



User's Guide

2801 **Multilock**



Firmware version 1.2.0.0

boosting wireless efficiency

Table of Contents

<u>Topic</u>	<u>Page</u>
1. PRE-OPERATION OVERVIEW	1
1.1. Scope of Manual	1
1.2. Safety Summary	1
1.2.1. Instrument grounding	1
1.2.2. Unit is live when plugged in	1
1.2.3. Keep away from live circuits	1
1.2.4. Explosive atmosphere	1
1.3. Warnings and Cautions	2
1.3.1. Analyzer operating voltage	2
1.3.2. DC power source	2
1.3.3. Maximum meter in voltages	2
1.3.4. Replacement fuses	2
1.3.5. Other cautions	3
1.3.6. Replacement and disposal of batteries	3
1.3.7. User maintenance of exterior surfaces	3
1.4. Installation	3
1.4.1. Packing	3
1.4.2. Initial setup	3
2. ANALYZER OVERVIEW	5
2.1. Description	5
2.2. Technical Specifications	7
2.3. Operator Interface and Controls	7
2.3.1. Front panel control keys	8
2.3.2. Control knobs	9
2.3.3. Display and indicators	10
2.3.4. Connectors	10
3. OPERATION	13
3.1. Overview	13
3.1.1. Basic navigation and operator control	13
3.1.2. Hotkeys for quicker zone navigation in Monitor, Generate, and Duplex modes	17

3.2. Operating Instructions	18
3.2.1. MONITOR mode	18
3.2.2. GENERATOR mode	22
3.2.3. Duplex mode	24
3.2.4. Audio zone	25
3.2.5. Display zone	35
3.2.6. Meter zone	44
3.2.7. Instrument Mode with full screen displays	49
3.2.8. Test mode	55
3.2.9. Settings mode	63
4. TEST APPLICATIONS	73
4.1. FM Transmitter Testing	73
4.1.1. Basic FM transmitter testing – initial setup	73
4.1.2. Transmit power, frequency, and frequency deviation Measurements	74
4.1.3. Modulation measurements	74
4.1.4. Off-the-air measurements	74
4.2. FM Receiver Testing	75
4.2.1. Basic FM receiver testing – initial setup	76
4.2.2. Receiver distortion measurement	77
4.2.3. SINAD measurement	77
4.2.4. Modulation acceptance bandwidth	77
4.2.5. Receiver sensitivity testing (20 dB quieting)	77
4.2.6. Squelch sensitivity test	77
Appendix A – List of Abbreviations and Acronyms	79
Appendix B – Tone and Code Specifications	81
Appendix C – Network Setup	87
Appendix D – 2801 Multilock Field Calibration Procedure	91
Appendix E – Warranty and Repair	93
Warranty information	93
Equipment return instructions	94

1. PRE-OPERATION OVERVIEW

1.1. Scope of Manual

This manual contains information for the 2801 Multilock. The 2801 Multilock 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. Willtek 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 Willtek 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. Instrument grounding

The 2801 Multilock 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 2801 Multilock uses the converter’s DC negative as system ground the instrument is also connected to AC ground at the power outlet. As a result most of the external connectors on the 2801 Multilock chassis are also at AC ground potential. **To minimize shock hazard it is critical to operate the 2801 Multilock 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 2801 Multilock has been placed in a non-operating mode using the front panel Power switch. To completely remove power from the instrument 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 the instrument from all voltage sources before removing covers for adjustments, maintenance or repairs. Capacitors inside may still be charged even if the instrument 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 2801 Multilock 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 2801 Multilock 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 2801 Multilock is powered by 24 V DC and operates from a three wire AC outlet using an AC to DC adapter. **Warning: It is critical that only the adapter provided by Willtek and shipped with the instrument is used to power the 2801 Multilock. Do not substitute other adapters without first consulting Willtek 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 DC voltage up to 24 V. **Warning: Connecting the instrument's 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 instrument.**

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 V DC (2801 Multilock input impedance set to 1 M Ω).
- 15 VAC RMS /24 V DC (2801 Multilock input impedance set to 600 Ω).

1.3.4. Replacement fuses

There are no user serviceable fuses on the 2801 Multilock. The unit is internally protected against overloads and risk of fire. If the 2801 Multilock fails to operate return it to the factory or an authorized repair center for diagnosis and repair.

The 2801 Multilock RF Gen Out 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 RF Gen Out port.

1.3.5. Other cautions

Other cautions relating to the operation of the instrument 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 instrument is used in a relatively dust free environment, no other periodic maintenance should be required.

1.4. Installation

1.4.1. Packing

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

1.4.2. Initial setup

1. Place the instrument 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 instrument for easier viewing.
3. Take the power cord of the AC to DC adapter and connect to a 3-wire 100 to 240 V AC power source. Attach the cord's DC plug to the mating connector on the 2801 Multilock 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 2801 Multilock to boot up. The instrument is now ready for use. Before operating the instrument, review the operating procedures described in this manual.

CAUTION

When installing the instrument in a vehicle it is preferable to operate the 2801 Multilock 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 2801 Multilock against overload but do not protect the vehicle electrical system.

2. ANALYZER OVERVIEW

2.1. Description

The 2801 Multilock is a portable test instrument designed to monitor and service radio communications equipment over the frequency range of 400 kHz to 3 GHz. The instrument'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 2801 Multilock 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

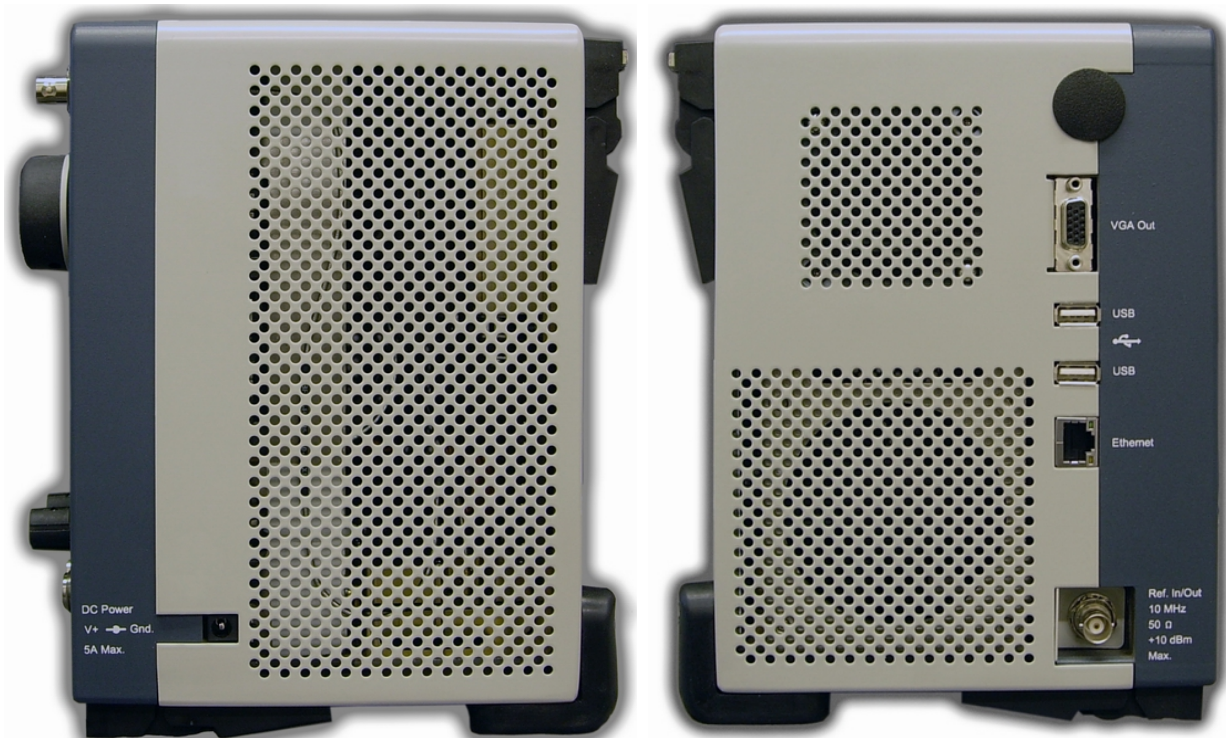


Figure 2.1-2. Left and Right Sides of the 2801 Multilock

2.2. Technical Specifications

Specifications for the AC Adapter

Input Voltage:	100 – 240 V AC
Input Current:	2.5 A maximum
Input Frequency:	50 – 60 Hz

Terminal Specifications

Demod Out:	±8 V peak
Mod In:	1V PK REF, ±8V PK
Mod Out:	±8V peak
Meter In:	70 V AC RMS / 100 V DC (1 MOhm), 15 V AC RMS / 24 V DC (600 Ohm)
RF Gen Out:	Do Not Input Power, +5 dBm maximum output, 250 kHz to 3 GHz
RF In:	50 W cont. / 150 W maximum, 250 kHz to 3 GHz
RF Out:	–30 dBm max. out, 250 kHz to 3 GHz
Antenna:	0 dBm max., 250 kHz to 3 GHz

Mechanical Specifications

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

For additional technical specifications of the 2801 Multilock, refer to the 2801 Multilock data sheet.

2.3. Operator Interface and Controls

The 2801 Multilock 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 2801 Multilock are Monitor, Generator, Duplex, Instrument, Test, and Settings. Dedicated keys near the main tuning knob on the front panel provide direct access to the 2801 Multilock 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 2801 Multilock and the specific test in progress. Pressing a softkey 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 which becomes active when a data entry field is shown on the display. The numeric entry can also be followed by a softkey press to set scaling units like “kHz”, as in the case of entering an RF frequency. Existing numeric values can be modified by using the left/right keys to move the cursor highlight over the number you wish to change. The up/down arrow keys increase and decrease the value with each key press. Pressing Enter completes the entry while the Esc key terminates the action without changing the original value.

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 field by the left/right (← and →) cursor control buttons. 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 softkey activates a user determined setting. Selections can also be chosen using the up/down (↑ and ↓) keys.

2.3.1. Front panel control keys

POWER SWITCH

Press ON to energize all circuitry and cycle the 2801 Multilock through the boot-up sequence.

NAVIGATION (function select) KEYS (Monitor, Generate, Duplex, Instrument, Test, Settings)

These keys determine the operating mode of the 2801 Multilock.

SOFTKEYS (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 2801 Multilock 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 2801 Multilock. Specific key functions are as follows:

KEYS (0-9) and (SHIFTED LETTERS A–Z)

These keys enter alphanumeric information into the instrument. Pressing a key during data entry places a new value into the highlighted symbol or number on the instrument screen. The instrument 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.

“Hotkeys” 1, 2, 4/5, & 7/8 also serve as shortcuts that directly activate the 4 “Zones” used for settings and metering in the 2801 Multilock Monitor, Generator, and Duplex modes. The zone displays are arranged on the 2801 Multilock main screen just like the outline around the hotkeys. Pressing the hotkey activates the zone and displays the associated settings submenu. The hotkeys 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 2801 Multilock to alpha or letter designation (A-Z). May also activate a special function on instrument 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 initiated by the alphanumeric keypad or a user toggled setting change so the 2801 Multilock will operate with the new value.

ESC Key

Cancels an action before it is completed. For example, pressing Esc while entering a value with the numeric keypad closes the direct entry field and leaves the original value unchanged. Esc also returns to previous modes or windows when navigating the 2801 Multilock's operational menus.

↑ ↓ (UP, DOWN), and ← → (LEFT, RIGHT) Keys

These cursor/editor keys move a highlighted cursor over the alphanumeric digits in data entry fields to allow changes. When used to change a value the 2801 Multilock responds in real time. They also cycle through the available selections on user determined settings.

RF ON/OFF Key

Disconnects the internal RF Generator from the RF In/Out and RF Gen Out ports.

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 2801 Multilock 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 softkey activates a user determined setting.

Sql. Knob

Squelch control. Clockwise rotation increases the receiver signal threshold level above which the squelch opens. For signals below the threshold the 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, softkey 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 2801 Multilock 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 2801 Multilock. 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 instrument's internal monitor or output signals from the instrument'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 2801 Multilock RF carrier. When set as an input, audio signals external to the 2801 Multilock 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.

DEMODO OUT

Provides the demodulated (recovered) audio output from a received carrier when the 2801 Multilock 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 $50\ \Omega$. Input level requirement is 70 mV to 1V RMS. Output level is approximately 250 mV RMS.

DC POWER

Primary DC power input port. Note: The 2801 Multilock requires 24 V DC – connect only the AC to DC adapter provided by Willtek to this port. Do not substitute other adapters without first consulting Willtek support personnel or a factory authorized service center.

3. OPERATION

3.1. Overview

The 2801 Multilock is operated using an intuitive and easy to navigate system of front panel function keys and menu driven display interface. Primary operating modes are enabled with dedicated key buttons on the front panel. Functions in the main operating modes have an associated display area where important settings can be seen at a glance (see figure 3.1.1-1). The groupings include the RF Zone, Audio Zone, Display Zone and Meter Zone. The Zones are highlighted when active for accepting user entries as shown in figure 3.1.1-2 for the RF Zone. Menus next to the softkeys on the right and bottom of the display show the settings available for adjustment. Pressing a key brings up a data entry window or additional submenus when appropriate.

The primary operating modes of the 2801 Multilock are controlled by the following navigation buttons left of the **ANTENNA** port on the front panel:

MONITOR

RF receiver mode with frequency coverage from 400 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 400 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

Direct access to test functions using a graphical display format such as the spectrum analyzer, tracking generator and oscilloscope.

TEST

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

SETTINGS

System configuration mode for viewing and entering general operating parameters for the 2801 Multilock 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 2801 Multilock into the labeled mode and presents related information on the display. Figure 3.1.1-1 shows the 2801 Multilock 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 settings and measured results for monitor operation. This includes the frequency of operation (Mon Freq), the signal input port (Mon Port), the input Attenuation, and other relevant data.

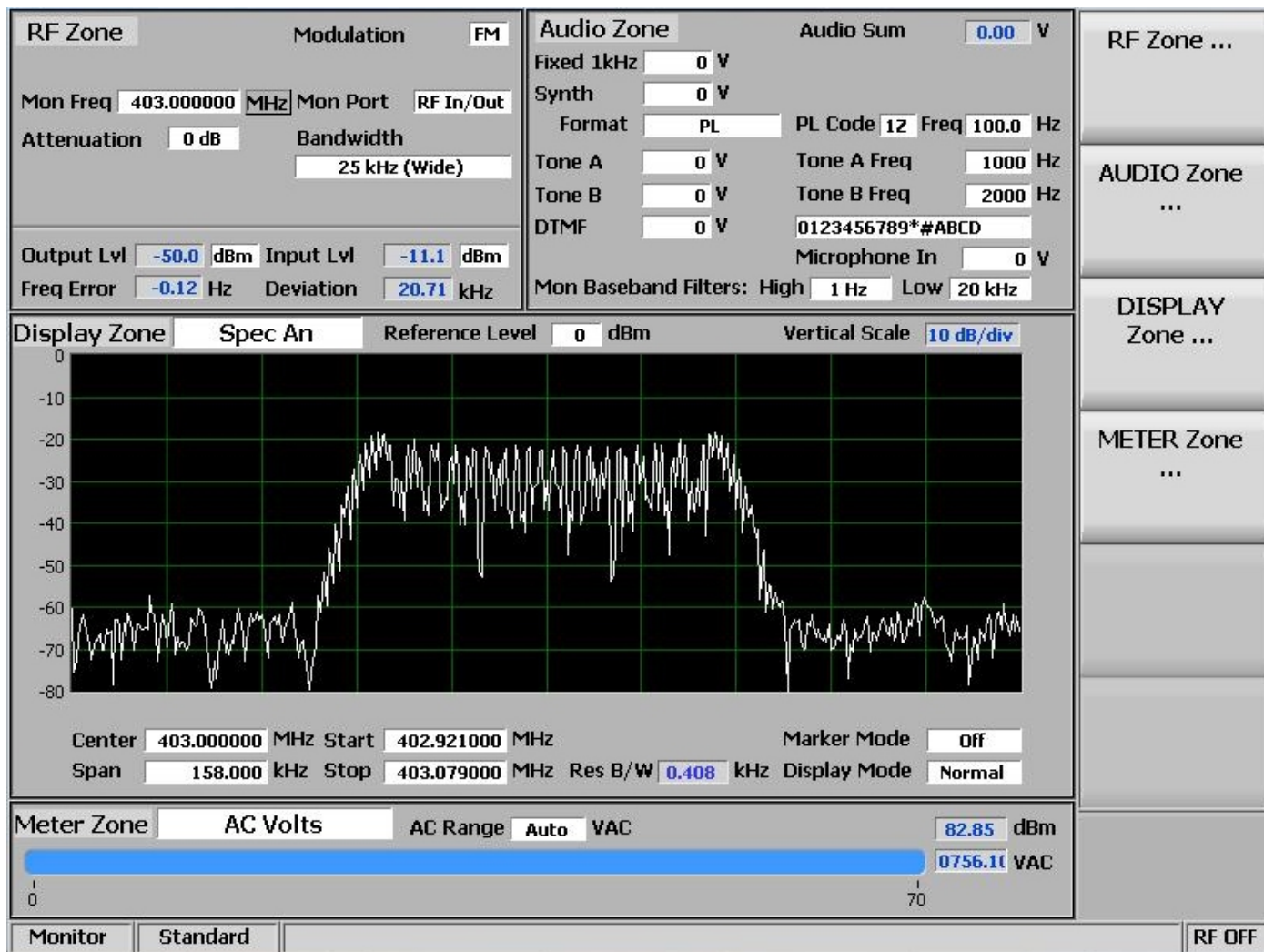


Figure 3.1.1-1 Main screen in Monitor mode showing related information in grouped display zones

Six softkeys to the right enable selection and adjustment of monitor specific modes and parameters. Figure 3.1.1-2 shows the 2801 Multilock display after pressing the **RF Zone** softkey while in Monitor mode – note the RF Zone section is highlighted. This indicates it is active for accepting user inputs and a new submenu with related selections appears next to the softkeys. Pressing the **ESC** key returns the 2801 Multilock to the previous menu.

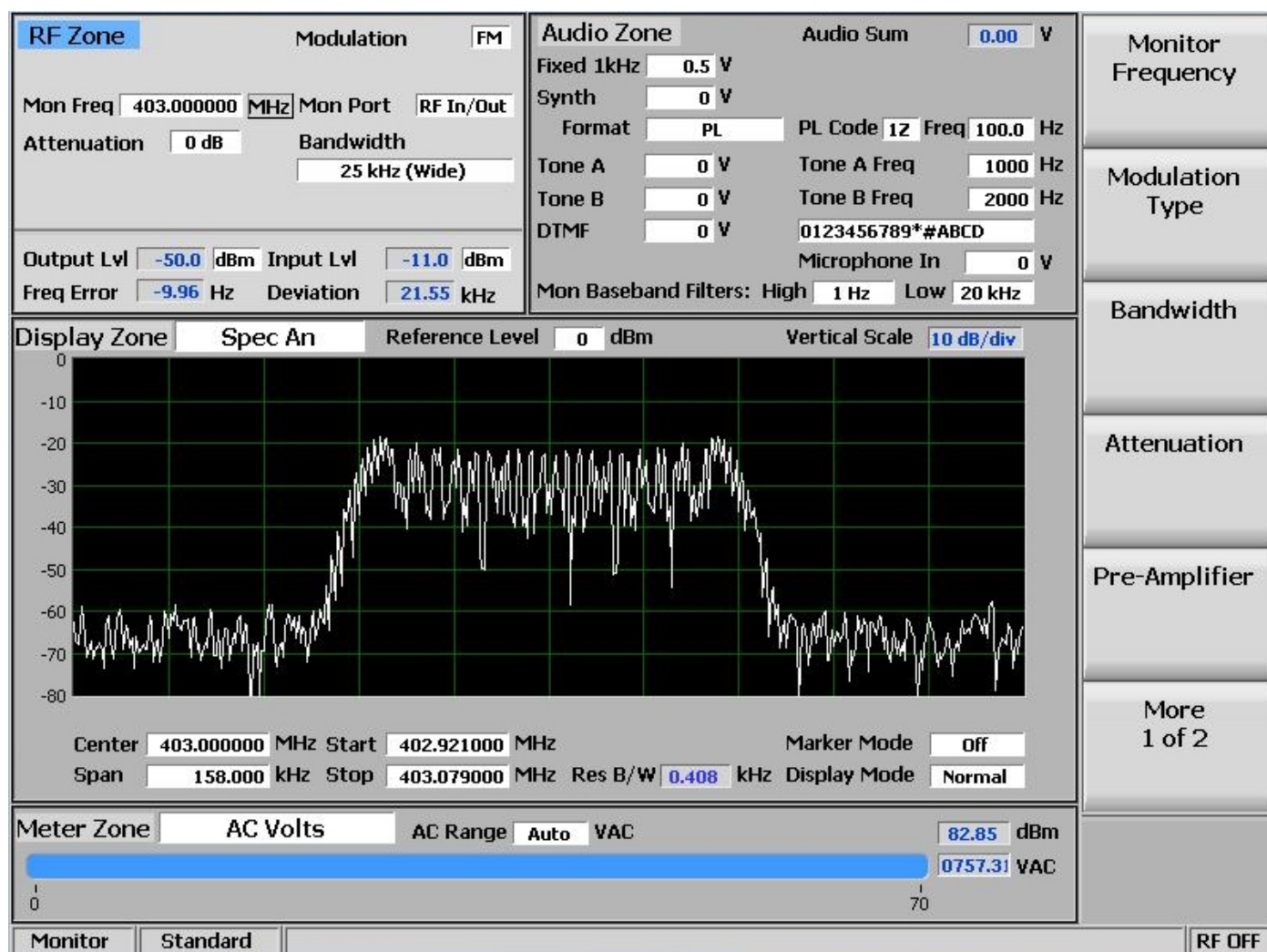


Figure 3.1.1-2. Softkey submenu in Monitor mode after RF Zone key press

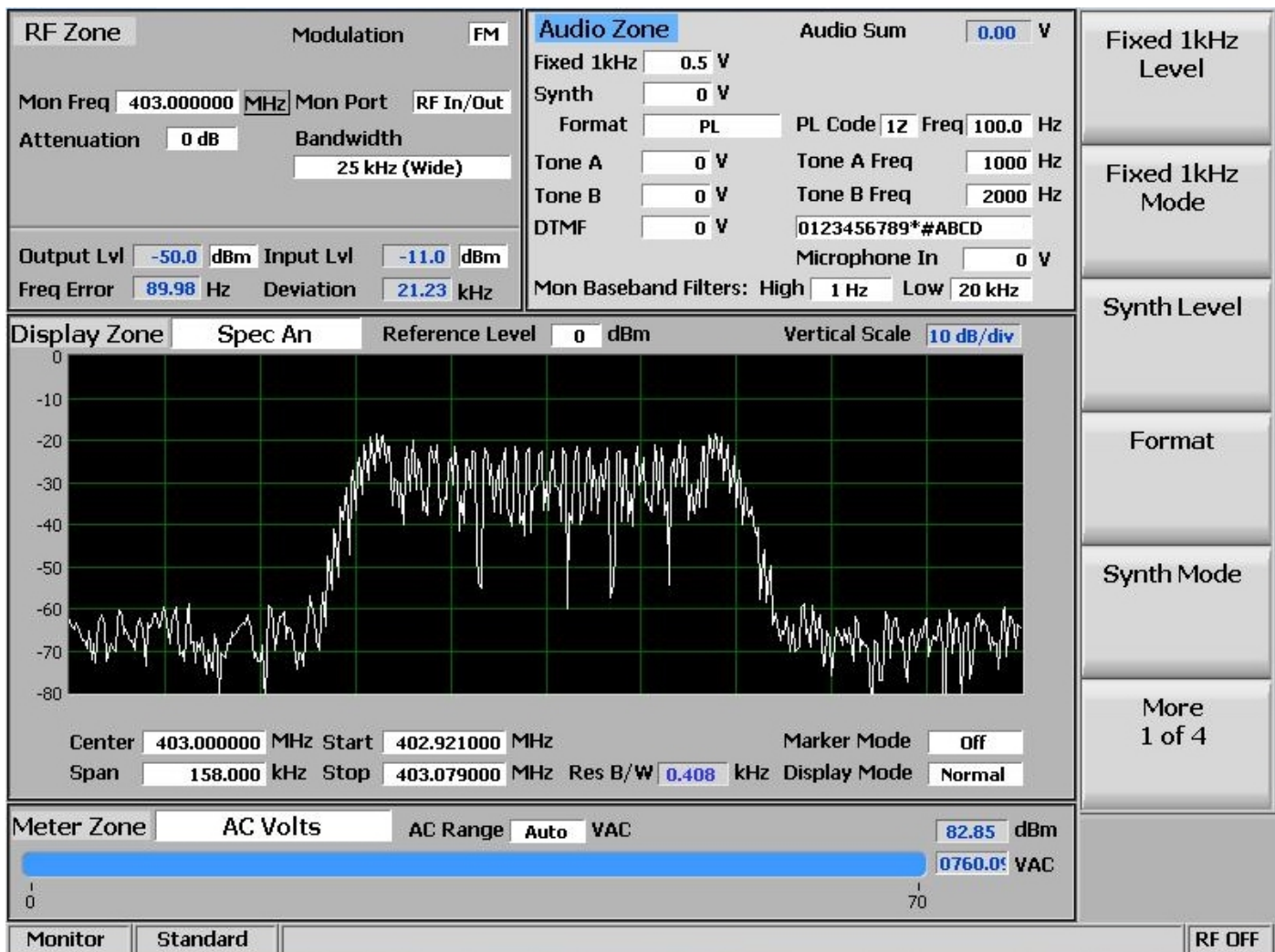


Figure 3.1.1-3. Submenu in Audio Zone after softkey press

Figure 3.1.1-3 shows the 2801 Multilock display after pressing the **Audio Zone** softkey from the main menu. Pressing the **Fixed 1kHz Level** softkey 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 arrows move the highlight over the desired number field. Numeric changes are entered directly via the keypad, or in steps using the up/down arrow keys or Tuning Knob.

