ASTRONICS
TEST SYSTEMS

FREEDOM
Communications System Analyzer
R8200

User's Guide

Notices

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Safety Notices

WARNING

A WARNING denotes a hazard. It calls attention to an operating procedure, practice, or instruction that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

CAUTION

A **CAUTION** denotes a hazard. It calls attention to an operating procedure, practice, or instruction that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

In This Guide

This user's guide refers to the R8200 Communications System Analyzer. The R8200 incorporates many devices and functions, enabling technical personnel to completely monitor and service radio communications equipment at the lab, the shop, and in the field. This guide will familiarize you with the service monitor and its design characteristics, operational modes, and system configuration.

This user's guide is organized as follows:

1 Getting Started

Explains how to unbox, set up, and initialize the analyzer. This chapter also introduces the front panel display organization and hardware features before explaining how to prepare the service monitor for safe and effective use.

2 Using Monitor Mode

Introduces Monitor Mode, the first of five operational configurations. In Monitor Mode, the instrument emulates an RF receiver focused on analyzing and displaying signals transmitted by Land Mobile Radio (LMR) equipment.

3 Using Generate Mode

Presents an overview of Generate Mode which enables the service monitor to emulate various LMR transmitters.

4 Using Duplex Mode

Explains Duplex Mode which enables the service monitor to act as a transceiver, simultaneously broadcasting and analyzing LMR signals.

5 Using Instrument Mode

Covers configuring the service monitor as a stand-alone Spectrum Analyzer, Modulation Scope, Oscilloscope, Dual Display, Tracking Generator, or Single-Port Vector Network Analyzer with a full-screen display.

6 Using Test Mode

Introduces Test Mode, the final operational configuration. This mode is used to recall preset configurations and automatically test and align specific radios. Optionally, Test Mode can analyze advance digital LMR protocols such as DMR, P25, dPMR, NXDN™ and TETRA.

7 Using Remote Front Panel

Describes how to use a Windows-based PC with the optional Remote Front Panel application to control the R8200 from a distance via network connection.

8 Monitor Mode Soft Keys

Provides essential details for all Monitor Mode soft keys including concise definitions, default settings, discrete values and ranges, and useful conceptual information.

9 Generate Mode Soft Keys

Furnishes essential details for all Generate Mode soft keys including concise definitions, default settings, discrete values and ranges, and useful conceptual information.

10 Duplex Mode Soft Keys

Offers essential details for all Duplex Mode soft keys including concise definitions, default settings, discrete values and ranges, and useful conceptual information.

11 Instrument Mode Soft Keys

Provides essential details for all Instrument Mode soft keys including concise definitions, default settings, discrete values and ranges, and useful conceptual information.

12 Test Mode Soft Keys

Outlines essential details for all Test Mode soft keys including concise definitions, default settings, discrete values and ranges, and useful conceptual information.

13 Settings Mode Soft Keys

Provides essential details for all Settings Mode soft keys including concise definitions, default settings, discrete values and ranges, and useful conceptual information.

Glossary

Offers a concise reference describing key abbreviations and acronyms.

Find the Latest Information

To maintain the highest operational fitness, Freedom Communication Technologies firmware and documentation is periodically updated. For the latest information, including firmware updates, application information, and product information, browse the following websites.

http://freedomcte.com/upgrades/

http://freedomcte.com/library/

Typeface Conventions

This guide uses the following typeface conventions to describe various aspects of the user interface.

Interface	Examples
Instrument ports, connectors, and markings	RF In/Out
Front panel hard keys and soft keys	Press **Instrument** > **Spectrum Analyzer** > **Monitor Frequency** to tune the receiver.
Menu, dialog, display, and data entry field names	The soft keys are available in the Marker menu.
Program messages	**Is the device connected?**
Data field entries	Enter `500` in the Mon Frequency dialog data entry field.
File and Folder names	Copy the file *IQ.txt* into the *Baseband* folder.

Contents

1 Getting Started

This chapter introduces the Freedom R8200 Communications System Analyzer and familiarizes you with its form, features, and functions. Review the following sections in order to ensure the safe operation of the equipment.

"Introducing the Analyzer" on the next page offers an overview of the analyzer's performance capabilities.

"Requirements for Safe Operation" on page 23 includes general safety precautions that must be observed during all phases of operation, service, and repair of this Communications System Analyzer including signal port limitations.

"Unboxing and Inspection" on page 30 offers instructions for unpacking and inspecting the R8200 Communications System Analyzer and its accessories.

"Initial Set Up" on page 31 includes steps to ensure a safe operating environment, physical stability, access to line power and battery installation.

"Front Panel Interface" on page 33 describes the organization and functions of the analyzer's front panel control interface.

"Display Features" on page 38 describes the organization and function of the analyzer's LCD screen.

"Chassis Features" on page 43 describes the locations and characteristics of the analyzer's signal ports and other hardware interface connectors along with their physical limitations.

"Configuring the Analyzer for Use" on page 47 explains how to activate and configure the instrument for use.

Introducing the Analyzer

The R8200 Communications System Analyzer is a portable test instrument designed to monitor and service LMR equipment over the frequency range of 250 kHz to 3 GHz. Firmware options provide test capability for advanced digital radio protocols such as P25 Phase 1 and 2, DMR, NXDN™, dPMR, TETRA, PTC and others. The R8200 generates and receives signals, measures return loss (VSWR), distance-to-fault, normalized impedance, power, modulation, and frequency, and performs a variety of tests normally associated with the following equipment:

- Single-port Vector Network Analyzer
- RF Signal Generator
- Sensitive Measurement Receiver
- Spectrum Analyzer
- Duplex Offset Generator

- Oscilloscope
- Frequency Counter
- AC/DC Voltmeter
- RF Watt Meter
- Cable Fault Analyzer (optional)
- Tracking Generator (optional)
- Signaling Encoder/Decoder
- Signal Strength Meter
- SINAD Meter
- Distortion analyzer

See **"Front Panel Interface" on page 33** for a description of the analyzer's hardware user interface, **"Display Features" on page 38** for an overview of the analyzer's LCD screen interface and, **"Chassis Features" on page 43** for a description of the analyzer's hardware connectors and ports.

Requirements for Safe Operation

The following general safety precautions must be observed during all phases of operation, service, and repair of this Communications System Analyzer. Failure to comply with these precautions or warnings violates safety standards of design, manufacture, and intended use of the equipment. Freedom Communication Technologies 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 Freedom Communication Technologies is aware. You should follow these warnings and all other precautions necessary for the safe operation of the equipment.

Environmental Requirements

The following table lists the environmental limitations to regard when considering appropriate areas for safe operation of the analyzer.

Environmental Factor	Limitations
Operating altitude	Up to 15,000 ft (4572 m)
Humidity	80 % maximum relative humidity
Operating temperature	–20 ºC to 55 ºC with external DC; 0 ºC to 50 ºC using supplied AC power adapter
Storage temperature	Without battery: –30 ºC to +85 ºC; With battery: –20 ºC to +50 ºC
Battery charging temperature	0 ºC to +45 ºC
Shock and vibration	Rated to MIL-PRF-28800F, Class 3

Analyzer Grounding

The R8200 is powered by a provided AC to DC converter connected to a grounded three-wire AC outlet. The negative (or –) output of the converter is internally connected to AC ground. Since the R8200 uses the converter's DC negative as system ground, the analyzer is also connected to AC ground at the power outlet. As a result, most of the external connectors on the R8200 chassis are also at AC ground potential.

WARNING

To minimize shock hazard, the R8200 must be operated 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.

Unit is Live When Plugged In or when Battery is Installed

Internal circuits are live when the DC power cable is plugged in, even when the R8200 has been placed in a non-operating mode using the front panel power switch. To completely remove power from the analyzer internal circuits, disconnect the DC power plug and remove the battery. Position the equipment so that the DC power plug may be easily removed.

Keep Away from Live Circuits

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

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 safety hazard.

WARNINGS AND CAUTIONS

Please observe several the following warning and precautions when configuring and operating this equipment:

WARNING	The R8200 analyzer is designed to operate with a provided AC power adapter connected to a properly grounded three-wire AC power source. This configuration provides an earth ground connection to the R8200 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.
WARNING	DO NOT operate the R8200 analyzer using a detachable mains supply cord with an inadequate current rating. Operating the R8200 with an inadequately rated mains supply cord could result in a fire hazard. Use only an adequately rated mains supply cord equivalent to the model supplied with the AC power adapter.
CAUTION	This equipment contains internal parts that are subject to damage by static electricity (Electro-Static Discharge or ESD sensitive). Factory and authorized service personnel must follow proper ESD precautions when handling internal components during repair or calibration.

CAUTION The AC power adapter provided with this equipment is not rated for outdoor use. Do not use this adapter outdoors, especially near water or rain.

CAUTION This equipment contains a Rechargeable Smart Lithium Ion Battery. Only use a model RRC2020 battery in the R8200. Do not attempt to insert any other type of battery into the battery enclosure of the R8200.

Analyzer Operating Voltage

The R8200 is powered by 15–16 VDC @ 8.0 A max and operates from a three-wire AC outlet providing 100–240 VAC, 2.5 A max, 50–60 Hz, using an AC power adapter.

WARNING Only the AC power adapter provided by Freedom Communication Technologies and shipped with the analyzer may be used to power the R8200. Do not substitute other adapters without first consulting Freedom Communication Technologies support personnel or a factory authorized service center. Make certain to plug the AC power adapter into a properly grounded three-wire AC outlet.

Battery

Rechargeable Lithium Ion (Li Ion) Battery pack, 9×18650 cells (3S3P) with 11.25 V / 8850 mAh / 99.6 Wh.

Compliance Information

The following table lists the R8200 compliance with international requirements for electromagnetic compatibility, safety, and hazardous materials standards.

Domicile	Compliance
European Directives	Electromagnetic Compatibility (EMC) EN 61326-1:2013; Low Voltage Directive EN61010-1
USA	EMC, FCC Part 15, Class A; Safety, UL 61010-1, UL61010-2-030
Canada	CSA-C22.2 No. 61010-1, CSA C22.2 No. 61010-2-030
Battery compliance	CE/ UL2054 / FCC / PSE / IEC 62133 / ROHS / UN 38.3 / RCM / EN6095

Chassis Symbols and Markings

The following table explains the markings and symbols found on the analyzer chassis.

