settings. They are especially useful when several unique operating configurations are required in a test environment. Presets ensure a fast and accurate method of configuring the analyzer for multiple test applications. To save time and avoid errors the R8000 can store over 100 preset operating configurations. Figure 3.2.8.1-1 shows the submenu after pressing the Presets soft key. If there are any Presets present they can be highlighted for further action by using the Up/Down keys (▲ ▼) or tuning knob. In Figure 3.2.8.1-1 the TEST1 Preset is highlighted (blue border).

3.2.8.1.1 Power Up configuration

If no presets are present the R8000 powers up in the default factory configuration. Otherwise the power up configuration becomes that of the last Preset loaded or saved before the unit was powered down.
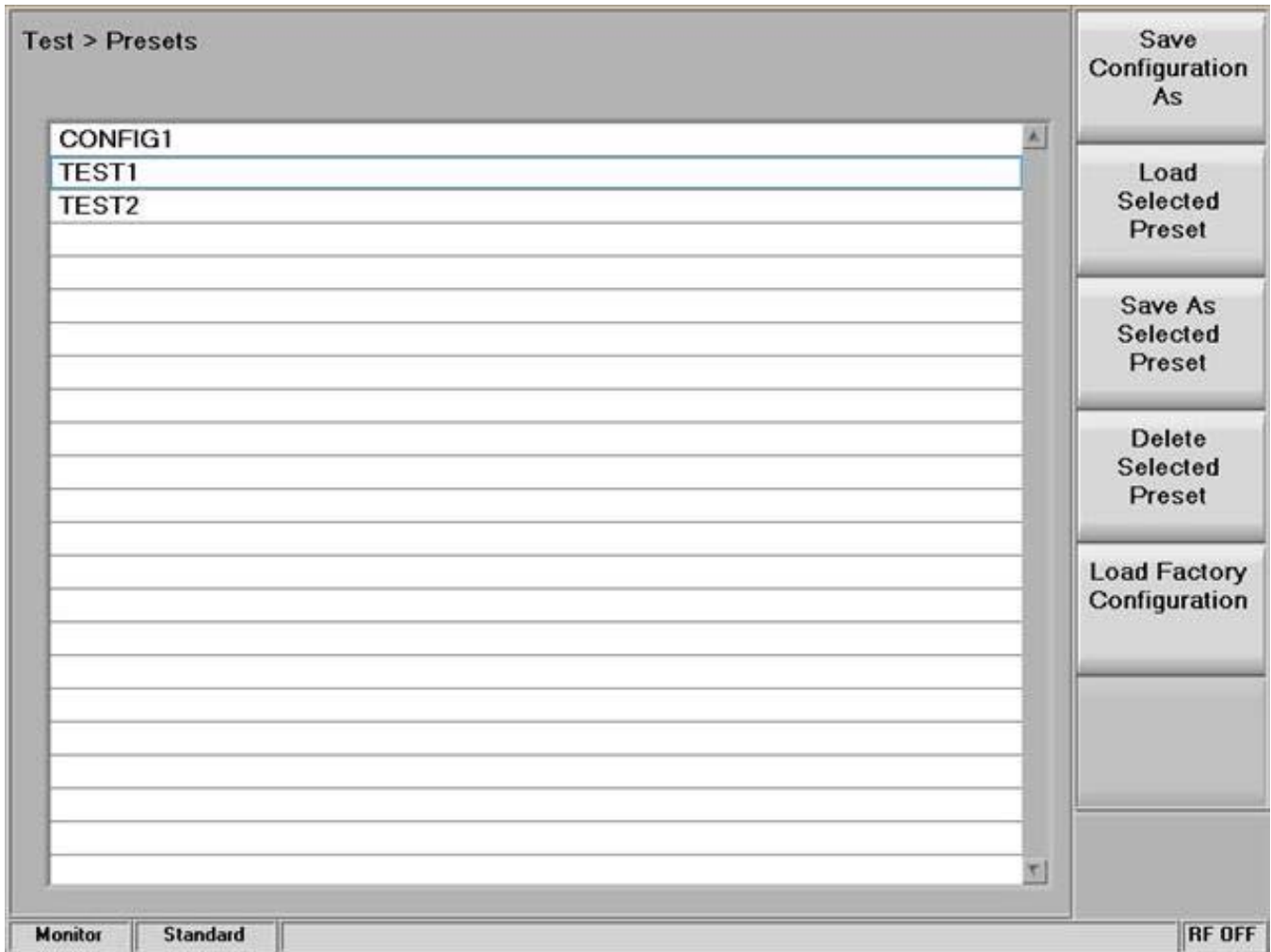
Figure 3.2.8.1-1   Submenu after pressing Presets soft key

Save Configuration As

This soft key saves the current R8000 operational settings into a memory Preset. Label the Preset in the data entry window using the Left/Right (◄►) keys and the numeric keypad as shown in Fig 3.2.8.1-2. You can cycle through the alphanumeric sequence marked on the keys with repeated keypad presses or by using the Up/Down keys (▲▼) and tuning knob. Names can't have spaces or blanks between characters. Pressing Enter adds the new Preset to the list while Esc cancels the entry.
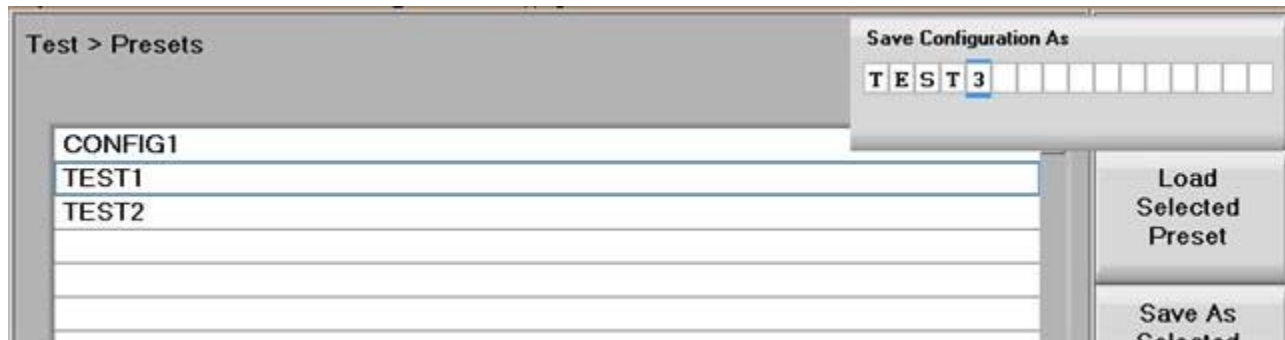
Figure 3.2.8.1-2   Data entry mode after pressing Save Configuration soft key

Load Selected Preset

*Pressing this soft key configures the R8000 to the settings saved under the highlighted Preset. Use the Up/Down keys (▲▼) or tuning knob to scroll through the available selections. **Note:** The selected Preset becomes the new default configuration on power up unless a different one is chosen or saved before powering down the analyzer.*

Save As Selected Preset

*Pressing this soft key saves the current R8000 operational settings to the highlighted Preset. Use the Up/Down keys (▲▼) or tuning knob to scroll through the available selections. Any existing operational settings under that Preset name are overwritten by the current R8000 settings. **Note:** The saved Preset becomes the new default configuration on power up unless a different one is chosen or saved before powering down the analyzer.*

Delete Selected Preset

Erases the highlighted Preset from the R8000 memory.

Load Factory Configuration

*Loads and configures the R8000 to the as shipped factory settings. **Note:** These become the default on power up unless a different Preset is loaded or saved before powering down the analyzer.*

3.2.8.2   Test Mode submenu

The Test Mode soft key displays the available transmission protocol or radio specific test modes on a horizontal submenu as shown in Figure 3.2.8.2-1. The R8000's current operating mode (e.g. Standard) is always shown at the bottom of the screen between the operational mode and the message bar. It is also shown by the horizontal soft key highlighted in blue, and the other available test modes are displayed. Motorola MOTOTRBO along with Project 25 are the initial test mode options for the R8000, with others under development as firmware upgrades.
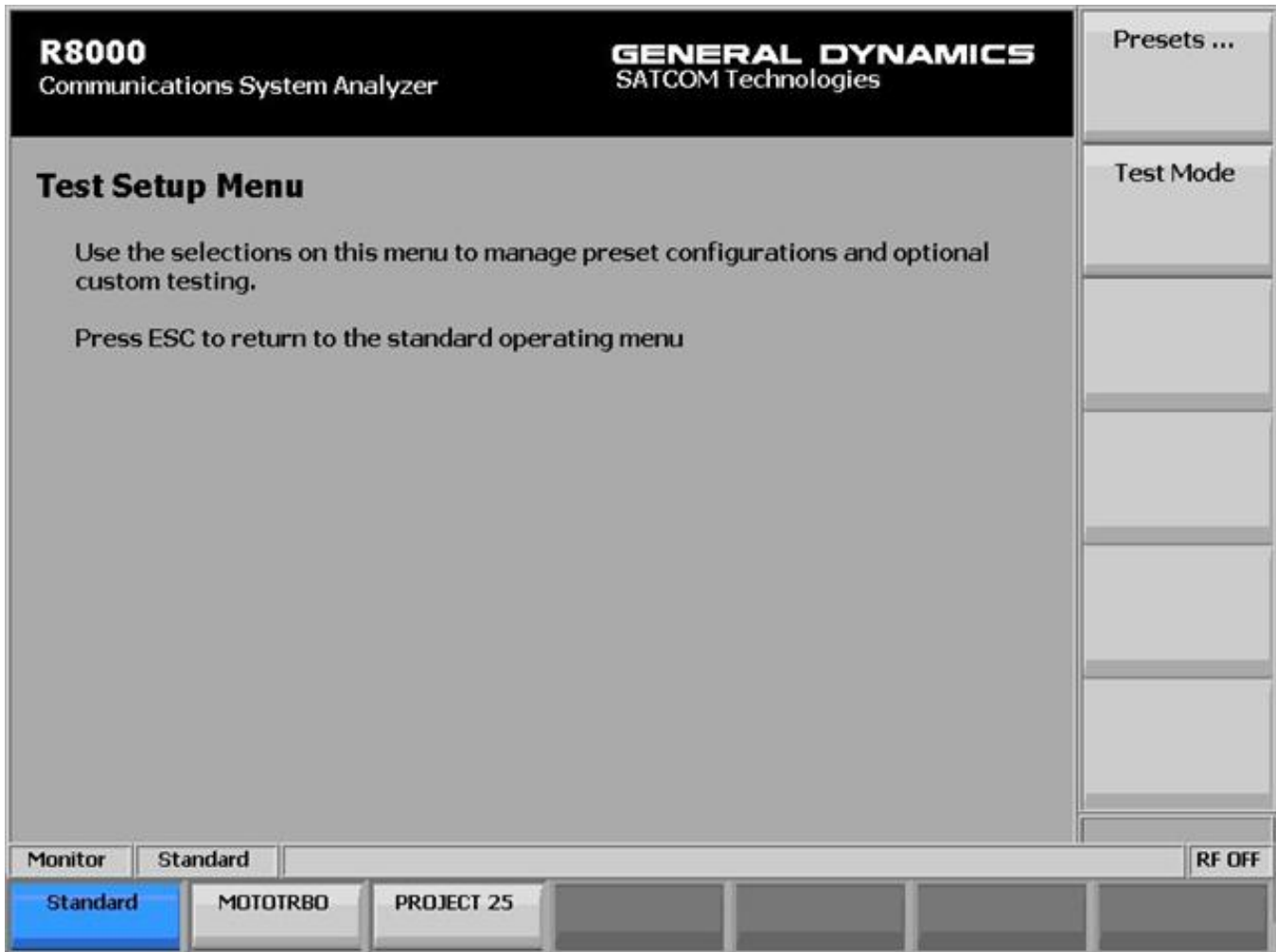
Figure 3.2.8.2-1   Test mode submenu

3.2.8.3   MOTOTRBO test mode

The MOTOTRBO option of the R8000 is used in conjunction with Motorola MOTOTRBO Radio Tuner software. The Tuner software places the radio in specific test modes, while the role of the R8000 service monitor is to transmit and receive test patterns compliant to the DMR (Digital Mobile Radio) physical layer.

Pressing the MOTOTRBO soft key initiates the Motorola MOTOTRBO test mode. The R8000 switches to the main display and a MOTOTRBO soft key replaces the Standard mode's AUDIO ZONE soft key – see Figure 3.2.8.3-1. In addition, the Audio Zone area on the main screen is replaced with MOTOTRBO specific content, and a Constellation display is shown in Meter Zone. Figure 3.2.8.3-2 shows the submenu after pressing the MOTOTRBO soft key in the R8000 main screen while in Monitor mode.
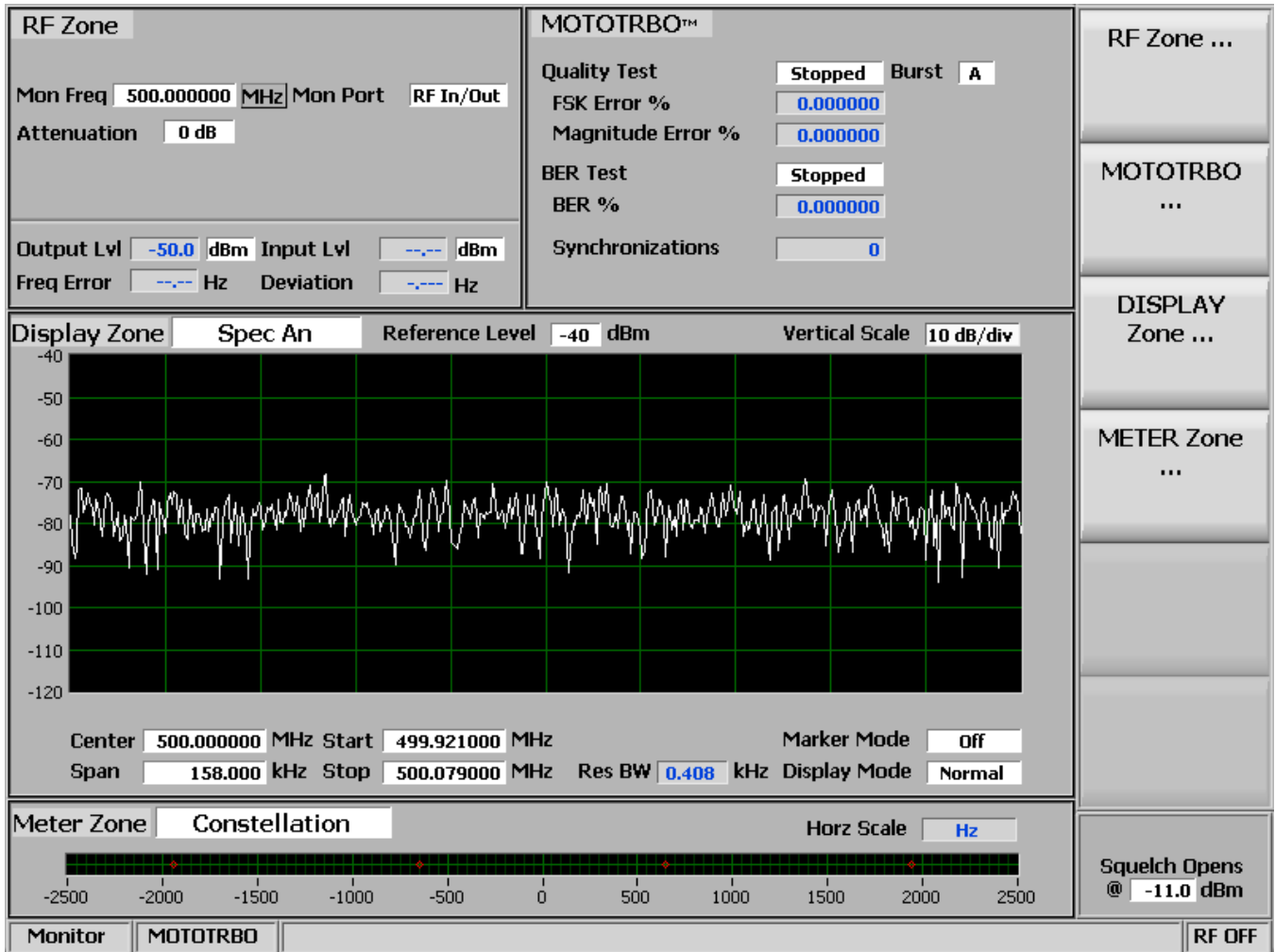
Figure 3.2.8.3-1   R8000 Monitor main screen after pressing MOTOTRBO Test Mode soft key