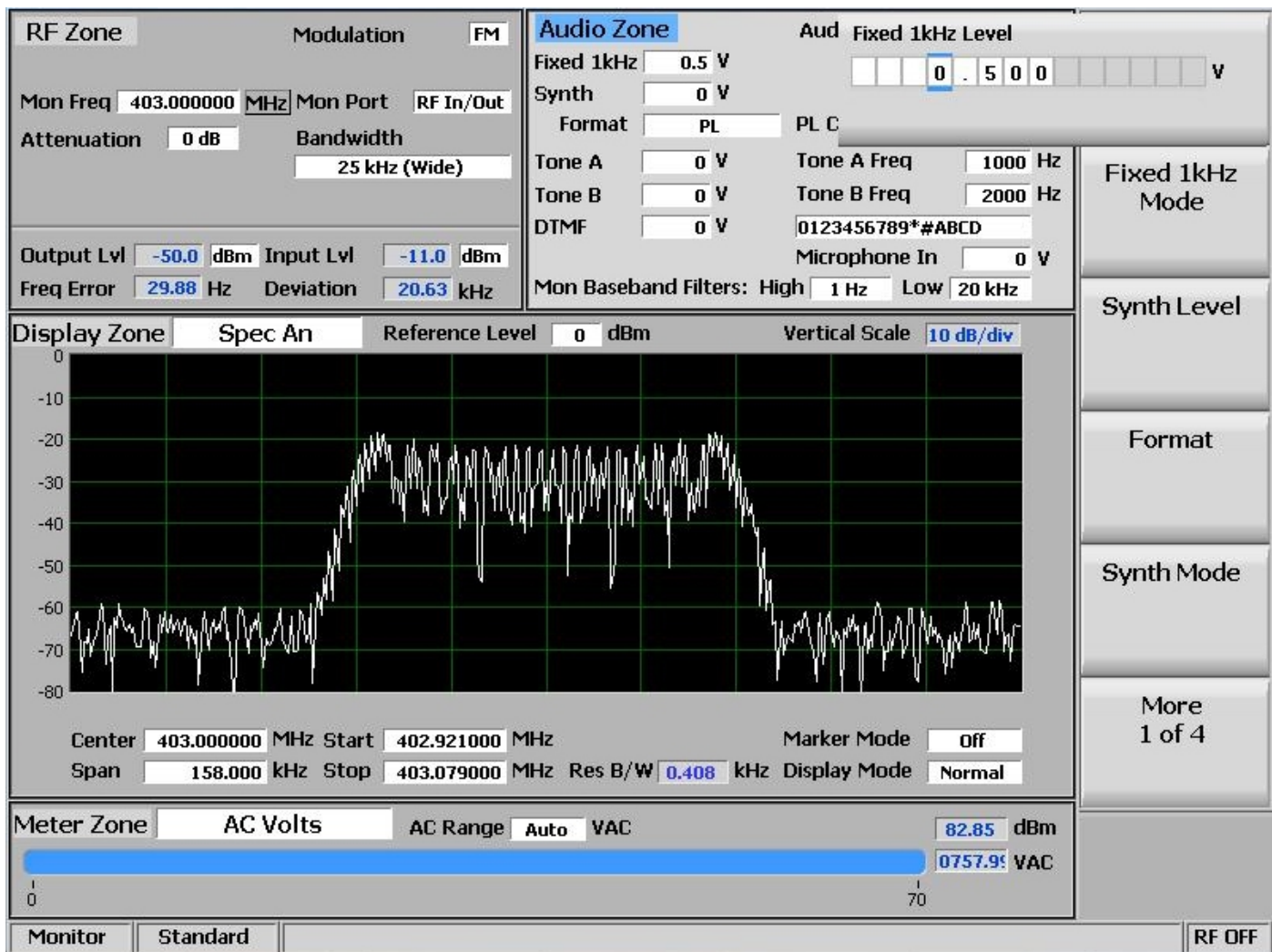


Figure 3.1.1-4. Audio Zone data entry for Fixed 1 kHz Level

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 arrow 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 2801 Multilock 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. Hotkeys for quicker zone navigation in Monitor, Generate, and Duplex modes

“Hotkeys” 1, 2, 4/5, & 7/8 on the numeric keypad serve as shortcuts that directly activate the 4 “Zones” used for settings and metering in the 2801 Multilock Monitor, Generator, and Duplex modes. The zone displays are arranged on the 2801 Multilock main screen just like the outline around the associated hotkeys – see Figure 3.1.2-1.

Pressing a hotkey activates the 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 hotkeys activate the respective zones and submenu as follows:

OPERATION

RF Zone – Press numeric hotkey 1

Audio Zone – Press numeric hotkey 2

Display Zone – Press numeric hotkey 4 or 5

Meter Zone – Press numeric hotkey 7 or 8



Figure 3.1.2-1. Outline around numeric keypad hotkeys

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

3.2. Operating Instructions

The main operating modes of the 2801 Multilock are oriented towards testing 2-way radios and related infrastructure. So for a majority of applications the 2801 Multilock 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 2801 Multilock 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 2801 Multilock Monitor mode provides the instrument'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 via the RF IN/OUT port. The operating frequency range is from 100 kHz to 3.0 GHz in 1 Hz increments with selectable bandwidths between 6.25 kHz and 200 kHz. The instrument processes AM and FM modulated carriers and a variety of audio encoding formats. Once set to an RF carrier's center frequency the 2801 Multilock accurately determines the frequency error, power level, and modulation characteristics. Figure 3.2.1-1 shows the 2801 Multilock in Monitor mode in the RF Zone section of the main display.

RF Zone		Modulation		FM
Mon Freq	200.000000	MHz	Mon Port	RF In/Out
Attenuation	0 dB	Bandwidth		
6.25 kHz (Narrow)				
Output Lvl	-50.0	dBm	Input Lvl	-16.4
Freq Error	-69.94	Hz	Deviation	4.15
		kHz		

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

To enable the 2801 Multilock Monitor mode press the **Monitor** navigation button from within any menu and confirm that "Monitor" is indicated in the lower left corner of the 2801 Multilock main display. Then press the **Esc** button repeatedly until the softkeys to the right of the display area indicate RF Zone, AUDIO Zone, DISPLAY Zone, and METER Zone. This places the 2801 Multilock 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 hotkey – 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 softkey or hotkey 1. The RF Zone area of the display highlights and the softkey submenu shown in Figure 3.2.1-2 appears with the following selections:

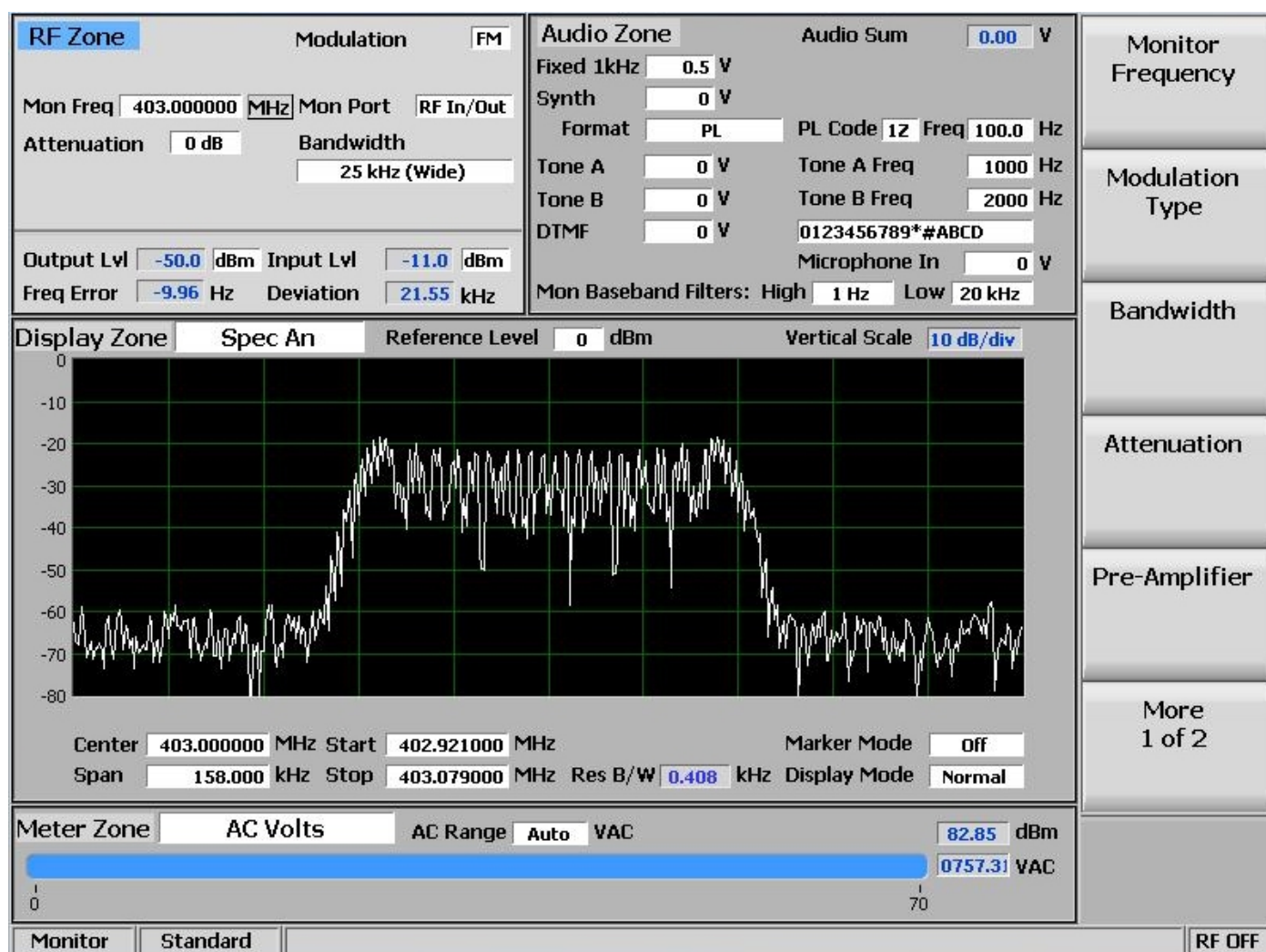


Figure 3.2.1-2. Monitor Mode submenu after RF Zone softkey press

Monitor Frequency

Sets the desired monitor frequency in a data entry window from 400 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 2801 Multilock receiver – either FM or AM.

Bandwidth

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

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 arrow keys or tuning knob.

Pre-Amplifier

Enables a supplementary input amplifier that extends the RF sensitivity of the 2801 Multilock

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 arrow 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 softkeys. 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 softkey 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

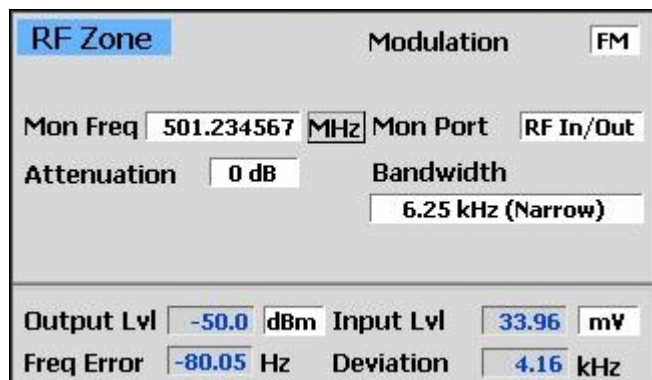


Figure 3.2.1-4. RF Zone display area after Monitor frequency change

Real time adjustments using the tuning knob and arrow keys

The frequency entry adjustment in Monitor mode is an example of where the 2801 Multilock 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 (← and →) 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 arrow keys provide

precise step changes for final adjustment after the 2801 Multilock is quickly dialed close to the desired frequency.

3.2.2. GENERATOR mode

The 2801 Multilock Generator mode is the instrument'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 100 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 2801 Multilock in the generate mode in the RF Zone section of the main display.

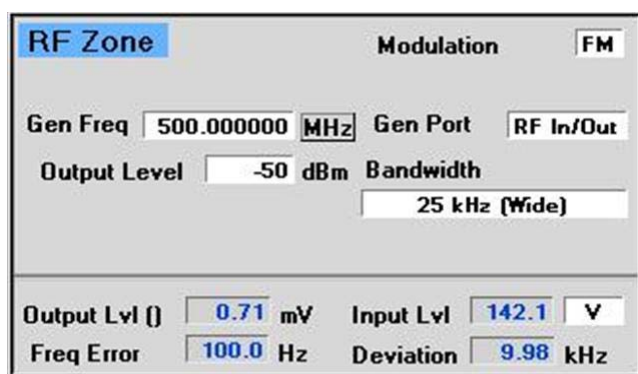


Figure 3.2.2-1. RF Zone display area showing Generator Mode data

To enable the 2801 Multilock Generate mode press the **Generate** navigation button from within any menu and confirm that “Generate” is indicated in the lower left corner of the 2801 Multilock main display. Then press the **ESC** button repeatedly until the softkeys to the right of the display area indicate RF Zone, AUDIO Zone, DISPLAY Zone, and METER Zone. This places the 2801 Multilock 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 hotkey – 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 softkey or hotkey 1. The RF Zone area of the display highlights and, a new softkey submenu appears as shown in Figure 3.2.2-2. The softkey selections are as follows:

RF Zone		Modulation FM		Audio Zone		Mod Sum 0.00 kHz		Generate Frequency	
Gen Freq 500.000000 MHz		Gen Port RF In/Out		Fixed 1kHz 0 kHz		Mod Port In			Modulation Type
Output Level -50.0 dBm		Bandwidth 25 kHz (Wide)		Synth 0 kHz		Volts Per kHz 0.64			
				Format PL		PL Code 12 Freq 100.0 Hz			
Output Lvl -50.0 dBm		Input Lvl --- uV		Tone A 0 kHz		Tone A Freq 1000 Hz		Output Level	
Freq Error -80.04 Hz		Deviation --- kHz		Tone B 0 kHz		Tone B Freq 2000 Hz			
				DTMF 0 kHz		0123456789*#ABCD			
				Mod In 0 kHz		Microphone In 0 kHz			
				Mon Baseband Filters: High 1 Hz Low 20 kHz				Gen Port	
Display Zone		Spec An		Reference Level 0 dBm		Vertical Scale 10 dB/div			
<div style="text-align: center;"> Spectrum Analyzer is Disabled in Generate Mode </div>									
Center 501.234567 MHz		Start 501.155567 MHz		Marker Mode Off				Bandwidth	
Span 158.000 kHz		Stop 501.313567 MHz		Res B/W 0.408 kHz		Display Mode Normal			
Meter Zone		AC Volts		AC Range Auto VAC		82.85 dBm		Output Level Units	
						0755.6 VAC			
Generate		Standard						RF ON	

Figure 3.2.2-2. Generator Mode submenu after RF Zone softkey press

Generator Frequency

Sets the desired monitor frequency in a data entry window from 400 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 2801 Multilock – either FM or AM.

Output Level

Adjusts the RF level of the transmitted carrier for 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.

Gen Port

Choose the active port (RF In/Out or Gen Out) for the 2801 Multilock carrier output in a selection table using the up/down arrow keys or tuning knob.

Bandwidth

Sets the maximum occupied bandwidth in kHz for the 2801 Multilock's carrier via a set of horizontal softkeys. The range is from 6.25 kHz (narrow) to 200 kHz (wide).

3.2.3. Duplex mode

The 2801 Multilock 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 2801 Multilock 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 2801 Multilock. Figure 3.2.3-1 shows Duplex operation of the 2801 Multilock in the RF Zone section of the main display.

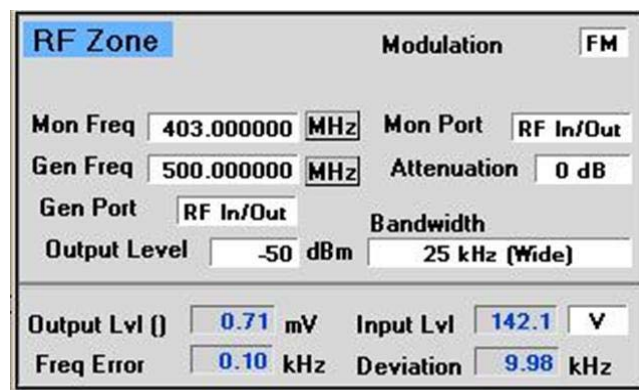


Figure 3.2.3-1. RF Zone display after Duplex key press

To enable the 2801 Multilock Generate mode press the **Duplex** navigation button from within any menu and confirm that "Generate" is indicated in the lower left corner of the 2801 Multilock main display. Then press the **ESC** button repeatedly until the softkeys to the right of the display area indicate RF Zone, AUDIO Zone, DISPLAY Zone, and METER Zone. This places the 2801 Multilock 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 hotkey – 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 softkey or hotkey 1. The RF Zone area of the display highlights and the softkey submenu shown in Figure 3.2.3-2 appears. Most of the softkeys 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.

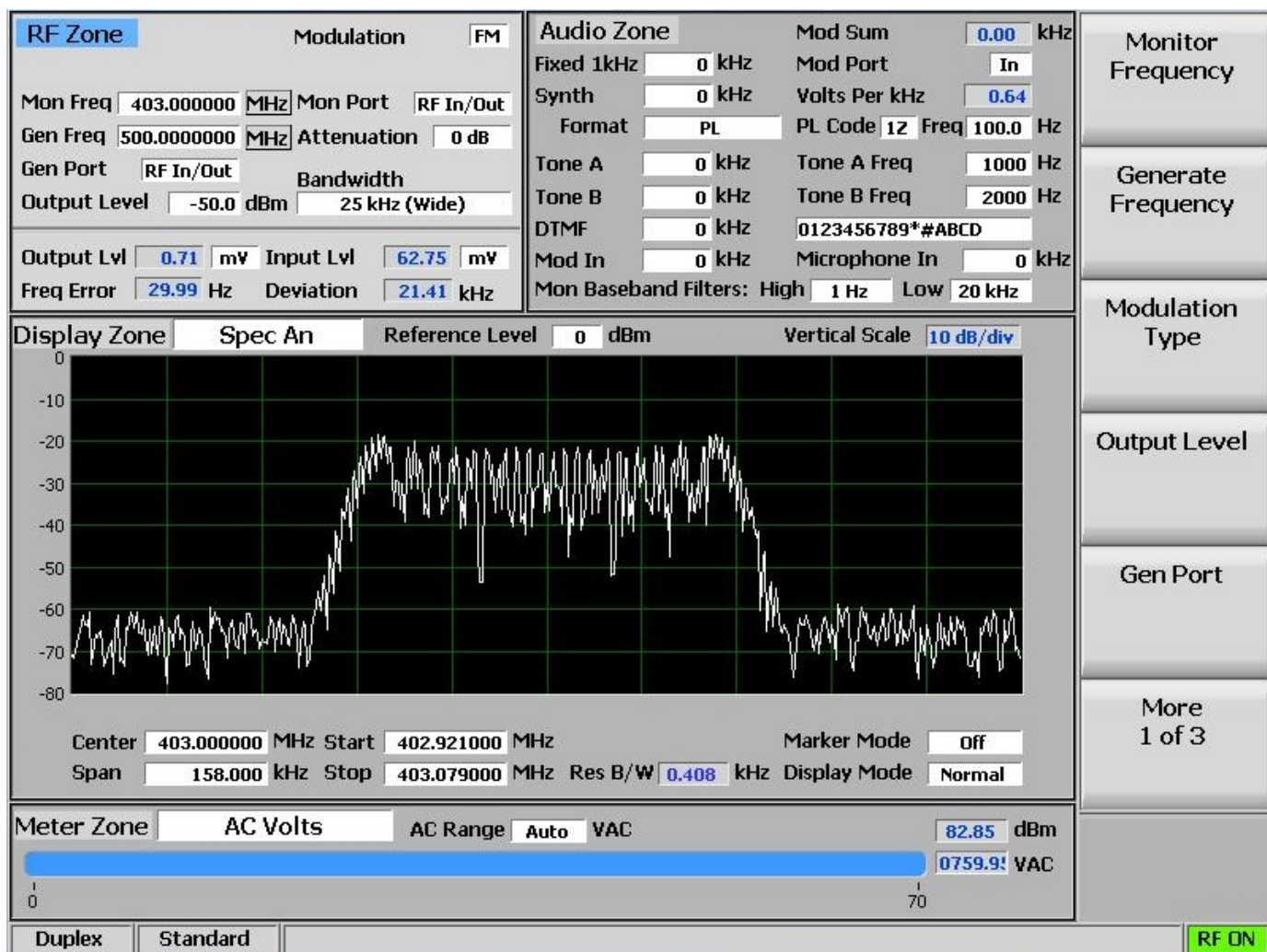


Figure 3.2.3-2. Duplex Mode submenu after RF Zone softkey press

3.2.4. Audio zone

The 2801 Multilock 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 2801 Multilock. 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 2801 Multilock 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 2801 Multilock main screen changes depending on the 2801 Multilock mode. Figure 3.2.4-1 shows the Audio Zone display area with the 2801 Multilock 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 2801 Multilock. 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.

Audio Zone		Mod Sum	0.00 kHz
Fixed 1kHz	0 kHz	Mod Port	In
Synth	0 kHz	Volts Per kHz	0.64
Format	PL	PL Code	12 Freq 100.0 Hz
Tone A	0 kHz	Tone A Freq	1000 Hz
Tone B	0 kHz	Tone B Freq	2000 Hz
DTMF	0 kHz	0123456789*#ABCD	
Mod In	0 kHz	Microphone In	0 kHz
Mon Baseband Filters: High		1 Hz	Low 20 kHz

Figure 3.2.4-1. Audio Zone display with the 2801 Multilock in Generate mode

Figure 3.2.4-2 shows the Audio Zone display area with the 2801 Multilock 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 2801 Multilock. 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.

Audio Zone		Audio Sum	0.00 V
Fixed 1kHz	0 V		
Synth	0 V		
Format	PL	PL Code	12 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

Figure 3.2.4-2. Audio Zone display with the 2801 Multilock in Monitor mode

Setting audio operating parameters in Monitor mode

Figure 3.2.4-3 shows page 1 of the Audio Zone submenu in Monitor mode after the softkey press. Recall that the 2801 Multilock 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 2801 Multilock Monitor mode.

Note: An important point regarding the screen pages for the Audio Zone submenu. It contains a common group of settings along with menu choices that change to reflect the Format (signal type) chosen for the audio synthesizer. Different submenu screens and settings are shown when other encoding types such as DPL, A/B Sequence, or 5/6 Tone are selected with the Format softkey. The following sections will first describe the common settings, followed by the alternate settings specific to each encoding format.