Marking or Symbol	Explanation
Antenna	Input for optional RF antenna
Mic In	Input for external microphone with RJ-45 connector.
Demod Out	Output for the demodulated (recovered) audio output from a received carrier when the analyzer is in Monitor or Duplex Mode.
Mod In/Out	As an output, this port provides a composite sum of all internally-generated modulation signals applied to the analyzer's RF carrier. As an input, audio signals external to the analyzer can be used to modulate the RF carrier. Audio input must be ±1 V_{pk} to provide a reference for correct display of the applied modulation level.
Meter In	Input for Oscilloscope vertical, SINAD meter, distortion meter, and DVM/-counter functions.
⚠	**WARNING** To ensure the safety of the user, the Meter In port should not be used to measure equipment containing mains voltages.
RF Gen Out	Output for high level Generate RF output port isolated from the Monitor input.
♨	**WARNING** The RF In/Out connector may become hot when inputting power. Exercise caution when removing cabling from the RF In/Out connector.
RF In/Out	Input for external RF signals to the analyzer's internal monitor and output for signals from the analyzer's internal generator.
VGA Out	15-pin connector output for external VGA monitor.
USB	(2) USB 3.0 serial ports for external peripheral devices such as keyboard or flash drive.
Ethernet	RJ-45 connector for 10/100 Mbps Ethernet LAN port for a computer network interface.
Ref In/Out 10 MHz 50 Ω +10 dBm Max	Input/Output for 5 MHz or 10 MHz reference signal
DC Power ⎓ 15–16 V 8A Max	Input for AC line voltage adapter
CE	Complies with European Economic Area health, safety, and environmental

Marking or Symbol	Explanation
	protection standards.
	Complies with Canadian and US health, safety, and environmental protection standards.
	Complies with Australian health, safety, and environmental protection standards.

Port Limitations

The following table lists the limitations and typical signals of the analyzer's input and output ports.

Port	Input Limitation or Typical Output	Notes
Antenna	0 dBm Max, 250 kHz–3 GHz (50Ω), 4.5 mA	Port Protection: 5 Watts Max
Demod Out	±8 V_{pk} max (600Ω), 13.3 mA	
Mod In	1 V_{pk} Ref; ±1.5 V_{pk} Max (600Ω), 2.5 mA	
Mod Out	±8 V_{pk} max (100Ω), 80 mA	
Meter In	33 V_{RMS}/70 VDC (1MΩ) Max; 15 V_{RMS}/24 VDC (600Ω) Max, 40 mA	

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

RF Gen Out	+5 dBm Max Out, 250 kHz – 3 GHz (50Ω)	Port Protection: 5 Watts/30 seconds Max
RF In	Absolute Max Power (250 kHz to 3 GHz) – 150 Watts (50Ω), 1.7A 50 Watts – 5 minutes ON Max/5 minutes OFF Min (0° to 50° C) 150 Watts – 30 seconds ON Max/5 minutes OFF Min (25° to 50° C) 150 Watts – 1.5 minutes ON Max/15 minutes OFF	

Port	Input Limitation or Typical Output	Notes
	Min (0° to 25° C)	

WARNING The RF I/O Port connector may become hot when inputting power. Exercise caution when removing cabling from the RF I/O Port. Do not apply 150 W for more than 90 seconds as temperature of RF In/Out connector can exceed 100° C.

RF Out	–30 dBm Max Out, 250 kHz – 3 GHz (50 Ohms), 0.142 mA	

Hot Surfaces

Be aware of possible changes in temperature to certain surfaces during operation.

WARNING The RF In/Out connector may become hot when inputting power. Exercise caution when removing cabling from the RF In/Out connector.

Mechanical Specifications

Parameter	Imperial	Metric
Weight	< 14 lbs	6.4 kg
Height	9.4 in	23.9 cm
Width	12.7 in	32.3 cm
Depth	7.5 in	19.1 cm

Maintenance of Exterior Surfaces

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

Accessories and Replaceable Parts

This section lists the accessories shipped with the Communications System Analyzer.

Item	Part Number	Note
Glove case	R9-CC	
Transit case	R9-TC	
AC power adapter	EA11011H(19)	Supplies 15 VDC @ 8 A max from a three-wire AC outlet providing 100–240 VAC, 2 A max, @ 50–60 Hz.

Send orders for accessories and user serviceable replacement parts to the Freedom Communication Technologies factory listed below. Be sure to include the complete identification number located on the equipment.

Service

All R8200 Communications System Analyzers are calibrated and repaired at the Freedom Communication Technologies factory:

FREEDOM COMMUNICATION TECHNOLOGIES

2002 Synergy Blvd. Suite 200
Kilgore, Texas, 75662, USA
Tel/Fax: 1-844-903-7333

Replacement Fuses

No user serviceable fuses are available on the R8200. The unit is internally protected against overloads and risk of fire. If the R8200 fails to operate, return it to the factory or an authorized repair center for diagnosis and repair.

Replacement Parts Orders

Send orders for user serviceable replacement parts to the Freedom Communication Technologies factory listed above. Be sure to include the complete identification number located on the equipment.

Shipping

Remove battery from unit before shipment. See the shipping requirements for your carrier.

Unboxing and Inspection

Follow these steps to unbox and inspect the analyzer and its accessories.

Steps	Actions	Notes
1. Inspect the shipping container and the packing material for signs of stress or damage.	**a.** Note any damage to the shipping container. **b.** Open the container and inspect the packaging material for signs of stress or damage. **c.** Store the packing container and materials for future use if it becomes necessary to return the analyzer to the factory for servicing.	Foam pieces protect the analyzer while it is packaged inside its shipping container.
2. Inspect the contents of the shipment.	**a.** Remove all packaging from the analyzer and accessories. **b.** Inspect each item to ensure the condition and fidelity of your order. **c.** Use the shipment contents list to verify the completeness of your shipment.	If the shipment is incomplete or damaged, save all of the shipping materials and contact your nearest Freedom Communications Technologies Service Center.

Initial Set Up

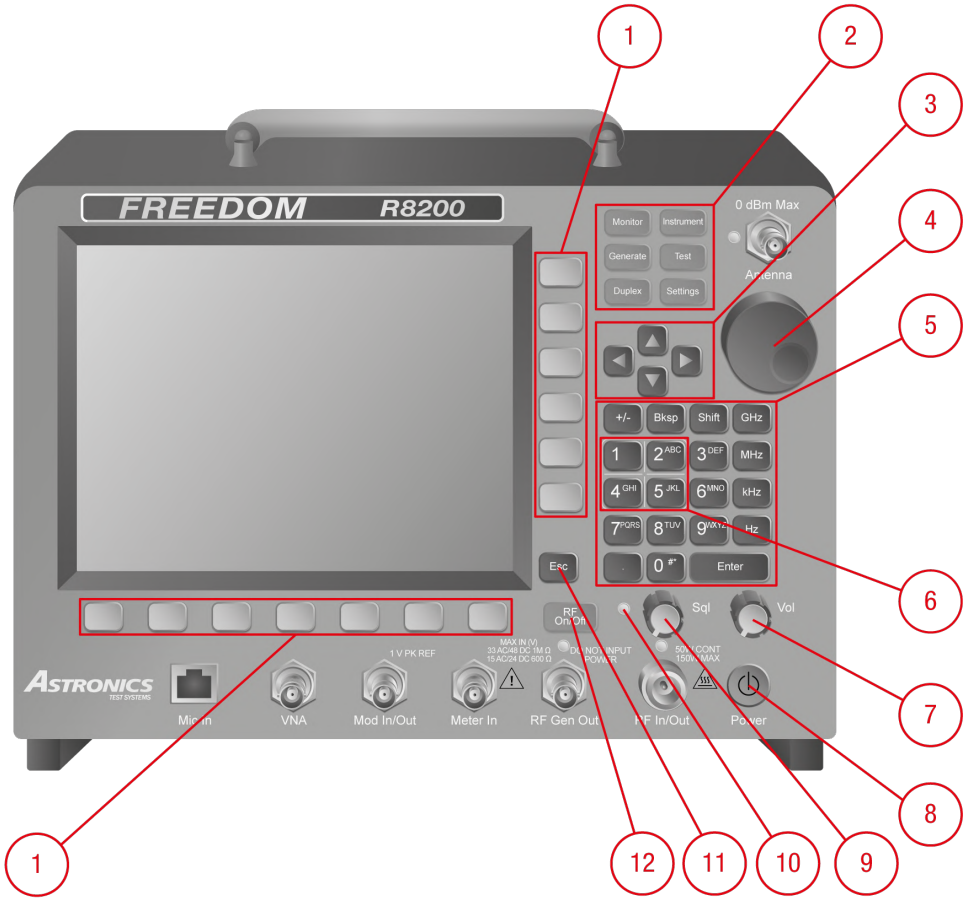
Follow these steps to initiate the analyzer, set your preferred language, and confirm its basic functionality:

Steps	Actions	Notes
1. Ensure a safe operational environment.	**a.** Place the analyzer on a workbench in the shop or mobile repair unit, ensuring that the area is free of hazardous environmental conditions. **b.** Position the analyzer so that the DC power plug on the lower-left side panel may be quickly and easily removed in case of unexpected hazardous situation such as a nearby liquid spillage. **c.** Ensure that the fan inlet and exhaust vent areas on the sides of the analyzer are unobstructed.	
2. Ensure physical stability.	**a.** Flip out the two lever actuated foot extensions underneath the front of the unit and the two underneath the rear of the unit. **b.** Ensure the analyzer's stability on the work surface.	
3. Access line power.	**a.** Connect the appropriate end of power cord to the AC to DC adapter. **b.** Connect the other end of the power cord to a three-wire 100-240 VAC power source.	

Steps	Actions	Notes
	c. Attach the cord's DC plug to the mating connector on the R8200 side panel.	
4. Install analyzer battery.	**a.** Remove battery from shipping box. **b.** Open battery access door on the lower left side of unit. **c.** Insert battery. **d.** Close and latch battery access door.	
5. Install antenna.	**a.** Remove antenna (and other accessories) from shipping box. **b.** Insert the whip antenna into the ANTENNA connector, located on the right top of the chassis.	The analyzer is now ready to operate. See the following section, **"Configuring the Analyzer for Use" on page 47**.

Front Panel Interface

The R8200 is intuitive and easy to operate. See the following table for an overview of the analyzer's front panel user interface.