3.2.8.3.1 MOTOTRBO transmitter tests

These tests are performed with the R8000 in Monitor mode – see Figure 3.2.8.3.1-1.
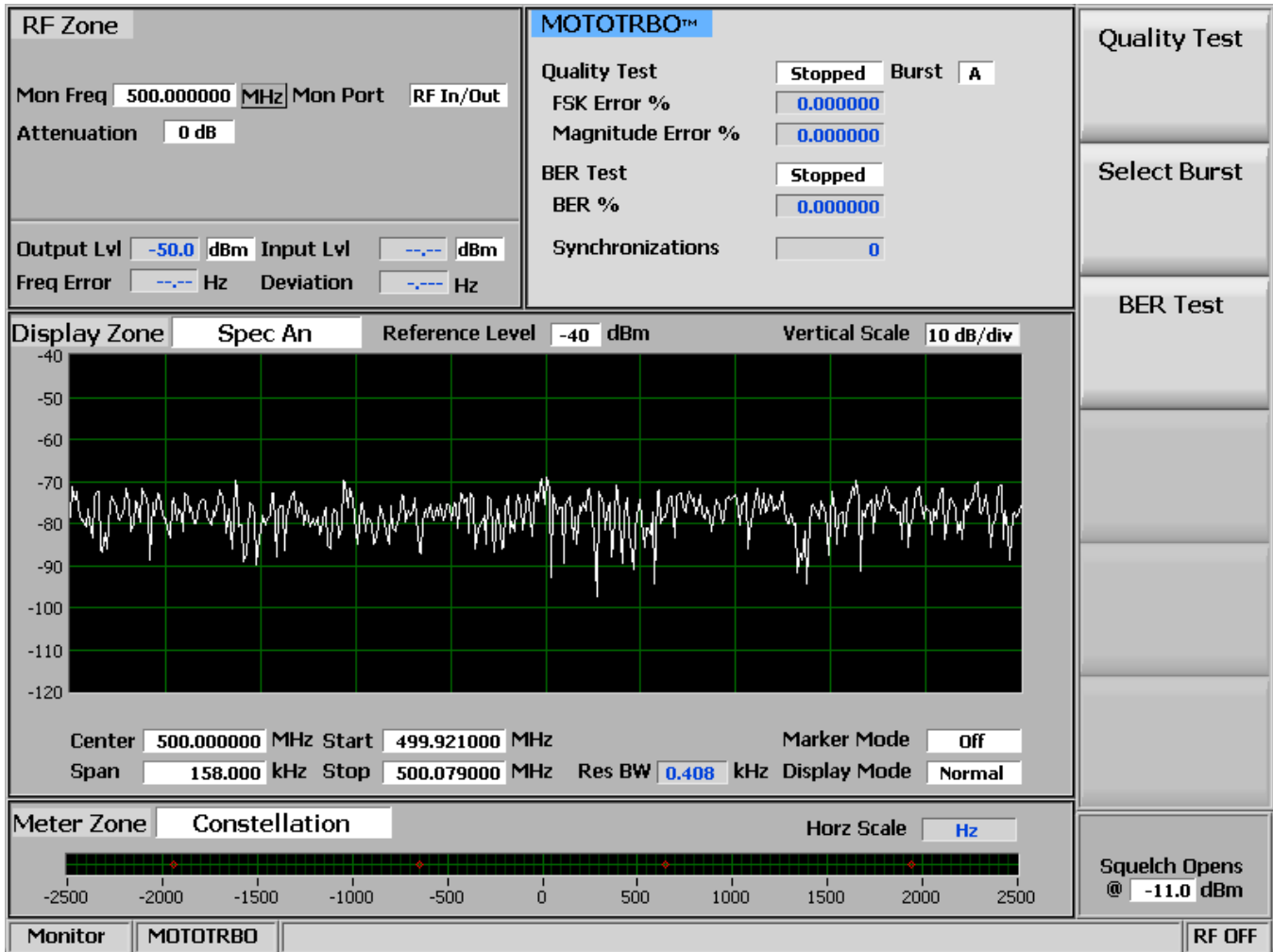
Figure 3.2.8.3.1-1   Submenu after pressing MOTOTRBO soft key in Monitor mode

Constellation Display (Meter Zone)

The Constellation Display gives a visual representation of overall transmitter operation. There are 4 highlighted areas on the display (in red). They represent the expected locations for the deviation states when the radio is transmitting data bits using 4FSK modulation.

Bits	Symbol	Deviation
01	+3	+1944 Hz
00	+1	+ 648 Hz
10	-1	- 648 Hz
11	-3	-1944 Hz

Quality Test

This test measures the quality of the radio's transmitted 4FSK signal over the 132 symbols that comprise an entire DMR TDMA burst, any of 6 predefined test patterns (264 bits). MOTOTRBO Tuner is used to select the O.153 test pattern mode in the radio under test. Although the service monitor synchronizes to the first burst, the radio transmits all 6 bursts. Use the horizontal submenu Stop/Start soft keys to activate the test.

Select Burst

Choose one of 6 test pattern bursts for the R8000 to synchronize with when performing the quality test for the MOTOTRBO radio's transmitter. Use the horizontal submenu to select the desired burst (A through F).

BER Test

This bit error rate test checks the modulation, encoding and timing of the transmit signal during the data period. The test is done at nominal power with the radio transmitting the O.153 super frame test pattern into the service monitor. (It is acceptable to have an attenuator between the radio under test and the service monitor.) MOTOTRBO Tuner is used to select the correct TX test pattern.

3.2.8.3.2 MOTOTRBO receiver tests

These tests are performed with the R8000 in Generate mode – see Figure 3.2.8.3.2-1.
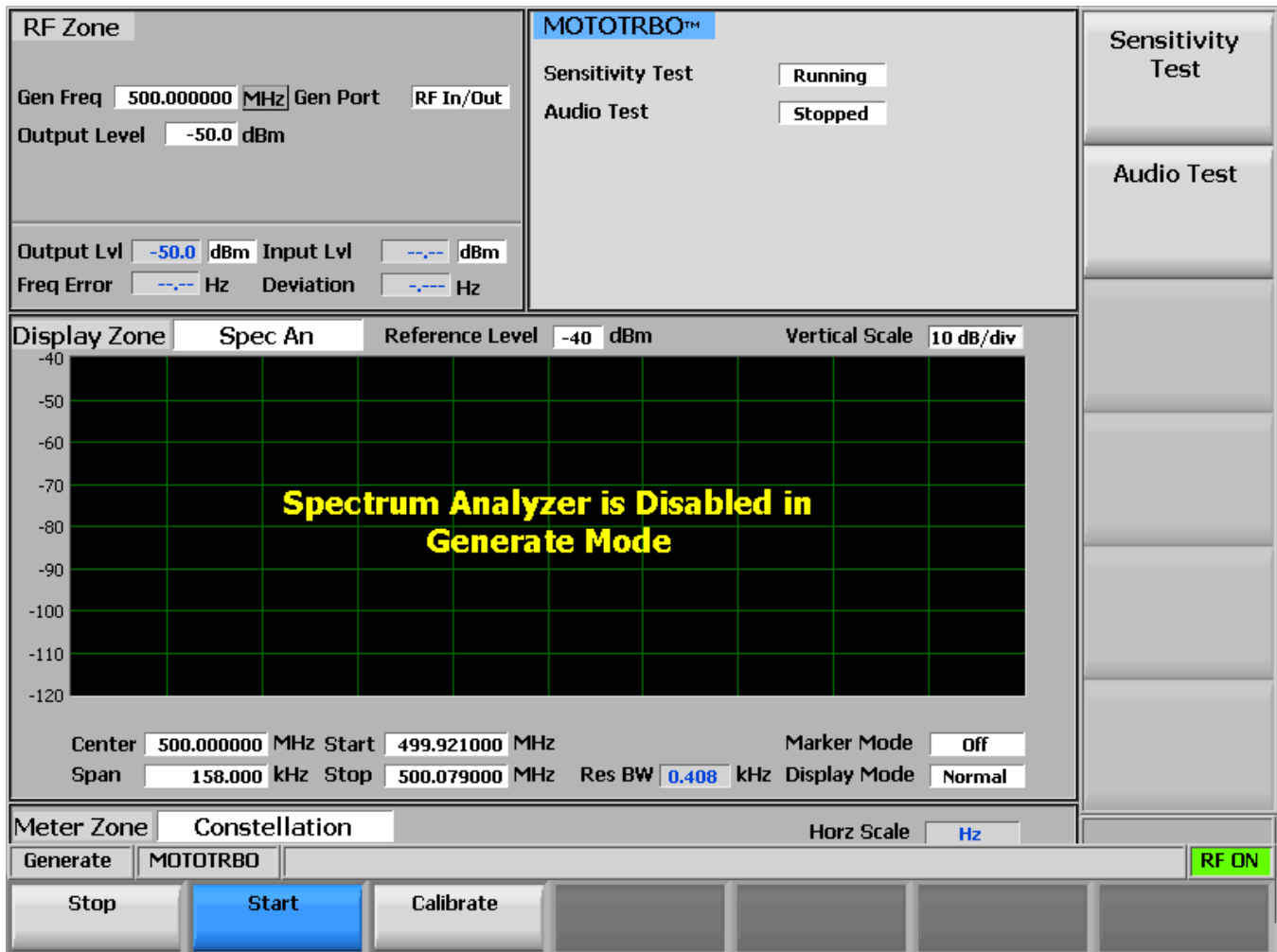
Figure 3.2.8.3.2-1   Submenu after pressing MOTOTRBO soft key in Generate mode

Sensitivity Test

MOTOTRBO Tuner software is used to place the radio into test mode to enable it to calculate BER internally. The calculated BER is then retrieved by the tuner application and displayed on the PC. The R8000 transmits a BER calibration signal, which is the 1% BER O.153 super frame test pattern at an output power level of -60 dBm. This transmission at the defined power level is used to validate that the internal BER calculator is operating correctly. For the sensitivity test the R8000 monitor is used to transmit the O.153 (V.52) super frame test pattern over an output power level range of -125 dBm to 0 dBm. This permits measurement of the reference sensitivity (1% or 5% BER) for the radio. A horizontal submenu allows selection of the Calibrate mode or Start/Stop options for the sensitivity test.

Audio Test

The R8000 transmits a 1031 Hz super frame test pattern tone at -60 dBm to quickly check the audio performance in the field, as it produces a 1031 Hz tone at the speaker of a receiving MOTOTRBO radio.

3.2.8.4   Project 25 test mode

The R8000 optional Project 25 mode allows testing of conventional (non-trunked) APCO Project 25 (P25) compliant radios. P25 radios use a digital transmission format employing Continuous 4 level FM (C4FM) modulation. The R8000 P25 mode provides a grouping of test functions compliant with the TIA/EIA-102.CAAA measurement standard. These include symbol deviation, modulation fidelity, Bit Error Rate (BER) test patterns, Frequency Error, and Power. In addition there is an Eye Diagram with graphical representation of the P25 signal, and a Voice Loop Playback function for audio verification of the radio's end-to-end operation (U.S. patent 5703479).

The manufacturer's Radio Service Software (RSS) is required to perform the entire test suite in P25 mode because certain measurements (BER) require placing the radio in a special test mode. However the P25 related tests detailed in section 3.2.8.4.2 can be executed without RSS. Figure 3.2.8.4-1 shows the R8000 main screen after choosing the Project 25 Test Mode
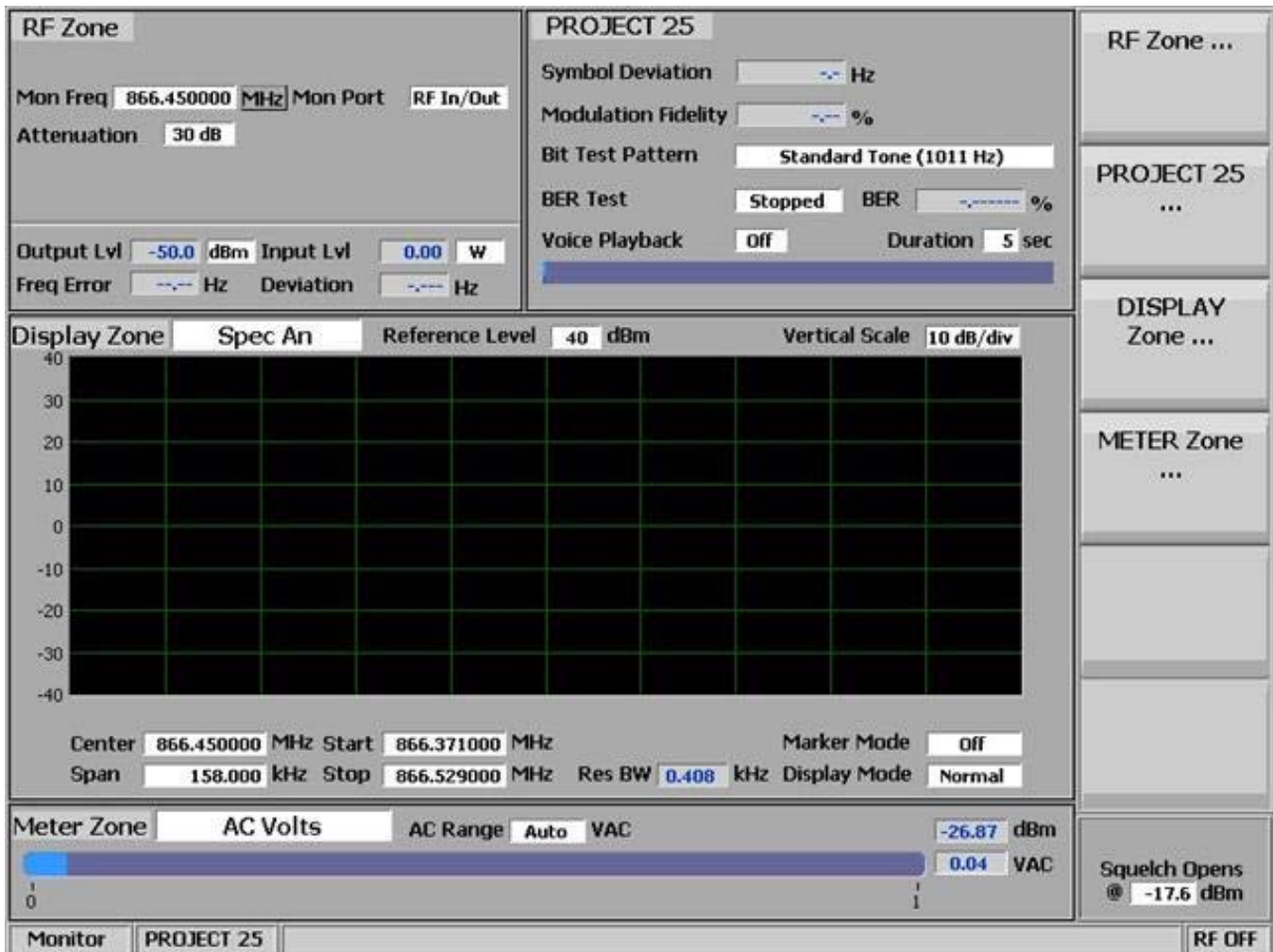
Figure 3.2.8.4-1   Main screen in Monitor mode after selecting the Project 25 Test Mode

3.2.8.4.1 P25 transmitter tests using manufacturer's RSS

These tests are performed with the R8000 in Monitor mode – see figure 3.2.8.4.1-1. For Bit Error Rate (BER) testing the manufacturer's RSS software is required. This configures the radio in a special test mode for transmitting TIA/EIA-102.CAAA compliant test patterns such as 1011Hz Tone, Calibration, V.52 etc. The R8000 compares the transmitted test patterns to the predefined patterns and displays any resulting error in %. The relevant menu selections are as follows:
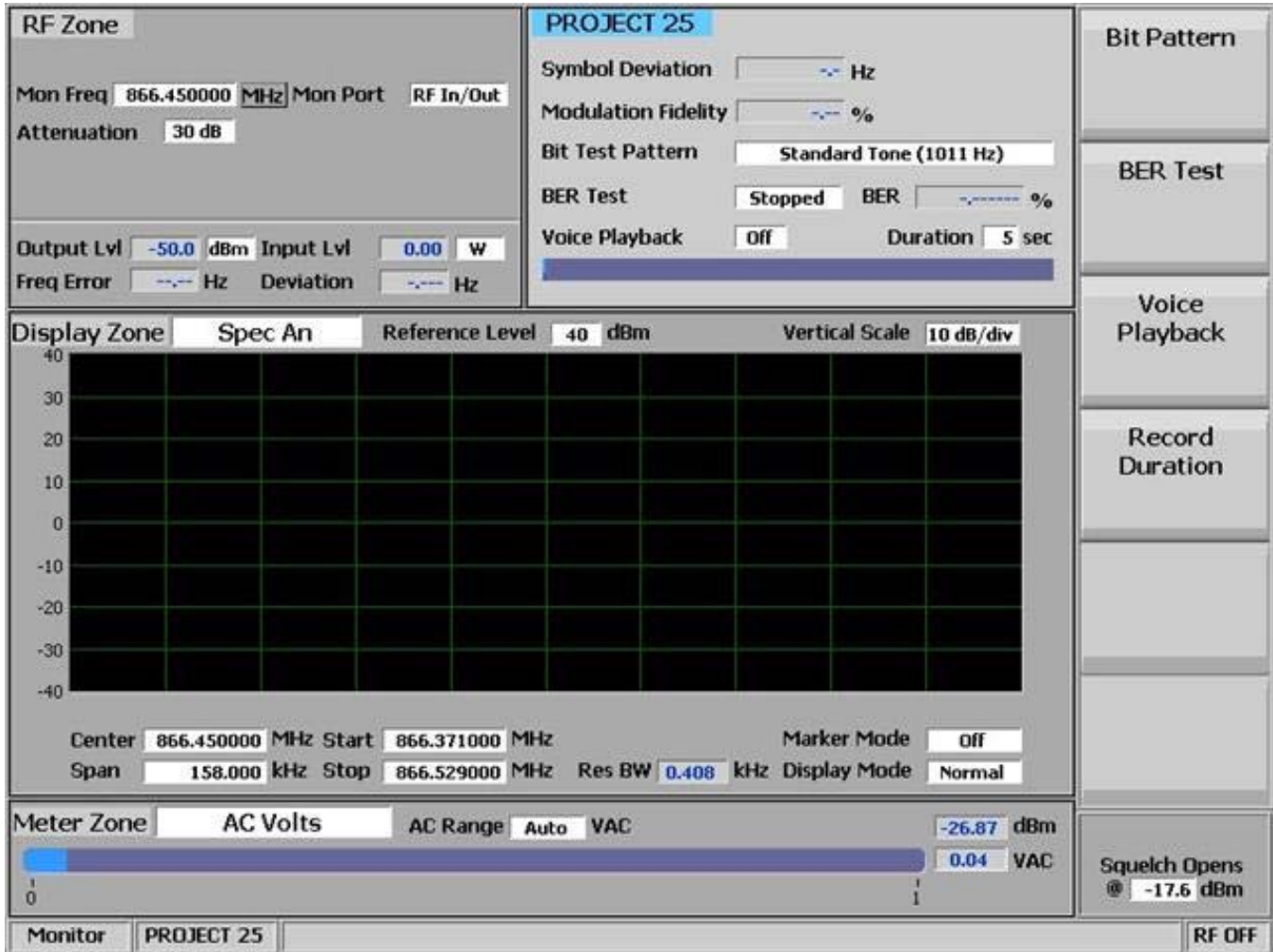
Figure 3.2.8.4.1-1   Main screen in Monitor mode after pressing the Project 25 soft key

Bit Pattern

Provides selection for one of 7 TIA/EIA-102.CAAA compliant predefined bit patterns for BER testing of a P25 radio in transmit mode as shown in Figure 3.2.8.4.1-2. The following patterns are available:

1011Hz Tone – Standard Tone test pattern yields a 1011 Hz tone at the reference level in the receiver VOCODER.