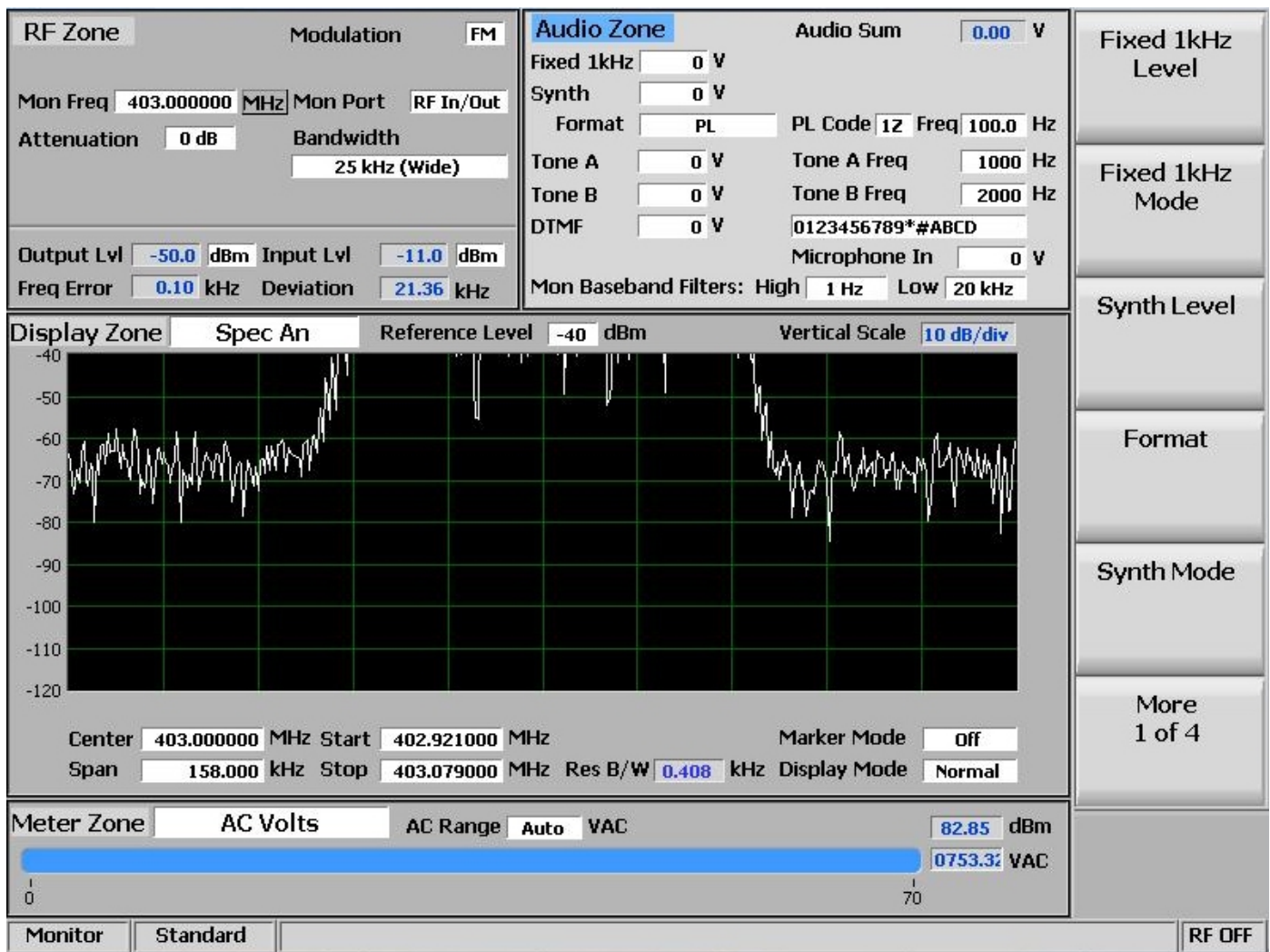


Figure 3.2.4-3. Audio Zone submenu in Monitor mode

3.2.4.1. 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 3.2.4.1-1. Selecting the format makes it the active encoding type for the audio synthesizer. Note: See paragraph 3.2.4.2 for specific submenu selections for these formats

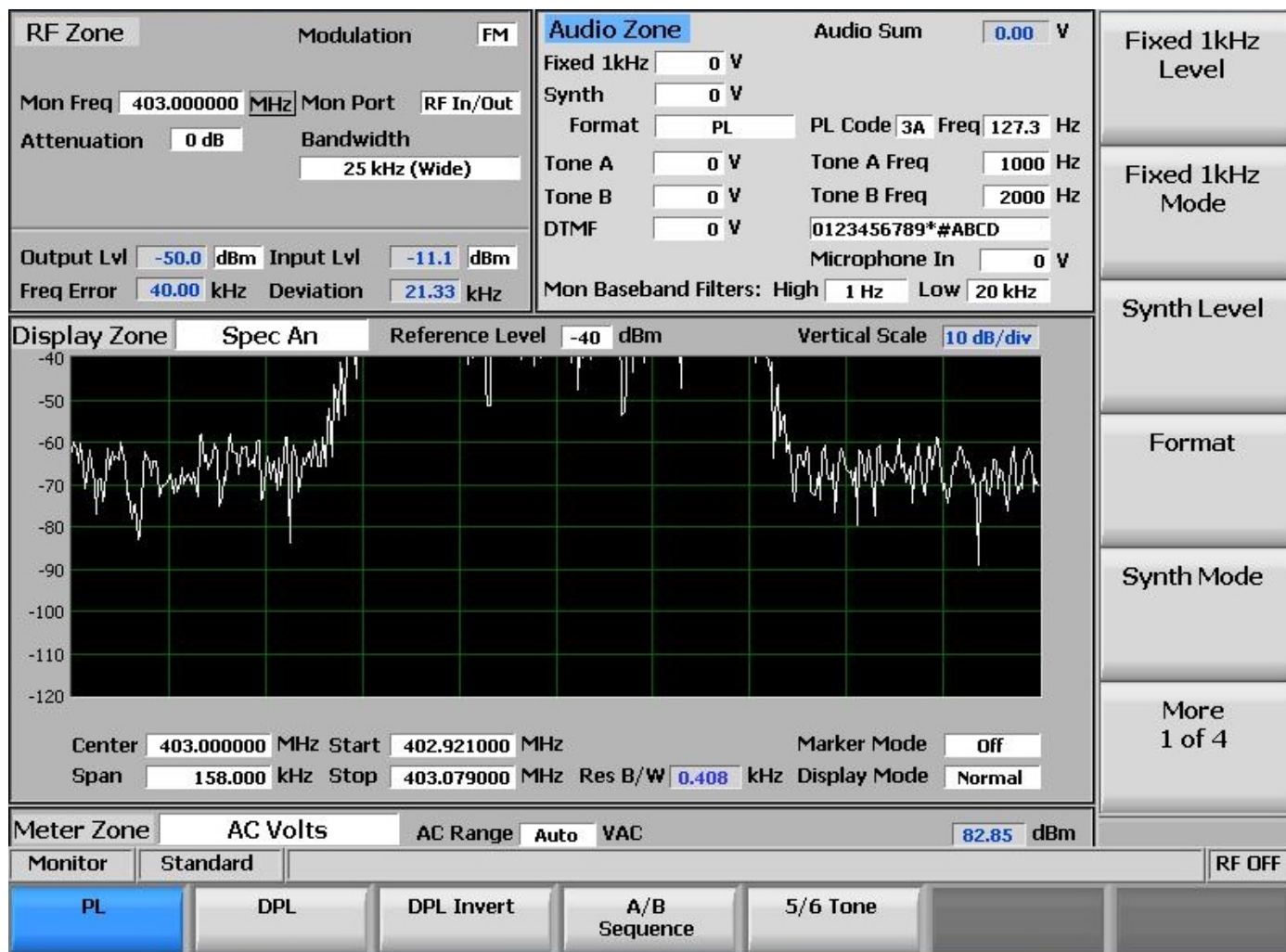


Figure 3.2.4.1-1. Format submenu in Audio Zone

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.

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 (← →) arrow keys move the highlight to the desired field. The code is entered either of several ways. The up/down (↑ ↓) arrow 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 softkeys 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 2801 Multilock'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 2801 Multilock baseband circuitry.

OPERATION

Low Pass Filter

Activates a horizontal submenu with audio filter selections that determine the low pass frequency for the 2801 Multilock’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 2801 Multilock baseband circuitry.

3.2.4.2. Settings and submenu screens for specific audio formats (PL, DPL, DPL Invert A/B Sequence, 5/6 Tone)

The following settings appear in Audio Zone submenu pages when specific encoding formats are chosen in the Format horizontal menu – see Figure 3.2.4.1-1.

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 3.2.4.2-2. The codes and associated frequencies are selected using the ↑ ↓ (Up, Down), and ← → (Left, Right) arrow 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.

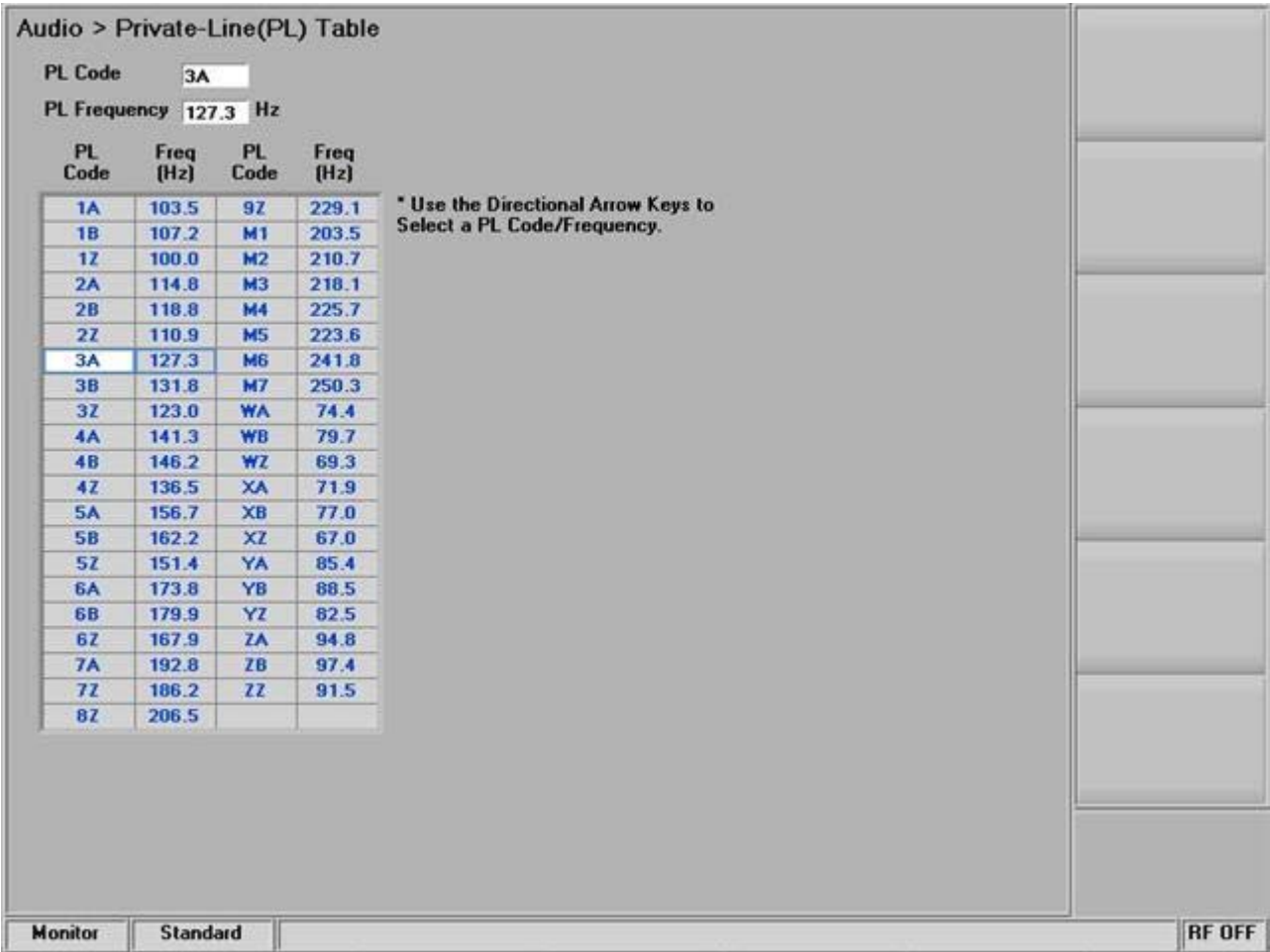


Figure 3.2.4.2-2. PL Table showing highlighted entry code.

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 3.2.4.2-3, 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 softkey. 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 arrow keys highlight the programmable sequences (3 and 4) a new submenu appears as shown in Figure 3.2.4.2-4. The tone frequencies, durations and delays are entered using this submenu.

Audio > A/B Sequence Table

Sequence # **1**

Seq #	Tone A Dur [Sec]	Delay [Sec]	Tone B Dur [Sec]	Delay [Sec]
1	0.40	0.00	0.80	1.30
2	1.00	0.00	3.00	1.30
3	0.00	0.00	0.20	0.10
4	0.99	5.01	9.00	0.00

Tone
Tone & Voice

* Use the Up and Down Arrow Keys or Change the Sequence # to Select a Sequence to Edit.

Tone A Frequency **1000** Hz

Tone B Frequency **2000** Hz

Sequence

Tone A Frequency

Tone B Frequency

Monitor Standard RF OFF

Figure 3.2.4.2-3. A/B Sequence table showing highlighted sequence.

Audio > A/B Sequence Table

Sequence #

Seq #	Tone A Dur (Sec)	Delay (Sec)	Tone B Dur (Sec)	Delay (Sec)	
1	0.40	0.00	0.80	1.30	Tone
2	1.00	0.00	3.00	1.30	Tone & Voice
3	0.00	0.00	0.20	0.10	
4	0.99	5.01	9.00	0.00	

Tone A Frequency Hz

Tone B Frequency Hz

* Use the Up and Down Arrow Keys or Change the Sequence # to Select a Sequence to Edit.

Sequence

Sequence 3
Tone A
Duration

Sequence 3
Tone A Delay

Sequence 3
Tone B
Duration

Sequence 3
Tone B Delay

More
1 of 2

Monitor Standard RF OFF

Figure 3.2.4.2-4. 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 3.2.4.2-5. 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 softkey adds the "X" tone to the transmission.

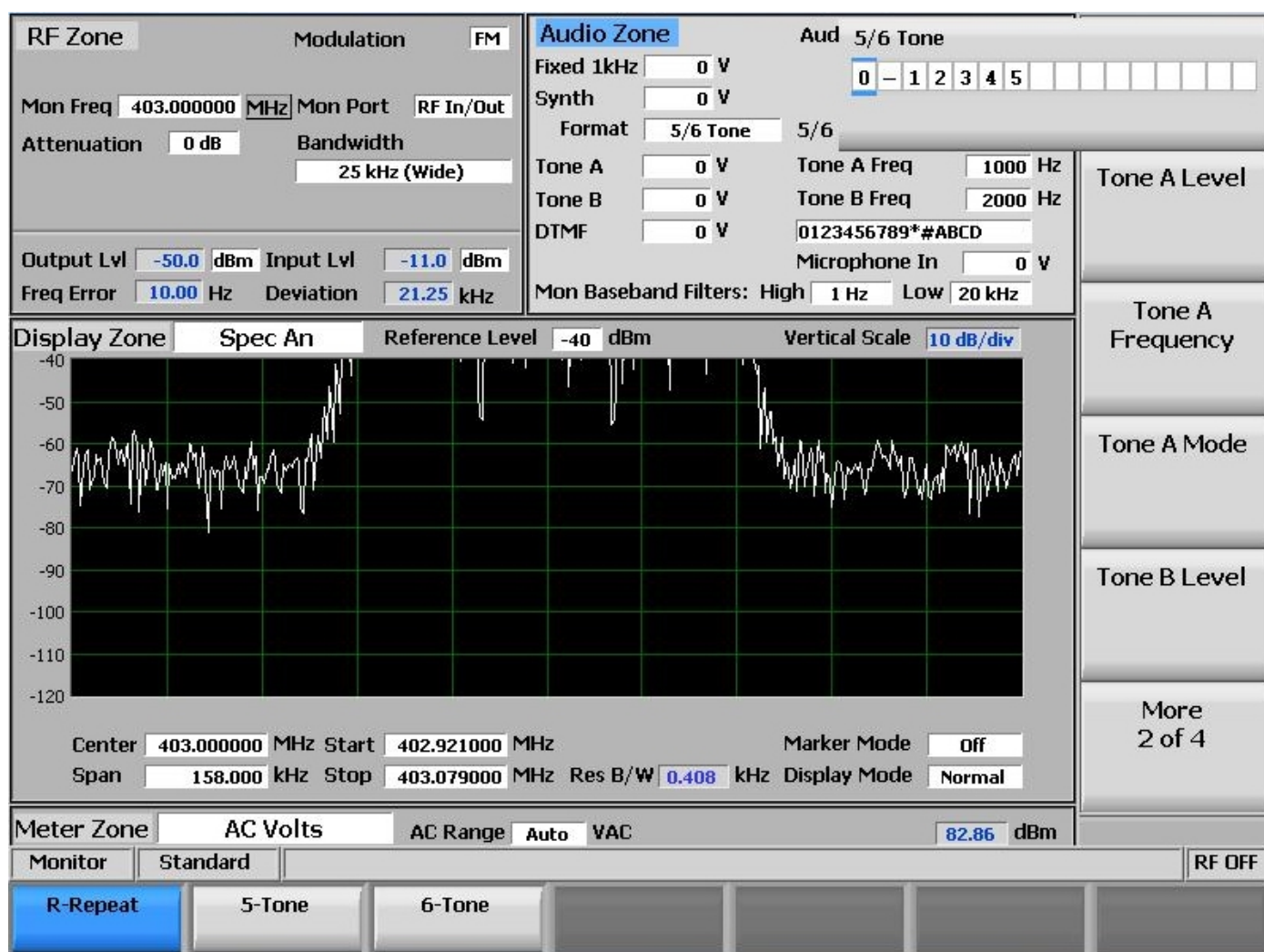


Figure 3.2.4.2-5. 5/6 Tone entry submenu

3.2.4.3. 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 3.2.4.3-1

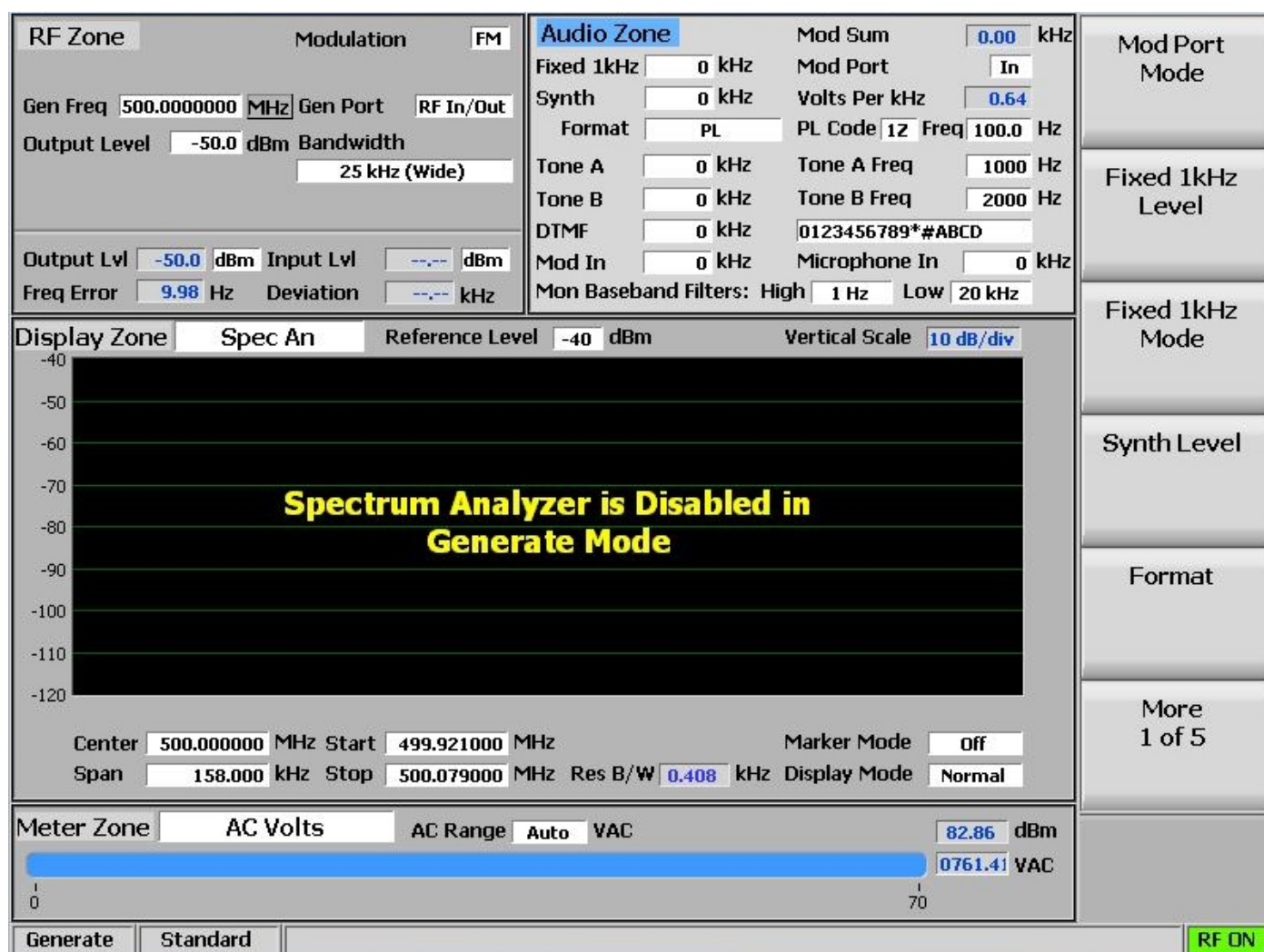


Figure 3.2.4.3-1. Audio Zone submenu in Generator mode

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

Mod Port Mode

This softkey 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 2801 Multilock. 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 2801 Multilock. 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 2801 Multilock. 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 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 2801 Multilock 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 softkey. 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** softkey press. Note the submenu selections below the “**Select Display**” softkey. These selections change depending on the chosen display – in this case the Spectrum Analyzer.