Item		Description
ID	Name	
1	Soft Keys	Two groups of mode-specific soft keys located below and beside the LCD screen. The current key function is shown in the adjacent screen area. Key functions are defined by the analyzer's current operating mode. Depending on the operating mode, pressing a soft key will either open a numeric

Item		Description
ID	Name	
		data entry dialog, provide additional selections for configuration, activate submenus, or perform a single measurement task (peak search, etc.). Multiple presses of the same key will toggle through all available selections for the setting.
2	Mode Keys	Enable five primary operating modes (Monitor, Generate, Duplex, Instrument, and Test) as well as access to the analyzer's global instrument settings. The current RF operating mode is shown in the Status Bar displayed at the bottom left of the LCD screen. An adjacent area shows the current test mode (Standard or optional modes like DMR, Project 25, NXDN, dPMR, TETRA, etc.). **Monitor** enables RF receiver mode for analyzing signals between 250 kHz to 3 GHz applied to the RF In/Out or Antenna port. Monitor Mode provides signal strength, frequency accuracy, and other metering measurements while decoding the modulation content of incoming RF carriers to produce a recovered baseband signal. Additional analysis is provided by Spectrum Analyzer and Modulation Scopes. **Generate** enables the RF transmitter mode providing carrier signals with configurable output levels, modulation types (AM, FM, etc.), and tone encoding formats from 250 kHz to 3 GHz at the RF Gen Out and RF In/Out ports. **Duplex** enables simultaneous operation and independent control of the receiver (monitor) and transmitter(generate) functionality. **Instrument** enables a full-screen Spectrum Analyzer, Modulation Scope, Oscilloscope, Tracking Generator, or a dual (simultaneous) display of the Spectrum Analyzer and Modulation Scope. **Test** enables access to preset instrument configurations and optional advanced LMR test applications, as well as the AutoTune and AutoScript functionality. **Settings** enables access to global instrument settings including input decoding, reference clock mode, measurement averaging, auto-attenuation, pre-amplification, antenna, DC, and RF offsets, pre-/de-emphasis, metering filters, and audio weighting. It also enables date, time and display language, optional DMR communication protocols licensing, application and firmware updating, and remote operation.
3	Arrow Keys	Move the cursor in order to select and modify existing values in data entry dialogs. The horizontal

Item		Description
ID	Name	
		arrow keys move across alphanumeric symbols in data entry dialogs to select values to enable changes via the vertical arrow keys, the tuning knob, or the alphanumeric keypad. They also step through the available selections in dialogs that display user-defined parameters. The analyzer immediately responds to changes made using the arrow keys. Pressing **Enter** closes the parameter adjustment dialog. Pressing **Esc** cancels the previous change in the manner of an Undo key. In the case of entering an RF frequency, pressing a frequency unit key (for example, **kHz**) also immediately alters the parameter and closes the parameter adjustment dialog.
4	Tuning Knob	Incrementally changes the value of the highlighted digit in an alphanumeric entry field. Clockwise rotation increases the value while counterclockwise rotation decreases the value. Rotating the knob immediately alters the selected parameter, providing the equivalent of an analog rotational control. For example, the operator can manually scan an RF frequency segment for an unknown carrier. The knob also cycles through the available selections when a soft key activates a parameter value dialog. The knob's press-to-enter function (pushing the knob inward until it clicks) closes the parameter value dialog, as does alternatively pressing **Enter**. Pressing **Esc** returns the value to its previous setting in the manner of an Undo key.
5	Alphanumeric Keys	Enter parameter values into the analyzer. Pressing a key during data entry places a new value into the highlighted symbol or number in a parameter value dialog or field. The analyzer immediately reacts to the new value. If an invalid entry is attempted, the key press is ignored, and the value on the screen remains unchanged. **+/-** toggles the directional value displayed in the currently active parameter value dialog or data entry field. **Enter** closes the active parameter value dialog or moves to the next field in a table.
6	Hot Keys	Numeric keys 1, 2, 4 and 5 highlighted with a gray border are navigational Hot Keys, directly activating the four functional Zones (see **"Display Features" on page 38**) used for measurement configuration, display, and metering. The functional Zones retain fixed arrangements on the LCD screen regardless of operating mode. These are mirrored by the same relative areas outlined around the Hot Keys. Pressing a Hot Key activates the associated Zone and displays its vetical soft key menu. Hot Keys enable navigation between Zones without navigating back to the top-level vertical soft key menu (RF, DISPLAY, AUDIO, and METER Zone soft keys).
7	Volume Knob	This knob controls audio volume. Clockwise rotation increases the volume. Fully counter-clock-

Item		Description
ID	Name	
		wise mutes the volume.
8	Line Power Switch	Press to activate and deactivate the analyzer. When operating, pressing the switch for three seconds or less deactivates the analyzer with an orderly power down sequence (recommended). Pressing the switch for four seconds or more forces an abrupt shutdown (should be avoided).
9	Sql Knob	The Squelch Knob adjusts the audio gating or *squelch* function. Clockwise rotation increases the receiver signal level required to overcome the gate threshold and pass the audio signal. The fully counterclockwise position disables squelch. The Squelch Opens field in the lower right corner of the main display shows the current RF threshold level required to open the gate. The level reflects the input signal strength of the RF carrier (not the recovered audio) necessary to overcome the squelch threshold, so that measurements can be performed on un-modulated carriers. For signals below the squelch threshold, various demodulation operations cease. For example, speaker audio is muted and the Freq Error and Deviation measurements are deactivated. **Monitor Port** / **Minimum Threshold** / **Maximum Threshold** Antenna / –130 dBm / –20 dBm RF In/Out / –100 dBm / +10 dBm In Monitor Mode, the squelch threshold range is set in the RF Zone *Mon Port* field. Rotating the tuning knob will adjust the threshold in 4 dB increments. NOTE Additional functions utilize squelch; for examples, see **"RF Scan" on page 102** and **"Voice Loopback (DMR submenu)" on page 584**.
10	LED Indicators	Specific port and control statuses are displayed by an adjacent LED indicator. For ports, illumination signifies 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. For controls, the LED indicator next to the Sql knob illuminates when the input signal

Item		Description
ID	Name	
		power at the RF In/Out port is above the squelch threshold.
11	Esc Key	The Escape Key has two functions. First, it acts as an Undo Key for a previous change to a parameter value. For example, pressing **Esc** while entering a value with the alphanumeric keypad closes the data entry dialog and leaves the original value unchanged. Second, it acts as a Return to Top Level *Zone* Menu Key or a Return to Top Level *Mode* Menu Key. For example, if you have finished configuring the DTMF Table in the AUDIO Zone, pressing **Esc** once will return the display to the top-level AUDIO Zone soft keys. Pressing **Esc** twice will return the display to the top-level Mode soft keys (RF Zone, AUDIO Zone, DISPLAY Zone, and METER Zone).
12	RF On/Off Key	Toggles the connection between the internal RF Generator and currently configured Gen Port (generator output), either the RF In/Out or RF Gen Out port. The current RF state is displayed at the bottom right of the screen next to the message bar. It is deactivated in Monitor Mode.

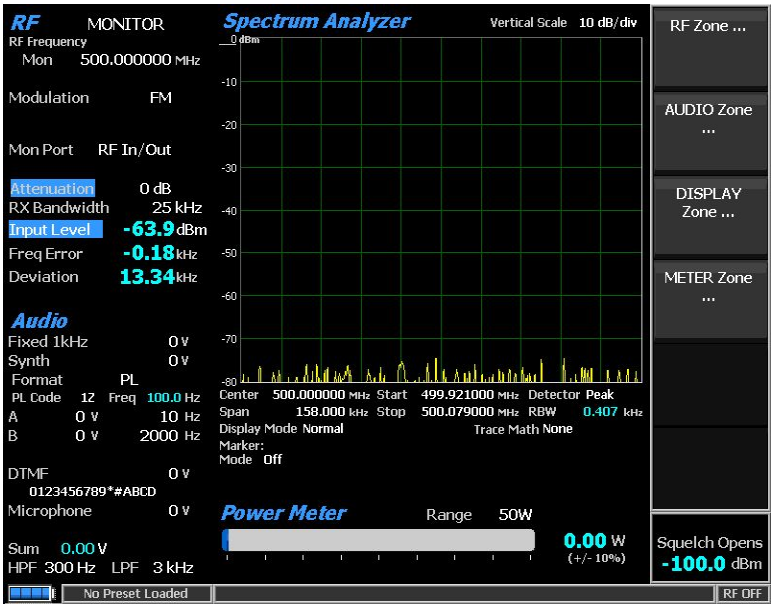
Display Features

The analyzer features a large 8.4-inch LCD screen that provides operational status, measurement data, soft key-driven menus and submenus of operating controls, and instructional information. It displays in digital, analog, and bar graph forms. For most applications, the display is divided into four functional Zones (RF, DISPLAY, AUDIO, and METER) atop the Status Bar which displays from left to right: line power/battery state, current test mode, message bar, and the current operating state of the RF In/Out port. For an alternative display format see the optional TETRA Base Station and TETRA TMO user interfaces described in **"Introducing TETRA Base Station Test Mode" on page 215** and **"Introducing TETRA TMO Test Mode" on page 253**, respectively.

The RF Zone is used to configure the analyzer's RF signal path. The DISPLAY Zone is used to configure the graphical display for the signal of interest. The AUDIO Zone displays parameters associated with encoding and decoding messaging content. The METER Zone displays an additional set of RF, audio, and baseband measurements.

NOTE In Test Mode, the AUDIO Zone displays parameters associated with the current digital communications test protocol. For example, in DMR mode, this area becomes the DMR Zone.

Functional Zones are activated by pressing their associated *Hot Key* (1 for RF, 2 for DISPLAY, 4 for AUDIO, and 5 for METER) or the eponymous soft key. Once active, use the arrow keys to select values and change parameter settings.

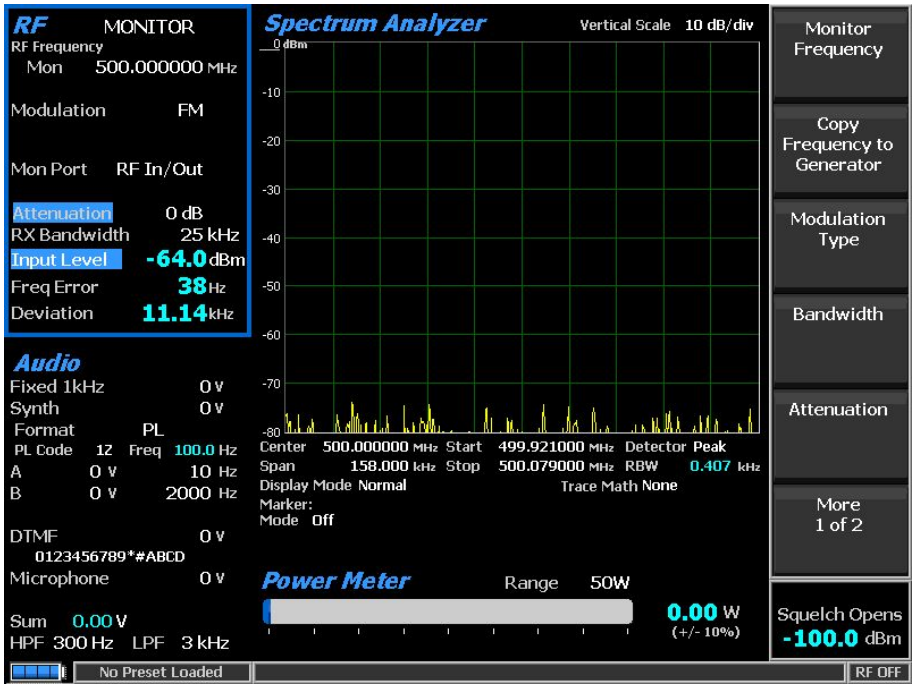


The LCD screen in the analyzer's default Monitor Mode is shown above.