Calibration – Provides a test pattern derived from the Standard Tone test pattern for BER measurement calibration purposes. Every 20th bit is inverted to yield 172 errors out of 3456 bits resulting in a 4.977 % BER.

Standard Tx – *The standard transmitter test pattern is a continuously repeating 511 bit binary pseudo random bit sequence based on ITU-T O.153 (formerly CCITT V.52)*

Silence – *This test pattern results in a silent output at the receiver VOCODER.*

Busy – *This test pattern provides channel busy information.*

Idle – *This test pattern provides channel idle information.*

AFC – *This test pattern allows alignment for Automatic Frequency Control by setting the status symbols of the 1011 Hz pattern to "Inbound Channel Idle".*

Figure 3.2.8.4.1-2   Bit Pattern submenu in P25 mode

BER Test

Enables or disables Bit Error Rate (BER) testing in the P25 mode of the R8000. When BER is enabled the radio transmitter under test must be placed in a test diagnostic mode using the manufacturer's Radio Service Software (RSS). BER test results are shown as an error in % in the Project 25 screen zone.

3.2.8.4.2 P25 transmitter tests without manufacturer's RSS

P25 transmitter tests can also be performed without the radio manufacturer's RSS. These measurements are shown in Figure 3.2.8.4.2-1 and are done by simply keying the transmitter of the P25 radio connected to the R8000. Tests include Symbol Deviation, Modulation Fidelity, Power, Frequency Error and Frequency Deviation. The Eye Diagram and Voice Loopback also provide qualitative indication of the radio's performance. The relevant measurements and menu selections are as follows:
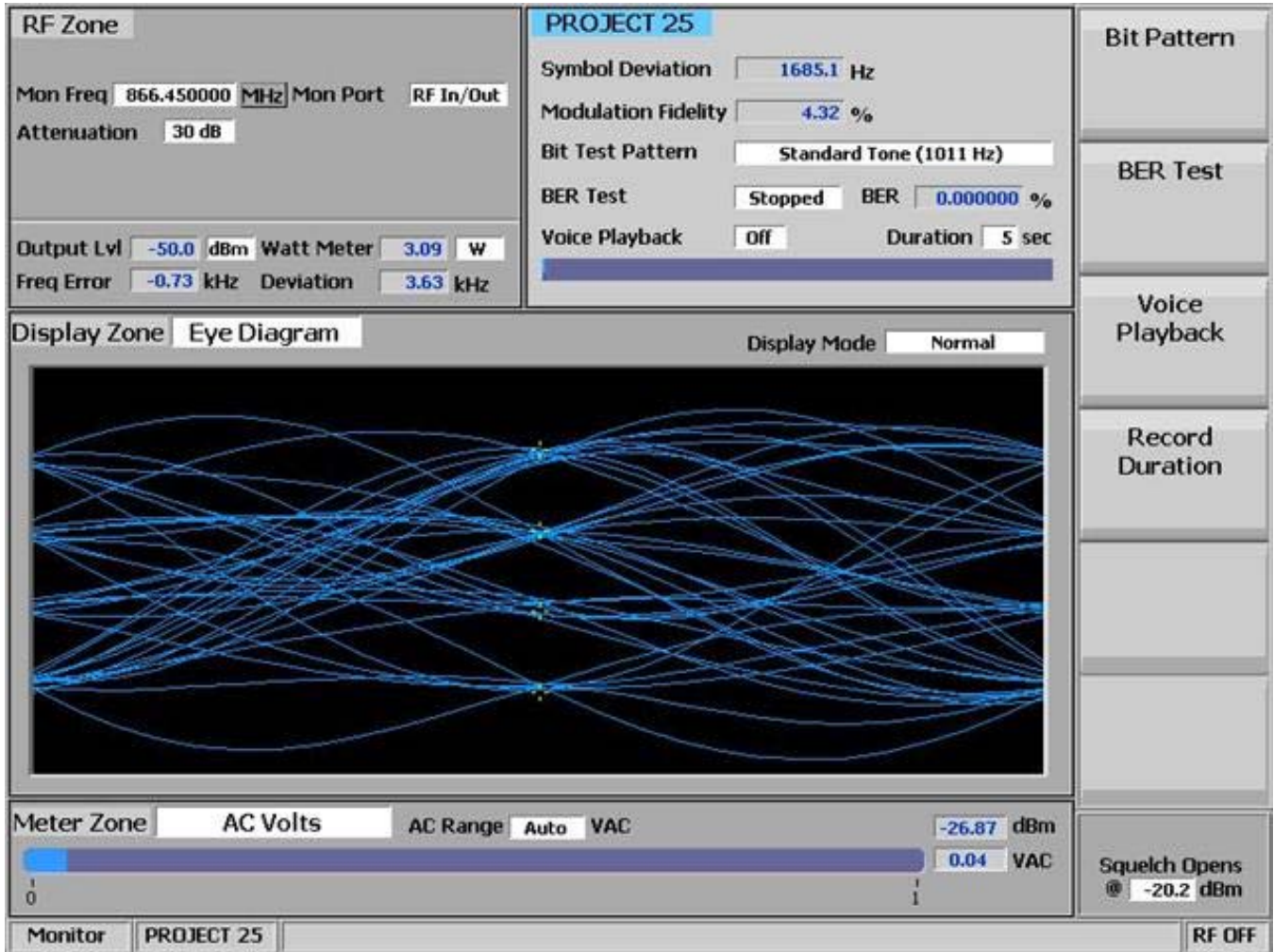
Figure 3.2.8.4.2-1   P25 related measurements without RSS control of radio

Symbol Deviation

P25 radios broadcast voice and data using a 4 level frequency deviation of the carrier to represent symbols containing data bits as shown in the table below. The nominal deviation value for a P25 radio using C4FM modulation is 1800 Hz. Since the deviation of a P25 C4FM signal is data dependent, that aspect is factored when measuring overall carrier deviation. The Symbol Deviation field provides the deviation measurement at symbol decision times.

Bits	Symbol	Deviation

75

01	+3	+1800 Hz
00	+1	+600 Hz
10	-1	-600 Hz
11	-3	-1800 Hz

Modulation Fidelity

Modulation Fidelity represents how accurately a P25 transmitter reproduces an ideal theoretical modulation. The measurement is performed by comparing the RMS difference between the deviation of the received signal and the ideal C4FM deviation at the symbol decision points (shown in the previous table). On the R8000 this is computed over a 72 symbol interval and reported as an RMS error in % relative to the ideal C4FM waveform.

Eye Diagram

The Eye Diagram provides a visual display of the received P25 signal and overlays the modulation response over the four "target" crossing points for an ideal P25 signal – see Figure 3.2.8.4.2-2. To select the Eye Diagram for viewing with the other P25 measurements on the main screen navigate to the Display Zone while in P25 mode. The Eye Diagram can indicate whether a transmitter has significant unbalances or offsets in the modulation circuitry by noting how tightly grouped the waveform is around the crossing points.
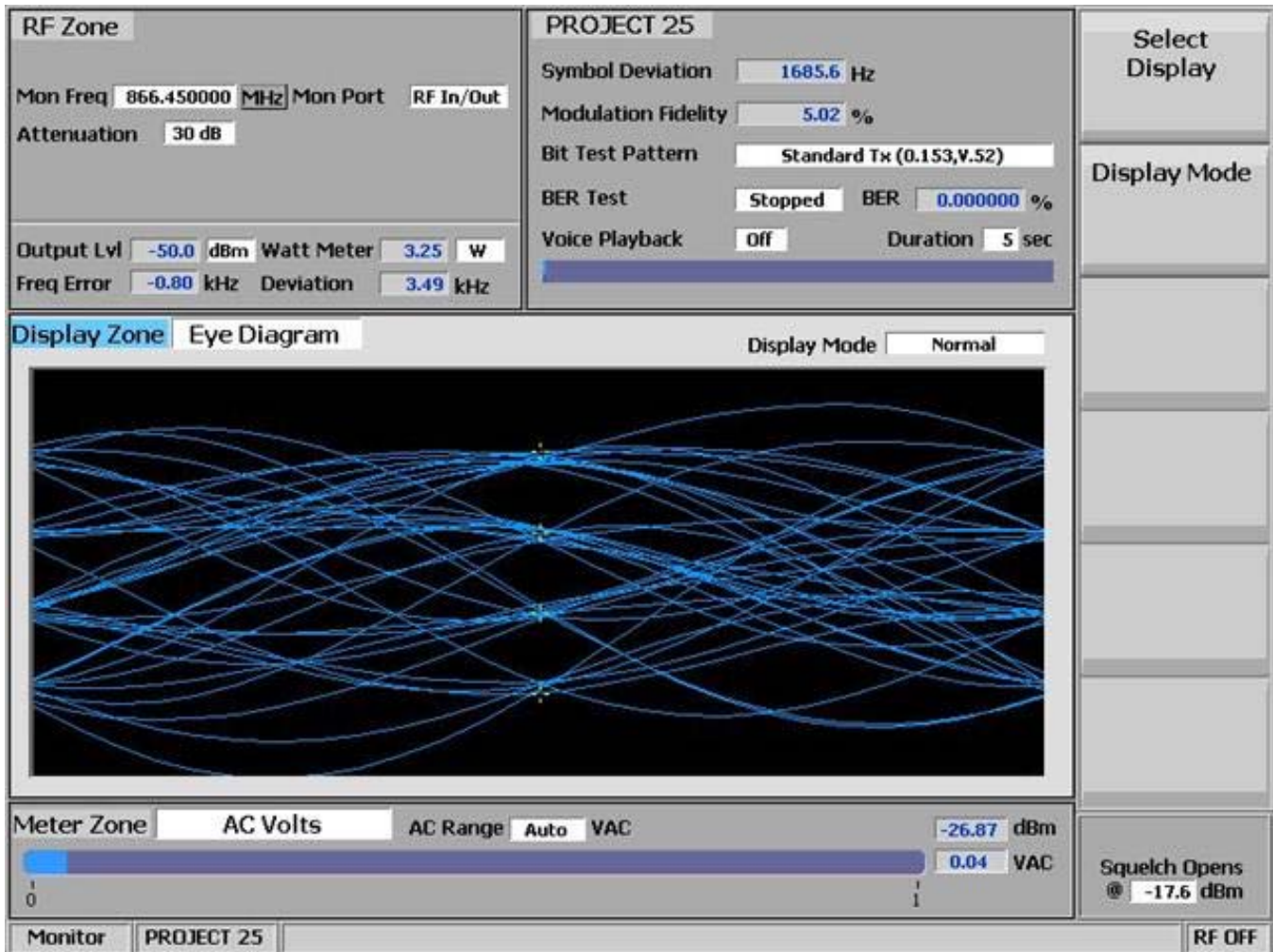
Figure 3.2.8.4.2-2   P25 Eye Diagram selection in Display Zone

Display Mode

Selects the display presentation using a horizontal menu with the following choices:

Normal – The display updates continuously.

*Fade Away – Similar to the persistence mode on an oscilloscope - see Figure 3.2.8.4.2-3. The intensity of each trace fades away or decays as new traces are received. The effect is to intensify the display in the area where the waveform spends most of its time. **Note:** Whenever the Display Mode is changed the R8000 reconfigures the presentation. This process takes approximately 10 seconds and is complete when the new setting appears in the Display Mode field.*
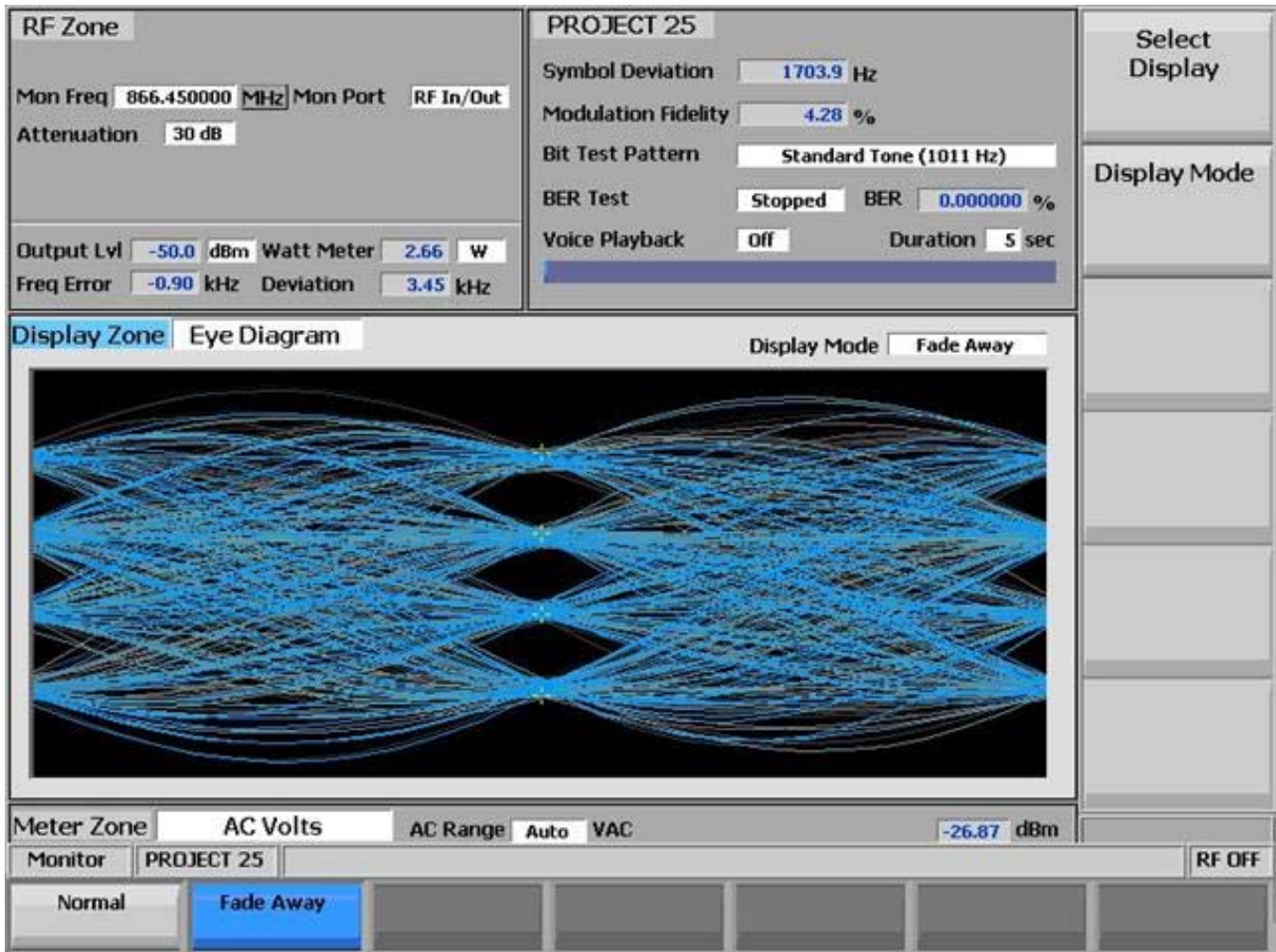
Figure 3.2.8.4.2-3   P25 Eye Diagram with display in Fade Away mode

Voice Playback

This menu selection enables the Voice Loop feature in P25 mode (U.S. patent 5703479). Once enabled the R8000 automatically records voice channel data when the radio under test transmits a signal above the squelch level setting. The Record Duration setting determines the time length or window of voice channel information captured, and a bar graph meter shows the recording's progress – see Figure 3.2.8.4.2-3. When the radio is un-keyed the R8000 automatically switches to Generate mode and transmits the captured voice channel information or speech back to the radio – see Figure 3.2.8.4.2-4. This provides a quick end to end test of the P25 radio transmitter and receiver. Also, while complete P25 encryption radio support will be an upcoming R8000 feature, Voice Playback can presently be used to quickly verify basic functionality of an encrypted P25 radio. Note: The R8000 captures and resends the Network Access Code (NAC) sent by the radio. For the radio to reproduce the voice playback the receive NAC must be the same as the transmit NAC. Also, radios configured for private calls requiring a selective squelch ID equal to that of the radio may not loopback.