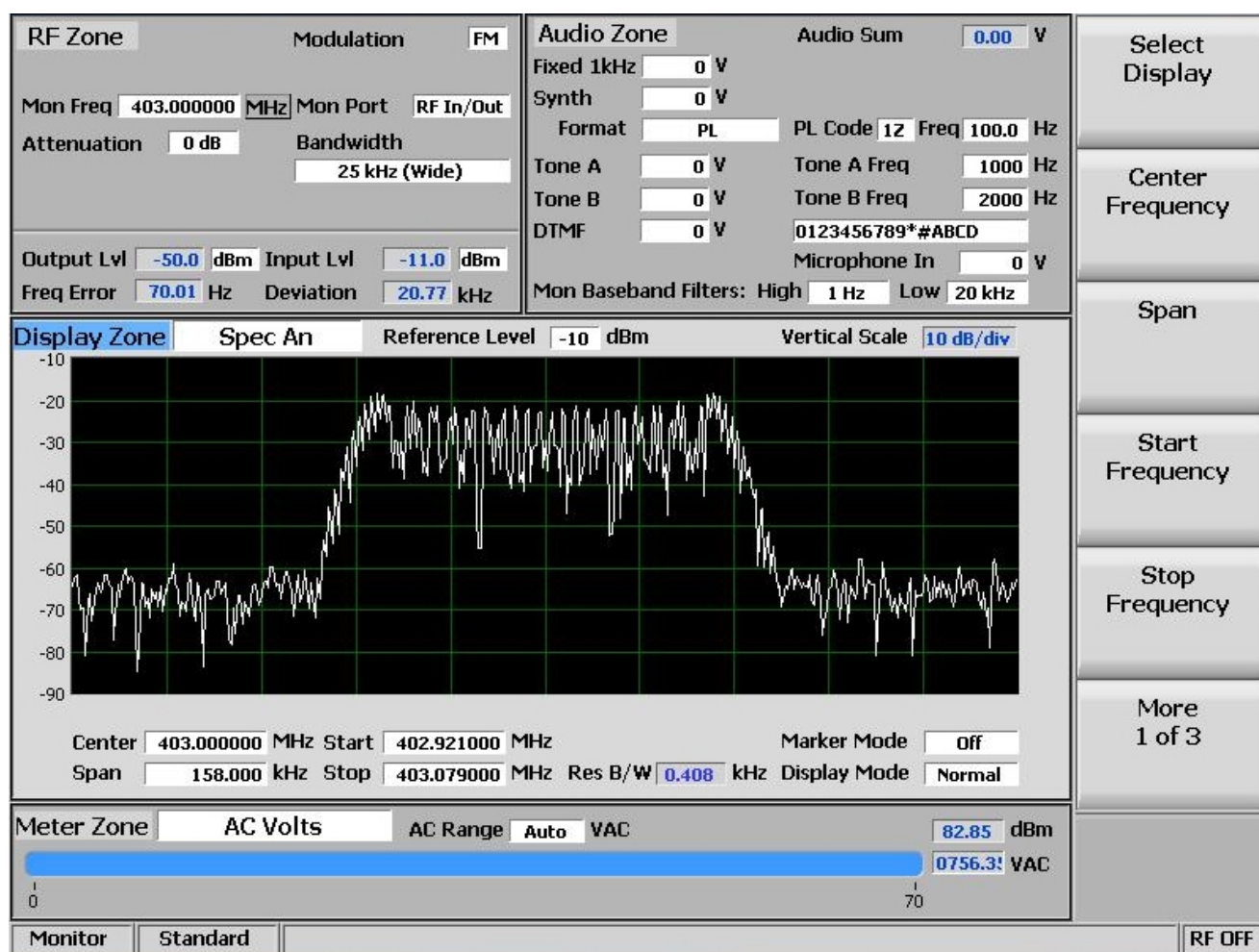


Figure 3.2.5-1. Display Zone submenu after softkey press

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

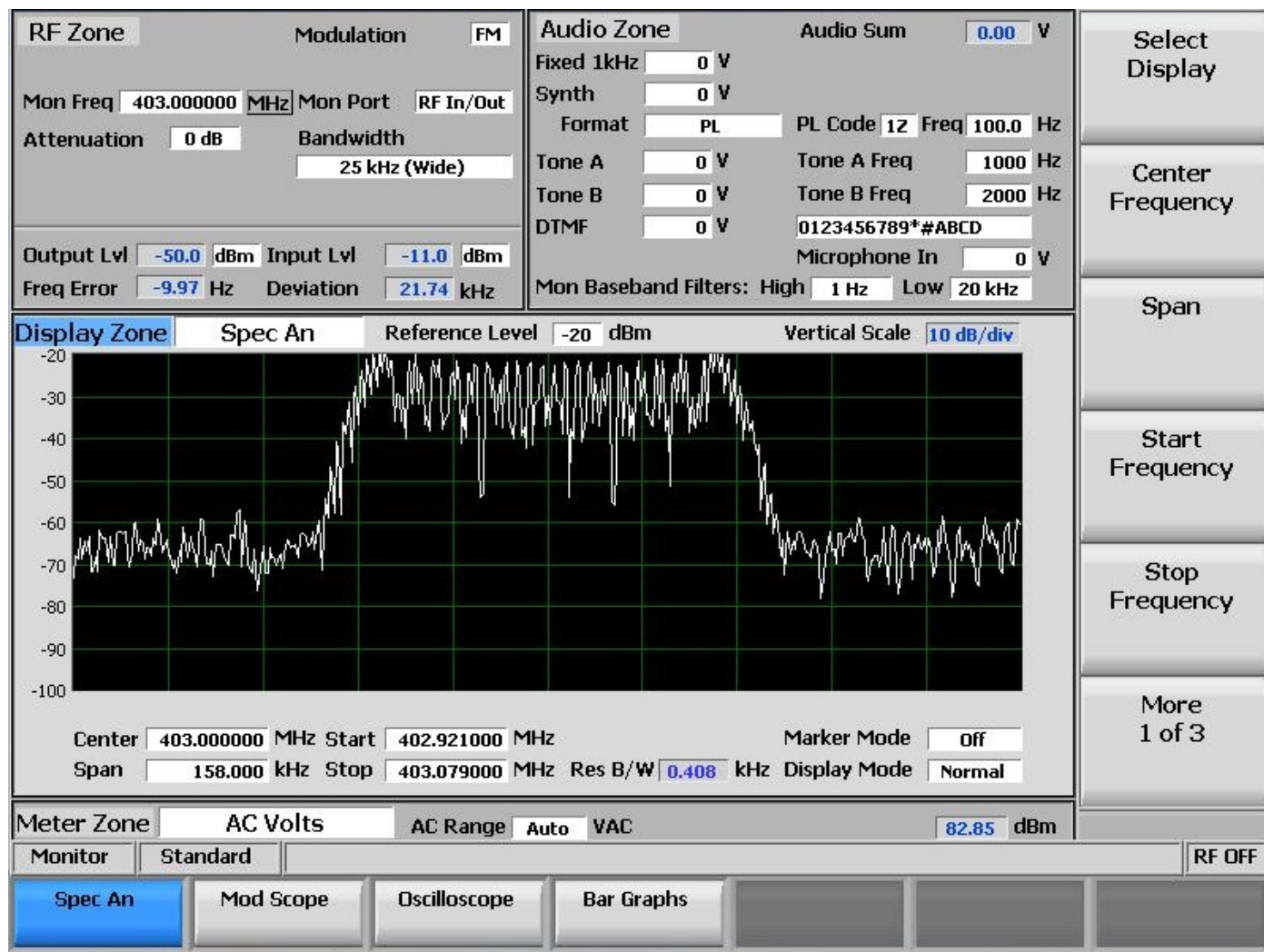


Figure 3.2.5-2. Submenu after Select Display softkey press

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

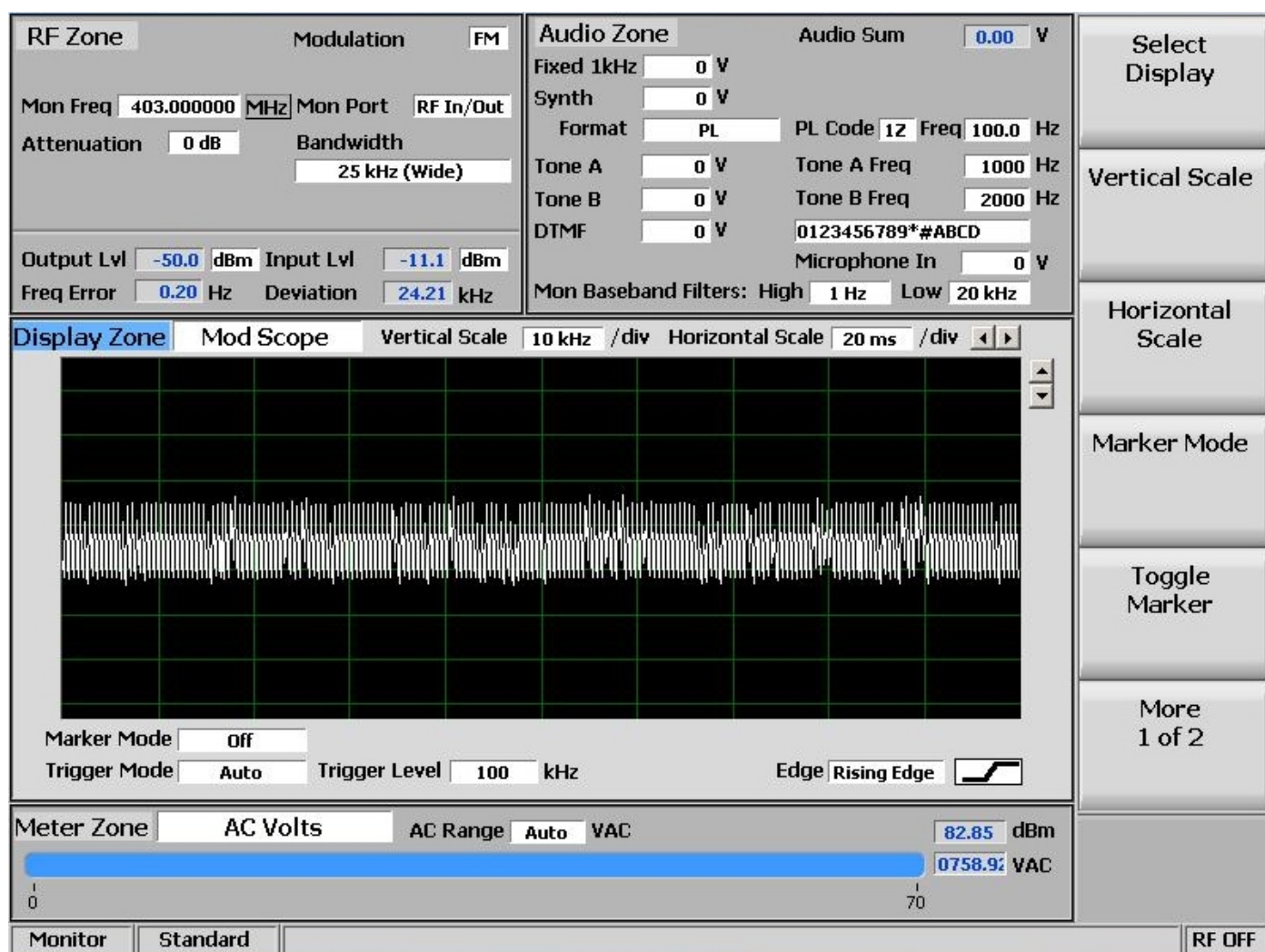


Figure 3.2.5-3. Display Zone submenu for the Mod Scope

Setting operating parameters in the Display Zone

The available displays include a Spectrum Analyzer, Modulation Scope, Oscilloscope, and a Bar Graph for RF signal deviation, frequency error and input level. The following section details the submenu and softkey selections for each display type.

3.2.5.1. Spectrum Analyzer settings

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

Center Frequency

Sets the center frequency from 400 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.

OPERATION

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 2801 Multilock 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 2801 Multilock 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 softkey 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 softkey 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.

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 100 averages.

Center Peak

Centers the operating frequency and display of the 2801 Multilock Spectrum Analyzer around the highest peak signal within the display range.

Marker Mode

Provides display marker control via a horizontal softkey 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 determine the active one for positional adjustment on the display. The active marker is moved via the left/right (← and →) cursor control buttons.

Center Marker

Centers the operating frequency and display of the 2801 Multilock 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

Places a marker at the frequency where the signal is -3 dB below the peak amplitude.

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** softkey 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 2801 Multilock'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 cursor keys or tuning knob. The units range from 20 μ s/div to 1 sec/div.

Marker Mode

Provides display marker control via a horizontal softkey 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.

Toggle Marker

Cycles through and highlights the available markers to determine the active one for positional adjustment on the display. The active marker is moved via the left/right (\leftarrow and \rightarrow) cursor control buttons.

Trigger Mode

Selects the trigger mode for the horizontal sweep via a submenu. 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** softkey.

Trigger Level

Adjusts the signal threshold at which a horizontal sweep is initiated. The softkey activates a numeric entry box and the left/right arrows move the highlight over the desired number field. Numeric changes are entered directly via the keypad, or in steps using the up/down arrow 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** softkeys shifts the waveform position by fixed increments.

3.2.5.3. Oscilloscope settings

The 2801 Multilock instrument 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** softkey to bring up the horizontal submenu display choices shown in Figure 3.2.5.3-1. The available adjustments are as follows:

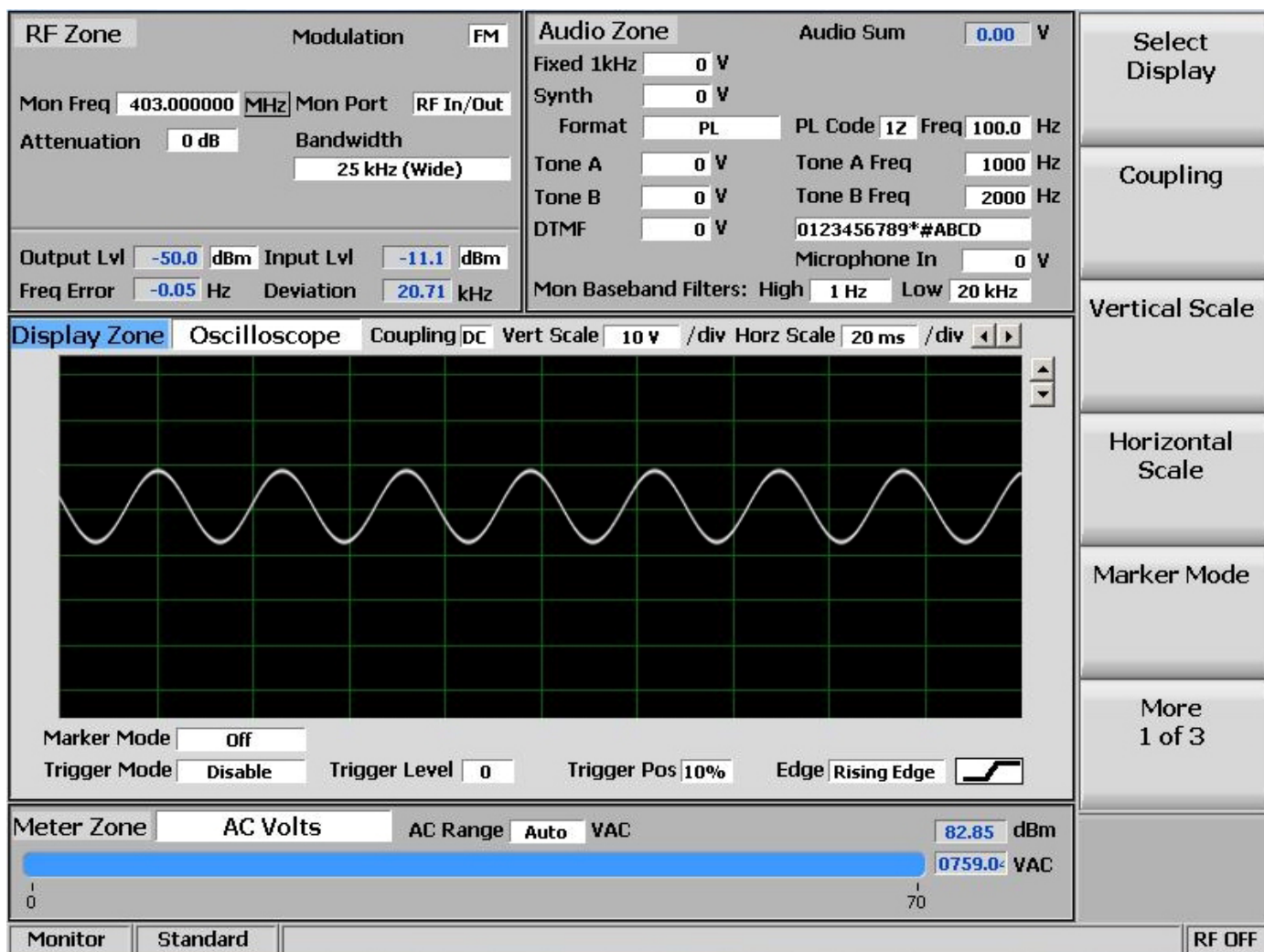


Figure 3.2.5.3-1 Display Zone submenu for the Oscilloscope

Coupling

Selects the input coupling for the external signal applied to the Meter In port via a dialog box. Select DC or AC coupling by pressing the **Coupling** softkey, the **UP/DOWN** cursor keys, or rotating the Tuning Knob.

Vertical Scale

Selects the vertical scale resolution for the display's major grid lines via a dialog entry box. The available selections range from 10 mV/div to 25 V/div and can be changed by pressing the **Vertical Scale** softkey, 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** cursor keys or tuning knob. The units range from 20 μ s/div to 1 sec/div.

Marker Mode

Provides display marker control via a horizontal softkey 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 determine the active one for positional adjustment on the display. The active marker is moved with the left/right (← and →) cursor control buttons.

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** softkey.

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 softkey activates a numeric entry box and the left/right arrows move the highlight over the desired number field. Numeric changes are entered directly with the keypad, or in steps using the **UP/DOWN** arrow 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** softkeys shifts the waveform position by fixed increments.

3.2.5.4. Settings for the bar graphs

The 2801 Multilock 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 softkey 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 2801 Multilock.

Input Level – Displays the RF input level of the carrier. Indicated units are Volts, Watts or dBm as set with “Input Level Units” softkey in the RF Zone.

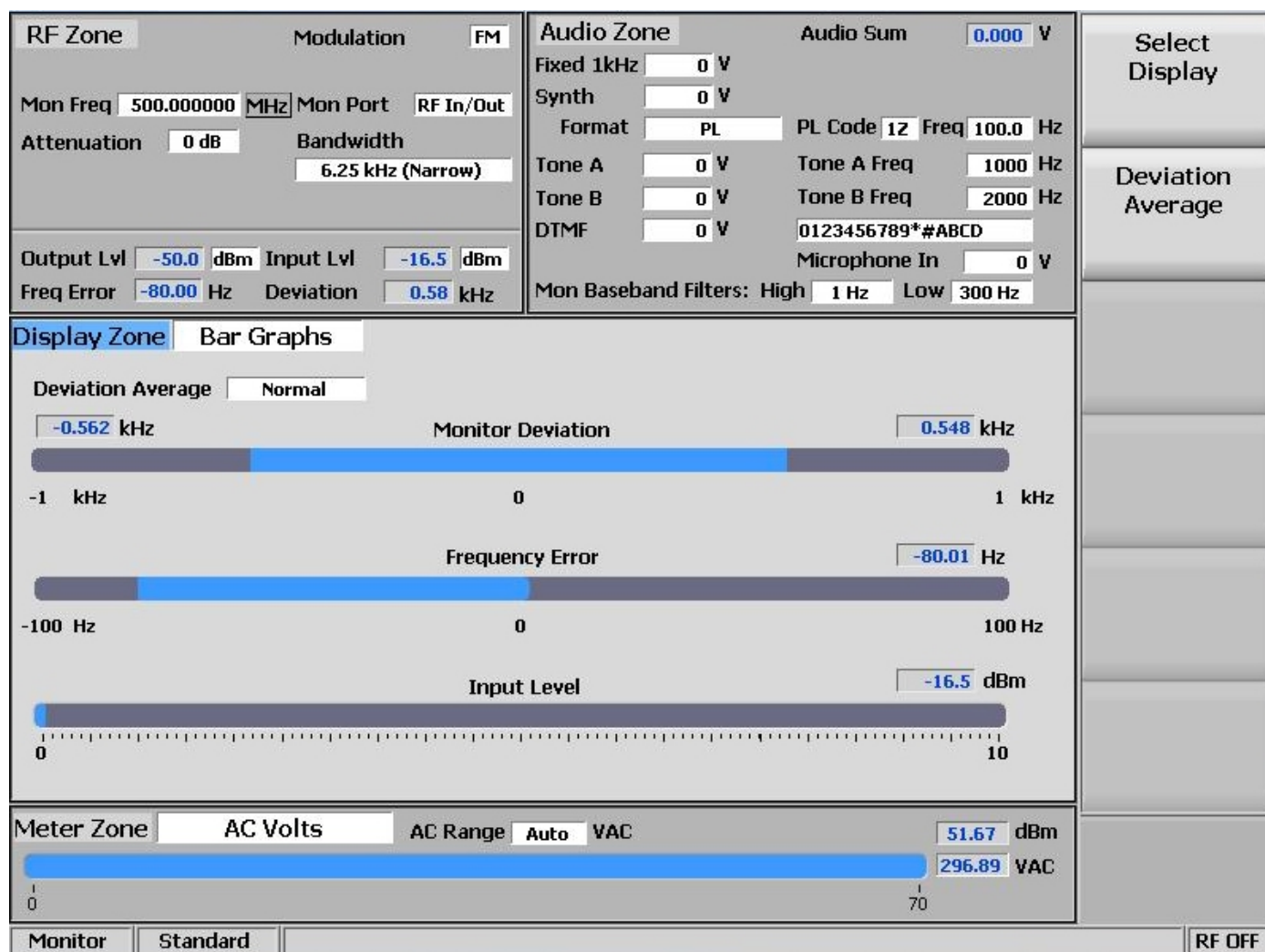


Figure 3.2.5.4-1. Bar Graphs screen in Display Zone

The Bar Graph display response can be adjusted using horizontal submenu selections activated with the **Deviation Average** softkey 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 smooths 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 2801 Multilock 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 softkey 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.

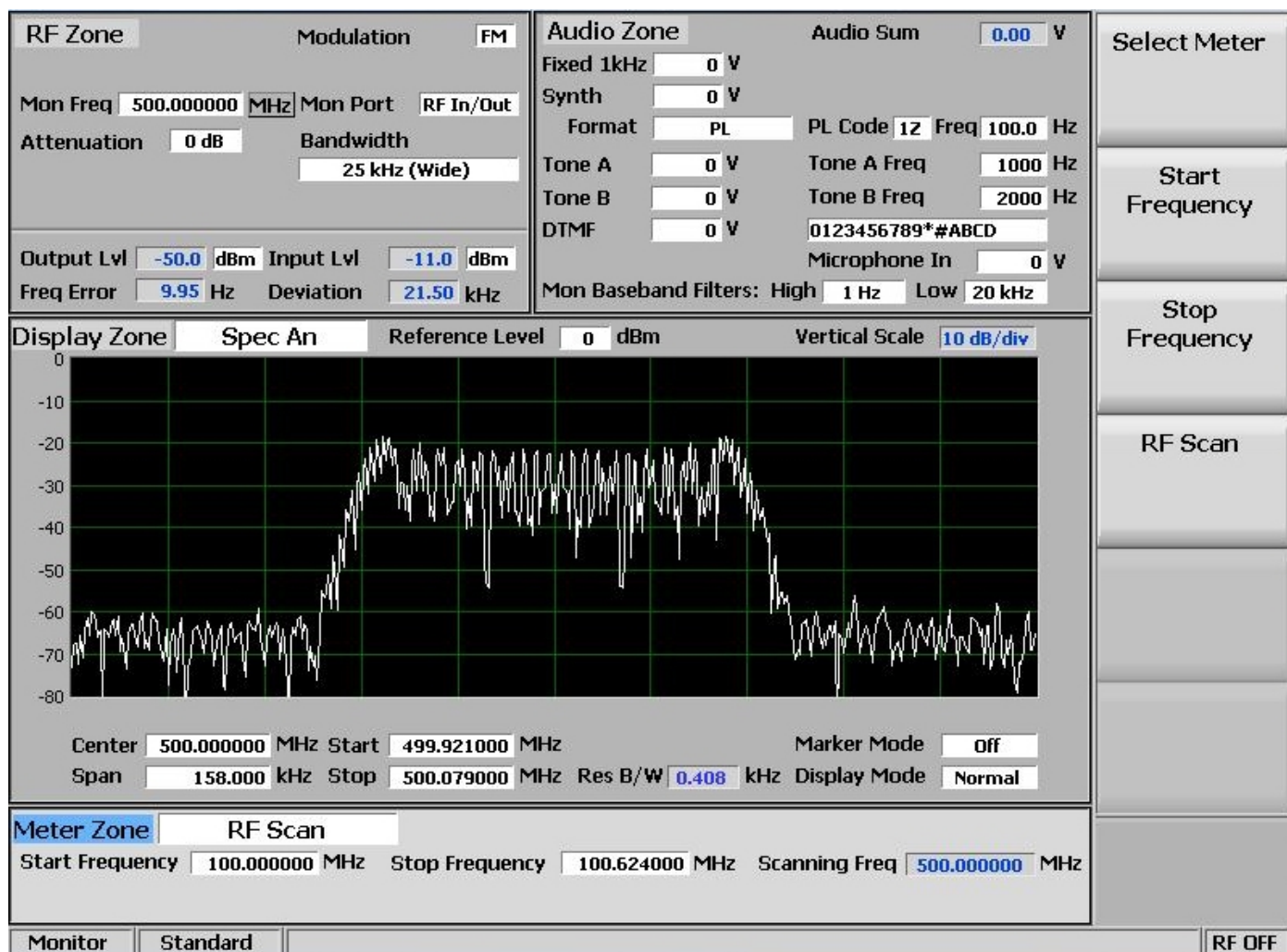


Figure 3.2.6-1. Meter Zone submenu showing RF Scan meter

Pressing the Select Meter softkey 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.