The following sections explain the functional parameters associated with the RF, DISPLAY, AUDIO, and METER Zones, respectively.

RF Zone

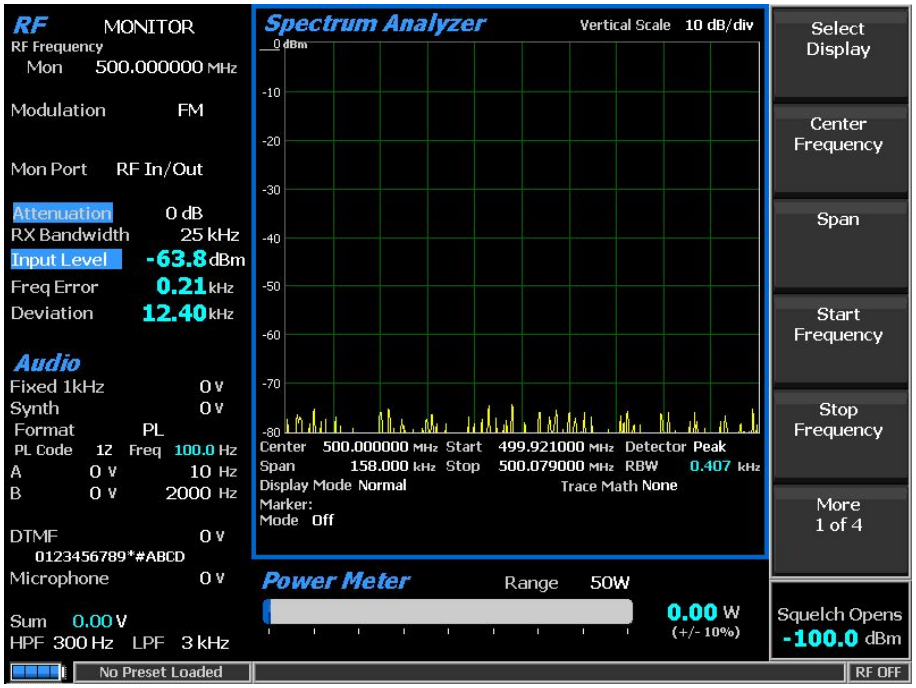
The RF Zone occupying the upper left-hand portion of the screen is activated by pressing the top-level **RF Zone** soft key or **Hot Key 1**. The activated RF Zone is highlighted in blue, as shown below.



The RF Zone displays the following adjustable parameters in Monitor and Duplex Mode: Mon (receiver center frequency), Modulation (type), Mon Port (receiver input), Attenuation, Pre-amplifier, and RX (receiver) Bandwidth. It also displays three automated carrier measurements: RF Input Level, Freq Error (frequency error), and (frequency) Deviation. The RF Zone displays the following additional adjustable parameters in Generate and Duplex Mode: Gen (transmitter center frequency), Duplex Offset, (transmitter) Output Level (RF output/voltage), Output Units, and Gen Port (transmitter output).

DISPLAY Zone

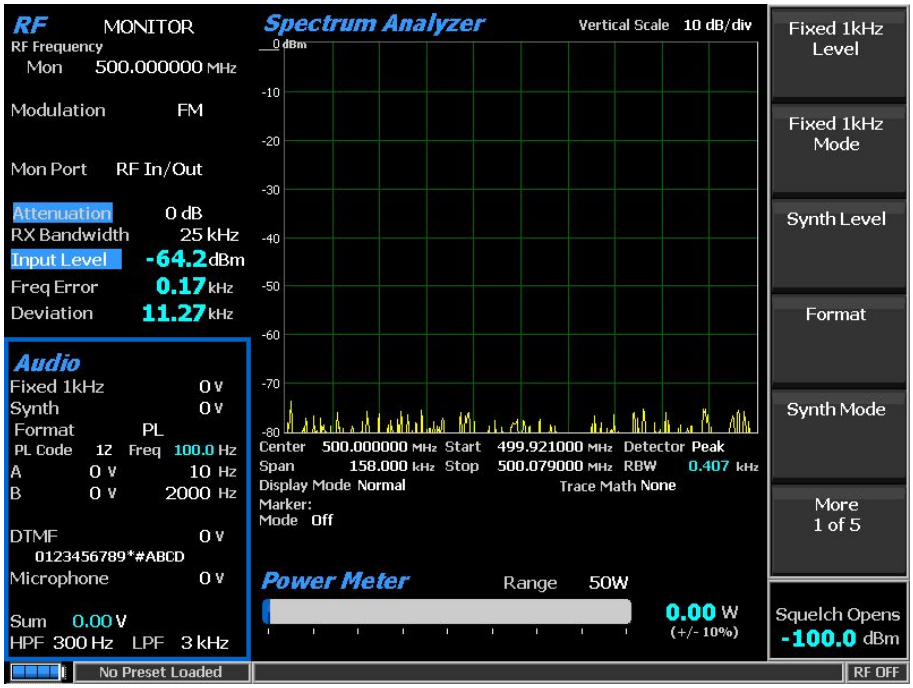
The DISPLAY Zone occupying the upper right-hand portion of the screen is activated by pressing the top-level **DISPLAY Zone** soft key or **Hot Key 2** and highlighted in blue, as shown below.



The DISPLAY Zone contains the graticule for the graphical display of the current signal of interest. The instrument type (Spectrum Analyzer, Modulation Scope, Oscilloscope, bar graphs, etc.) is shown at the top of the screen along with the vertical scale-per-division. Vertical Scale and Reference Level are shown on the Y-axis. Frequency, Marker, and Trace Math parameters are shown below the X-axis. The yellow measurement trace is displayed on the graticule.

AUDIO Zone

The AUDIO Zone occupying the lower left-hand portion of the screen is activated by pressing the top-level **AUDIO Zone** soft key or **Hot Key 4** and highlighted in blue, as shown below.

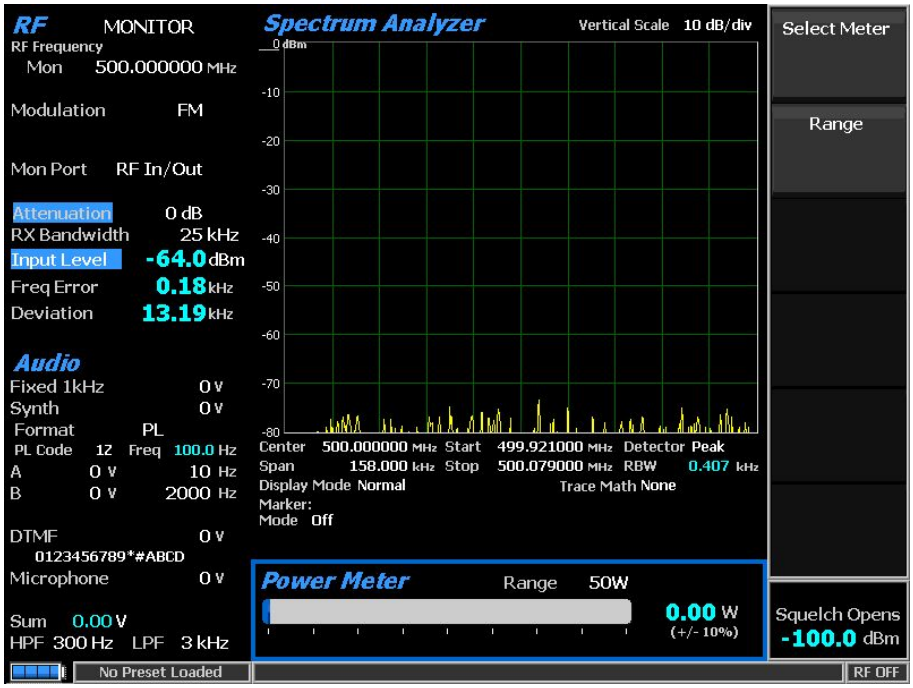


The content of the AUDIO Zone changes depending on the current mode. It contains a variety of audio settings and encoding/decoding parameters associated with the modulation of the carrier transmitted from the R8200 in Generate and Duplex Modes or the baseband filter settings for demodulation in Monitor and Duplex Modes. In Generate and Duplex Modes, the audio/modulation sources include a fixed 1 kHz tone generator, two independent variable-frequency tone (Tone A/Tone B) generators, a wide band (Tone C) generator, a dedicated dual tone multi-frequency (DTMF) generator, external inputs (microphone/modulation) and a synthesizer for generating various other encoding formats used in two-way radio performance verification testing. This synthesizer-generated composite audio modulates the internally generated RF carrier. The carrier modulation level is indicated in frequency units of deviation for FM (kHz) or amplitude percent for AM. The composite audio modulation is also available on the Mod In/Out connector. Decoding parameters for the carrier-recovered audio are primarily located in the METER Zone.

NOTE In Test Mode, the AUDIO Zone displays parameters associated with the current digital communications test protocol. For example, in DMR mode, this area becomes the *DMR Zone*.

METER Zone

The METER Zone occupying the lower right-hand portion of the screen is activated by pressing the top-level **METER Zone** soft key or **Hot Key 5** and highlighted in blue, as shown below.