Voice channel recordings can be played back at any time by pressing the Play Last Recording soft key (this selection only appears after a recording has been made). Note: Recorded information is lost if the

R8000 is power cycled, or if the Generate mode is selected and a new bit pattern is enabled by setting the modulation to Continuous or Burst.
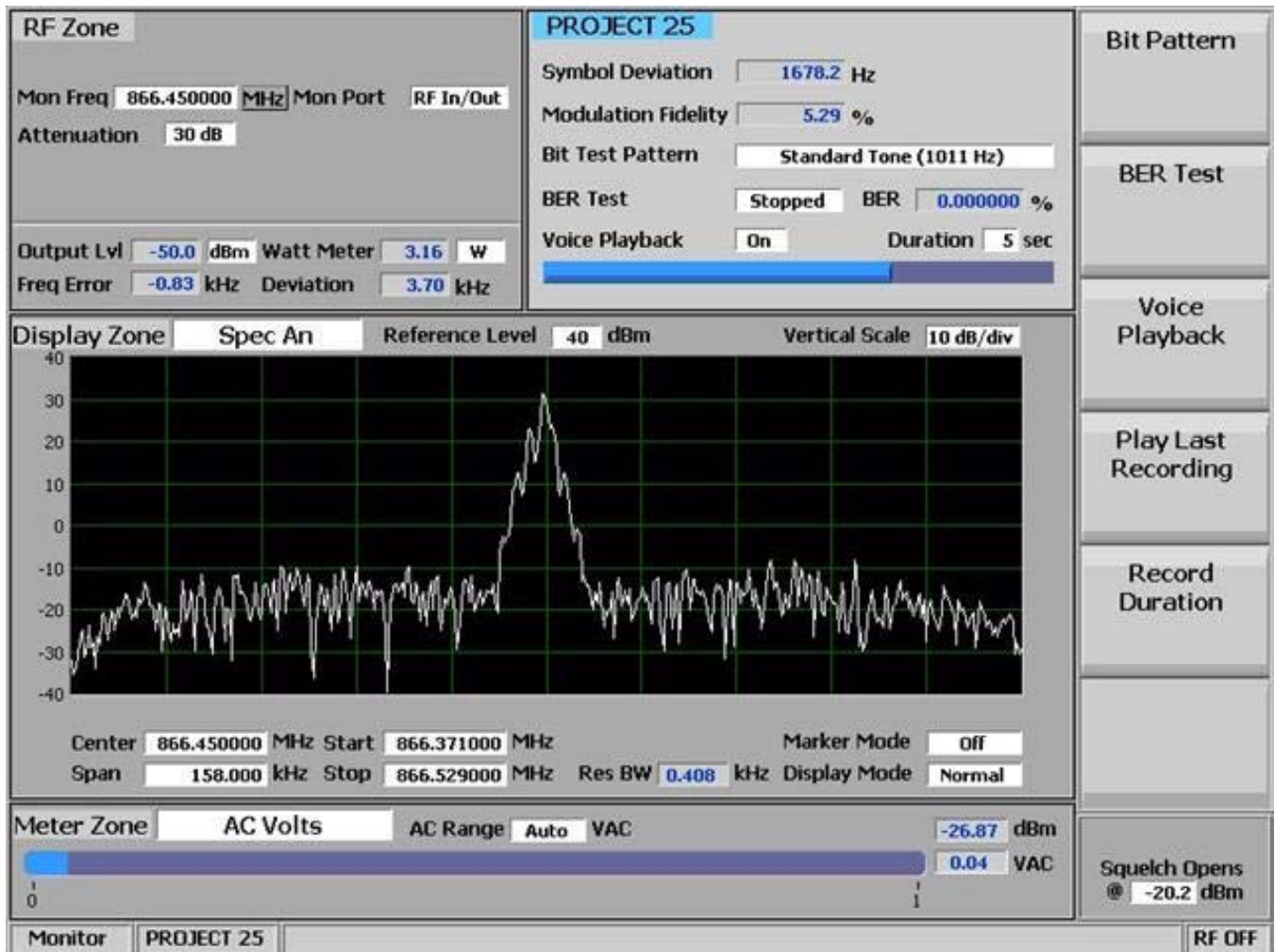
Figure 3.2.8.4.2-3   P25 Voice Playback in record mode
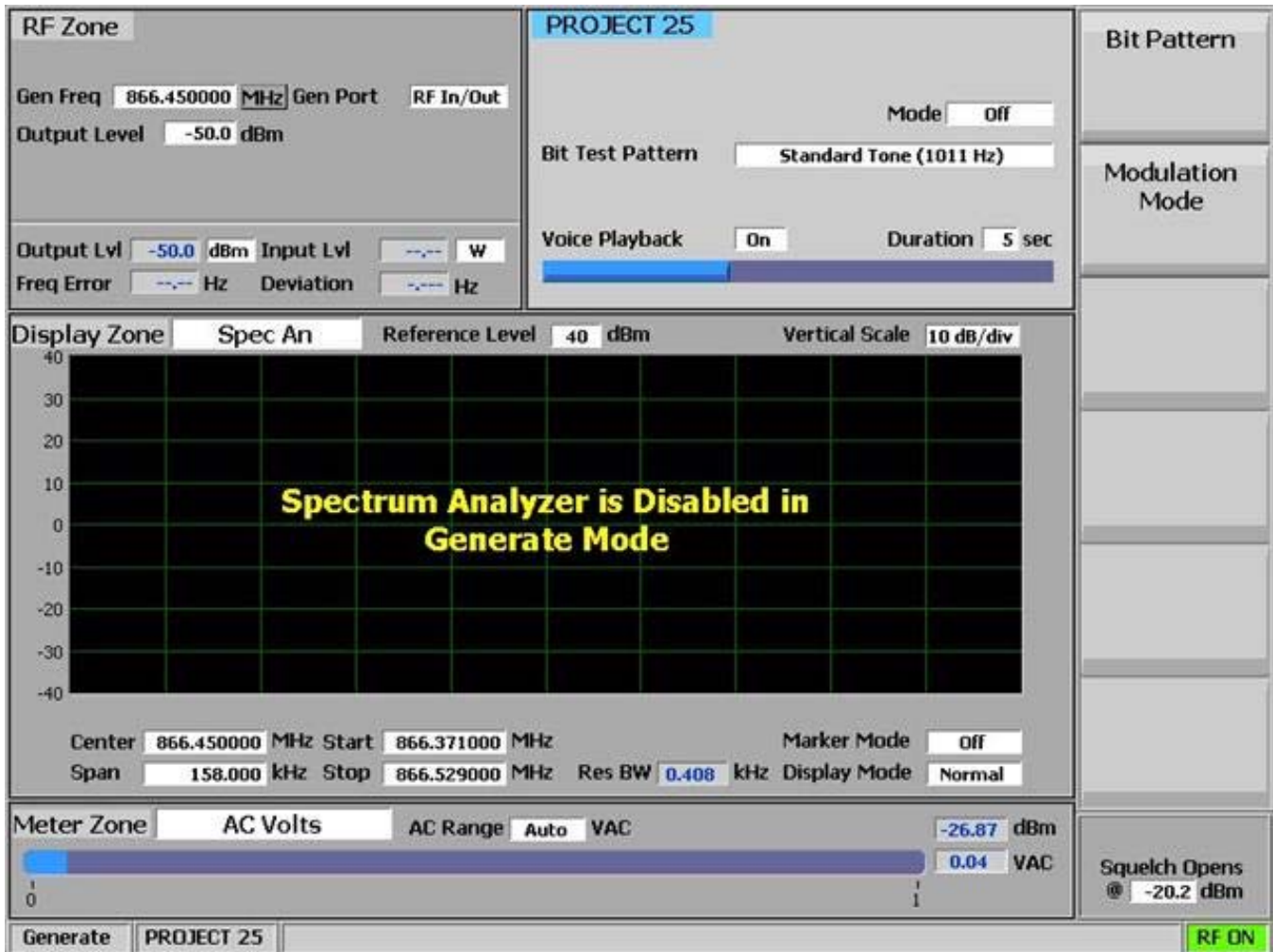
Figure 3.2.8.4.2-4   P25 Voice Playback in play mode

Play Last Recording

Pressing this soft key places the R8000 in Generate mode and modulates the carrier with the most recently recorded voice channel data after the Voice Playback function is enabled – see Figure 3.2.8.4.2-4. The total transmission time is equal to the length of recorded data, and a bar graph indicates the remaining transmission time during playback. Speech recorded from a transmitting P25 radio under test should be heard from its receiver if the radio is operating properly.

Record Duration

Sets the time length or window for recording voice channel information from a transmitting P25 radio. The time can be varied from 1 to 10 seconds in a data entry window using the arrow keys, keypad, or tuning knob.

3.2.8.4.3 R8000 P25 Generate mode

The R8000 can generate various P25 compliant test patterns using C4FM modulation – see Figures 3.2.8.4.3-1 and 3.2.8.4.3-2. Bit patterns that yield an audio tone can be heard in the receiver of the radio

under test (radio's NAC setting must be 293). Others can be used in conjunction with the radio manufacturers' RSS to perform BER testing and alignment.

Figure 3.2.8.4.3-1   P25 Generate mode bit patterns – page 1

Figure 3.2.8.4.3-2   P25 Generate mode bit patterns – page 2

Bit Pattern

Provides selection for one of 10 TIA/EIA-102.CAAA compliant predefined bit patterns for BER testing of a P25 radio in receive mode. The following patterns are available:

1011Hz Tone – Standard Tone test pattern yields a 1011 Hz tone at the reference level in the receiver VOCODER.

Calibration – Provides a test pattern derived from the Standard Tone test pattern for BER measurement calibration purposes. Every 20th bit is inverted to yield 172 errors out of 3456 bits resulting in a 4.977 % BER.

Standard Tx – The standard transmitter test pattern is a continuously repeating 511 bit binary pseudo random bit sequence based on ITU-T O.153 (formerly CCITT V.52)

Silence – This test pattern results in a silent output at the receiver VOCODER.

Busy – This test pattern provides channel busy information.

Idle – This test pattern provides channel idle information.

AFC – This test pattern allows alignment for Automatic Frequency Control by setting the status symbols of the 1011 Hz pattern to "Inbound Channel Idle".

Symbol Rate – This test pattern provides a continuously repeating bit stream of high deviation symbols.

Low Deviation – This test pattern provides a continuously repeating bit stream of low deviation symbols.

C4FM Mod Fidelity – This provides a continuously repeating 24 bit sequence used for measuring C4FM modulation fidelity.

Note: *When receiving bit patterns generated from the R8000 the radio under test must be programmed to the default Network Access Code (NAC) of 293 embedded in the R8000. This will break the radio's selective squelch so the tone or pattern can be reproduced in the audio circuits.*

Modulation Mode

A horizontal submenu provides choice of Off, Continuous, or Burst mode for the selected bit pattern.
Note: *Enabling a bit pattern in Generate mode will erase any previously captured Voice Recordings.*

3.2.9   Settings Mode

System settings for the R8000 are accessed by pressing the Settings navigation button – see Figure 3.2.9-1. The submenu presents a user initiated self calibration function and various configuration settings that affect R8000 operation along with information on the unit's firmware, installed options and diagnostic messages generated during operation.
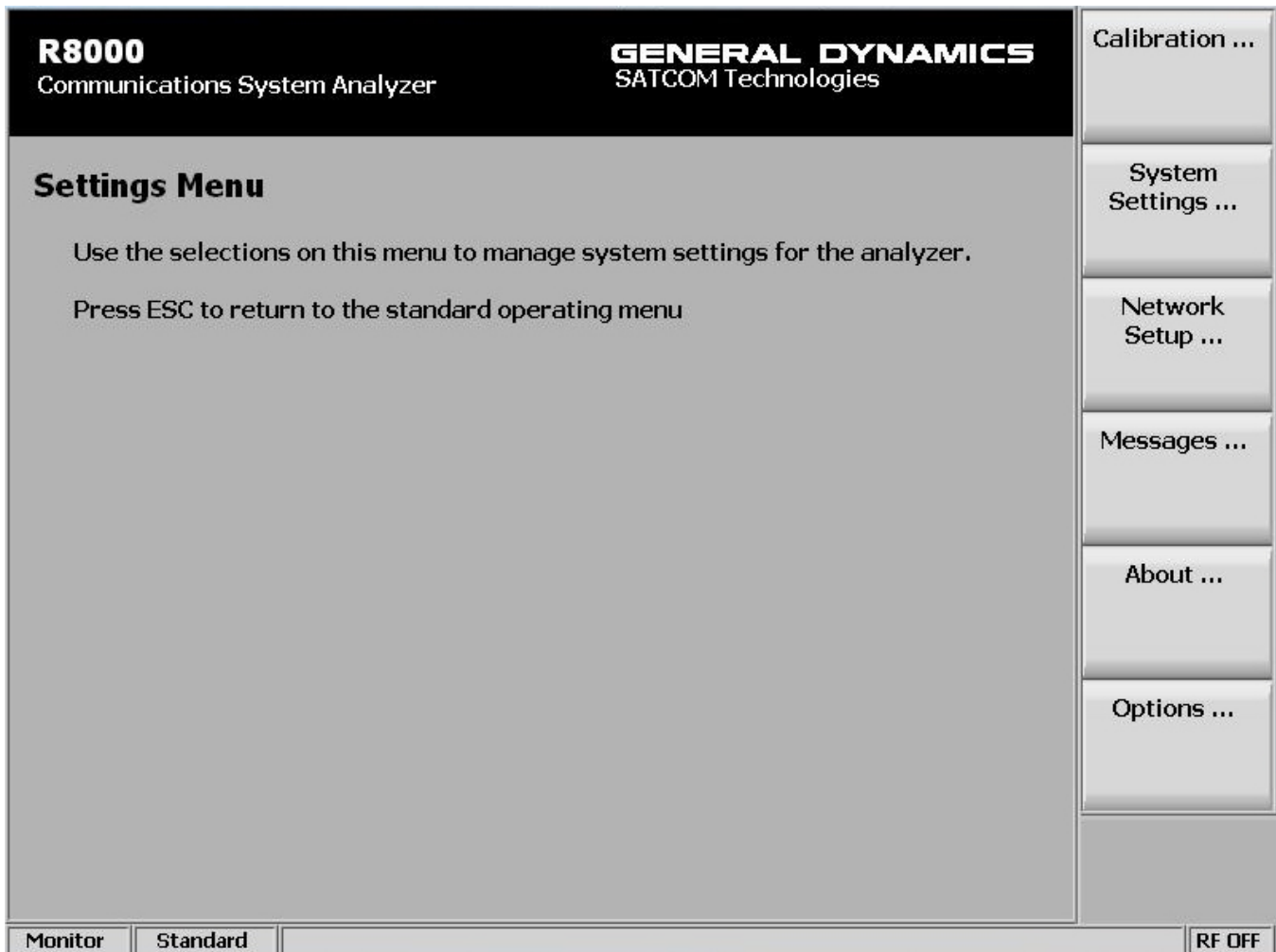
Figure 3.2.9-1   Submenu after pressing Settings navigation button on R8000 front panel

3.2.9.1   Calibration

The R8000 has a calibration function to assure accurate and consistent performance over time and in a variety of environmental settings. The options presented by the Calibration soft key are as follows:

Calibrate Now

This initiates a self alignment process for the R8000 to compensate for component aging or adjust operation to a significant change in external environmental temperature. New calibration values are generated and stored in memory and used for all future operation of the R8000. See Appendix C – R8000 Field Calibration Procedure.

Load Factory Defaults

The calibration values generated during factory alignment prior to shipment are loaded. These establish a nominal baseline for R8000 operation in the event the user generated self calibration tables are lost or corrupted.