Figure 3.2.6-2. Meter Zone submenu after Select Meter softkey press

RF Scan

Searches for the strongest RF signal on the selected input port (Figure 3.2.6-3). The 2801 Multilock will lock onto and automatically center its operating frequency on this carrier. The search frequency range is entered using Start Frequency and Stop Frequency softkeys (Figure 3.2.6-1). The RF Scan softkey starts or stops the scan.

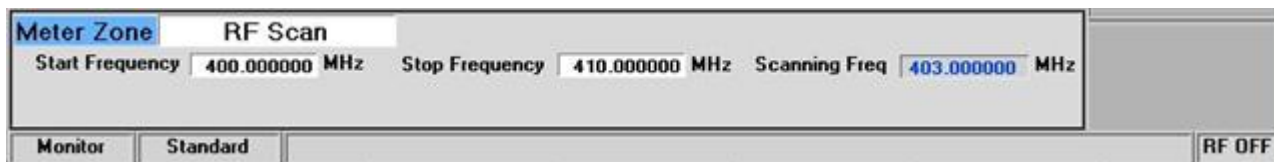


Figure 3.2.6-3. RF Scan display

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 2801 Multilock is in Monitor mode (Figure 3.2.6-6).



Figure 3.2.6-6. Internal Distortion display

OPERATION

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 2801 Multilock (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.



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.

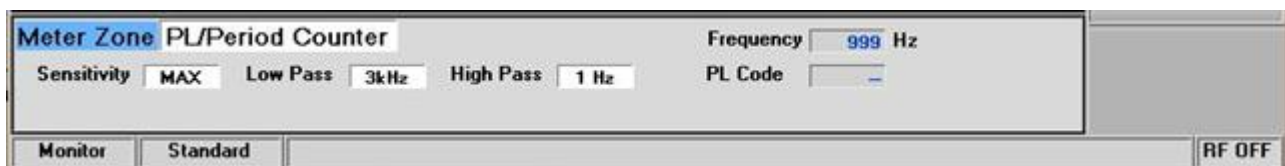


Figure 3.2.6-9. PL/Period Counter screen

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.

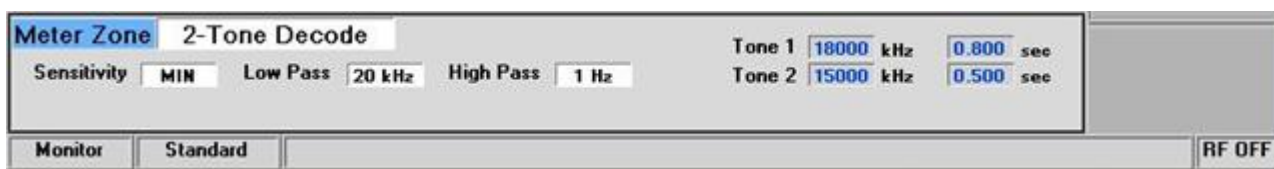


Figure 3.2.6-12. 2-Tone Decode screen

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 capcode along with the individual tone frequencies and durations. A vertical submenu allows selection of the meter sensitivity from MIN to MAX via the Tuning knob, up/down arrow keys, or repeated presses of the Sensitivity softkey. 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.

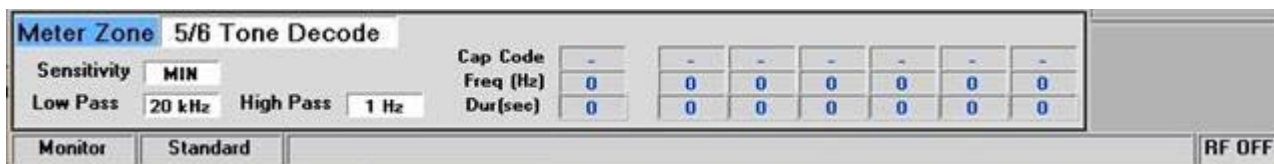


Figure 3.2.6-13. 5/6-Tone Decode screen

Frequency Counter

In Monitor mode this softkey 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.

OPERATION

The Resolution softkey 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.

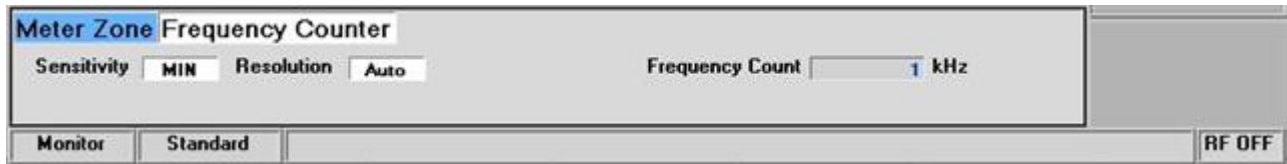


Figure 3.2.6-14. Frequency Counter screen

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).

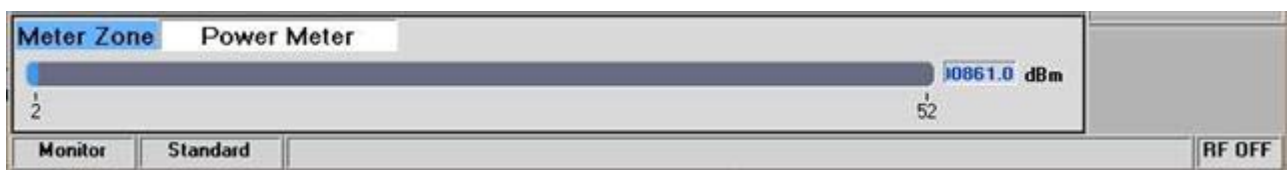


Figure 3.2.6-15. Frequency Counter screen

3.2.7. Instrument Mode with full screen displays

In the Instrument mode several of the measurement functions on the 2801 Multilock 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 INSTRMNT navigation button. The vertical softkey submenu lists the instruments available in a full screen display. While the Spectrum Analyzer, Modulation Scope, and Oscilloscope displays are available elsewhere on the 2801 Multilock, the size is limited in those areas since they are shared with other measuring functions. The optional Dual Display and Tracking Generator functions are full screen instruments and only available in Instrument mode. For convenience the other meters on the 2801 Multilock such as RF Scan, AC Volts, etc can also be directly accessed in Instrument mode.

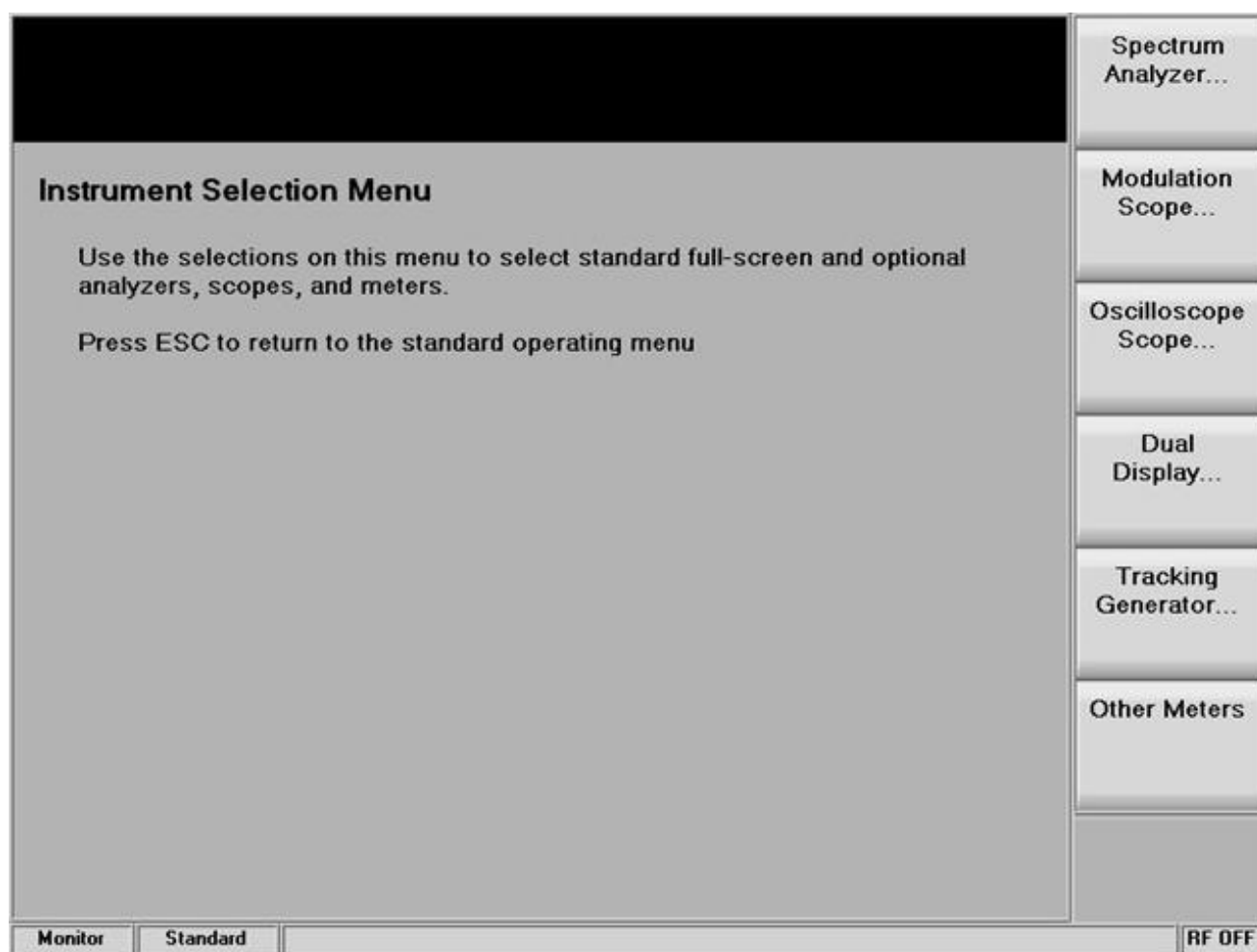


Figure 3.2.7-1. Submenu after pressing INSTRMNT navigation key

The submenus, control, and settings for the full screen instruments duplicate those of the limited screen versions in the Display Zone. Where applicable, additional softkeys 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.

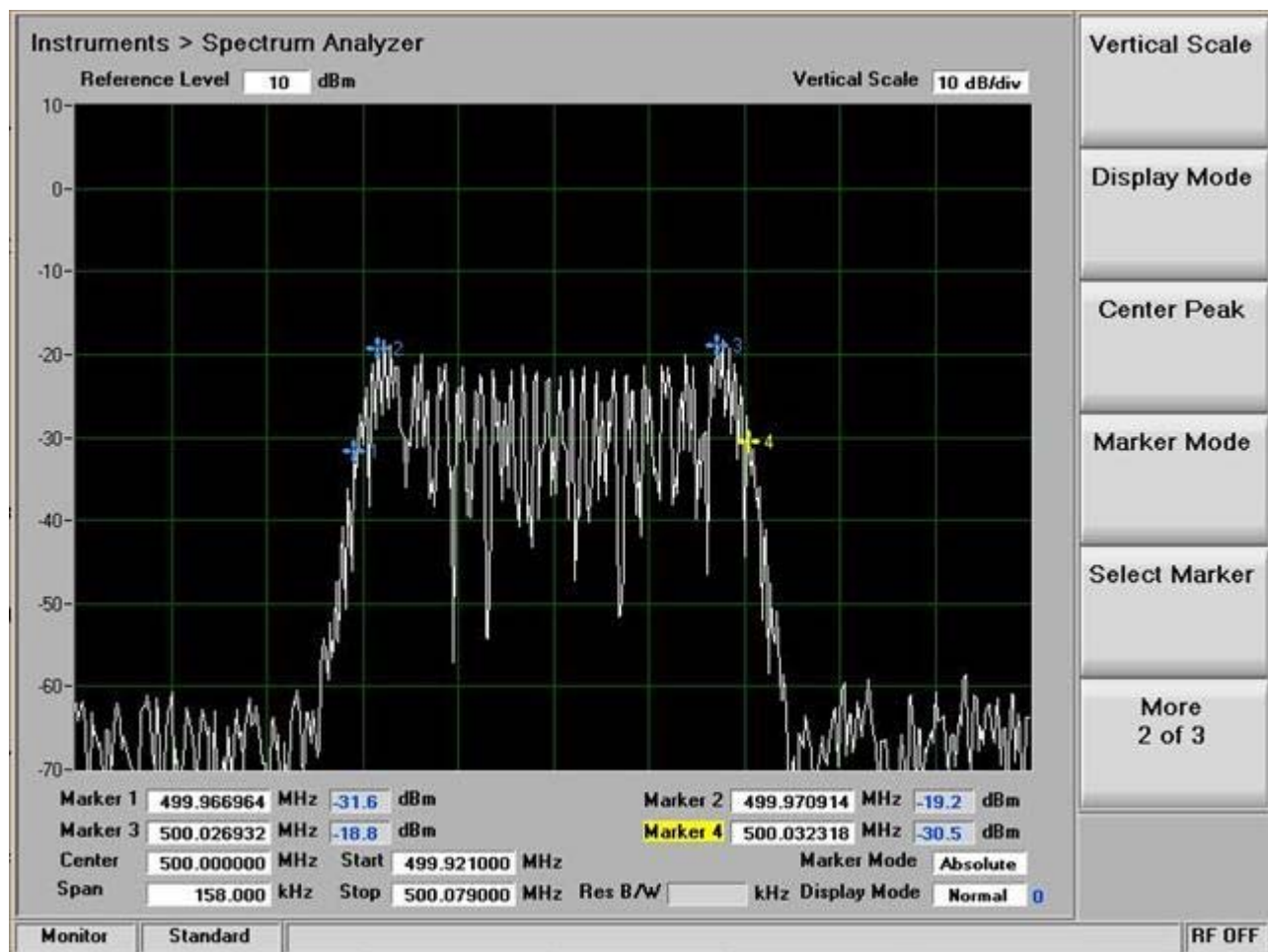


Figure 3.2.7-2. Submenu in Spectrum Analyzer Instrument mode

3.2.7.1. Dual Display mode

The optional Dual Display function 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 2801 Multilock screen after pressing the Dual Display softkey.

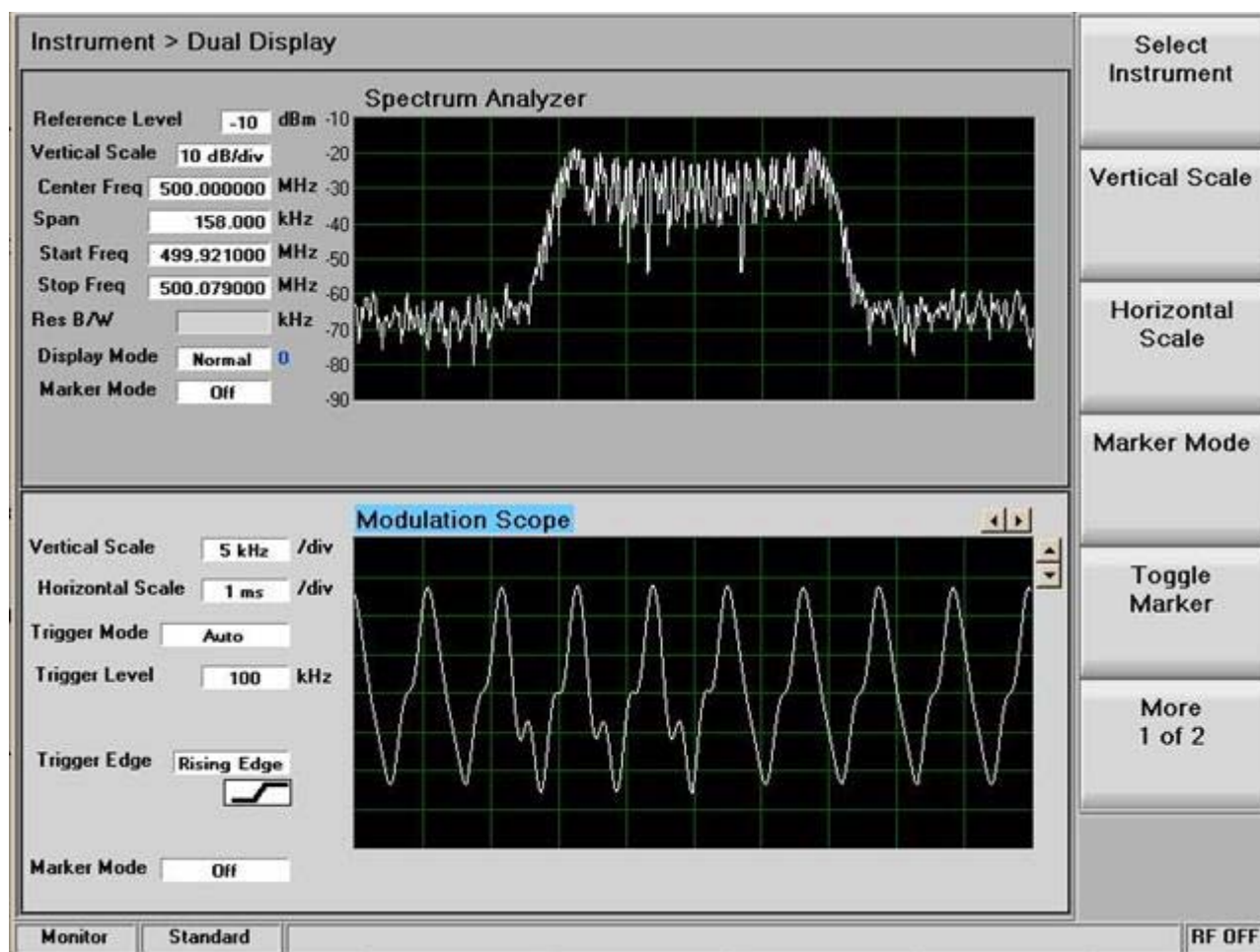


Figure 3.2.7.1-1. Dual Display mode

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

3.2.7.2. Tracking Generator mode

The optional Tracking Generator function sets up the 2801 Multilock 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 2801 Multilock (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.

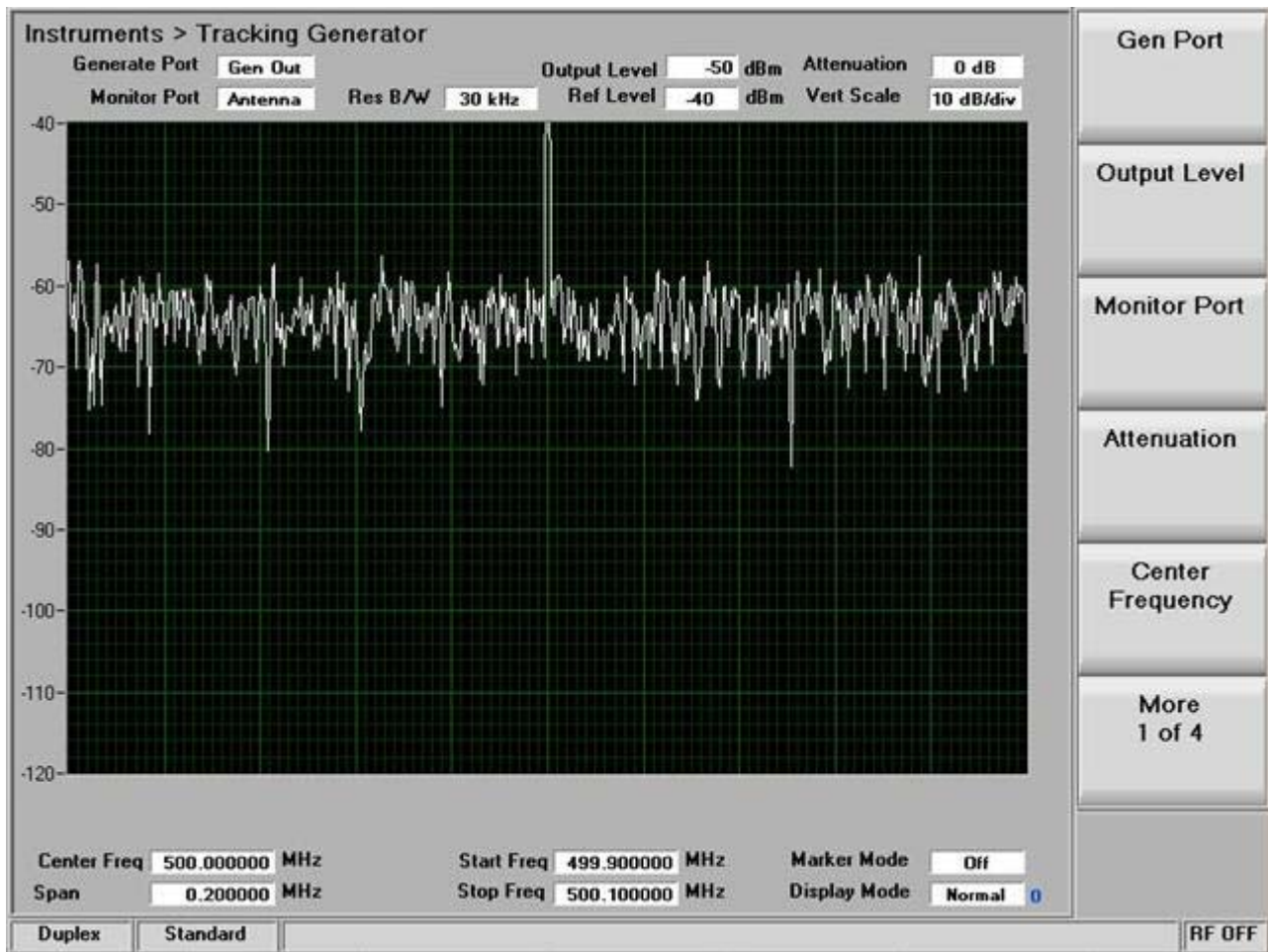


Figure 3.2.7.2-1. Tracking Generator mode

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.

Gen Port

Selects the active port (RF In/Out or Gen Out) for the swept 2801 Multilock tracking generator output in a selection table using the up/down arrow keys or tuning knob.

Center Frequency

Sets the tracking generator center frequency from 400 kHz to 3 GHz in a data entry window using the arrow keys, keypad, or tuning knob. If no Frequency Offset is specified the Tracking Generator and Spectrum analyzer are locked to the same frequency. Pressing Enter completes the change and Esc cancels the entry.

Frequency Offset

Sets an offset frequency for the Tracking Generator away from the center frequency of the Spectrum Analyzer. In this mode the Tracking generator frequency span will match that of the Spectrum Analyzer but the generator's center frequency will be offset from that of the Spectrum Analyzer.

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.

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.

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 arrow keys or tuning knob.

Attenuation

Adjusts the Spectrum Analyzer RF input signal attenuation in 2 dB steps from 0 to 90 dB. Select in a windowed table using the up/down arrow keys or tuning knob.

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 2801 Multilock 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 2801 Multilock 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 –50 dBm to + 0 dBm in 1 dB increments.

Vertical Scale

Selects the vertical scale resolution for the display's major grid lines from 1 dB/div to 15 dB/div via a horizontal softkey menu.

Center Peak

Centers the operating frequency and display of the 2801 Multilock Spectrum Analyzer around the highest peak signal within the display range.

Marker Mode

Provides display marker control via a horizontal softkey 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.

Select Marker

Cycles through and highlights the available markers to determine the active one for positional adjustment on the display. The active marker is moved via the left/right (← and →) cursor control buttons.

OPERATION

Center Marker

Centers the operating frequency and display of the 2801 Multilock 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

Places a marker at the frequency where the signal is -3 dB below the peak amplitude.

3.2.7.3. Other meters

Pressing the "Other Meters" softkey provides a shortcut to the Meter Zone operation of the 2801 Multilock. The screen displays the same horizontal menu of meter selections shown when the "Select Meter" softkey in the Meter Zone is pressed.

3.2.8. Test mode

The 2801 Multilock Test Mode provides operator presets and dedicated modes for radio or protocol specific tests. The presets permit storage or recall of 2801 Multilock 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. At present the 2801 Multilock is provided with the Motorola TRBO protocol with others in development that will be available as a firmware upgrade. Figure 3.2.8-1 shows the submenu screen after pressing the dedicated Test navigation key.