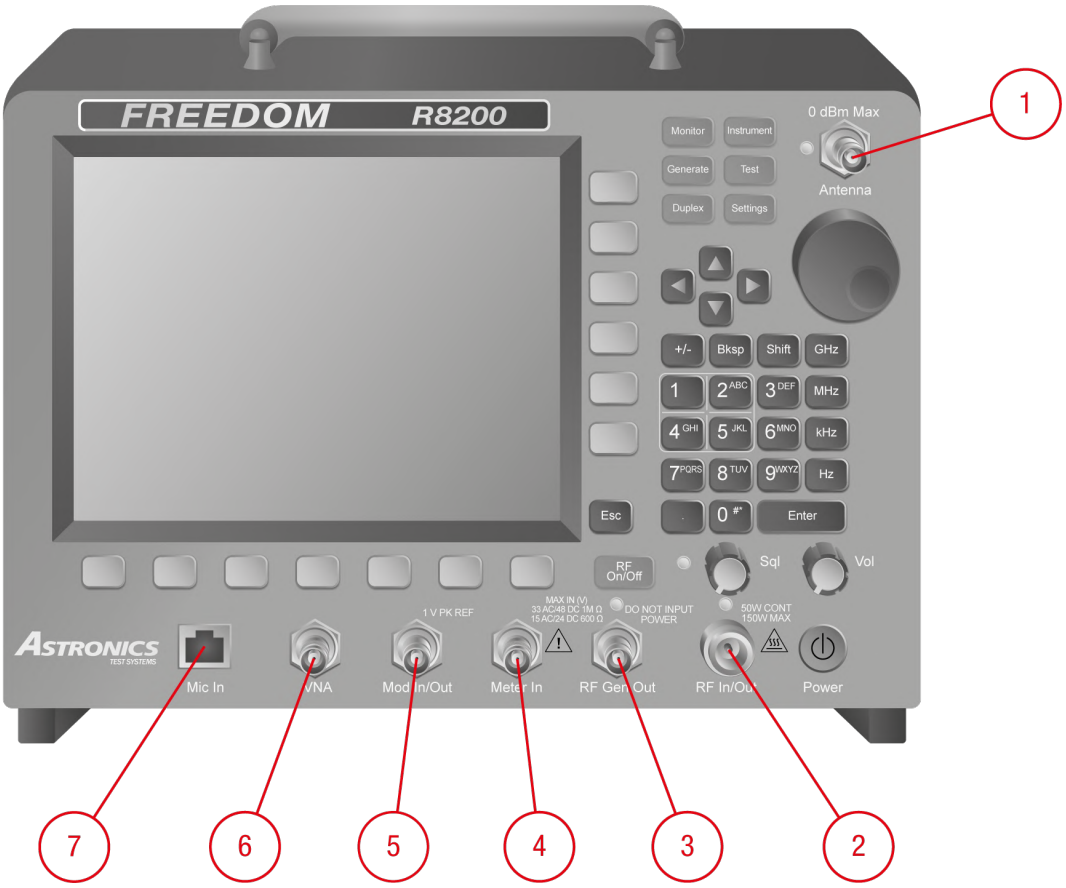


The METER Zone contains the metering display for the analyzer. The R8200 provides a Power Meter, Voltmeter, SINAD/Distortion Meter, Decoder, Frequency Counter, RF Scanner, and SNR Meter to provide detailed analysis of the RF carrier as well as the recovered baseband content. Additional meters are provided for optional digital protocol Test Modes.

Chassis Features

The analyzer can be ordered with several unique port and panel configurations. While all possible chassis configurations are described below, some may not reflect the configuration of your analyzer.

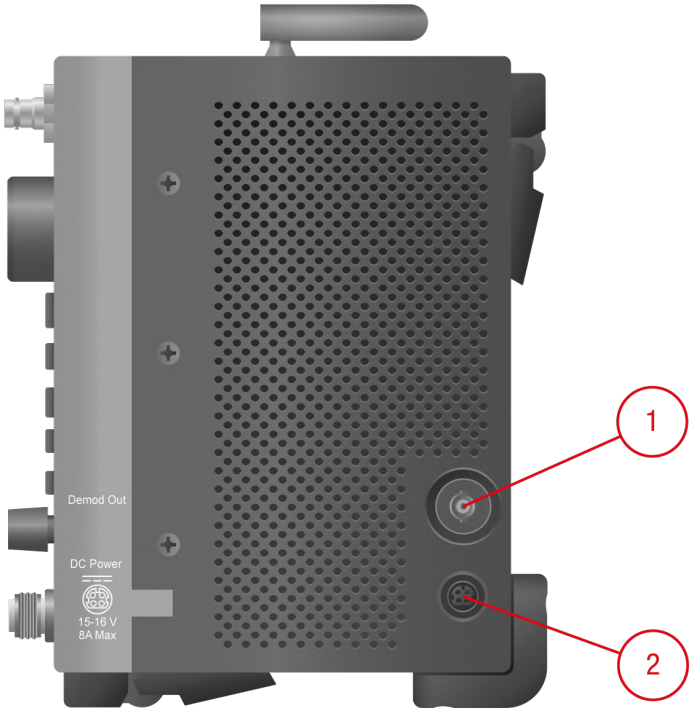
Front Panel Ports



Item		Description
ID	Name	
1	Antenna	BNC connector offering a low-level RF input port for the analyzer's sensitive receiver. Use for off-

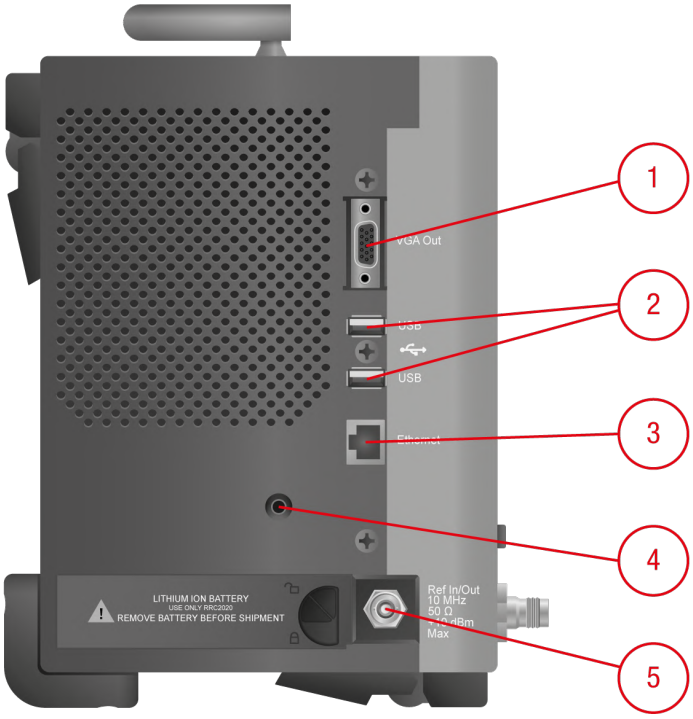
Item		Description
ID	Name	
		the-air and other low-level measurements where the RF power is less than 0 dBm. **CAUTION** Do not apply RF power ≥ 0 dBm to the Antenna port.
2	RF In/Out	Type N (f) connector offering a bidirectional port that routes RF input signals to the analyzer's internal monitor or output signals from the analyzer's internal generator. It also provides combined input/output in Duplex Mode and contains the RF Watt meter load. **NOTE** This is the only port that allows high-level RF power.
3	RF Gen Out	BNC(f) connector offering a high-level RF output port from the Generator which is isolated from the Monitor input. **CAUTION** Do not apply RF power to the RF Gen Out port.
4	Meter In	TNC(f) connector offering a combined input port for Oscilloscope vertical, SINAD meter, distortion meter, and DVM/counter functions.
5	Mod In/Out	BNC(f) connector, when configured as an output, this port provides a composite sum of all internally-generated modulation signals applied to the RF carrier. When set to input, external audio signals can be used to modulate the R8200 RF carrier. **CAUTION** Do not exceed +/- 1.5 V_{pk} at the Mod In/Out port or damage may occur to internal circuitry. **NOTE** The audio signals must equal +/- 1 V_{pk} to provide a reference for accurate display of the applied modulation level.
6	VNA	TNC(f) with Type N adapter (female SMA port optional) providing single-port vector network analyses including Return Loss/VSWR and Distance To Fault.
7	Mic In	RJ-45 connector offering input for an external accessory microphone with RJ-45 connector.

Right-Side Panel Connectors



Item		Description
ID	Name	
1	Demod Out	BNC connector provides demodulated (recovered) audio output from a received carrier when the analyzer is in Monitor or Duplex Mode.
2	DC Power	Input for AC line voltage adapter

Left-Side Panel Connectors



Item		Description
ID	Name	
1	VGA Out	15-pin connector for external VGA color monitor.
2	USB	Two USB 3.0 serial ports for connecting a radio under test or flash drive.
3	Ethernet	RJ-45 connector for 10/100 Mbps Ethernet LAN interface.
4	Headphone	3.5 mm stereo headphone output.
5	Ref. In/Out	BNC connector providing input/output for 10 MHz reference frequency or input for 5 MHz reference frequency. Input impedance is 50 Ω. Input level requirement is 70 mV to 1 V_{RMS}. Output level is approximately 250 mV_{RMS}.

Configuring the Analyzer for Use

This section describes how to activate the analyzer, configure global parameters such language, preset states, and remote operation. Follow these steps to initiate the analyzer, set your preferred language, and confirm its basic functionality.

Steps	Actions	Notes
1. Activate the analyzer.	**a.** Press the green circular power switch in the lower right-hand corner of the front panel.	It takes less than 90 seconds for the analyzer to boot up.
2. Set the preferred language.	**a.** Press **Settings** > **System Settings** > **More** × 4 > **Language**. **b.** Choose **English** or **Spanish**.	This opens a horizontal soft key menu where you can select your preferred language.
3. Set the date.	**a.** Press **Date**. **b.** Use the arrow keys, tuning knob, or the alphanumeric keypad to enter the values for the current month, day and year. **c.** Press **Enter**.	The date is formatted as mm.dd.yyyy. You can use the horizontal arrow keys to move between values.
4. Set the time.	**a.** Press **Time**. **b.** Use the vertical arrow keys, tuning knob, or the alphanumeric keypad to enter the values for the hour and minute. **c.** Press **More > Apply Date/Time Changes**.	The time is in 24-hour format.
5. Prepare to make your initial RF measurements.	**a.** Connect your device to the analyzer. **b.** Configure the analyzer to perform the desired analysis.	The analyzer can be used immediately after boot up with best accuracy achieved after a suitable warm-up period. The OCXO time base stabilizes within five minutes

Steps	Actions	Notes
	c. Complete the measurement.	of operation, permitting frequency-dependent measurements at the specified accuracy of the analyzer (e.g., operating frequency, frequency error, audio tone generation, etc.). For all other measurements, a minimum warm-up of 15 minutes is recommended, with full measurement stability after 30.
6. Otherwise, power down the analyzer.	**a.** Quickly press the front panel switch to turn the analyzer off.	When operating, pressing the switch for three seconds or less turns off the analyzer with an orderly power down sequence (recommended). Pressing the switch for four seconds or more forces an abrupt shutdown (should be avoided).

Operating Modes

The R8200 has six unique operating modes:

- **Monitor** – for analyzing the transmitter performance of LMR mobile and portable radios. In Monitor Mode, the R8200 emulates a series of instruments traditionally used to measure various aspects of microwave, RF, and audio signals such as Vector Network Analyzers, Spectrum Analyzers, Modulation Scopes, Oscilloscopes, and Tracking Generators.
- **Generate** – for producing precision microwave, RF, and audio signals necessary to evaluate LMR mobile and portable radios' receiver performance. In Generate Mode, analyzer emulates a series of signal generators such as microwave and RF signal sources, function generators, and synthesized sweepers.
- **Duplex** – which combines Generate and Monitor functionality to simultaneously stimulate and measure the performance of LMR mobile and portable radio transceivers.
- **Instrument** – for analyzing a particular aspect or component of LMR mobile and portable radio transmitters. In Instrument Mode, the R8200 emulates a stand-alone, full-screen Vector Network Analyzer, Spectrum Analyzer, Modulation Scope, Dual Display (Spectrum Analyzer with Modulation Scope), Oscilloscope, Tracking Generator, or Cable Fault Locator.
- **Test** – for simultaneous broadcast and measurement of signals defined by advanced digital radio protocols such as P25 Phase 1 and 2, DMR, NXDN™, dPMR, TETRA, PTC and others employed by the world's largest LMR mobile, portable, and infrastructure manufacturers.
- **Settings** – for managing the global operational parameters of the R8200.