3.2.9.2   System Settings

The R8000 has various hardware control related settings that are accessed in the Systems Settings submenu. Once set these parameters aren't affected by the operational mode or other choices in the R8000 menu system. Figure 3.2.9.2-1 shows the Systems Settings submenu and the options are as follows:
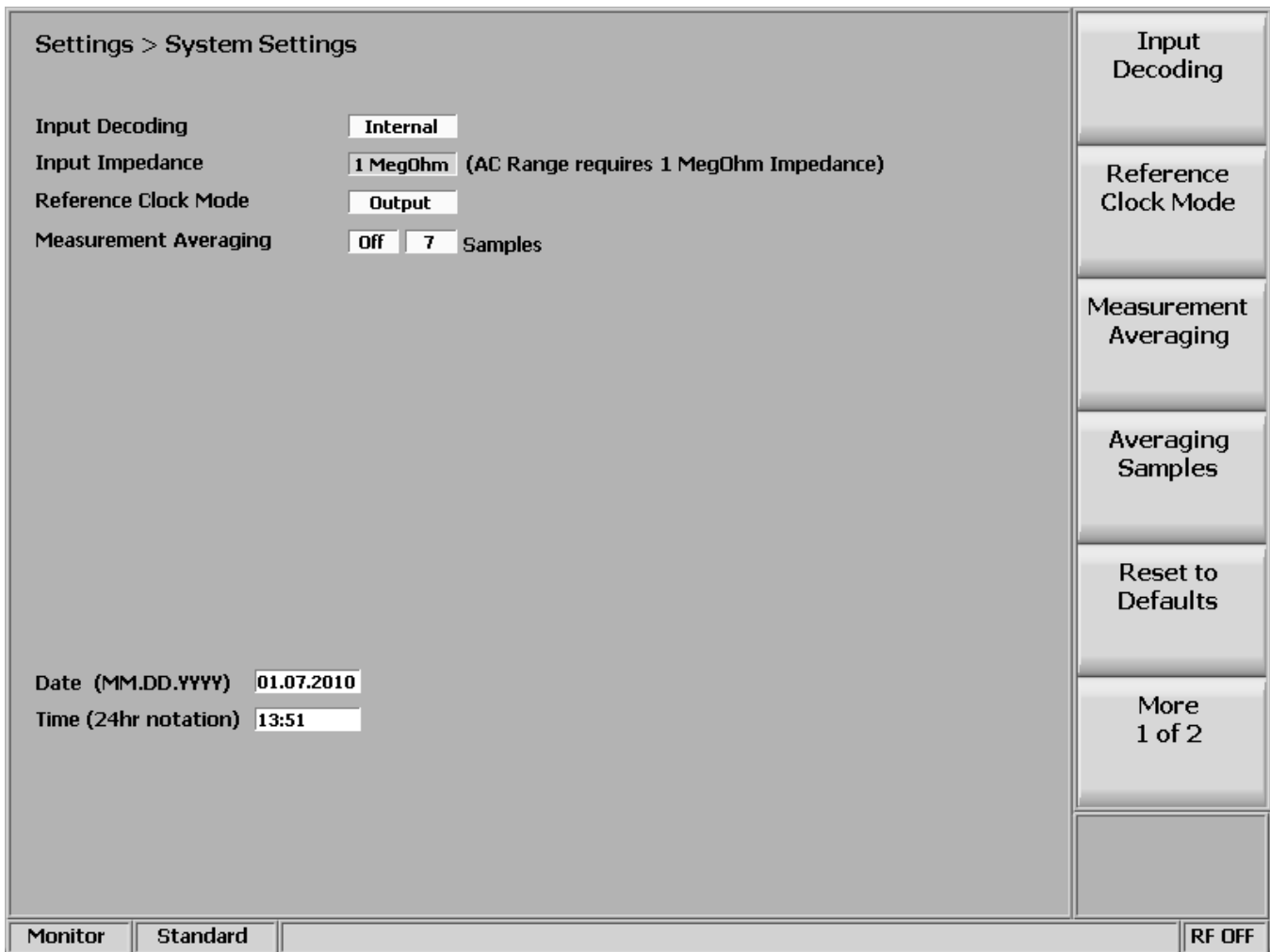
Figure 3.2.9.2-1   Submenu after pressing System Settings soft key in the Settings menu

Input Decoding

Selects the signal source used for the R8000 frequency counter and decode functions. When set to Internal the recovered audio or tones from a demodulated received signal are used as the signal source. The external setting routes an externally applied signal at the Meter In port to the R8000 frequency counter and decode circuits.

Input Impedance

Selects the input impedance for the Meter In port to either 600 Ω or 1 MΩ.

Reference Clock Mode

Selects the mode for the 10 MHz REF connector at the side of the R8000. "Output" routes the internal 10 MHz time base signal to the 10 MHz REF connector for use as a frequency reference by external equipment. "Input" allows an external time base signal applied to the 10 MHz REF connector to be routed into the R8000.

Measurement Averaging

Enables measurement averaging to smooth readings in metering functions like Deviation, Frequency Error, SINAD, etc.

Averaging Samples

Sets the number of samples from 2 to 100 used when Measurement Averaging is enabled.

Reset to Defaults

All R8000 system settings are restored to the factory defaults.

Time

Sets the R8000 system clock in 24-hour notation. Use the numeric keypad and the Up/Down (▲▼), and Left/Right (◄►) keys to make or change entries.

Date

Sets R8000 system date in month, day, year (MM.DD.YYYY) notation. Use the numeric keypad and the Up/Down (▲▼), and Left/Right (◄►) keys to make or change entries.

Apply Date/Time Changes

Applies the time and date changes selected above to the R8000 system clock.

3.2.9.3 Network Settings for Remote Operation

The R8000 can be connected to a TCP/IP network for remote operation (see section

4   REMOTE OPERATION) using the unit's Remote Front Panel option (R8-Remote). Communication over the network requires an IP address for the R8000. The analyzer uses a dynamic IP assigned using DHCP (Dynamic Host Configuration Protocol). Figure 3.2.9.3-1 shows the Network Settings setup submenu.
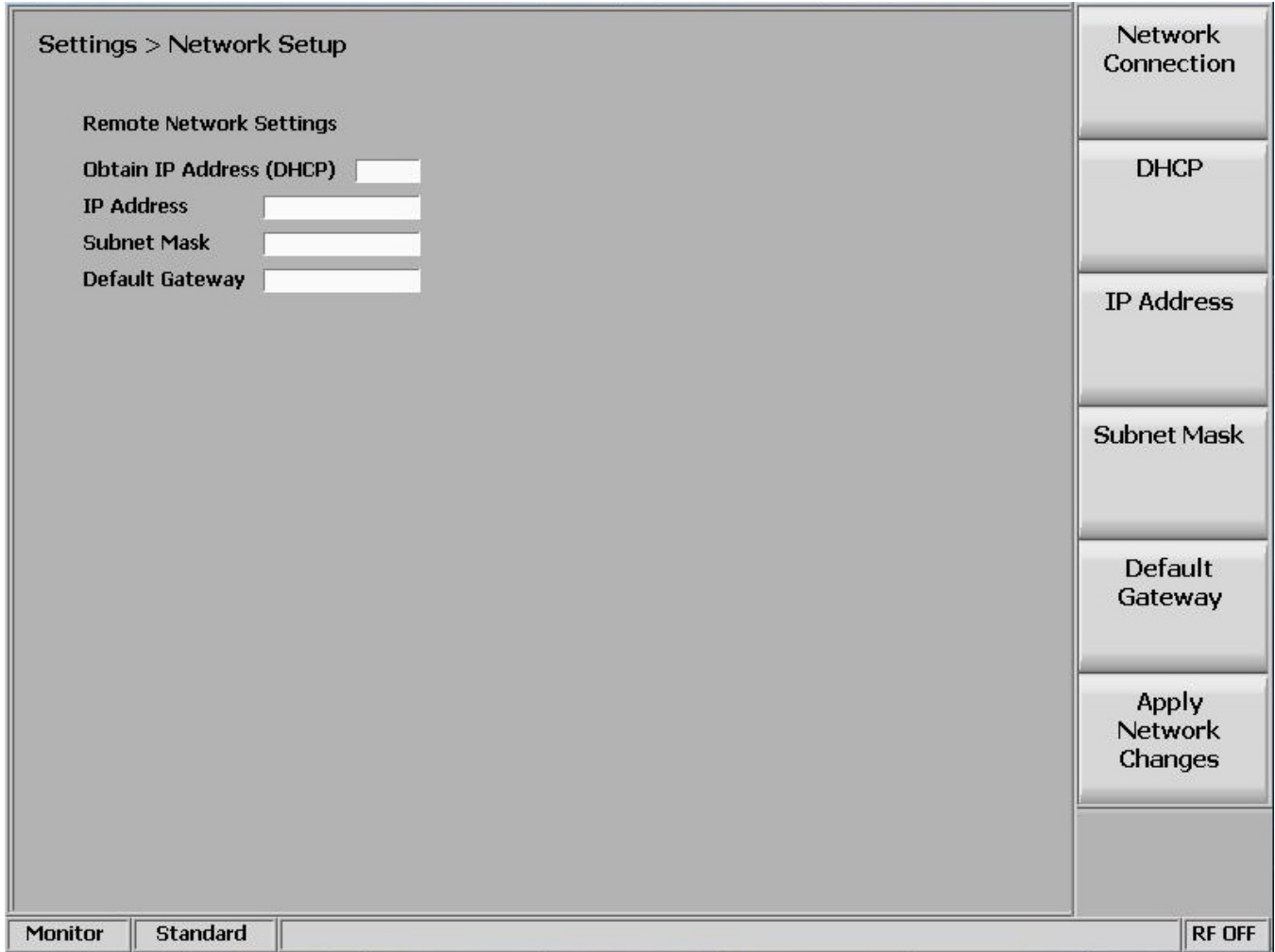
Figure 3.2.9.3-1   Submenu after pressing Network Setup soft key in the Settings menu

Network Connection

Enables or disables the network connection for remotely operating the R8000. It is recommended that external security measures are taken when enabling the connection to prevent unauthorized access to the R8000. When the Network Connection is first enabled, DHCP is on by default.

Note: see section 4   REMOTE OPERATION

DHCP

Enables DHCP (or Dynamic Host Configuration Protocol) by which an IP address is assigned to the R8000 during boot by a DHCP server on the Local Area Network. When the R8000 boots, it puts out a request on the Local Area Network for a DHCP server to assign it an IP address. The DHCP server has

a pool (or scope) of IP addresses available. The server responds to this request with an IP address from the pool, along with a lease time. Once the lease time for a given IP address lease has expired, the client must contact the server again and repeat the negotiation. If DHCP is set to off then a static IP address must be entered for network control. Note, when DHCP is on, the fields for IP Address, Subnet Mask, and Default Gateway are populated with their respective values from the DHCP server.

Note: *Static IP Address support is not yet implemented.*

IP Address

Use this to enter the IP address assigned to the R8000 by the network administrator.

Subnet Mask

Use this to enter the subnet mask address assigned to the R8000 by the network administrator.

Default Gateway

Use this to enter the Default Gateway address assigned to the R8000 by the network administrator. This is the address of the router that passes data outside the subnet the R8000 is attached to.

Apply Network Changes

Pressing this soft key loads the network settings shown on the Remote Setup screen into the R8000 configuration memory.

3.2.9.4 Messages during R8000 operation

During operation the R8000 may display selective information on the message bar at the bottom of the screen between the test mode and the RF state. The messages relate the status of the analyzer during test transitions or warn the operator of a fault or condition requiring attention. Warning messages are highlighted in yellow or red. Some messages may flash temporarily, and if there's more than one message only the one reflecting the current condition is displayed. The R8000 keeps a running log of messages generated during the operational session. The message log as shown in Figure 3.2.9.4-1 can be viewed using the Messages soft key. Message numbers in the five-thousands appear grey on the message bar; those in the six-thousands appear yellow; all others appear red.
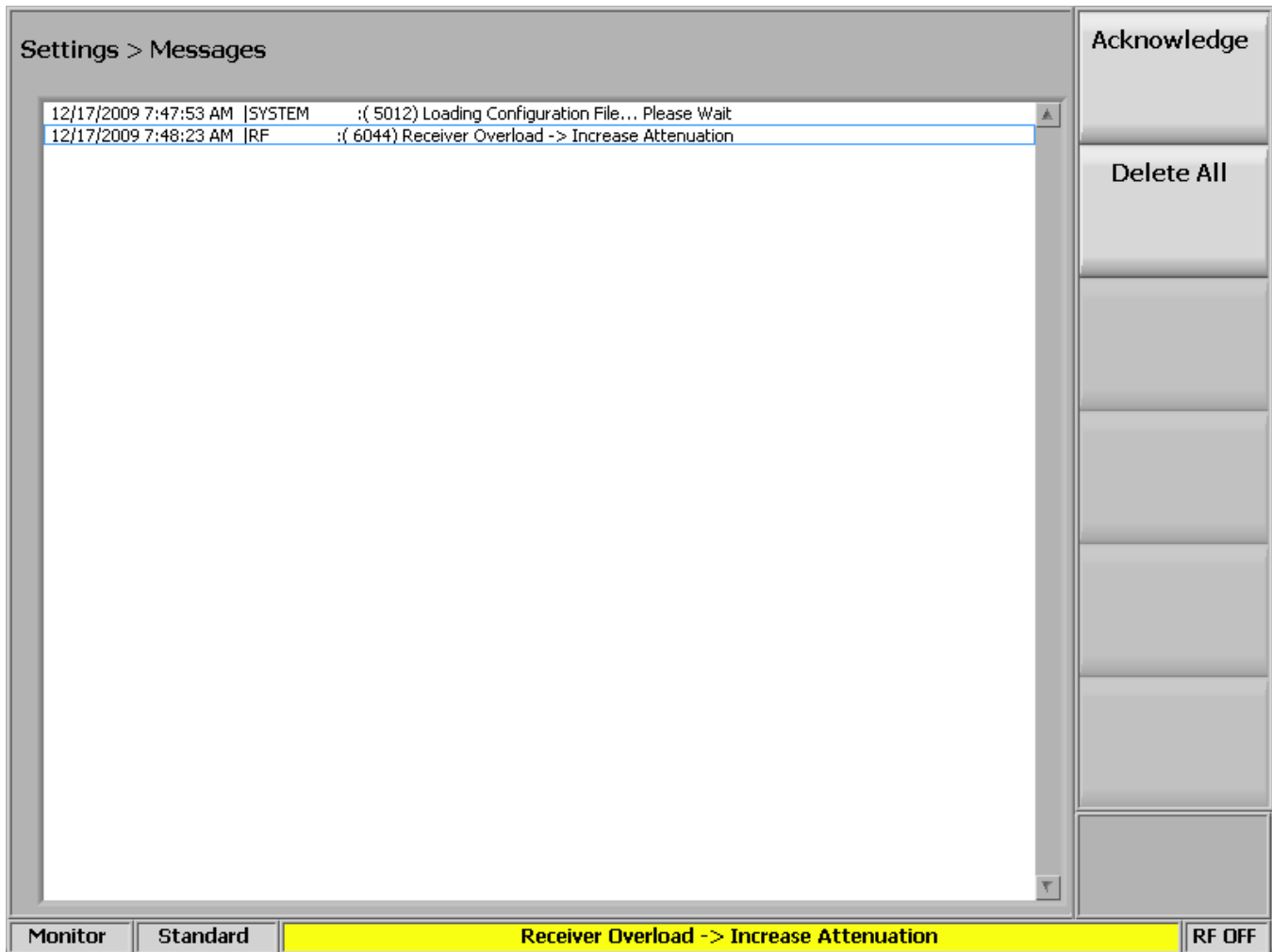
Figure 3.2.9.4-1   Submenu after pressing Messages soft key in the Settings menu

Acknowledge

Pressing this soft key removes the highlighted message from being displayed on the message bar. Use the spin knob or up/down arrow keys to select a message.

Delete All

Pressing this soft key removes all messages from the message log and message bar.

3.2.9.5   About

The About soft key loads a submenu that displays the current version of operational software on the R8000. This information is important when interacting with General Dynamics personnel to resolve technical issues or determine if a firmware upgrade is required. Figure 3.2.9.5-1 shows the submenu and current subsystem firmware versions after pressing the About soft key in the Settings menu.

Settings > About

R8000
Communications System Analyzer

GENERAL DYNAMICS
SATCOM Technologies

Search for Updates

	Version		Model No. R8000A3111-1101-000
System:	1.6.2.0		
Application:	1.6.2.0		Serial No.
Dynamic Link Library:	1.0.3.0		
Signal Service Provider:	1.34.2.0		
Sound Device Interface:	1.0.1.0		Communication Protocols:
Firmware:	1.4.0.0	Control	MOTOTRBO™	1.0.1.0
	1.2.0.0	Comm	Project 25	1.0.3.0
	1.5.0.0	TX		
	1.2.0.0	RX		
	1.17.3.0	BIOS		
Operating System:	3.1.14.0		

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Download software updates at
www.gdsatcom.com/_private/cte/r8000_software_upgrades.php

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Monitor   Standard   RF OFF

Figure 3.2.9.5-1   Submenu after pressing About soft key in the Settings menu

3.2.9.5.1 Search for Updates

The R8000 firmware can be upgraded in the field using a USB Flash Drive. *Caution: firmware changes can significantly affect analyzer operation and should be performed carefully. An improperly executed firmware upgrade can render the analyzer inoperable. It is recommended that General Dynamics support personnel be consulted and involved in firmware upgrades of the R8000.*

89
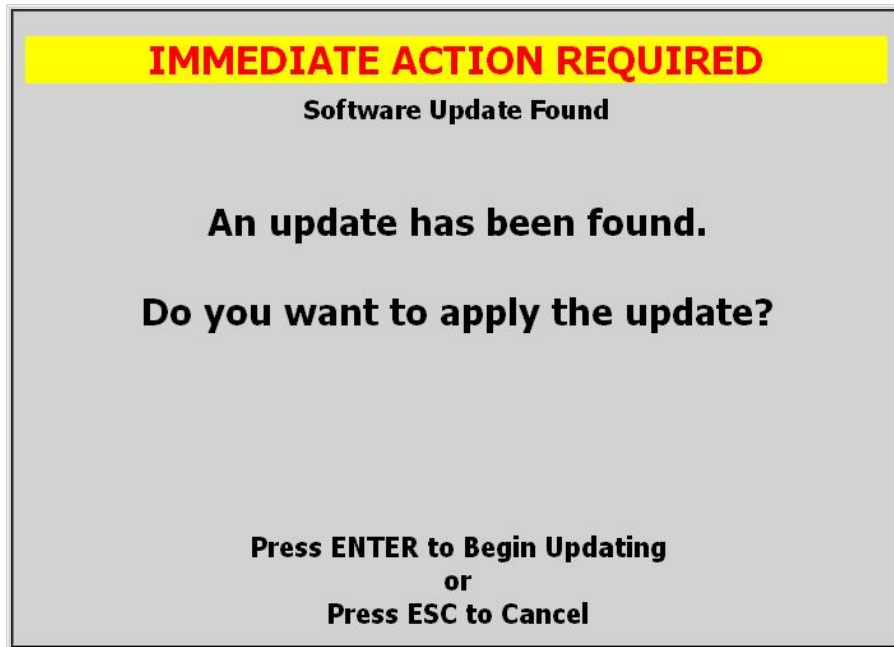
Figure 3.2.9.5.1-1Alert screen as R8000 finds a valid update on a USB flash drive