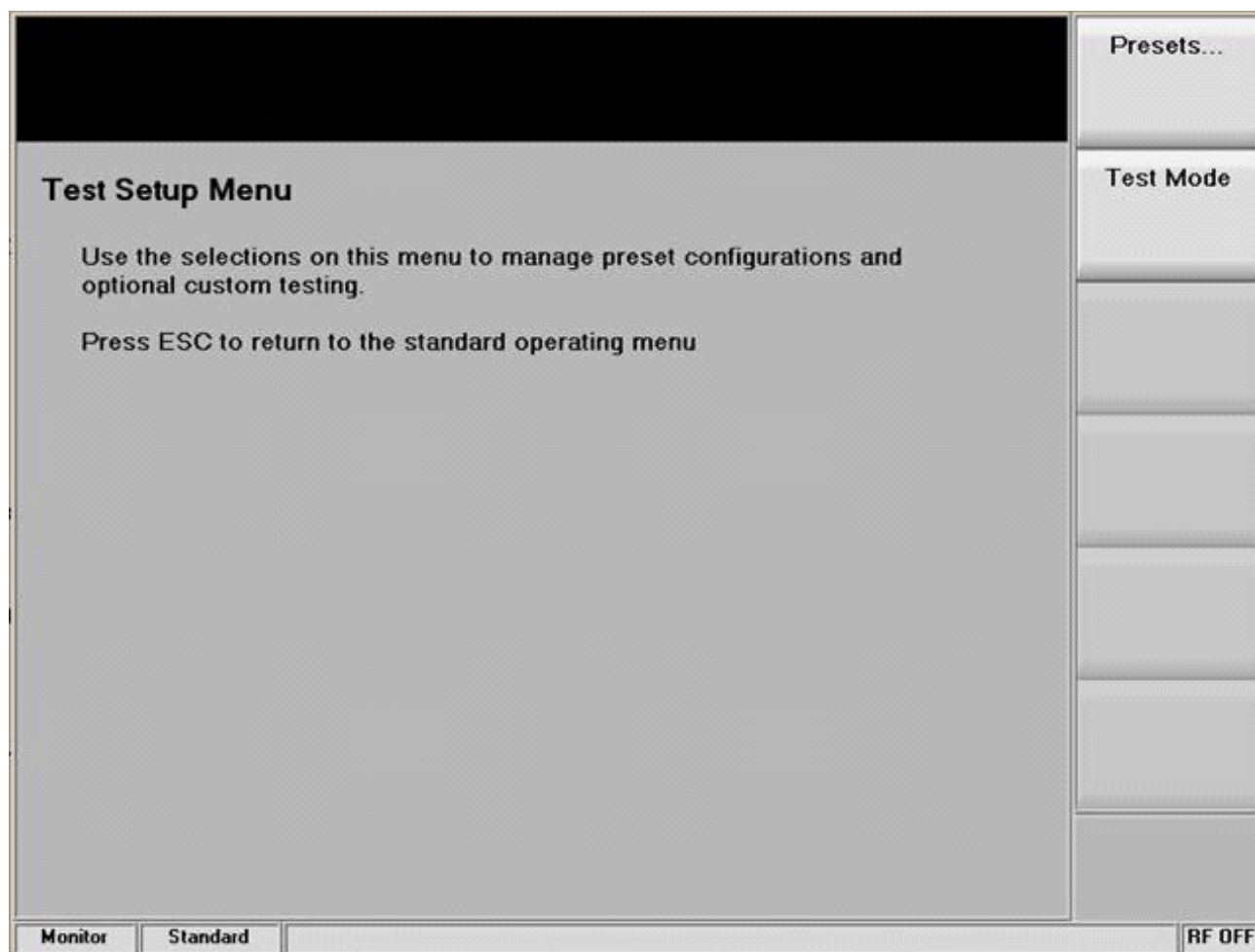


Figure 3.2.8-1. Submenu after pressing Test navigation key

3.2.8.1. Presets

Presets are a convenient tool for storing and recalling 2801 Multilock operational settings. Figure 3.2.8.1-1 shows the submenu after pressing the Presets softkey. If there are any Presets present they can be highlighted for further action by using the Up/Down. In Figure 3.2.8.1-1 the TEST1 Preset is highlighted (blue border).

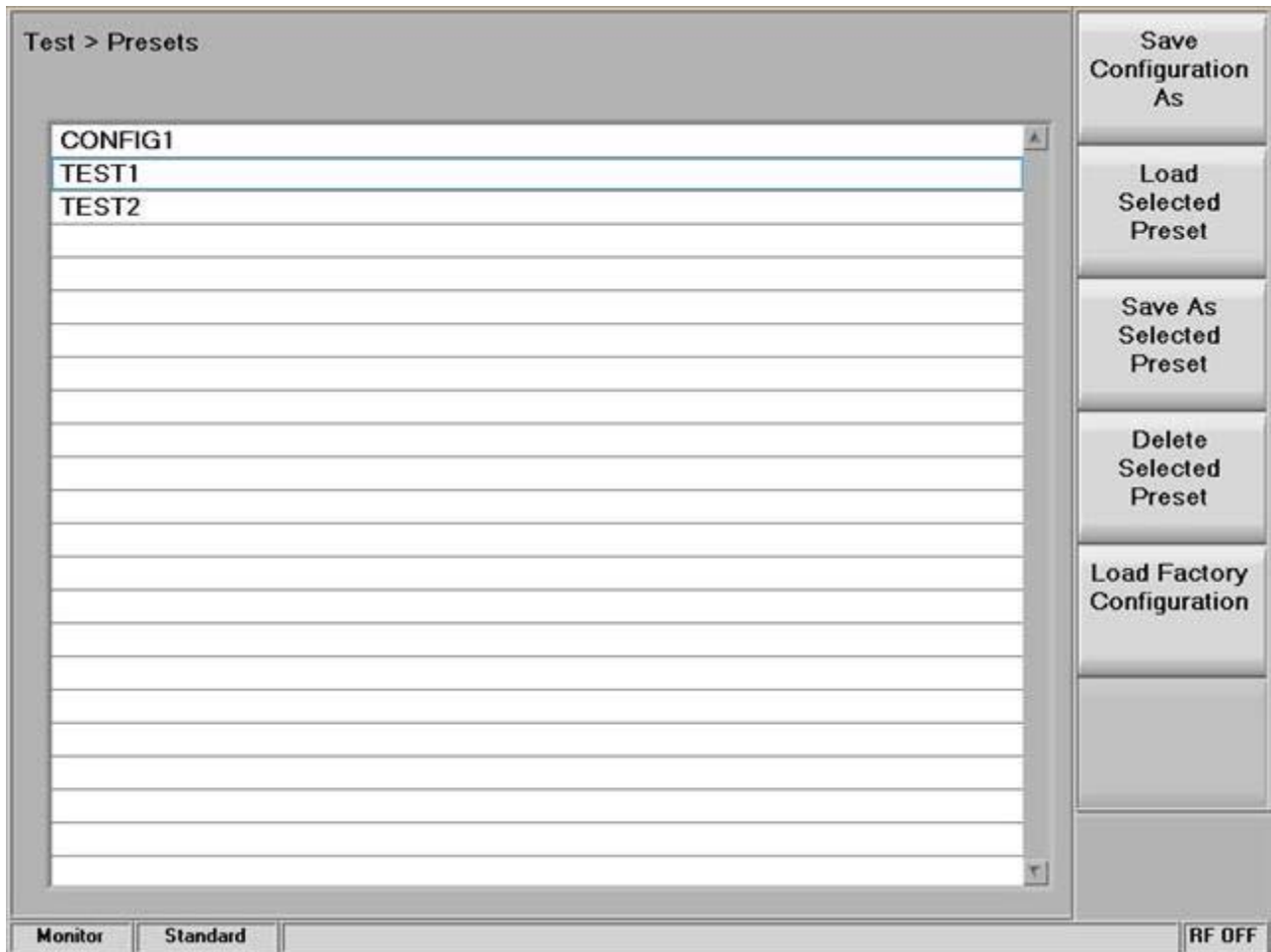


Figure 3.2.8.1-1. Submenu after pressing Presets softkey

Save Configuration As

This softkey saves the current set of 2801 Multilock operational settings into a memory preset. Use the keypad to enter a name for the preset in the data entry window as shown in Fig 3.2.8.1-2. The value can be adjusted with the front panel keypad and tuning controls. Use the left/right arrows to move the highlight over the desired field. Enter numbers or letters using the keypad. Repeated key presses will cycle through the alphanumeric sequence marked on the keys. Names can't have spaces or blanks between characters.

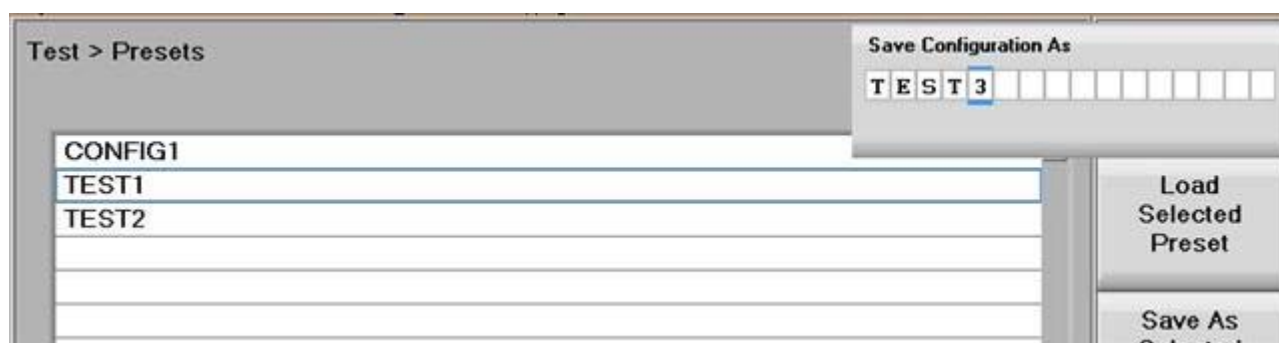


Figure 3.2.8.1-2. Data entry mode after pressing Save Configuration softkey

Load Selected Preset

Pressing this softkey loads the highlighted Preset and configures the 2801 Multilock to the operational settings saved by the operator at that memory location. This Preset becomes the new default configuration on power up unless a different one is chosen or the Factory Configuration is reloaded in the Preset menu.

Save As Selected Preset

Pressing this softkey saves the current set of 2801 Multilock operational settings to the highlighted Preset. Any existing operational settings at that memory location are overwritten by the current 2801 Multilock settings.

Delete Selected Preset

Erases the highlighted Preset from the 2801 Multilock memory.

Load Factory Configuration

Loads and configures the 2801 Multilock to the as shipped factory settings. These become the default on power up unless a different Preset is loaded.

3.2.8.2. Test Mode submenu

The Test Mode softkey displays the available dedicated test modes for protocol or radio specific tests as shown in Figure 3.2.8.2-1. The 2801 Multilock's current mode is shown (Standard) by the highlighted horizontal softkey, along with all other available test modes. The Motorola MOTOTRBO test mode is one of the initial options for the 2801 Multilock with others under development as firmware upgrades.

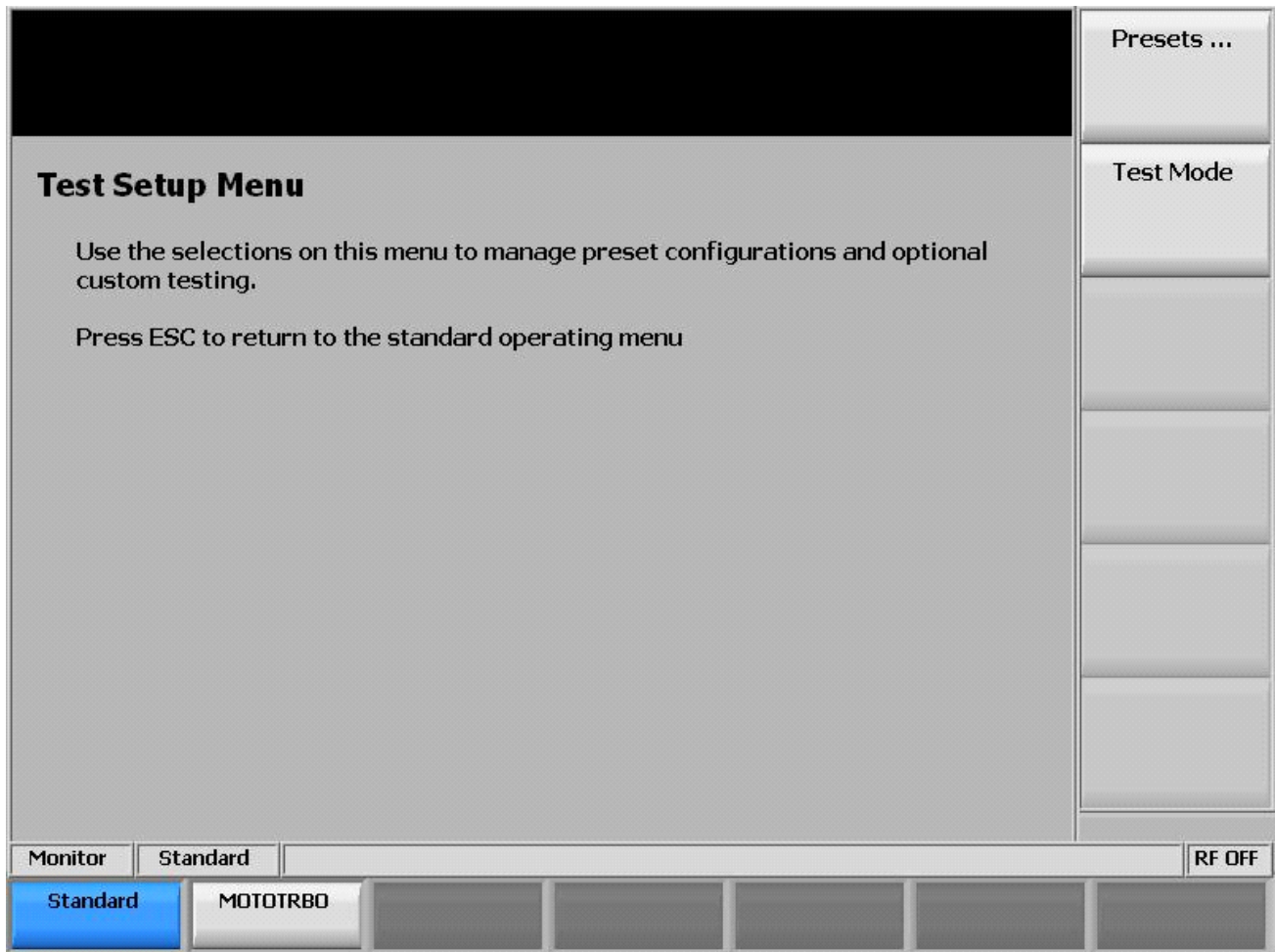


Figure 3.2.8.2-1. Test mode submenu

3.2.8.3. MOTOTRBO test mode

The MOTOTRBO option of the 2801 Multilock 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 2801 Multilock service monitor is to transmit and receive test patterns compliant to the DMR (Digital Mobile Radio) physical layer.

Pressing the MOTOTRBO softkey initiates the Motorola MOTOTRBO test mode. The 2801 Multilock switches to the main display and a MOTOTRBO softkey replaces the Standard mode's AUDIO ZONE softkey – 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 softkey in the 2801 Multilock main screen while in Monitor mode.

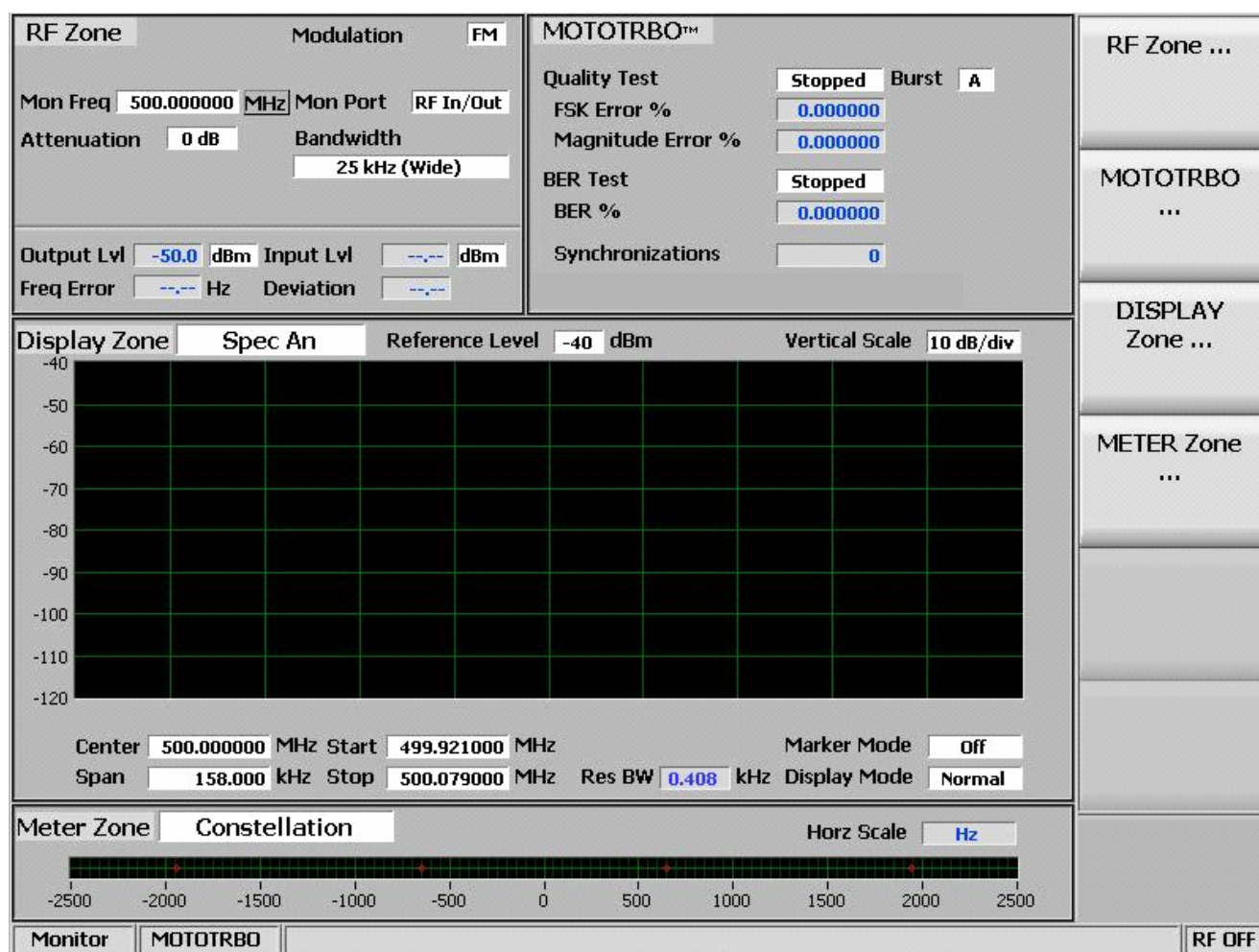


Figure 3.2.8.3-1. 2801 Multilock Monitor main screen after pressing MOTOTRBO softkey in the Test submenu

MOTOTRBO transmitter tests

These tests are performed with the 2801 Multilock in Monitor mode – see figure 3.2.8.3-2.

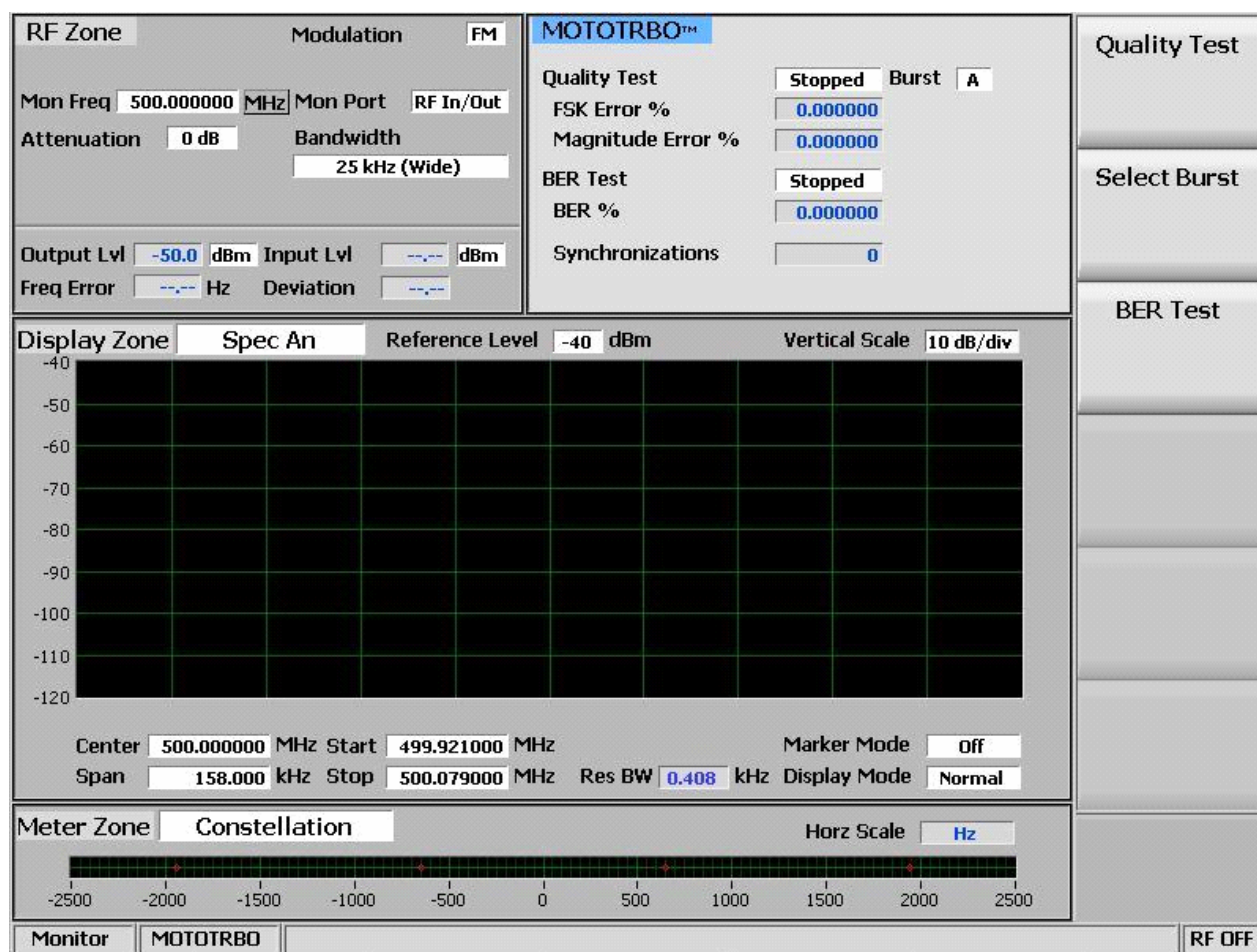


Figure 3.2.8.3-2. Submenu after pressing MOTOTRBO softkey on 2801 Multilock main screen in Monitor mode

Constellation Display

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 location for the deviation state when the radio is transmitting data bits using 4FSK modulation.

Data Bit	Symbol	Deviation
01	+3	+1.944 kHz
00	+1	+0.648 kHz
10	-1	-0.648 kHz
11	-3	-1.944 kHz

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 0.153 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 softkeys to activate the test.

Select Burst

Choose one of 6 test pattern bursts for the 2801 Multilock 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 0.153 super frame test pattern into the service monitor. (It is acceptable to require an attenuator between the radio under test and the service monitor.) MOTOTRBO Tuner is used to select the correct TX test pattern.

MOTOTRBO receiver tests

These tests are performed with the 2801 Multilock in Generate mode – see Figure 3.2.8.3-3.