Together, these six unique operating modes make the R8200 an indispensable tool for the ongoing care and maintenance of your valuable LMR assets.

Turn to **"2 Using Monitor Mode" on page 50** for step-by-step instructions on using the R8200 to analyze the transmitter performance of an LMR mobile or portable radio.

2 Using Monitor Mode

This chapter explains how to use the analyzer as a stand-alone monitor or RF receiver for testing LMR transmitters or other RF signal sources. It includes an overview of the use model and display features with links to the detailed soft key reference and an example measurement configuration.

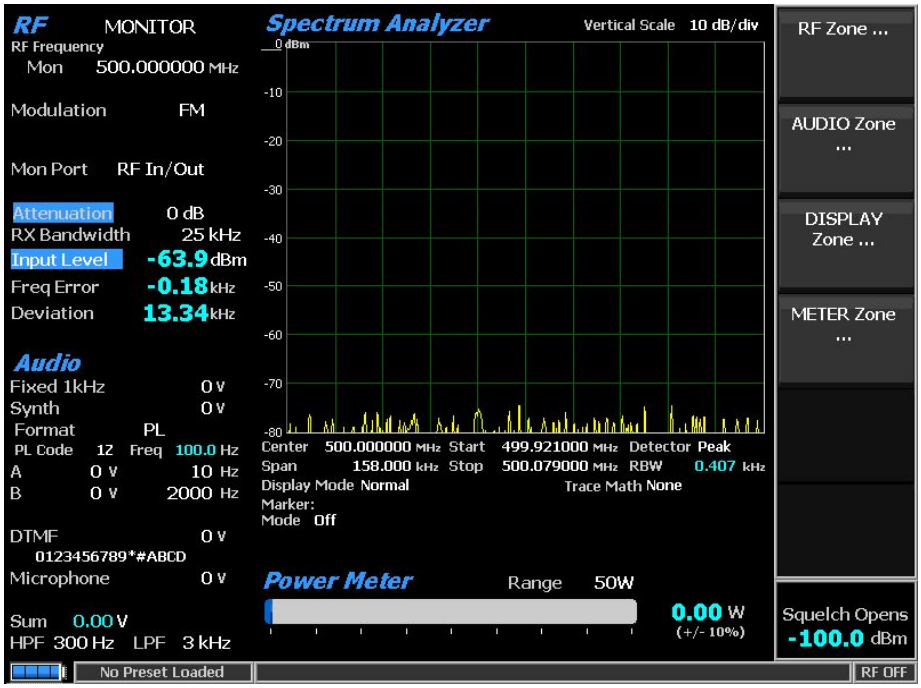
See **"Introducing Monitor Mode" on the next page** for an introduction to using the R8200 in Monitor Mode to measure the output of LMR transmitters or other RF signal sources.

See **"Measuring LMR Signals in Monitor Mode" on page 60** for step-by-step instructions on configuring the R8200, connecting the radio to the R8200, and configuring the radio to make an initial carrier power and frequency analysis of the unit under test.

Introducing Monitor Mode

In Monitor Mode, the analyzer operates as a stand-alone RF receiver for testing radio transmitters. It is capable of monitoring either over the air (OTA) RF signals through its ANTENNA port or a direct connection to the transmitter through the RF In/Out port. The operating frequency range is 250 kHz to 3 GHz in 1 Hz increments with selectable bandwidths between 6.25 kHz and 200 kHz.

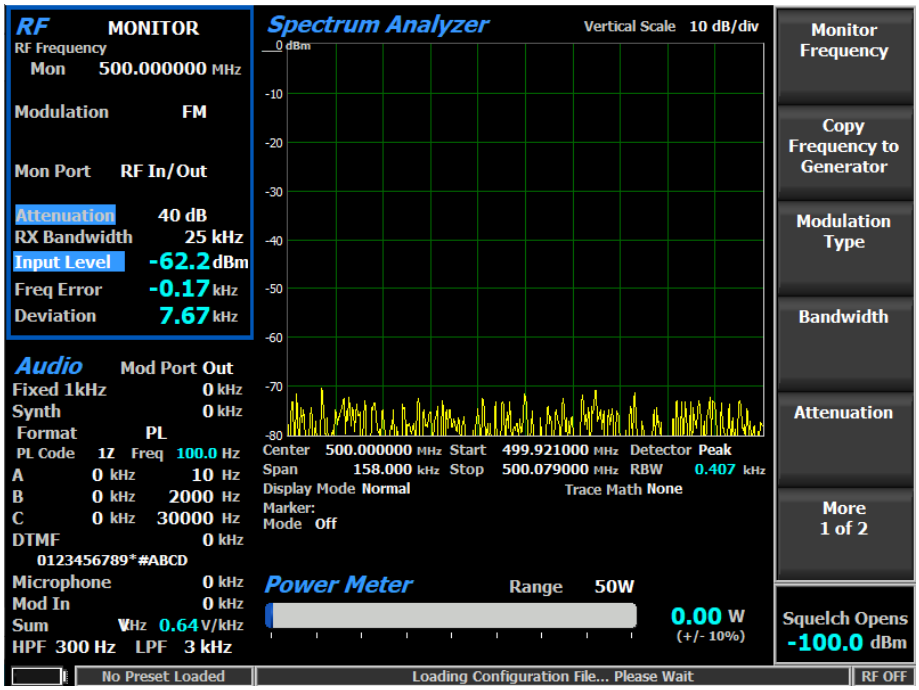
The analyzer processes AM and FM carriers and a variety of audio encoding formats. It provides signal strength, frequency accuracy, and other metering results while decoding the messages on incoming RF carriers to produce a recovered baseband signal. Additional analysis is provided by a Spectrum Analyzer and a Modulation Scope. When activated by pressing the blue Monitor operating mode key, the Monitor Mode is displayed as shown.



The following sections explain the functional parameters associated with the RF, DISPLAY, AUDIO, and METER Zones, respectively.

RF Zone

The RF Zone in the upper left-hand screen is activated by pressing the top-level **RF Zone** soft key or Hot Key 1. The active RF Zone is bordered in blue, as shown.



The RF Zone displays the following adjustable parameters: Mon (receiver center frequency), Modulation (type), Mon Port (receiver input), Input Source, Input Units, Attenuation, Pre-Amplifier. and RX (receiver) Bandwidth. It also displays three fields of automated carrier measurements: Input Level, Freq Error (frequency error), and (frequency) Deviation.

NOTE

When the RF input power on the RF In/Out port is above +20 dBm (100 mW), the R8200 utilizes a broadband power detector for the measurement. The Input Level field in the RF Zone changes to Watt Meter to indicate broadband power measurement.

Input Level – Displays the RF input level of the received carrier. Different units may be selected using the Input Level Units soft key.

Watt Meter – Displays the level of broadband power applied to the RF In/Out port. For increased Watt Meter accuracy, disable the Pre-amplifier in Monitor Mode (press **Settings** > **System Settings** > **More** × 2 > **Pre-Amplifier Auto Off** > **Enable**), and in Generate Mode, set the Gen Port to RF In/Out (press **Generate** > **Gen Port** > **RF In/Out**).

Freq Error – Displays the frequency difference between the received carrier frequency and the R8200 current Monitor Center Frequency.

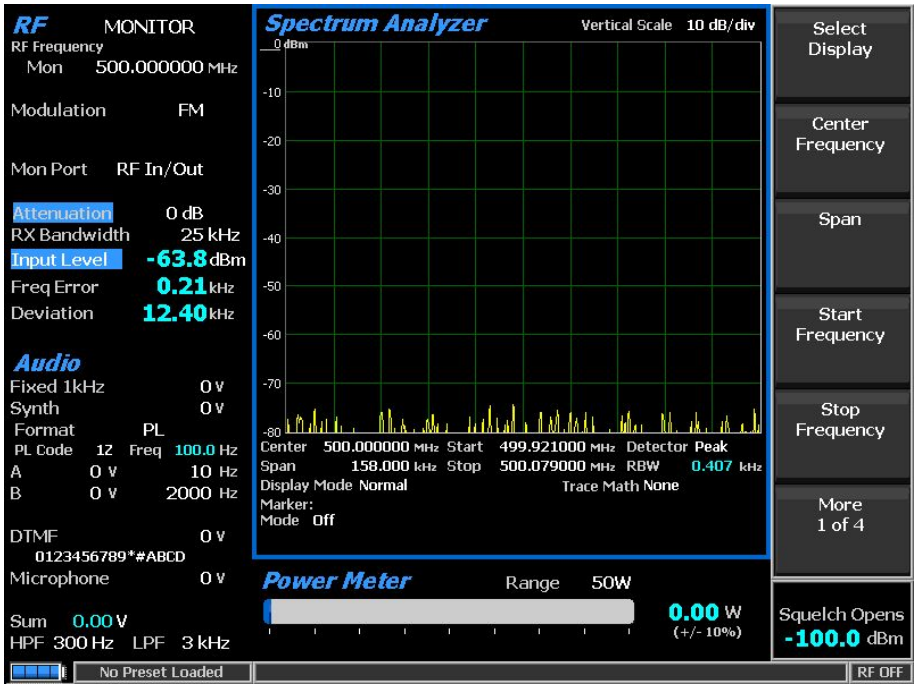
Deviation – When the selected modulation type is FM, displays the positive peak frequency deviation of the received modulated carrier (i.e., from the Frequency Error mean). Negative peak frequency deviation can be observed by selecting Bar Graphs in the DISPLAY Zone (press **DISPLAY Zone** > **Select Display** > **Bar Graphs**).

%AM – When AM modulation is selected, displays the positive peak AM percentage of the received modulated carrier.

For RF Zone soft key definitions, ranges, discrete and default values, and detailed notes, see **"RF Zone Soft Keys for Monitor Mode" on page 331**.

DISPLAY Zone

The DISPLAY Zone in the upper right-hand screen is activated by pressing the top-level **DISPLAY Zone** soft key or Hot Key 2. The active DISPLAY Zone is bordered in blue, as shown.



The DISPLAY Zone contains the graticule for the graphical display of the current signal of interest providing a visual presentation of received RF signal measurements, recovered audio, internally-generated audio, and externally-measured audio signals. These include a Spectrum Analyzer, Modulation Scope, Oscilloscope, and Bar Graphs. The instrument type is shown at the top of the screen along with the vertical scale-per-division. Vertical scale and reference level are shown on the Y-axis. Frequency, Marker, and Trace Math parameters are shown below the X-axis. The yellow measurement trace is displayed on the graticule.