Pressing the Search for Updates soft key initiates a search for firmware updates on a USB Flash Drive attached to the any of the analyzer's USB ports. **Note:** *In order for the R8000 to recognize an attached Flash Drive it is important to have any security features such as password protection or encryption disabled.* **Details of the firmware update process are not included in this manual since they tend to evolve with analyzer development. The latest and correct update procedure is provided with each firmware revision made available to users.**

3.2.9.6   Options

Pressing this soft key displays all the installed operating options on the R8000. These include enhanced features for the main R8000 system along with additional radio communication protocols or special test functions. - see Figure 3.2.9.6-1.
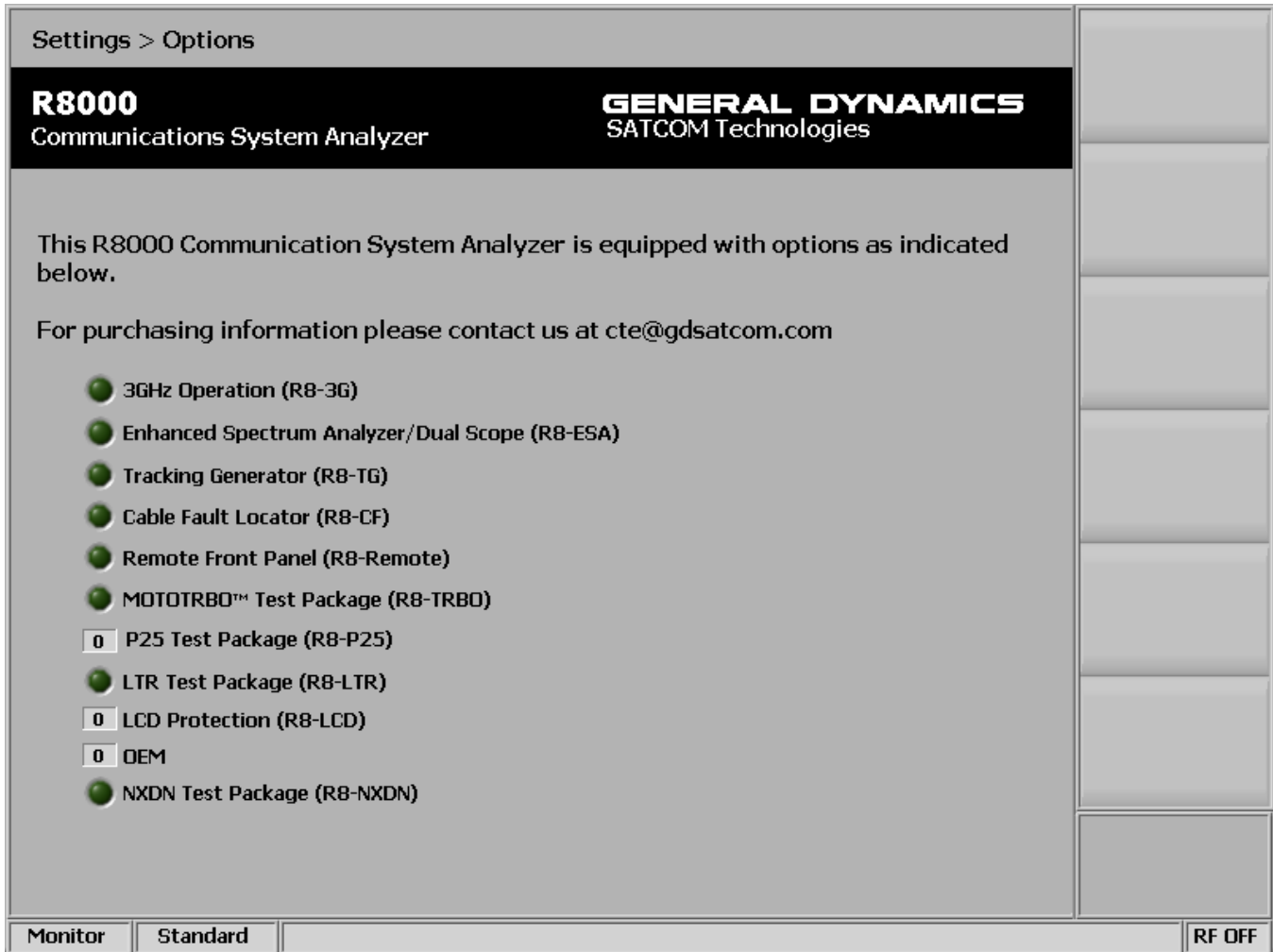
Figure 3.2.9.6-1   Submenu after pressing Options soft key in the Settings menu

4   REMOTE OPERATION

This section describes the Remote Front Panel option (R8-Remote). Operation of the R8000 from another location is possible from a web browser via a TCP/IP network. Requirements for setup follow:

1. R8000 unit with AC power adapter

2. USB keyboard

3. Ethernet 10/100Base-T patch cable

4. Ethernet 10/100Base-T network

5. DHCP server (for operation over routed networks)

6. Network technician and/or administrator

7. Computer with network connectivity and administrative privileges
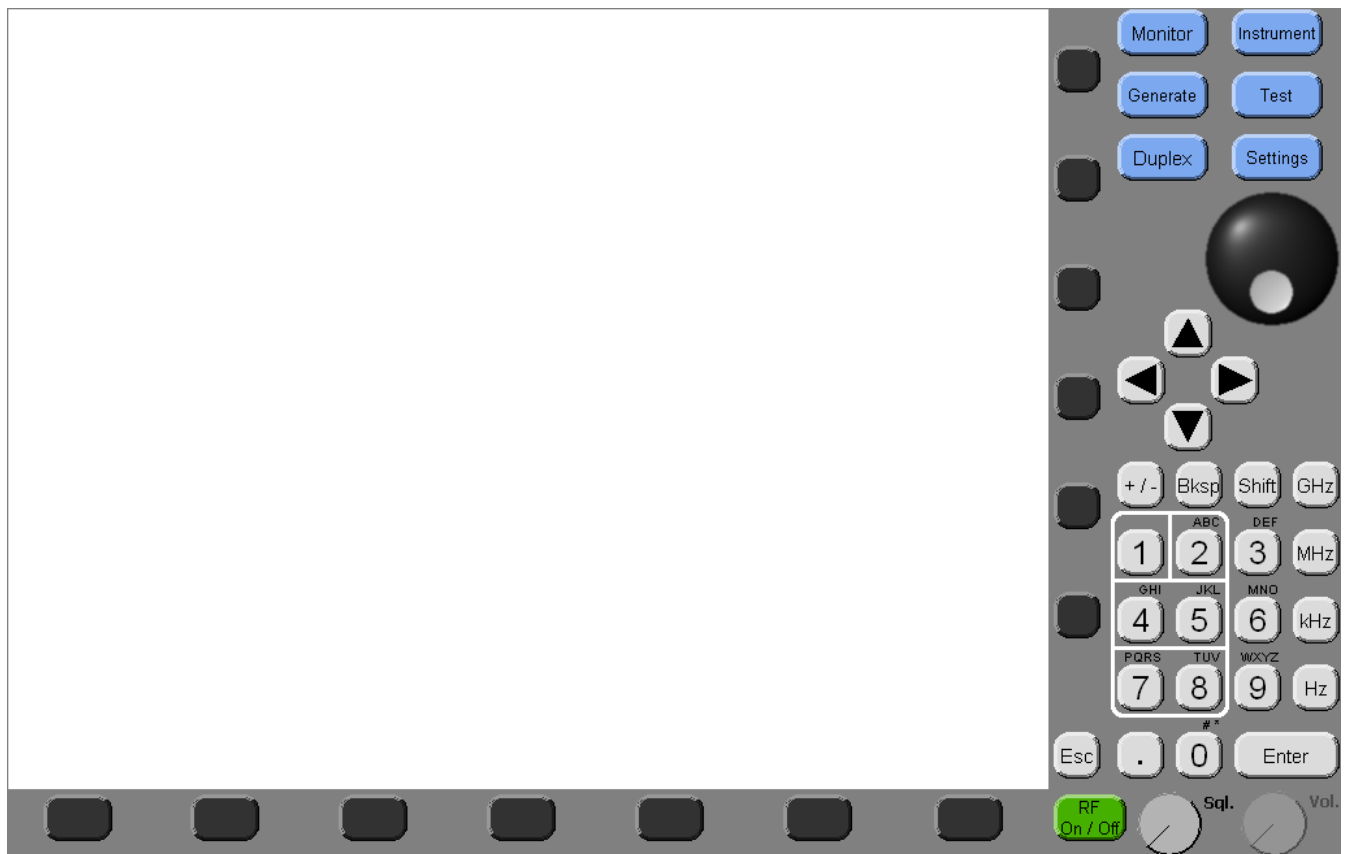
Figure 4-1 Remote Front Panel

4.1   BIOS Power-loss Setup

A BIOS setting must be changed for the unit to turn back on automatically after losing power in order to resume operation remotely. Initially, the R8000 is configured to remain off when power is restored. Follow the procedure below to change the power-loss behavior.

1. Turn off the R8000 power.

2. Connect a USB Keyboard to an R8000 USB port.

3. Hold down the keyboard's Delete key.

4. Turn on the R8000 power and continue to hold down the Delete key until prompted for a password.

CAUTION

Do NOT turn off the R8000 power while it is booting. If the Delete key was not depressed in time to start the BIOS SETUP UTILITY, allow the unit to finish booting then turn off the R8000 power and try again.

5. At the "Enter CURRENT Password:" prompt, press the Enter key.

6. In the "BIOS SETUP UTILITY", use the right arrow key to select the Boot screen.

7. In the Boot screen, use the down arrow key to select the "Power Loss Control" item at the bottom of the "Boot Settings Configuration" section.

8. Press the +/- key to select the desired setting: Remain Off, Turn On, or Last State.

Note: Last State causes the unit to turn back on as soon as power is restored after losing power. Turn On will cause the unit to turn on when power is restored even if it had been turned off when power was lost.

9. Press the keyboard's F10 key.

10. At the "Save configuration changes and exit setup?" prompt, press the Enter key.

11. Disconnect the keyboard.

4.2 DHCP Server Setup

The DHCP server must assign an IP address for the R8000 to be entered into the Internet browser (see section 4.4). Obtain assistance from your network technician or administrator. Three common scenarios are listed below.

1. The DHCP server assigns the next available IP address to the R8000 for some duration (lease). The address is displayed by the R8000 on the Network Settings screen. The address may not be valid if the lease expires or it may change if the unit reboots. Obtaining a new address from a remote location may be difficult, e.g. connecting to the DHCP server to obtain it.

2. (Recommended) The DHCP server assigns a fixed IP address for the specific physical address (MAC address) of the R8000. That IP address is always valid (e.g. 10.20.30.40).

3. The DHCP server assigns an IP address to the R8000. The address is given a fixed name by DNS. That name is always valid even if the IP address changes. Instead of entering the IP address into the browser, the name may be entered (e.g. unit1.company.com).

4. No DHCP server is present. The R8000 supports Automatic Private IP Addressing (APIPA), appropriate for simple networks that have only one subnet. With APIPA, if no DHCP server is available, the R8000 automatically assigns itself a private IP address. If a DHCP server later becomes available, the R8000 changes its IP address to one obtained from the DHCP server. Using APIPA, the R8000 assigns itself an IP address from a range reserved for authorized

private class B network addresses (169.254.0.1 through 169.254.255.254), with a subnet mask of 255.255.0.0; it does not assign a default gateway.

4.3   Network Port Setup

The following procedure documents the configuration of the R8000 Communications System Analyzer network port.

1. Confirm the network cable is connected

2. Turn the R8000 on (press the green power button on the front of the R8000 unit) and wait for the boot sequence to complete

3. Press the Settings navigation button

4. Press the "Network Setup" soft key (see section 3.2.9.3   Network   Settings   for   Remote Operation)

5. Press the "Network Connection" soft key

6. Press the Enable soft key (to enable the network connection)

7. Read the warning message (see Figure 4.3-1) and press Enter

<div align="center">

CAUTION

When the network connection is enabled, the R8000 may be controlled by other computers on the network without restriction. It is strongly recommended that the R8000 be protected from unauthorized access through the use of external security measures.

</div>

<div align="center">Figure 4.3-1   Network Connection Security Alert</div>

8. Observe the green indicator below the configuration data fields that reads "Configuration In Progress"

9. Wait several seconds for the configuration to complete. The R8000 remembers the previously set network settings.

Note: If a DHCP server does not respond, the R8000 may display 000.000.000.000 values for the IP Address, Subnet Mask, and Default Gateway until APIPA values are displayed several more seconds later.

10. DHCP must be On; it is On by default when the Network Connection is enabled for the first time. If it is Off, turn it On and Apply Network Changes.

CAUTION

When DHCP is used to configure the network interface, the R8000 may be controlled by computers on local or external networks.

11. Record the IP Address configuration data field for use later (see section 4.4)

4.4 Computer Setup

The R8000 provides a home page with hyperlinks for computer setup and remote use. Internet browser software is required to access the home page. The internet address of the home page must be typed into the browser. The address consists of the R8000 IP address (see section 4.3.10), the port number (8000), and the name of the home page (R8000.html). Examples:

1. http://10.20.30.40:8000/R8000.html

2. http://unit1.company.com:8000/R8000.html (if it was given a name)

Note: If the web pages on the R8000 are changed by an R8000 update, local copies in the computer's browser cache may have to be updated manually, e.g. by pressing the browser's Refresh button.

4.4.1 Setup

3rd-party software must be installed on the computer to control the R8000. The software is National Instruments' NI LabVIEW Run-Time Engine 8.2.1 (Web Browser Only). Various links to the software are provided. Setup via Intranet R8000 installs it from the R8000 (recommended); the other links require Internet access to install it from NI. Select the desired method to download the application supporting file, LVRunTimeEng.exe (~24MB). Either Open (run) the file directly or Save it to your computer and run it from there. Perform the installation as directed. The default settings in the WinZip Self-Extractor window are acceptable; press the Unzip button to install the program. The program will be listed in the Control Panel, Add or Remove Programs.

NOTE

To setup a remote computer that is not yet connected to an R8000, obtain NI LabVIEW Run-Time Engine 8.2.1 (Web Browser Only) with a computer that has Internet access:
http://joule.ni.com/nidu/cds/view/p/id/550 or ftp://ftp.ni.com/support/labview/runtime/windows/8.2
For an operating system or language other than Windows/English click here.

CAUTION

It is recommended that only one browser tab or window be used to access the R8000 in order to reduce the potential of losing control of the access license for the single point of control.

4.4.2 Control

One client may view the R8000 display and control the interface with a computer mouse (see Figure 4-1). Controlling the unit remotely does not prevent control locally and vice versa. Java, ActiveX, and 3rd-party software are required. Minimum network bandwidth is 1.5MB/s.

4.4.2.1   Software Requirements

1. Allow Java scripts to run

2. Allow ActiveX controls to run

3. Install 3rd-party software (see section 4.4.1 Setup)

4. Display resolution 1024x768 pixels (minimum)

4.4.2.2   Interface Differences

1. The graphical update rate is slower and depends on network latency

2. Calibration, which requires that RF connections be removed, is not supported

3. Updates, which requires that a USB drive be inserted, are not supported

4. The following user-interface items are not supported: microphone, speaker, volume knob, squelch LED, and power button

4.5   Disable Remote Access

1. Press the Settings navigation button

2. Press the "Network Setup" soft key (see section 3.2.9.3   Network   Settings   for   Remote Operation)

3. Press the "Network Connection" soft key

4. Press the Disable soft key

4.6   Verification / Troubleshooting Information

1. The R8000 responds to ICMP ping. Default gateway connectivity questions are best resolved by confirming that both local and remote pings to the R8000 succeed.

2. The Remote Front Panel application communicates with the R8000 via TCP port 8000. If the network is protected by one or more firewalls, ensure that the network configuration does not block access to the R8000.

3. R8000: Network Configuration Failed (6002) message when applying network changes. The DHCP server may have responded late. The interface could be functional afterwards.

4. Browser: Requested VI is not loaded into memory on the server computer. The R8000 Remote Front Panel (R8-Remote) option may not be enabled; verify by pressing the R8000 Settings hard key then the Options soft key. If the R8-Remote option is enabled, the R8000 Remote Front Panel Control page may have been loaded or refreshed too early. Wait until the R8000 has finished starting.

5. Browser: Any of the following messages may occur as a result of the R8000 losing power, being turned off, being disconnected from the network, the network connection being disabled, or network settings being changed. Verify R8000 power and settings then try again.
   ▪ Downloading panel. 0.00% of 0 bytes.
   ▪ Remote panel connection is closed

- Fatal error occurred during operation, closing connection
- The connection with the server has been broken.
- Server #.#.#.# has disconnected client for unknown reason.

5 TEST APPLICATIONS

This section contains information on typical test setups to perform some of the more common radio tests using the R8000 Series Communications System Analyzer. General Dynamics takes no responsibility for application accuracy, applicability, or safety. Always refer to your own transceiver's service manual for recommended test methods and specifications.

5.1 FM Transmitter Testing

The R8000 has extensive capability for evaluating the performance of FM transmitters. However, detailed instructions for the wide variety of transmitter types are outside the scope of this manual. This section will outline basic FM transmitter testing and focus on fundamental items of importance such as transmit power, carrier frequency, and voice quality measurements.