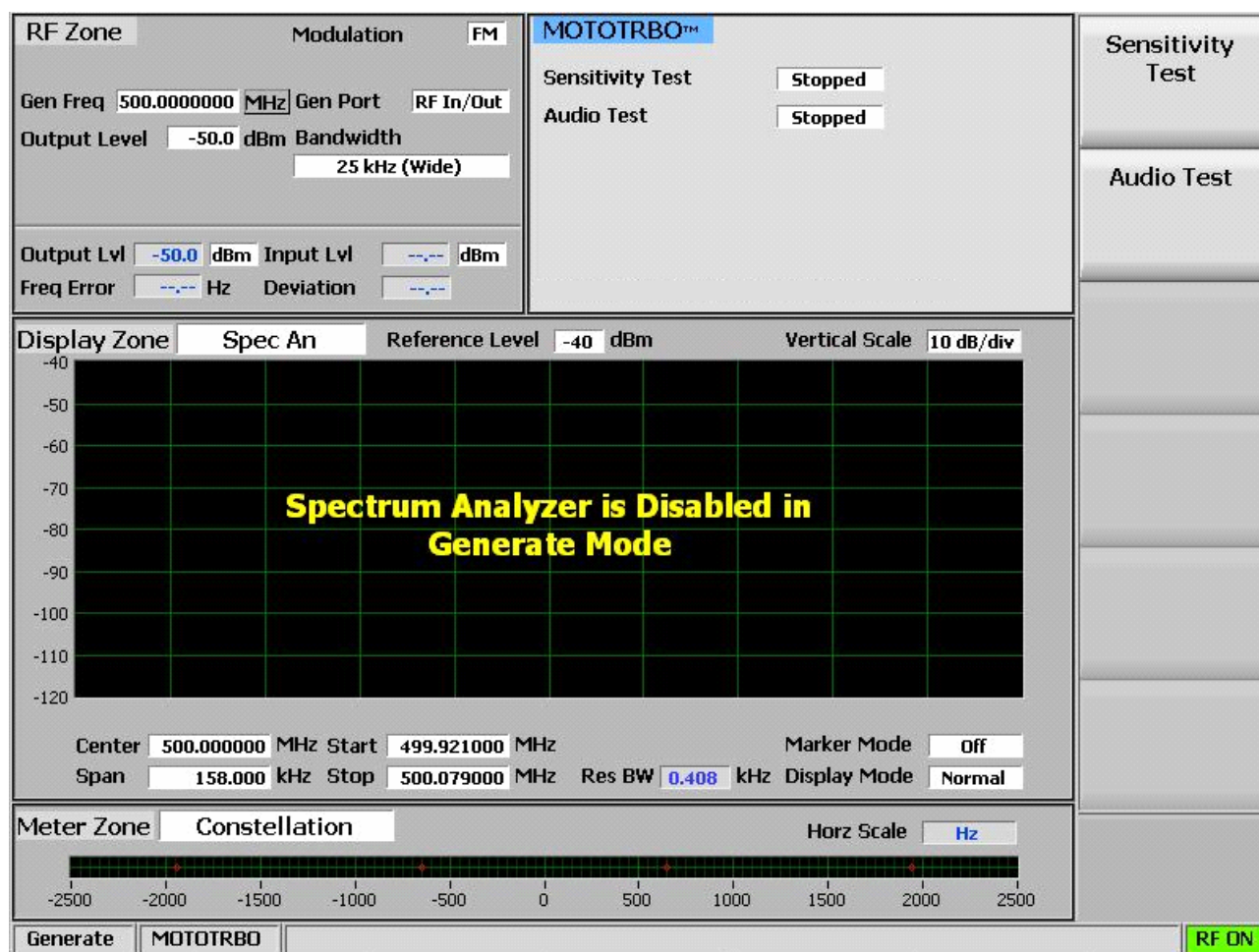


Figure 3.2.8.3-3. Submenu after pressing MOTOTRBO softkey on 2801 Multilock main screen in Generate mode

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 2801 Multilock will transmit a BER calibration signal, which is the 1% BER 0.153 super frame test pattern at an output power level of –60 dBm. The transmission of this signal at the defined power level is used to validate that the internal BER calculator is operating correctly. For the sensitivity test the 2801 Multilock monitor is used to transmit the 0.153 (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 2801 Multilock 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.

3.2.9. Settings mode

System settings for the 2801 Multilock 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 2801 Multilock operation along with information on the unit's firmware, installed options and diagnostic messages generated during operation.

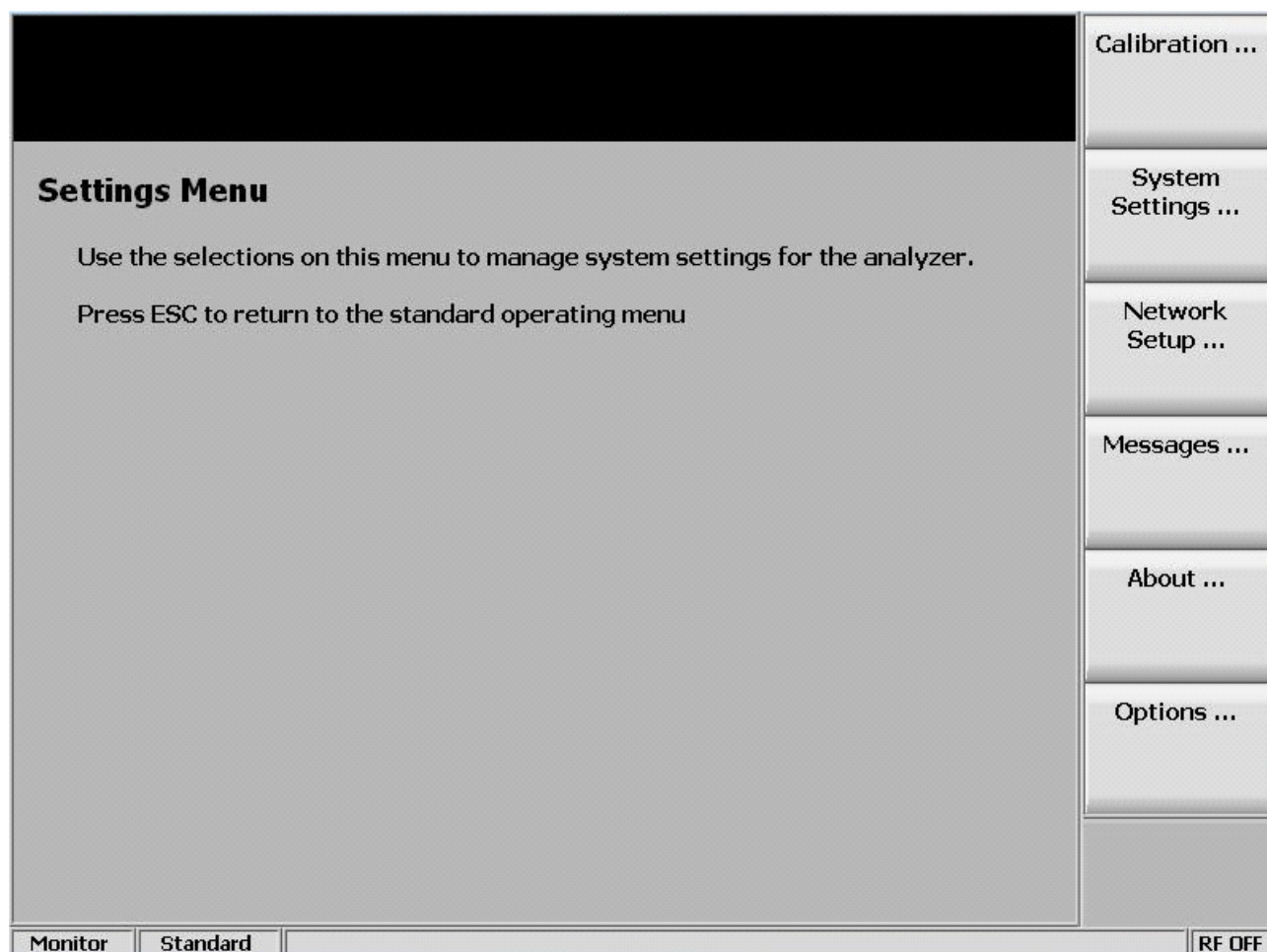


Figure 3.2.9-1. Submenu after pressing Settings navigation button on 2801 Multilock front panel

3.2.9.1. Calibration

The 2801 Multilock has self test and calibration functions to assure accurate and consistent performance over time and in a variety of environmental settings. The options presented by the Calibration softkey are as follows:

Self Test

This initiates an internal self-diagnostic test to ensure that critical 2801 Multilock modules and sub-circuits are performing properly.

Calibrate Now

This initiates a self alignment process for the 2801 Multilock 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 2801 Multilock.

Load Factory Defaults

The calibration values generated during factory alignment prior to shipment are loaded. These establish a nominal baseline for 2801 Multilock operation in the event the user generated self calibration tables are lost or corrupted.

3.2.9.2. System settings

The 2801 Multilock 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 2801 Multilock menu system. Figure 3.2.9.2-1 shows the Systems Settings submenu and the options are as follows:

Settings > System Settings

Generate Mode Speaker	<input type="checkbox"/> ON	Generate Mode Speaker
SINAD Audio	<input type="checkbox"/> OFF	SINAD Audio
Input Decoding	Internal	Input Decoding
Deviation Level Alarm (0 = Alarm Off)	0 kHz	Deviation Level Alarm
Input Impedance	1 MegOhm	Input Impedance
Reference Clock Mode	Output	
Reference Clock Source	Internal	
Peak Detect Threshold	50 %	
Date (MM.DD.YYYY) 07.16.200		
Time (24hr notation) 14:24:35		
		More 1 of 3
Monitor Standard		RF OFF

Figure 3.2.9.2-1. Submenu after pressing System Settings softkey in the Settings menu

Generate Mode Speaker

Enables or disables the 2801 Multilock internal speaker while in Generate mode. With the speaker enabled the operator hears the audio modulation applied to RF carriers generated by the 2801 Multilock.

SINAD Audio

Enables or disables routing of the signal applied to the Meter In port to the 2801 Multilock internal speaker while in SINAD mode. With SINAD Audio enabled the operator will hear the audio recovered by an external radio that is applied to the **METER IN** port during SINAD testing.

Input Decoding

Selects the signal source used for the 2801 Multilock 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 2801 Multilock frequency counter and decode circuits.

Deviation Level Alarm

Sets the deviation level in kHz above which an alarm sounds when receiving an FM modulated signal in Monitor mode. To disable the alarm set the deviation level to 0 kHz.

Input Impedance

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

Reference Clock Mode

Selects the mode for the 10 MHz REF connector at the side of the 2801 Multilock. "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 2801 Multilock.

Reference Clock Source

Selects the source for the frequency reference clock (time base) used by the 2801 Multilock for its operation. The Internal setting utilizes the internal stabilized 10 MHz time base. The external setting selects a user provided 10 MHz time base signal applied to the **10 MHz REF** connector at the side of the 2801 Multilock.

Peak Detect Threshold

Adjusts the level at which ...

Reset to Defaults

All 2801 Multilock system settings are restored to the factory defaults.

Time

Sets the 2801 Multilock system clock in 24-hour notation. Use the numeric keypad and the up/down ($\uparrow \downarrow$), and left/right (\longleftrightarrow) cursor control to make or change entries.

Date

Sets 2801 Multilock system date in mm.dd.yyyy notation. Use the numeric keypad and the up/down ($\uparrow \downarrow$), and left/right (\longleftrightarrow) cursor control to make or change entries.

Apply Date/Time Changes

Applies the time and date changes selected above to the 2801 Multilock system clock.

3.2.9.3. Network settings for remote operation

The 2801 Multilock can be connected to a TCP/IP network for remote operation using the unit's remote command syntax. Communication over the network requires setting an IP address for the 2801 Multilock. The instrument can use either a static IP address assigned by a network administrator, or a dynamic IP assigned using DHCP (Dynamic Host Configuration Protocol). Figure 3.2.9.3-1 shows the Network Settings setup submenu.

The screenshot displays the 'Settings > Network Setup' submenu. The main area is titled 'Remote Network Settings' and contains four input fields: 'Obtain IP Address (DHCP)' with a checkbox, 'IP Address', 'Subnet Mask', and 'Default Gateway', each followed by a text entry box. To the right of the main area is a vertical sidebar with several buttons: 'Network Connection', 'DHCP', 'IP Address', 'Subnet Mask', 'Default Gateway', and 'Apply Network Changes'. At the bottom of the screen, there are three tabs: 'Monitor', 'Standard', and 'RF OFF'.

Figure 3.2.9.3-1. Submenu after pressing Network Setup softkey in the Settings menu

Network Connection

Enables or disables the network connection for remotely operating the 2801 Multilock. It's recommended that external security measures are taken when enabling the connection to prevent unauthorized access to the 2801 Multilock.

DHCP

Enables DHCP (or Dynamic Host Configuration Protocol) by which an IP address is assigned to the 2801 Multilock during boot by a DHCP server on the Local Area Network. When the 2801 Multilock 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.

IP Address

Use this to enter the IP address assigned to the 2801 Multilock by the network administrator.

Subnet Mask

Use this to enter the subnet mask address assigned to the 2801 Multilock by the network administrator.

Default Gateway

Use this to enter the Default Gateway address assigned to the 2801 Multilock by the network administrator. This is the address of the router that passes data outside the subnet the 2801 Multilock is attached to.

Apply Network Changes

Pressing this softkey loads the network settings shown on the Remote Setup screen into the 2801 Multilock configuration memory.

3.2.9.4. Messages during 2801 Multilock operation

During operation the 2801 Multilock may display system related messages on the bottom of the screen next to the field showing the operational mode of the instrument. The messages relate the status of the instrument during test transitions or warn the operator of fault or other 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 2801 Multilock keeps a running log of all messages generated during the operational session. These can be viewed using the Messages softkey as shown in Figure 3.2.9.4-1.



Figure 3.2.9.4-1. Submenu after pressing Messages softkey in the Settings menu

Clear

Pressing this softkey loads clears the highlighted message from the 2801 Multilock message log.

Clear All

Pressing this softkey clears all messages from the 2801 Multilock message log.

3.2.9.5. About (Search for Updates)

The 2801 Multilock firmware can be upgraded in the field using a USB Flash Drive. **Caution: firmware changes can significantly affect instrument operation and should be performed carefully. An improperly executed firmware upgrade can render the instrument inoperable. It is recommended that Willtek support personnel be consulted and involved in firmware upgrades of the 2801 Multilock.** Figure 3.2.9.5-1 shows the submenu and current subsystem firmware versions after pressing the About softkey in the Settings menu.

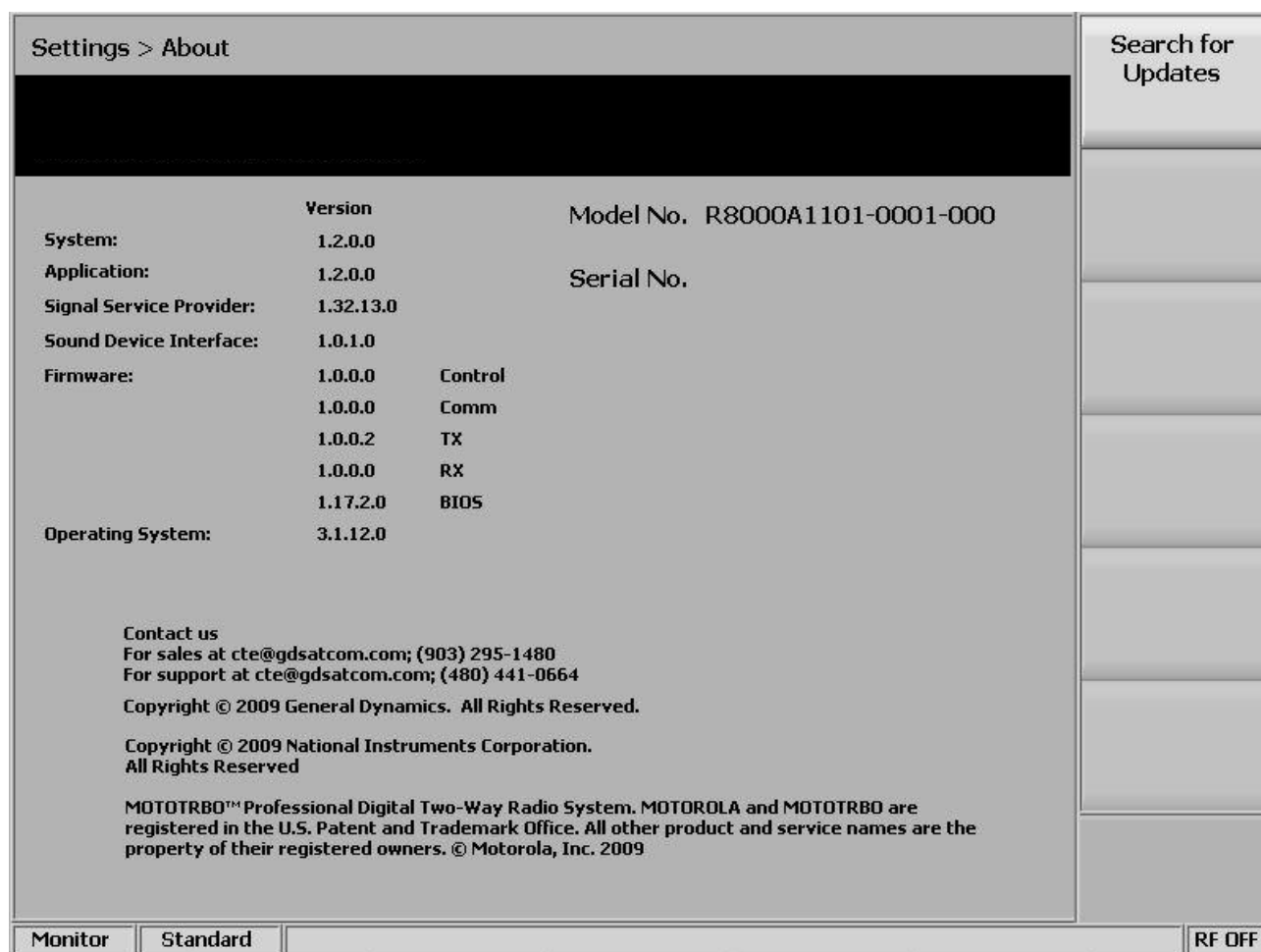


Figure 3.2.9.5-1. Submenu after pressing About softkey in the Settings menu

Search for Updates

Pressing this softkey initiates a search for 2801 Multilock firmware updates on a USB Flash Drive.

3.2.9.6. About

The About softkey loads a submenu that displays the current version of operational software on the 2801 Multilock – see Figure 3.2.9.6-1. This information is important when interacting with Willtek personnel to resolve technical issues or determine if a firmware upgrade is required.

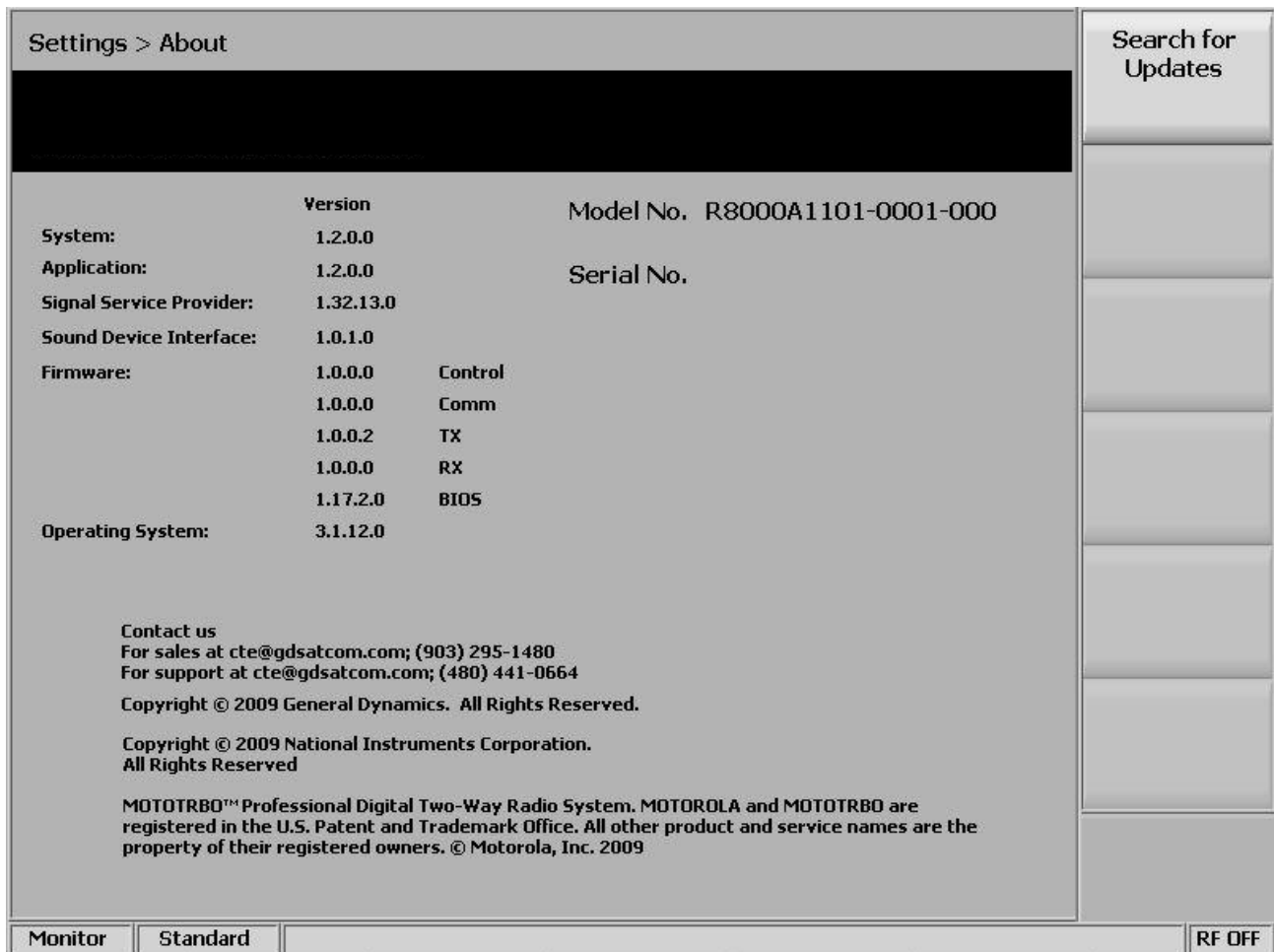


Figure 3.2.9.6-1. Submenu after pressing About softkey in the Settings menu

3.2.9.7. Options

Pressing this softkey displays all the installed operating options on the 2801 Multilock. These include enhanced features for the main 2801 Multilock system along with additional radio communication protocols or special test functions. – see Figure 3.2.9.7-1.