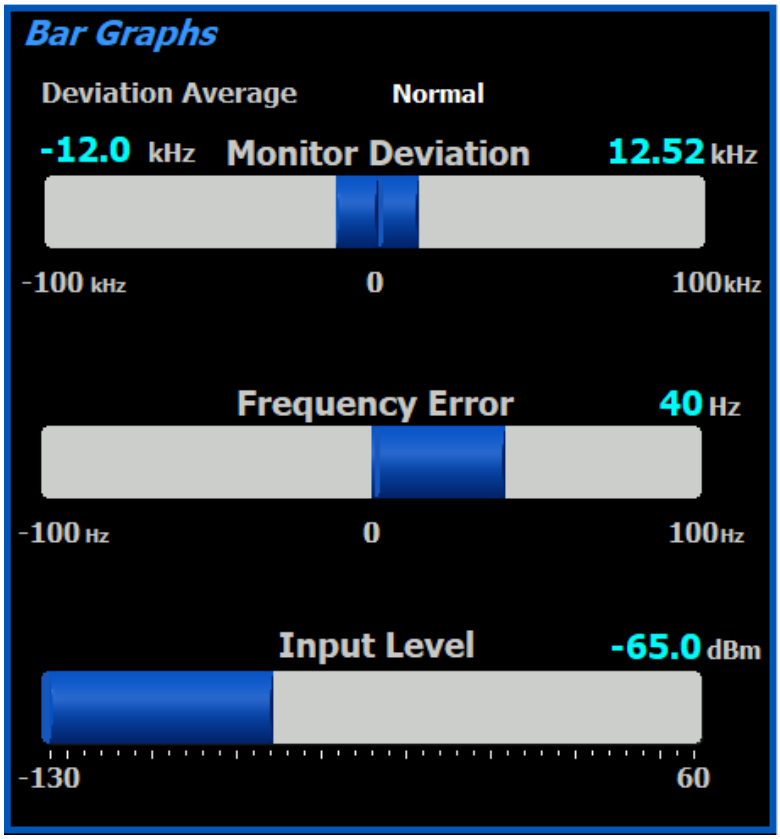
For bar graph displays, see **"Bar Graphs" on the next page**. For General Sequence display, see **"Introducing Monitor Mode" on page 51**.

For details regarding the individual instrument displays, see:

- **"Introducing the Spectrum Analyzer" on page 90**
- **"Introducing the Modulation Scope" on page 91**
- **"Introducing the Oscilloscope" on page 92**

Bar Graphs

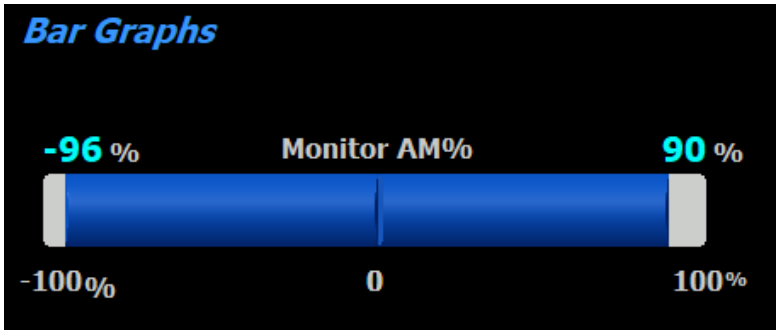
The Bar Graphs display provides a simultaneous analog and digital readout of critical signal characteristics. The analog display facilitates real time tuning adjustments of two-way radios while the digital reading provides precision in the measured result. The Monitor Deviation response can be changed to peak averaging, power-weight averaging, RMS averaging, or +/-Peak/2.Three bar graphs are displayed for the received carrier while in Monitor and Duplex Modes, as shown here when FM is selected as the Modulation Type.



Monitor Deviation

This graph displays the negative and positive peak frequency deviation of a modulated carrier (i.e., from the Frequency Error mean), available when Modulation Mode is FM.

Monitor AM%



When Modulation mode is AM, this graph displays the negative and positive peak AM percentages of a modulated carrier.

Frequency Error

Represents the frequency difference (error) of the input carrier minus the current center frequency setting of the receiver (i.e., Monitor Frequency).

Input Level

Displays the RF input level of the carrier. Indicated units are Volts, Watts, or dBm as defined by the Input Level Units parameter in the RF Zone.

NOTE

When the RF input power on the RF In/Out port is above +20 dBm (100 mW), the R8200 utilizes a broadband power detector for the measurement. The Input Level field in the RF Zone changes to Watt Meter to indicate this measurement mode.

The Input Source parameter can be used to force narrow or broadband power. That is useful for TDMA protocols whose on and off slots can cause the indicator to toggle between them.

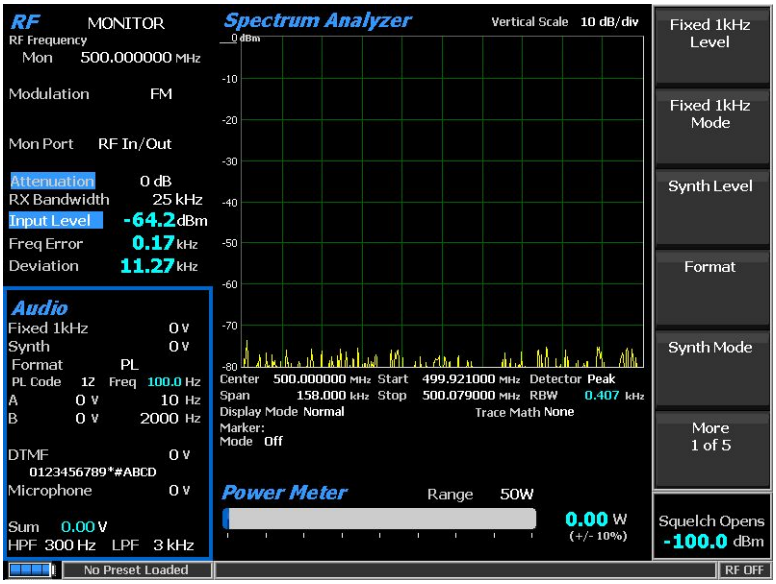
General Sequence

When General Sequence is selected as the Decoder in the METER Zone, the DISPLAY Zone is occupied by the General Sequence display which shows the current Selective Calling Tone Standard detected by the meter, as well as the frequency and duration of its 20 Tone Codes (0 to 9 and A to J).

For DISPLAY Zone soft key definitions, ranges, discrete and default values, and detailed notes, see **"DISPLAY Zone Soft Keys for Monitor Mode" on page 362**.

AUDIO Zone

The AUDIO Zone in the lower left-hand screen is activated by pressing the top-level **AUDIO Zone** soft key or **Hot Key 4**.



In Monitor Mode, the AUDIO Zone contains audio and baseband filter settings for retrieving test signals and a display of the current encoding format and voltage level.

NOTE AUDIO Zone menu screens display common settings along with menu choices that change to reflect the Format (signal type) chosen for the audio synthesizer. Different submenu screens and settings appear when other encoding types such as DPL, A/B Sequence, or 5/6 Tone are selected with the Format soft key.

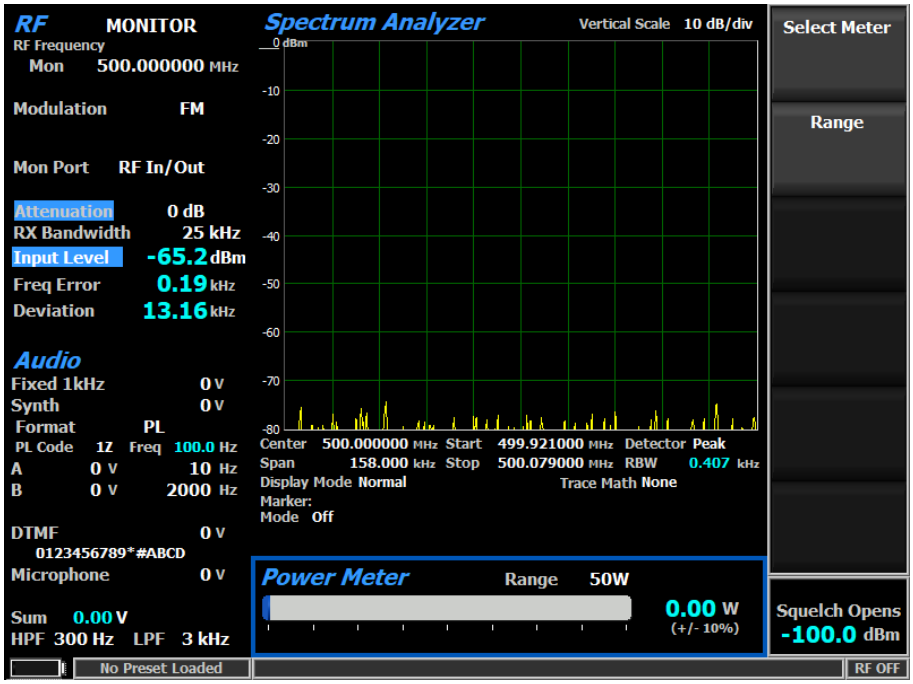
The audio synthesizers operate like a stand-alone audio generator since they are not modulating a carrier. The composite audio signal is available at the Mod In/Out port.

Sum – displays the composite sum of all audio sources enabled in volts.

NOTE Decoding parameters for the carrier-recovered audio are primarily located in the METER Zone.

For AUDIO Zone soft key definitions, ranges, discrete and default values, and detailed notes, see **"AUDIO Zone Soft Keys for Monitor Mode" on page 335**.

METER Zone



The METER Zone in the lower right-hand screen is activated by pressing the top-level **METER Zone** soft key or **Hot Key 5**. It contains the metering display for the receiver, represented in a dedicated area on the LCD screen below the DISPLAY Zone. The R8200 offers a Power Meter, Voltmeter, SINAD/Distortion, Decoder, Frequency Counter, RF Scan, and SNR meter to provide detailed analysis of the RF carrier as well as the recovered baseband content. For individual meter descriptions, see **"Introducing the Meters" on page 96**.

For METER Zone soft key definitions, ranges, discrete and default values, and detailed notes, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

See the following section, **"Measuring LMR Signals in Monitor Mode" on the next page** for instructions on configuring a simple FM transmitter test using Duplex Mode.

Measuring LMR Signals in Monitor Mode

This section provides an example verification measurement of a portable radio's digital signal processing without the need for specialized power supplies, test boxes, or radio service software. It can be completed using only the radio, a single BNC cable, and two adapters. This section describes a simple procedure for verifying the basic functionality of the radio's RF transmitter and physical layer protocol using the R8200 in Monitor Mode. Follow these steps to connect the radio to the R8200 and configure your measurement.