5.1.1 Basic FM Transmitter Testing – initial setup

Refer to Figure 5.1.1-1. Connect the analyzer's RF I/O port to the RF output of the transmitter under test. Connect the analyzer's MOD In/Out jack to the microphone audio input of the transmitter under test. Access to the microphone input is often provided through a special interface connector on the radio used for testing purposes. Refer to your radio's service manual.

*Caution: For transmit power output measurements connect the transmitter under test only to the analyzer's RF I/O port. **Do not connect it to the ANTENNA port**. The ANTENNA port is used for low level signals or those captured with an antenna during "Off-The -Air" reception*
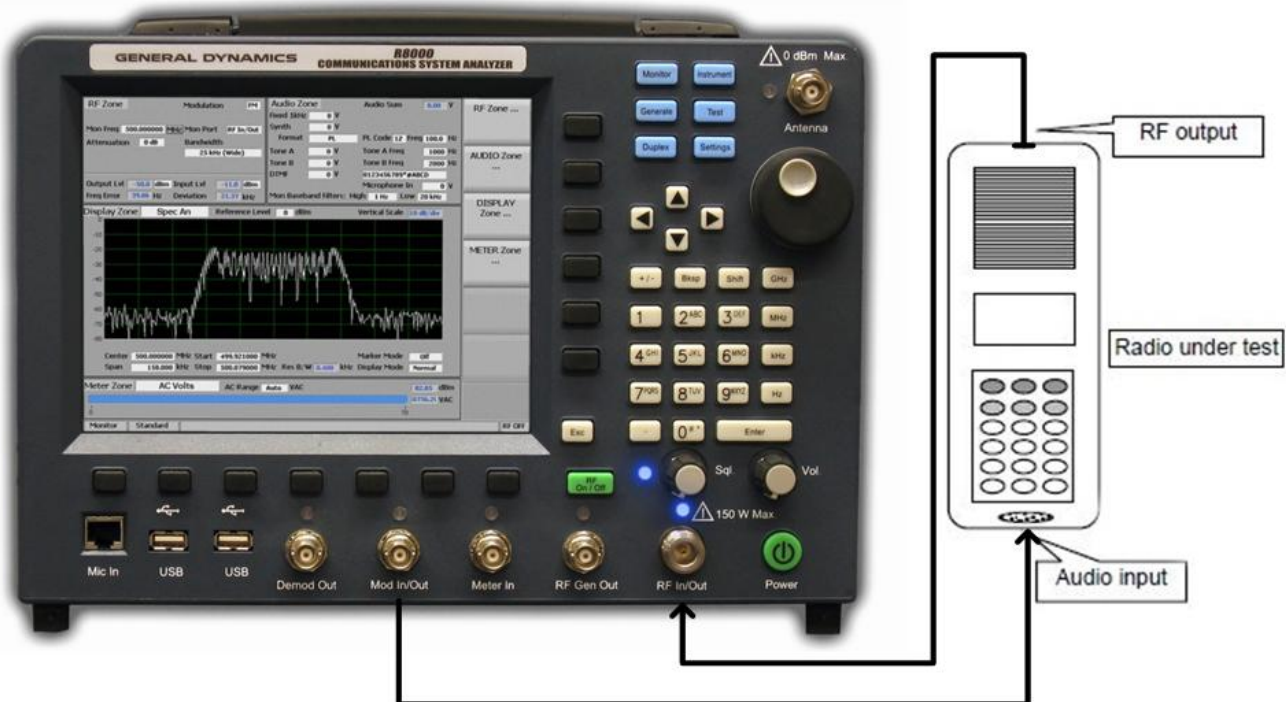
Figure 5.1.1-1   Setup for FM Transmitter testing

5.1.2 Transmit Power, Frequency, and Frequency Deviation Measurements

Place the R8000 in Monitor mode by pressing the Monitor front panel hard key. Press the RF Zone soft key and set the Monitor Frequency to that of the radio under test and the Modulation Type to FM. For best accuracy set the Bandwidth just wide enough to cover the channel spacing allocated to the radio under test.

To eliminate the background noise from the R8000 when the transmitter isn't keyed, adjust the SQUELCH control appropriately. With the VOLUME control set to a comfortable listening level turn the threshold control clockwise to just quiet the R8000 receiver. For low-power transmitters it may be necessary to reduce the RF attenuation value to un-squelch the monitor when the transmitter is keyed. Too high an attenuation setting or too tight a squelch setting also inhibits the frequency error reading. Deviation and frequency error measurements require sufficient signal level from the radio to fully quiet the analyzer's receiver. Accuracy is best when the signal levels are 10 dB or higher than that required to quiet the receiver. Use good quality cable of minimum length to prevent cable-loss which can be a significant factor in RF power measurements, especially at UHF and above.

Key the transmitter and read the power (Input Lvl), frequency error (Freq Error) and deviation (Deviation) in the RF Zone section of the R8000 main screen. Refer to your radio's service manual to determine if power, frequency, and deviation are within specified limits and determine if any adjustments are required.

5.1.3   Modulation Measurements

Place the R8000 in Monitor mode by pressing the Monitor front panel hard key. Press the RF Zone soft key and set the Monitor Frequency and Modulation Type to match that of the radio under test. For best accuracy set the Bandwidth just wide enough to cover the channel spacing allocated to the radio under test.

CTCSS (Continuous Tone-Coded Squelch System) test

Enable the CTCSS mode on the radio (called PL or DPL on Motorola units). Enable the 300 Hz low pass filter on the R8000 to prevent external pickup in the microphone from causing deviation errors. Key the transmitter and read the deviation of the PL/DPL tone. Refer to the radio's service manual to determine if an adjustment is required.

Voice frequency modulation and quality test

In the R8000 Audio Zone set the High Pass Filter to 300 Hz and the Low Pass Filter to 3 kHz. Set the Fixed 1 kHz Mode to continuous. Set the Fixed 1 kHz level at the R8000 MOD In/Out connector to the minimum required for proper microphone sensitivity as specified in the radio service manual. ***Note: The voltage levels displayed in the Audio Zone are peak open circuit voltages.*** Verify proper microphone sensitivity by reading the deviation and comparing to the service manual specification to determine if adjustments are needed.

Set the Fixed 1 kHz level at the R8000 MOD In/Out connector to the maximum required for proper microphone sensitivity as specified in the radio service manual. Navigate to the R8000 METER Zone and select the Internal Distortion meter. Read the percent distortion and compare to the service manual specification to determine if adjustments are needed.

5.1.4   Off-The-Air Measurements

Place the R8000 in Monitor mode by pressing the Monitor front panel hard key. Press the RF Zone soft key and set the Monitor Frequency and Modulation Type to match that of the 2-way radio or transmitter under test. For best accuracy set the Bandwidth just wide enough to cover the channel spacing allocated to the radio under test. In the R8000 Audio Zone set the High Pass Filter to 300 Hz and the Low Pass Filter to 3 kHz.

Connect the supplied whip antenna to the R8000 ANTENNA port. Connect a dummy RF load or hook the radio's working antenna into the antenna port of the radio. Adjust the squelch control to ensure the incoming radio signal will un-squelch the monitor. Otherwise rotate the knob fully counter-clockwise (squelch off) and lower the volume if the background noise is excessive.

Key the radio or activate the transmitter being monitored. Deviation and frequency error measurements require sufficient signal level to fully quiet the analyzer's receiver. Accuracy is best when the signal levels are 10 dB or higher than the receiver's quieting threshold. Read the signal level (Input Lvl), frequency error (Freq Error), and deviation (Deviation) in the RF Zone section of the R8000 main screen.

5.2   FM Receiver Testing

The R8000 has extensive capability for evaluating the performance of FM receivers. However, detailed instructions for the wide variety of receiver types are outside the scope of this manual. This section will outline basic FM receiver testing and focus on fundamental items of importance such as receiver sensitivity, frequency accuracy, audio distortion, and squelch sensitivity.

5.2.1   Basic FM Receiver Testing – initial setup

Refer to Figure 5.2.1-1. Connect the analyzer's RF I/O port to the RF input of the radio or receiver under test. Connect the radio's speaker/audio output to the analyzer's Meter In port.   Access to the speaker/audio output is often provided through a special interface connector on the radio used for testing purposes. Refer to your radio's service manual.

CAUTION

The analyzer's Meter In port is unbalanced (ground referenced). On some radios grounding the speaker output will damage the audio circuitry. Use an appropriate interface to measure balanced or DC powered audio circuits with the Meter In port of the R8000. Typically this requires the use of an isolation transformer which is an optional R8000 accessory.
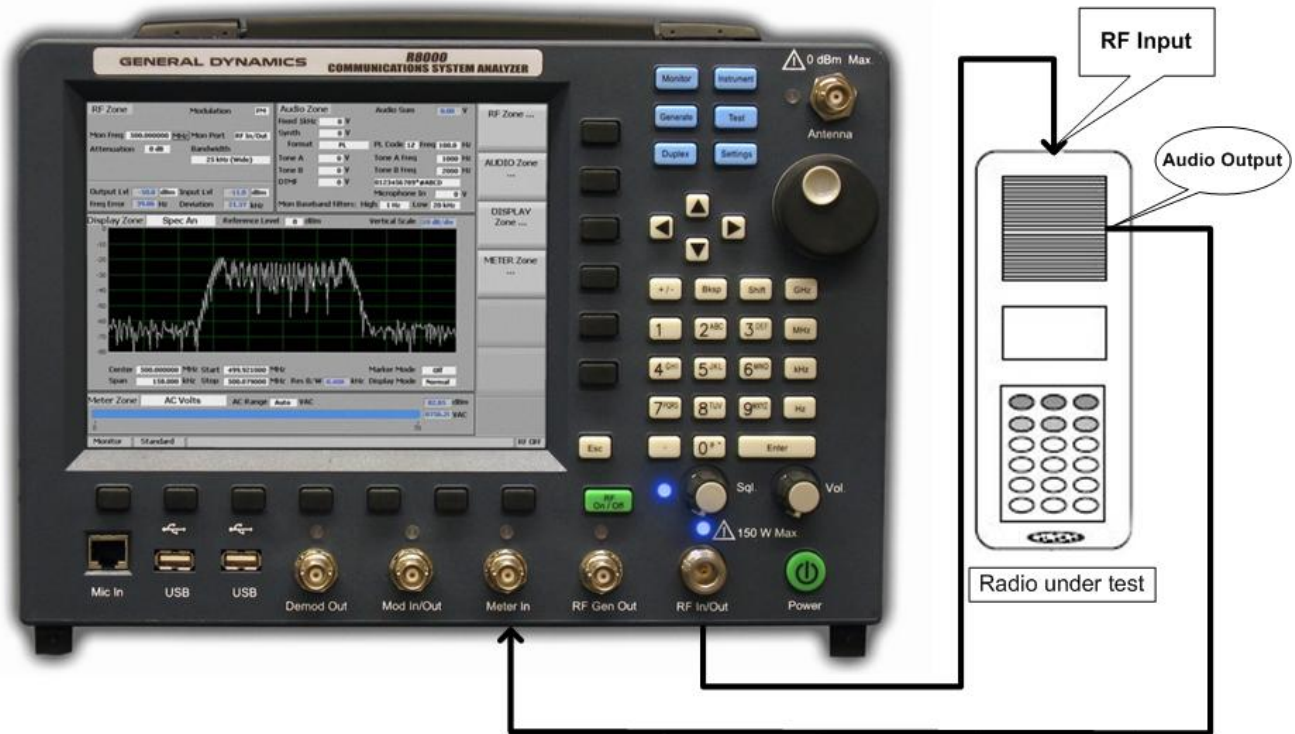
Figure 5.2.1-1   Setup for FM Receiver testing

Place the R8000 in Generator mode by pressing the Generate front panel hard key. Press the RF Zone soft key and set the Generator Frequency to match that of the radio under test and the Modulation Type to FM. Set the Bandwidth just wide enough to cover the channel spacing allocated to the radio under test.

For initial setup set the RF output level to at least 30 dB above the receiver's sensitivity threshold. A starting level of -80 dBm is recommended. Navigate to the AUDIO Zone and set the Fixed 1 kHz Mode to Continuous. Set the Fixed 1 kHz Level to 60% of the system deviation for the receiver. For narrowband 2 way radios a typical setting is 3 kHz. Page through the submenu and set the High Pass Filter to 300 Hz and the Low Pass Filter to 3 kHz.

Navigate to the METER Zone and select the AC Volts meter. Adjust the radio for rated power output by calculating the voltage needed across the load resistor/speaker in use. Adjust the radio volume until the meter reads the calculated voltage.

Navigate to the Display Zone and select the Oscilloscope display. Adjust the vertical and horizontal settings and observe the recovered audio sine wave from the receiver.

5.2.2   Receiver Distortion Measurement

Navigate to the METER Zone and select the External Distortion meter. Read the displayed distortion in percent and compare the radio's service manual specification to determine if any repairs or adjustments are needed.

5.2.3   SINAD Measurement

Select the SINAD meter and note the bar graph and digital indication in dB. You may need to adjust the radio's volume until the signal level is within the meter's range. Navigate to the RF Zone and adjust the

Generator level until the reading averages 12 dB. Note the RF level required for a 12 dB SINAD and compare to the radio's specification. Typical values for 2 way radios range from -100 to -120 dBm.

5.2.4   Modulation Acceptance Bandwidth

Set the radio's volume control to 10% of its rated output. Adjust the R8000 RF output level 6 dB above that needed for 12 dB SINAD as determined in 5.2.3 (a 6 dB increase is double the RF voltage). Increase the deviation level until the SINAD meter returns to 12 dB. Read the deviation and compare to the radio's specification.

5.2.5   Receiver Sensitivity Testing (20 dB Quieting)

Place the R8000 in Monitor mode to remove input signal from the radio. In the METER Zone select the AC Voltmeter. Make certain the radio is un-squelched and adjust the volume control to feed noise to the analyzer at approximately ¼ the rated audio power. Record the noise reading in dBm.

Switch the R8000 to Generate mode, Navigate to the Audio Zone and turn off all modulation. In the RF Zone adjust the RF output level until the noise reading on the AC voltmeter is 20 dB less than the recorded value. Refer to the radio's service manual and determine if any adjustments or repairs are needed.

5.2.6   Squelch Sensitivity Test

Threshold Squelch Sensitivity

Place the R8000 in Monitor mode to remove input signal from the radio. Disable the radio's PL/DPL squelch if provided. Carefully adjust the radio's squelch control to the point where the receiver just quiets and no further.

Switch the R8000 to Generate Mode, navigate to the Audio Zone and turn off all modulation. In the RF Zone adjust the RF output level below that required to un-squelch the radio's receiver. Gradually raise the level until the receiver just un-squelches. This is the threshold squelch sensitivity of the radio.

Tight Squelch Sensitivity

Repeat the test after adjusting the radio's squelch to the tight setting – this is either a maximum or pre-determined higher setting used to reject weak noisy signals. Refer to the radio's service manual and determine if any adjustments or repair are needed.

PL/DPL Squelch Sensitivity

With the R8000 in Generate mode navigate to the Audio Zone. Change the Synth Format to PL or DPL and enter the appropriate code for the radio under test in the PL or DPL Table submenu. See Table B-3 and B-5 in Appendix B for standard codes used in PL/DPL enabled systems. Turn the Synth mode to On and adjust the level to provide a 750 Hz deviation or that specified in the manufacturer's specifications.

Enable the radio's PL/DPL squelch mode and fully open the squelch control (minimum setting or fully counter-clockwise on many radios).   In the RF Zone gradually raise the RF output level until the receiver just breaks or opens the squelch. Refer to the radio's service manual and determine if any adjustments or repair are needed.

5.3   Cable Fault Testing

The R8000 Cable Fault Locator is used with the Cable Fault Option Kit to determine distance to a fault or termination mismatch in RF cables. The kit contains a resistive RF power splitter, a 50 Ohm load, and two male BNC cables for connecting the splitter to the R8000 analyzer. Figure 5.3-1 shows the connections to the analyzer.
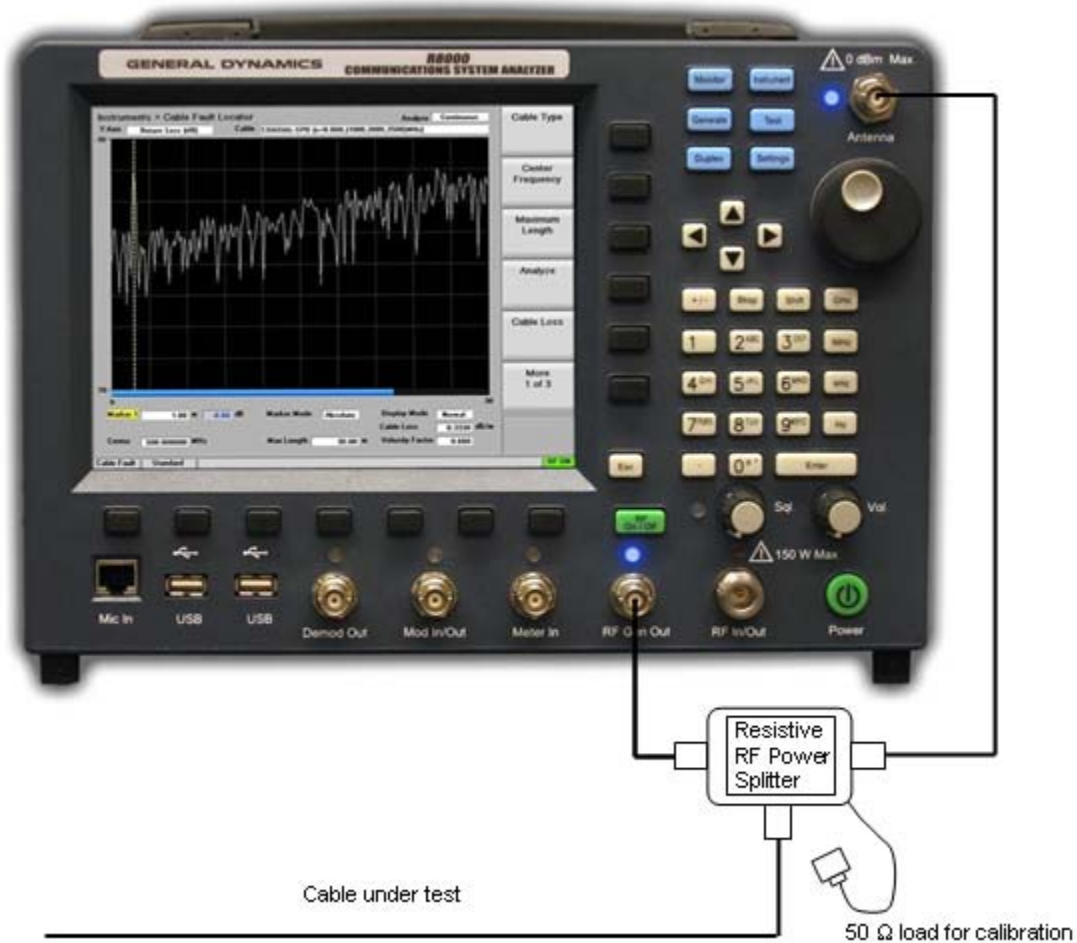
Figure 5.3-1   Connections for Cable Fault testing

5.3.1   Cable Fault Locator Setup and Operation

For accurate results the R8000 Cable Fault Locator must be configured with four cable parameters before testing. These are the Center Frequency, Maximum Length, Cable Loss, and Velocity Factor.