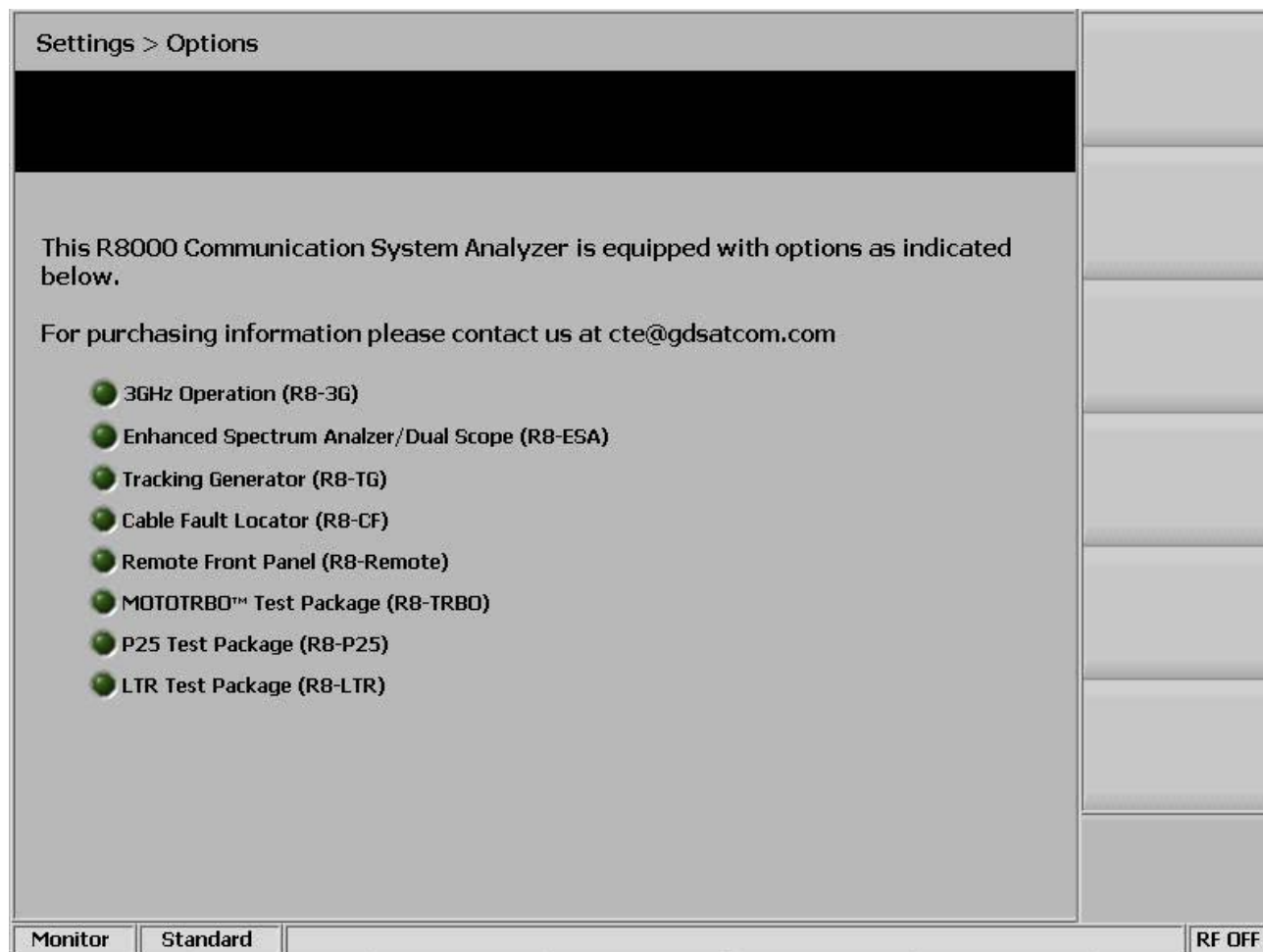


Figure 3.2.9.7-1. Submenu after pressing Options softkey in the Settings menu

4. TEST APPLICATIONS

This section contains information on typical test setups to perform some of the more common radio tests using the 2801 Multilock. Willtek takes no responsibility for application accuracy, applicability, or safety. Always refer to your own transceiver's service manual for recommended test methods and specifications.

4.1. FM Transmitter Testing

The 2801 Multilock has extensive capability for evaluating the performance of FM transmitters. However, detailed instructions for the wide variety of transmitter types is 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.

4.1.1. Basic FM transmitter testing – initial setup

Refer to Figure 4.1.1-1. Connect the instrument's RF I/O port to the RF output of the transmitter under test. Connect the instrument'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

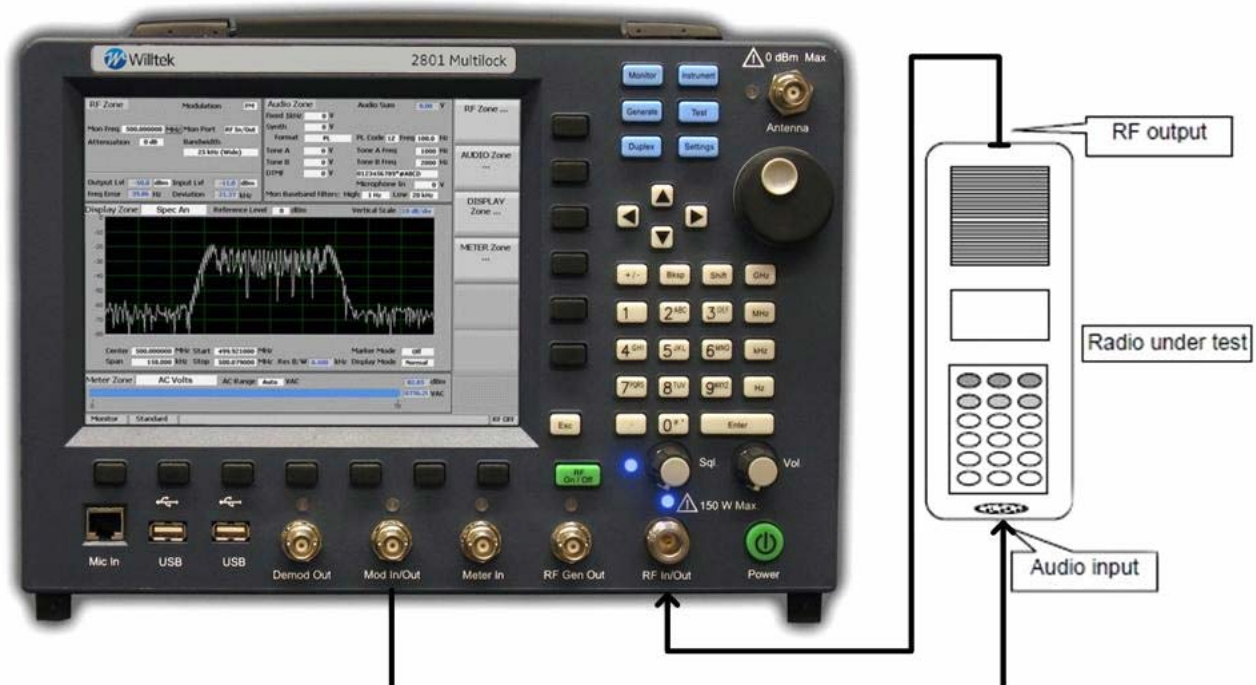


Figure 4.1.1-1. Setup for FM Transmitter testing

4.1.2. Transmit power, frequency, and frequency deviation Measurements

Place the 2801 Multilock in Monitor mode by pressing the Monitor front panel hard key. Press the RF Zone softkey 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 2801 Multilock 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 2801 Multilock 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 instrument'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 2801 Multilock 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.

4.1.3. Modulation measurements

Place the 2801 Multilock in Monitor mode by pressing the Monitor front panel hard key. Press the RF Zone softkey 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 2801 Multilock 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 2801 Multilock 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 2801 Multilock 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 2801 Multilock MOD IN/OUT connector to the maximum required for proper microphone sensitivity as specified in the radio service manual. Navigate to the 2801 Multilock 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.

4.1.4. Off-the-air measurements

Place the 2801 Multilock in Monitor mode by pressing the Monitor front panel hard key. Press the RF Zone softkey 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 2801 Multilock 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 2801 Multilock 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 instrument'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 2801 Multilock main screen.

4.2. FM Receiver Testing

The 2801 Multilock has extensive capability for evaluating the performance of FM receivers. However, detailed instructions for the wide variety of receiver types is 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.

4.2.1. Basic FM receiver testing – initial setup

Refer to Figure 4.2.1-1. Connect the instrument'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 instrument'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 instrument'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 2801 Multilock. Typically this requires the use of an isolation transformer which is an optional 2801 Multilock accessory.

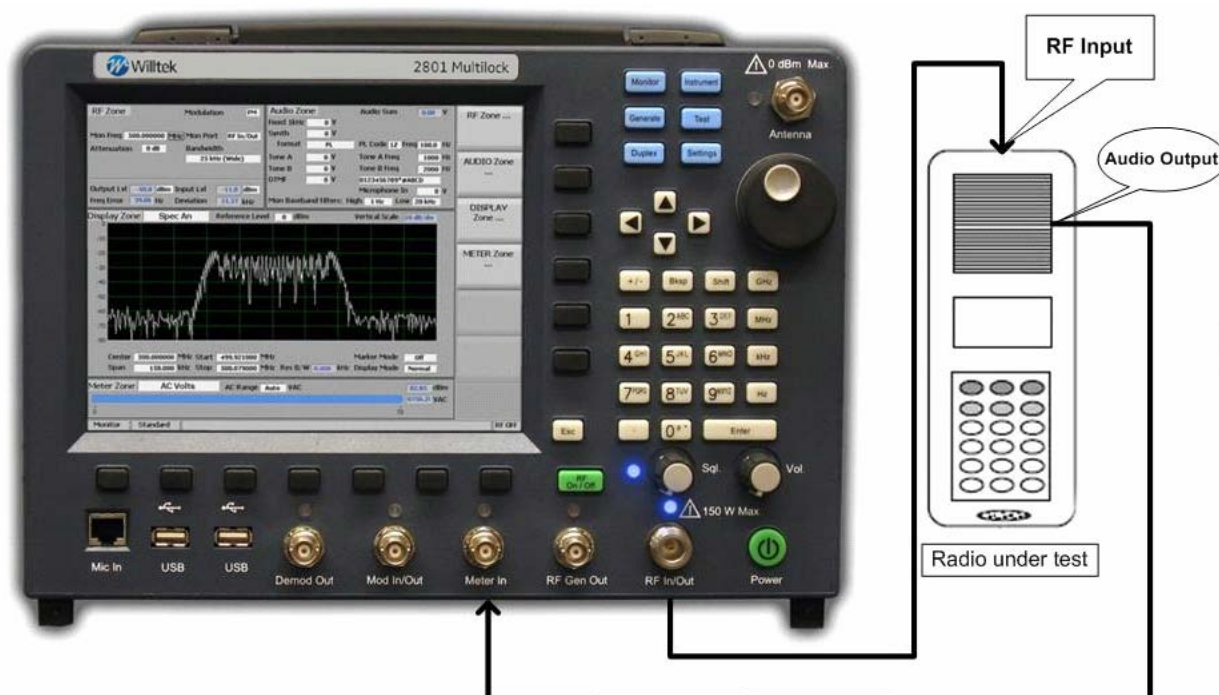


Figure 4.1.1-2. Setup for FM Receiver testing

Place the 2801 Multilock in Generator mode by pressing the Generate front panel hard key. Press the RF Zone softkey 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.

4.2.2. 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.

4.2.3. 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.

4.2.4. Modulation acceptance bandwidth

Set the radio's volume control to 10% of its rated output. Adjust the 2801 Multilock RF output level 6 dB above that needed for 12 dB SINAD as determined in 4.2.3 (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.

4.2.5. Receiver sensitivity testing (20 dB quieting)

Place the 2801 Multilock 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 1/4 the rated audio power. Record the noise reading in dBm.

Switch the 2801 Multilock 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.

4.2.6. Squelch sensitivity test

Threshold Squelch Sensitivity

Place the 2801 Multilock 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 2801 Multilock 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 2801 Multilock 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.

Appendix A – List of Abbreviations and Acronyms

A	Ampere	Ext'l	External
AC	Alternating Current	FM	Frequency Modulation
AM	Amplitude Modulation	FREQ	Frequency
ATTEN	Attenuation	GEN	Generate
AUTO	Automatic	GHz	Gigahertz
BATT	Battery	Horiz	Horizontal
BNC	Coaxial RF Connector	HPF	High Pass Filter
BW	Bandwidth	Hz	Hertz
C	Celsius	IC	Integrated Circuit
CAL	Calibrate	IDC	Instantaneous Deviation Control
CCIR	International Radio Consultative Committee	IEEE	Institute of Electrical and Electronics Engineers
cm	Centimeters	IF	Intermediate Frequency
CMOS	Complementary Metal Oxide Semiconductor	IMTS	Improved Mobile Telephone System
Cntr	Counter	I/O	Input/Output
CRLF	Carriage-return-line feed	kohm	Kiloohm
CW	Continuous Wave	kHz	Kilohertz
dB	Decibel	LCD	Liquid Crystal Display
dBc	Decibel (referred to carrier)	LED	Light-Emitting Diode
dBm	Decibel (referred to 1 mW into 50 Ω)	LPF	Low Pass Filter
DC	Direct Current	Lvl	Level
Demod	Demodulation	MHz	Megahertz
DEV	Deviation	MIC	Microphone
Disp	Dispersion	MIN	Minimum
DIST	Distortion	MOD	Modulation
Div	Division	MON	Monitor
DPL	Digital Private Line, a Motorola registered trademark	μ s	Microsecond
DTMF	Dual-tone multi-frequency	ms	Millisecond
Dur	Duration	msec	Millisecond
DVM	Digital Voltmeter	MTS	Mobile Telephone System
EEA	Electronic Engineering Association	mV	Millivolt
EIA	Electronics Industry Association	μ V	Microvolt
		mW	Milliwatt
		n	Number

APPENDIX A – LIST OF ABBREVIATIONS AND ACRONYMS

N/A	Not Applicable	ZVEI	Zentral-Verband der Elektro-Industrie (a German Electronics Industry Association)
NB	Narrow Bandwidth		
NVM	Non-volatile memory		
ORIG	Originated		
PCT	Percent		
PL	Private Line, a Motorola registered trademark		
+/-	Plus or minus		
PRT	Print		
RF	Radio Frequency		
RMS	Root-Mean-Square		
Rng	Range		
RS	Receiver Specification		
SEQ	Sequence		
SINAD	Ratio of (Signal + Noise + Distortion)/(Noise + Distortion)		
SPF	Special Function		
SSB	Single Sideband		
STD	Standard		
SW	Switch		
SWP	Sweep		
Synth	Synthesizer		
TN	Tone		
Trig	Trigger		
TX	Transmitter		
UHF	Ultra High Frequency		
V	Volts		
V AC	Volts Alternating Current		
V DC	Volts Direct Current		
Vert	Vertical		
V RMS	Volts (root-mean-square)		
W	Watts		
WB	Wide Bandwidth		
XCVR	Transceiver		
XX	(Select Any Valid Number)		

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			•					•
*				•	•			
0				•		•		
#				•			•	
D				•				•

*The instrument 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
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
d065	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 – Network Setup

The following procedure documents the configuration of the 2801 Multilock network port.

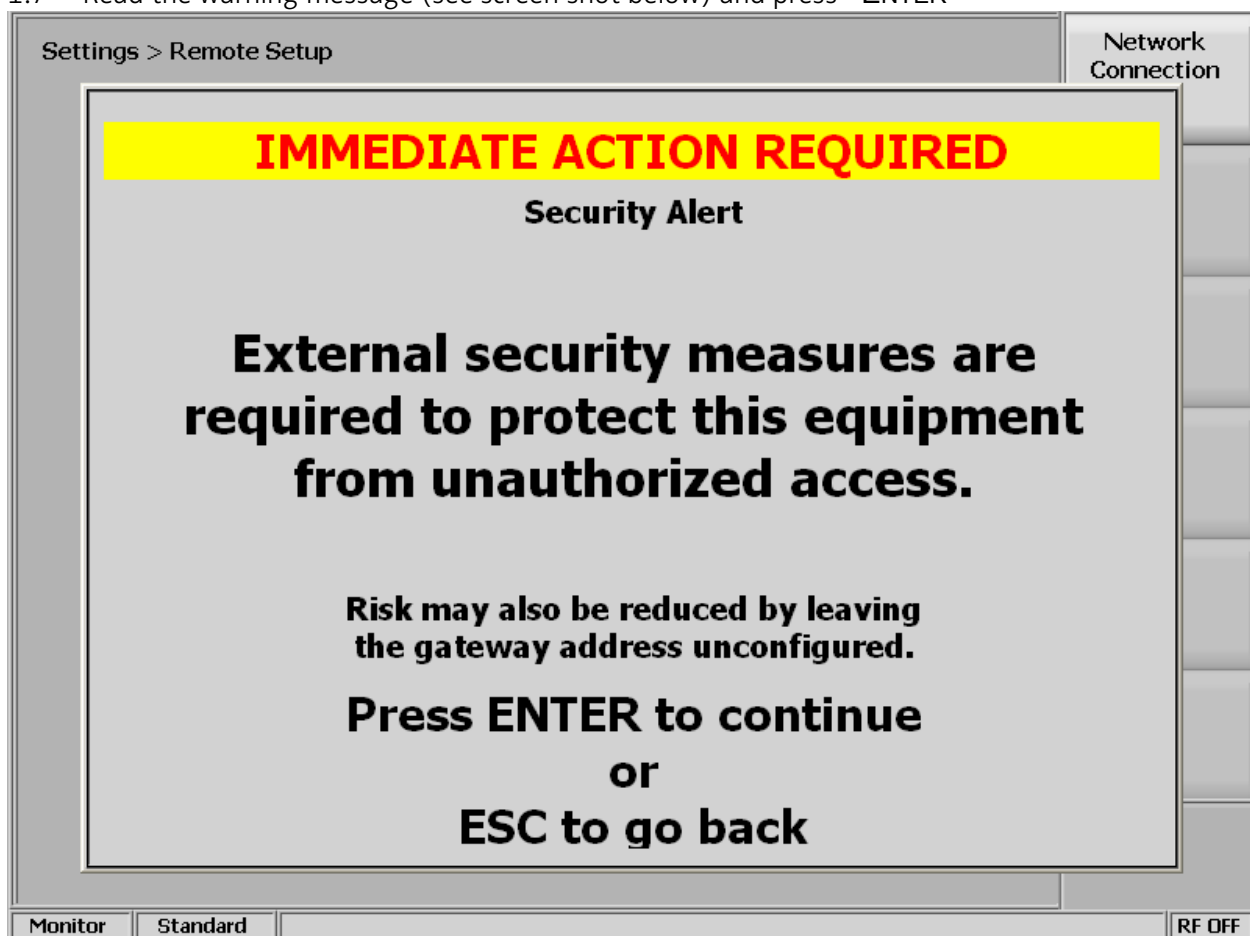
Requirements


- 2801 Multilock unit with AC power adapter.
- Ethernet 10/100Base-T patch cable.
- Ethernet 10/100Base-T network.
- DHCP Server (optional).

Procedure

Section 1 – Enable the Network Connection

- 1.1 Confirm the network cable is connected then press the green power button on the front of the 2801 Multilock unit.
- 1.2 Wait approximately half a minute for the boot sequence to complete.
- 1.3 Press the <SETTINGS> button
- 1.4 Press the “Network Setup” softkey
- 1.5 Press the “Network Connection” softkey
- 1.6 Press the “Enable” softkey (to enable the network connection)
- 1.7 Read the warning message (see screen shot below) and press <ENTER>



 **Warning:** When the network connection is enabled, the 2801 Multilock may be controlled by other computers on the network without restriction. It is strongly recommended that the 2801 Multilock be protected from unauthorized access through the use of external security measures.

1.8 To configure a DHCP address, skip to Section 3, otherwise proceed to Section 2.


Section 2 – Configure a Static Address

2.1 Press the “DHCP” softkey and use the arrow keys to select “off”

2.2 Press <ENTER> (to turn off DHCP)

2.3 Press the “IP Address” softkey

2.4 Set the IP address using the keypad

 **Note:** Use of an invalid IP address can severely cripple the network. Use only valid IP addresses that conform to IPv4 standards and ones that are not in use by other devices on the network. When in doubt about the correct configuration, consult a network technician.


2.5 Press <ENTER>


2.6 Press the “Subnet Mask” softkey

2.7 Set the subnet mask using the keypad

2.8 Press <ENTER>

2.9 Press the “Default Gateway” softkey

 **Note:** The default gateway address is optional. If it is not needed, press the ESC button, press the “Apply Network Changes” softkey, skip the remaining steps in this section, and proceed directly to Section 4 – Network Configuration Complete.

 **Warning:** When the gateway is configured, the 2801 Multilock may be controlled by computers on external networks. It is strongly recommended that the gateway be configured on an as needed basis, and only when the 2801 Multilock is protected from unauthorized access through the use of external security measures.

2.10 As needed, set the default gateway using the keypad


2.11 Press <ENTER>

2.12 Press the “Apply Network Changes” softkey

2.13 Skip to Section 4

Section 3 – Configure a DHCP Address

3.1 DHCP is on by default when the Network Connection is enabled for the first time. The 2801 Multilock remembers the previously set network settings. If the network connection was previously enabled and used a static address configuration, then continue. Otherwise skip to Section 4. If unsure, continue.

 **Warning:** When DHCP is used to configure the network interface, the 2801 Multilock may be controlled by computers on local or external networks.

- 3.2 Press the “DHCP” softkey and use the arrow keys to select “on”
- 3.3 Press <ENTER> (to enable DHCP)
- 3.4 Press the “Apply Network Changes” softkey
- 3.5 Proceed to Section 4

Section 4 – Network Configuration Complete

- 4.1 Observe a green indicator below the configuration data fields that reads “Configuration in Progress”
- 4.2 Press the <MON> button (to return to the main application screen)

Section 5 – Verification / Troubleshooting Information

- 5.1 The 2801 Multilock responds to ICMP ping.



Note: Default gateway connectivity questions are best resolved by confirming that both local and remote pings to the 2801 Multilock succeed. The gateway address may be incorrect if local devices can ping the 2801 Multilock but remote devices cannot do so successfully.

- 5.2 The Remote Front Panel application communicates with the 2801 Multilock via TCP port 80.



Note: If the network is protected by one or more firewalls, ensure that the network configuration does not block access to the 2801 Multilock.

Section 6 – Disable the Network Connection

- 6.1 Press the <SETTINGS> button
- 6.2 Press the “Network Setup” softkey
- 6.3 Press the “Network Connection” softkey
- 6.4 Press the “Disable” softkey (to disable the network connection)
- 6.5 Press the <MON> button (to return to the main application screen)

Appendix D – 2801 Multilock Field Calibration Procedure

The 2801 Multilock has two field calibration tables, one RF Input calibration table and one RF Output calibration table. These tables are initially created at the factory and should not normally need to be updated 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 21°C (70°F).

1. Power on the 2801 Multilock.
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 softkey menu.
6. Press **Calibrate Now** on the softkey menu. The 2801 Multilock 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.

Appendix E – Warranty and Repair

Warranty information

Willtek warrants that all of its products conform to Willtek's published specifications and are free from defects in materials and workmanship for a period of one year from the date of delivery to the original buyer, when used under normal operating conditions and within the service conditions for which they were designed. This warranty is not transferable and does not apply to used or demonstration products.

In case of a warranty claim, Willtek's obligation shall be limited to repairing, or at its option, replacing without charge, any assembly or component (except batteries) which in Willtek's sole opinion proves to be defective within the scope of the warranty. In the event Willtek is not able to modify, repair or replace nonconforming defective parts or components to a condition as warranted within a reasonable time after receipt thereof, the buyer shall receive credit in the amount of the original invoiced price of the product.

It is the buyer's responsibility to notify Willtek in writing of the defect or nonconformity within the warranty period and to return the affected product to Willtek's factory, designated service provider, or authorized service center within thirty (30) days after discovery of such defect or nonconformity. The buyer shall prepay shipping charges and insurance for products returned to Willtek or its designated service provider for warranty service. Willtek or its designated service provider shall pay costs for return of products to the buyer.

Willtek's obligation and the customer's sole remedy under this hardware warranty is limited to the repair or replacement, at Willtek's option, of the defective product. Willtek shall have no obligation to remedy any such defect if it can be shown: (a) that the product was altered, repaired, or reworked by any party other than Willtek without Willtek's written consent; (b) that such defects were the result of customer's improper storage, mishandling, abuse, or misuse of the product; (c) that such defects were the result of customer's use of the product in conjunction with equipment electronically or mechanically incompatible or of an inferior quality; or (d) that the defect was the result of damage by fire, explosion, power failure, or any act of nature.

The warranty described above is the buyer's sole and exclusive remedy and no other warranty, whether written or oral, expressed or implied by statute or course of dealing shall apply. Willtek specifically disclaims the implied warranties of merchantability and fitness for a particular purpose. No statement, representation, agreement, or understanding, oral or written, made by an agent, distributor, or employee of Willtek, which is not contained in the foregoing warranty will be binding upon Willtek, unless made in writing and executed by an authorized representative of Willtek. Under no circumstances shall Willtek be liable for any direct, indirect, special, incidental, or consequential damages, expenses, or losses, including loss of profits, based on contract, tort, or any other legal theory.

Equipment return instructions

Please contact your local service center for Willtek products via telephone or web site for return or reference authorization to accompany your equipment. For each piece of equipment returned for repair, attach a tag that includes the following information:

- Owner's name, address, and telephone number.
- Serial number, product type, and model.
- Warranty status. (If you are unsure of the warranty status of your instrument, include a copy of the invoice or delivery note.)
- Detailed description of the problem or service requested.
- Name and telephone number of the person to contact regarding questions about the repair.
- Return authorization (RA) number or reference number.

If possible, return the equipment using the original shipping container and material. Additional Willtek shipping containers are available from Willtek on request. If the original container is not available, the unit should be carefully packed so that it will not be damaged in transit. Willtek is not liable for any damage that may occur during shipping. The customer should clearly mark the Willtek-issued RA or reference number on the outside of the package and ship it prepaid and insured to Willtek.

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