Center Frequency
The Cable Fault Locator analyzes a cable by measuring signal reflections as the R8000 sweeps its generator over a band of frequencies. The Center Frequency defines the center of the band and is ideally the center of the cable's operational frequency.

Maximum Length
This is the maximum expected length of the cable with an additional safety factor. Underestimating the length can cause imperfections to appear at the wrong location. Overestimating reduces the distance resolution.

Cable Loss

Defines the power lost per unit length of cable. The return loss measurement is compensated for by this factor to ensure accuracy.

Velocity Factor

This is the relative velocity of the RF electromagnetic wave traveling through the cable as compared to *c*, the velocity of light. Typical values range between 0.66 and 0.84

Procedure

Start the Cable Fault Locator by pressing the Instrument key. Select "Cable Fault Locator…" from the vertical submenu – you may have to first choose "More 1 of 2". The display should appear as shown in Figure 5.3.1-1.
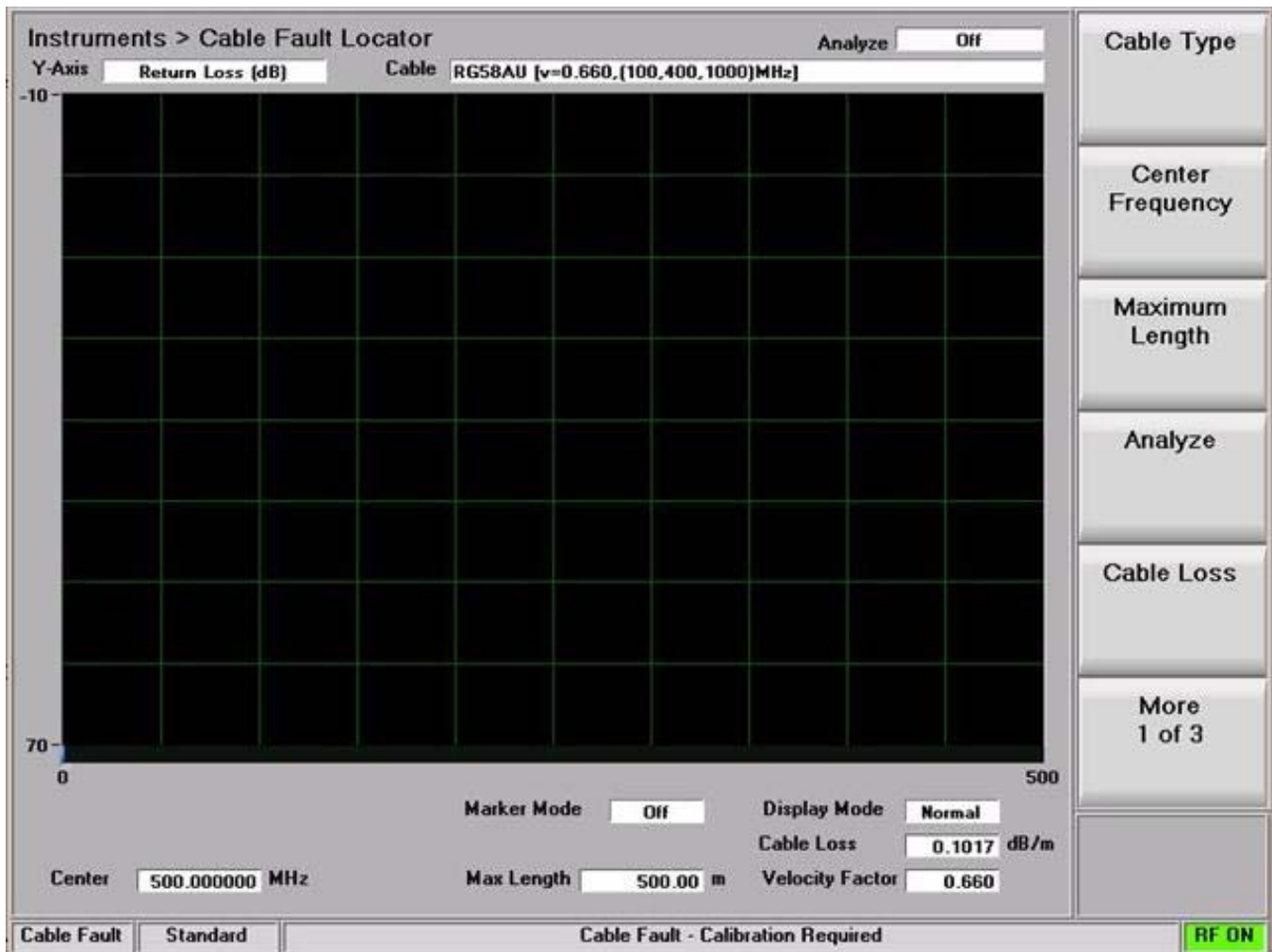
Figure 5.3.1-1   Cable Fault Instrument Display

Enter the Center Frequency, Maximum Length, Cable Loss, and Velocity Factor for the cable under test.

Note: For frequent tests or multiple frequencies it's advantageous to save these parameters using the "Add Cable Type" soft key function. This allows custom parameter entry for a user defined cable not

on the standard selection list. A submenu allows entering a "Cable Description" and associated cable specifications, including attenuation factors for 3 separate frequencies. "Next" advances the menu to each successive Frequency/Nominal Attenuation entry, and "Back" returns to the previous entry menu. Once the 3rd frequency point is populated with data, "Save New Cable" stores the entry in R8000 memory. The user defined cable will now appear in the "Cable Type" selection window.

Connect the Power Splitter to the R8000 as shown in Figure 5.3-1, but leave the Cable Under Test disconnected.

Note: The Power Splitter has a symmetrical internal configuration, so connections from the R8000 and cable under test can be made to any port on the Power Splitter (in other words all Power Splitter ports are interchangeable). However it may be physically convenient to connect them as follows: R8000 RF Gen Out to Power Splitter port 1; R8000 Antenna to Power Splitter port 2; Cable under test to Power Splitter port S.

Connect the 50 Ohm load to the open port on the Power splitter and start a calibration sweep by pressing "Analyze" then "Calibrate". The calibration sweep takes approximately 1 minute to complete. *Note: Whenever the Center Frequency, Maximum Length, or Velocity Factor are changed the Cable Fault instrument will force a recalibration before performing an analysis sweep.*

Remove the 50 Ohm load and connect the cable to be tested - choose either Single Sweep or Continuous in the "Analyze" submenu. Each sweep takes approximately 1 minute to complete and the display will update with a plot of return loss vs. distance.

Appendix A – List of Abbreviations and Acronyms

A	Ampere
AC	Alternating Current
AM	Amplitude Modulation
ANT	Antenna
APCO	Association of Public-Safety Communications Officials
APIPA	Automatic Private IP Addressing
ATTEN	Attenuation
AUTO	Automatic
BATT	Battery
BER	Bit Error Rate
BIOS	Basic Input/Output System
BNC	Coaxial RF Connector
BW	Bandwidth
C	Celsius
C4FM	Continuous 4 Level FM
CAL	Calibrate
CCIR	International Radio Consultative Committee
CCITT	International Telegraph and Telephone Consultative Committee
Cm	Centimeters
CMOS	Complementary Metal Oxide Semiconductor
Cntr	Counter
CRLF	Carriage-return-line feed
CTCSS	Continuous Tone-Coded Squelch System
CW	Continuous Wave
dB	Decibel
dBc	Decibel (referred to carrier)
dBm	Decibel (referred to 1 mW into 50 Ω)
DC	Direct Current
Demod	Demodulation
DEV	Deviation

DHCP	Dynamic Host Configuration Protocol
Disp	Dispersion
DIST	Distortion
Div	Division
DMR	Digital Mobile Radio
DNS	Domain Name System/Server
DPL	Digital Private Line, a Motorola registered trademark
DTMF	Dual-tone multi-frequency
Dur	Duration
DVM	Digital Voltmeter
EEA	Electronic Engineering Association
EIA	Electronics Industry Association
Ext'l	External
FFT	Fast Fourier Transform
FM	Frequency Modulation
FREQ	Frequency
FSK	Frequency Shift Keying
FTP	File Transfer Protocol
GEN	Generate
GHz	Gigahertz
Horiz	Horizontal
HPF	High Pass Filter
HTTP	Hyper-Text Transfer Protocol
Hz	Hertz
i.e.	that is to say; in other words
I/O	Input/Output
IC	Integrated Circuit
ICMP	Internet Control Message Protocol
ID	Identification
IDC	Instantaneous Deviation Control
IEEE	Institute of Electrical and Electronics Engineers

IF	Intermediate Frequency		P25	Project 25
IMTS	Improved Mobile Telephone System		PRT	Print
IP	Internet Protocol		REF	Reference
Kohm	Kilo ohm		RF	Radio Frequency
kHz	Kilohertz		RMS	Root-Mean-Square
LCD	Liquid Crystal Display		Rng	Range
LED	Light-Emitting Diode		RS	Receiver Specification
LPF	Low Pass Filter		RSS	Radio Service Software
Lvl	Level		S/N	Signal to Noise
MAC	Media Access Control		SEC	Second
MHz	Megahertz		SEQ	Sequence
MIC	Microphone		SINAD	Ratio of (Signal + Noise + Distortion) / (Noise + Distortion)
MIN	Minimum			
MOD	Modulation		SPF	Special Function
MON	Monitor		SSB	Single Sideband
us	Microsecond		STD	Standard
MB	Megabytes		SW	Switch
ms	Millisecond		SWP	Sweep
Mtr	Metering		Synth	Synthesizer
MTS	Mobile Telephone System		TCP	Transmission Control Protocol
mV	Millivolt		TDMA	Time Division Multiple Access
NI	National Instruments Corporation		TIA/EIA	Telecommunications Industry Association / Electronic Industries Association
uV	Microvolt			
mW	Milliwatt			
n	Number		TN	Tone
N/A	Not Applicable		Trig	Trigger
NAC	Network Access Code		TX	Transmitter
NB	Narrow Bandwidth		UHF	Ultra High Frequency
NVM	Non-volatile memory		USB	Universal Serial Bus
ORIG	Originated		V	Volts
PC	Personal Computer		VAC	Volts Alternating Current
PCT	Percent		VDC	Volts Direct Current
PL	Private Line, a Motorola registered trademark		Vert	Vertical
			VGA	Video Graphics Array
+/-	Plus or minus		vocoder	voice encoder
			VRMS	Volts (root-mean-square)

vs.	versus
W	Watts
WB	Wide Bandwidth
XCVR	Transceiver
XX	(Select Any Valid Number)
ZVEI	Zentral-Verband der Elektro-Industrie (a German Electronics Industry Association)

Appendix B – Tone and Code Specifications

Table B-1   Standard DTMF Tones

TONE GROUP	STANDARD DTMF (Hz)
LOW	697
LOW	770
LOW	852
LOW	941
HIGH	1209
HIGH	1336
HIGH	1477
HIGH	1633

Table B-2   DTMF Frequency Coding*

KEY	LOW GROUP TONE (Hz)				HIGH GROUP TONE (Hz)			
	697	770	852	941	1209	1336	1447	1633
1	•				•			
2	•					•		
3	•						•	
A	•							•
4		•			•			
5		•				•		
6		•					•	
B		•						•
7			•		•			
8			•			•		
9			•				•	
C			•					•
*				•	•			
O				•		•		
#				•			•	
D				•				•

*The analyzer has provisions for encoding and decoding 16 different keys. Each key is assigned two frequencies: one from a low tone group and one from a high tone group. Four tones are available from each group, with 16 different combinations of low and high group tones. This table shows the tone assignments of each key.

Table B-3   Private-Line (PL) Codes

CODE	FREQUENCY (Hz)
XZ	67.0
WZ	69.3
XA	71.9
WA	74.4
XB	77.0
WB	79.7
YZ	82.5
YA	85.4
YB	88.5
ZZ	91.5
ZA	94.8
ZB	97.0
1Z	100.0
1A	103.5
1B	107.2
2Z	110.9
2A	114.8
2B	118.8
3Z	123.0
3A	127.3
3B	131.8
4Z	136.5
4A	141.3
4B	146.2
5Z	151.4
5A	156.7
5B	162.2
6Z	167.9
6A	173.8
6B	179.9
7Z	186.2
7A	192.8
M1	203.5
8Z	206.5
M2	210.7
M3	218.1
M4	225.7
9Z	229.1
M5	233.6
M6	241.8
M7	250.3

Table B-4   5/6 Tone Paging Tones

DIGIT	FREQUENCY (HZ)
0	600
1	741
2	882
3	1023
4	1164
5	1305
6	1446
7	1587
8	1728
9	1869
R	459
X	2010

Table B-5   DPL Standard Codes

023	174	445
025	205	464
026	223	465
031	226	466
032	243	503
043	244	506
047	245	516
051	251	532
054	261	546
065	263	565
071	265	606
072	271	612
073	306	624
114	311	627
115	315	631
116	331	632
125	343	654
131	351	662
132	364	664
134	365	703
143	371	712
152	411	723
155	412	731
156	413	732
162	423	734
165	431	743
172	432	

Table B-6   Select V Frequencies

CHARACTER	ZVEI STD (Hz)	ZVEI MOD (Hz)	ZVEI FRENCH (Hz)	CCIR STD (Hz)	CCIR 70MS (Hz)	EEAA (Hz)
0	2400	2200	2400	1981	1981	1981
1	1060	970	1060	1124	1124	1124
2	1160	1060	1160	1197	1197	1197
3	1270	1160	1270	1275	1275	1275
4	1400	1270	1400	1358	1358	1358
5	1530	1400	1530	1446	1446	1446
6	1670	1530	1670	1540	1540	1540
7	1830	1670	1830	1640	1640	1640
8	2000	1830	2000	1747	1747	1747
9	2200	2000	2200	1860	1860	1860
G	2800	885	885	2400	2400	1055
B	810	810	810	930	930	930
C	970	2600	2600	2247	2247	2247
D	885	2800	2800	991	991	991
F	930	930	930	873	873	873
R	2600	2400	970	2110	2110	2110
N_T Tone	0	0	0	0	0	0
Length (ms)	70	70	70	100	70	40

Appendix C – R8000 Field Calibration Procedure

The R8000 series Communication Systems Analyzer has two field calibration tables, one for the RF Input and one for the RF Output. These tables are initially created at the factory and should not normally require an update in the field. However, if a problem is suspected or a software update is performed, a field calibration may be necessary.

The following procedure should be followed when performing a field calibration:

Note: The field calibration should only be performed in a stable room temperature environment of approximately 70°F.

1. Power on the R8000.
2. Operate the unit for at least 30 minutes before continuing.
3. Make sure no cables are connected to the front panel. A 50-ohm load is *not* necessary since the transmit signal is terminated internally.
4. Press the Settings hard key on the front panel.
5. Select Calibration… from the soft key menu.
6. Press Calibrate Now on the soft key menu. The R8000 unit will begin the field calibration – the process takes approximately 20 minutes. When the field calibration is complete, "Calibration Complete" will appear in the Calibration menu progress bar.

Note: The Calibration menu status for both RF Input and RF Output will indicate "Incomplete" during that part of the field calibration. Once each part is finished, the status will be marked "Complete." This feature is helpful in the event that power to the unit is lost during field calibration. Once power is restored and the Calibration menu is navigated to as described in steps 4 and 5, an "Incomplete" status will indicate that part of the field calibration did not complete successfully and the procedure should be rerun.

REVISION HISTORY

Rev. No/change	Revised By	Date	Approved By	Date	ECO#
P25/RFP Added – Rev D	B. Tanner	1/15/10	D. Bulgrien	1/15/10	9486
Updates – Rev C	B. Tanner	8/31/09	D. Fredrickson	8/31/09	9073
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