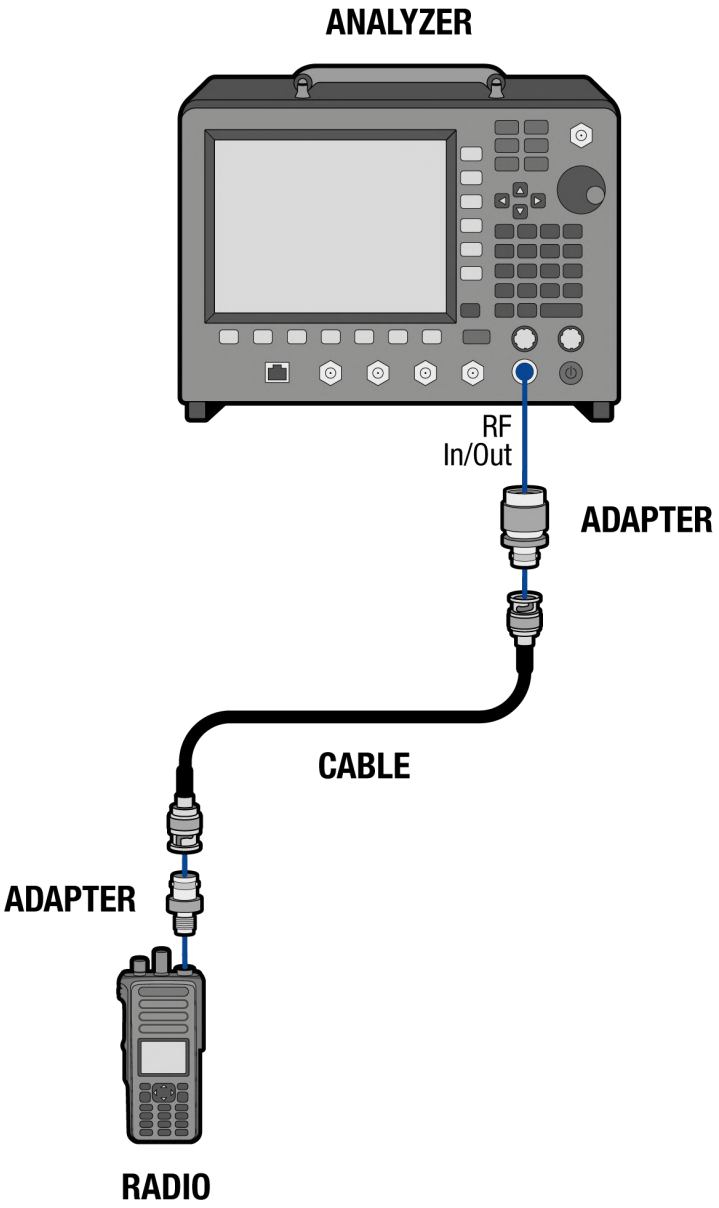
Required Equipment

- Freedom R8200 Communications System Analyzer
- Portable Radio, programmed for Project 25 (i.e., Motorola APX 6000 or similar)
- Cable, coax, BNC (m-m)
- Adapter, Type N(f)-to-BNC(f)
- Adapter, SMA(f)-to-BNC(f)

Video Support

A video of this transmitter verification procedure is available on the Freedom Communication Technologies YouTube channel at https://youtu.be/tJsqk0edFQU.

Test Setup



Procedure

Steps	Actions	Notes
1. Configure the test setup.	**a.** Connect the Type N(f)-to-BNC(f) adapter to the R8200's RF In/Out port. **b.** Remove the antenna from the radio. **c.** Connect the SMA(f)-to-BNC(f) Adapter to the Antenna port of the radio. **d.** Connect the BNC cable between the radio and the R8200.	
2. Configure the R8200.	**a.** To access the PROJECT 25 Test Mode, press **Test** > **Test Mode** > **PROJECT 25.** **b.** To set the receiver Center Frequency to match the radio transmitter, press **Hot Key 1** > **Monitor Frequency** > **851** > **MHz**. **c.** In the RF Zone, confirm that Mon Port displays **RF In/Out** as the receiver's input. **d.** To appropriately attenuate the receiver's input, press **Attenuation** > **40** > **dB**.	This opens the PROJECT 25 Test menu. Alternatively, press **RF Zone** > > **Monitor Frequency** > **851** > **MHz**. If not, press **Mon Port** > **RF In/Out** > **Enter.**
3. Activate and key the radio.	**a.** Turn the On/Off/Volume Knob clockwise to activate the radio. **b.** Press **PTT** on the portable.	This initiates a broadcast of the voice content picked up by the radio microphone.
4. Observe the DISPLAY Zone.	**a.** Confirm that the analyzer is	You should observe change in the

Steps	Actions	Notes
	decoding the radio's transmitted Voice Frame Data.	Voice Frame Data display.
5. Observe the RF Zone**.**	**a.** Confirm that the Input Level displays the radio's output as approximately **3 W**. **b.** Confirm that the Freq Error displays the radio's frequency error as **less than 100 Hz**.	This verifies the performance of the radio's RF transmitter.
6. Observe the PROJECT 25 Zone.	**a.** Confirm that NAC displays a valid Network Access Code. **b.** Confirm that Mod Fidelity displays **less than 1%**. **c.** Confirm that Symbol Dev displays **less than 2 kHz**.	This verifies that the radio correctly encoding the PROJECT 25 message content.

Having confirmed these transmission parameters, you can verify that the transmitter on this radio is working properly in PROJECT 25 Test Mode.

3 Using Generate Mode

This chapter explains how to use the analyzer as a stand-alone RF signal source or RF transmitter for testing LMR receivers. It includes an overview of the use model and display features with links to the detailed soft key reference and an example LMR broadcast configuration.

See **"Introducing Generate Mode" on the next page** for an overview of the Generate Mode display and use model.

See **"Producing LMR Signals in Generate Mode" on page 69** for step-by-step instructions on configuring the R8200, connecting the radio, and configuring the radio to make an initial carrier power and frequency analysis of the radio's receiver.

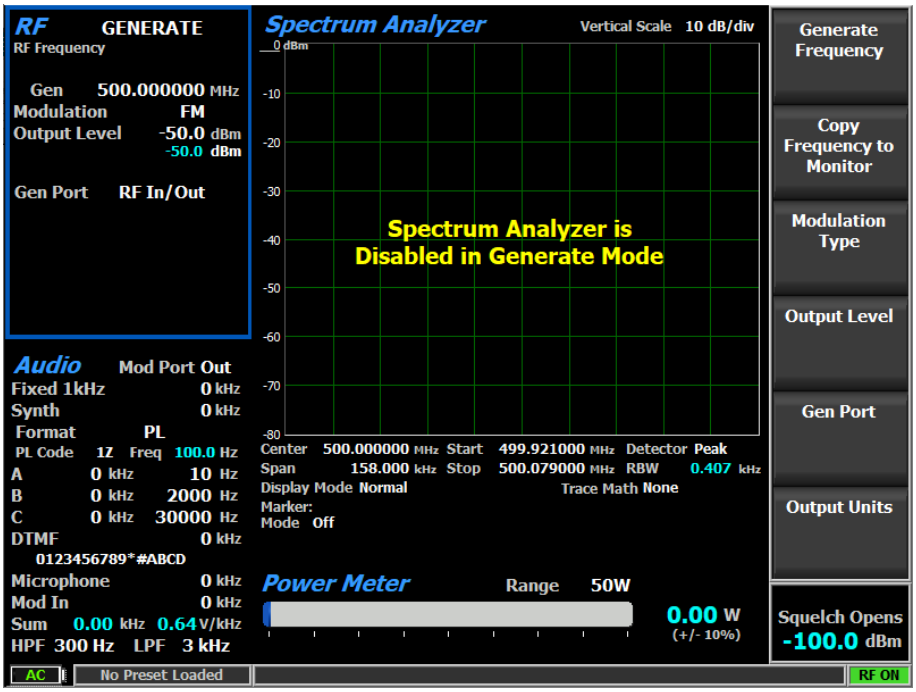
Introducing Generate Mode

In Generate Mode, the analyzer operates as an RF transmitter for testing radio receivers over an operating frequency range of 250 kHz to 3 GHz in 1 Hz increments. The RF carrier output is accessible through the RF Gen Out or RF In/Out ports for over the air (OTA) operation or direct coupling to a receiver. The output level is adjustable from –95 dBm to +5 dBm (Standard) or –125 dBm to +5 dBm (Optional) on the RF Gen Out port, and –130 dBm to –30 dBm on the RF In/Out port. A variety of modulation types and encoding formats are available for the RF carrier.

The following sections explain the unique functional parameters associated with the RF, Display, Audio and METER Zones respectively while in Generate Mode.

RF Zone

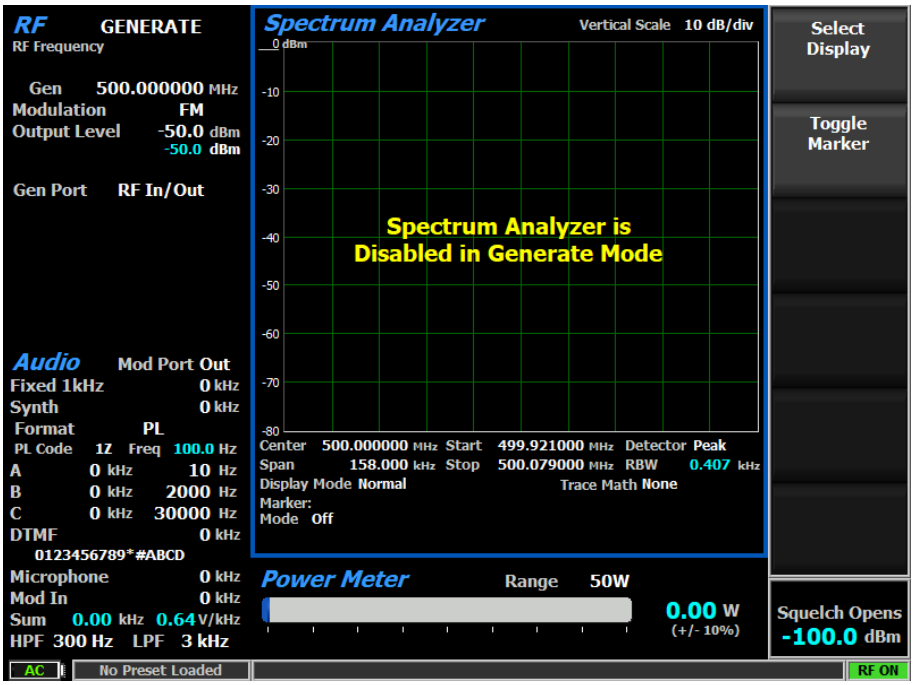
When the RF Zone is selected while in Generate Mode, the R8200 display appears as shown.



In Generate Mode, the RF Zone displays the following adjustable parameters: Gen (transmitter center frequency), Duplex Offset, Modulation (type), Output Level (RF output power/voltage), Output Units, and Gen Port (transmitter output).

For RF Zone soft key definitions, ranges, discrete and default values, and detailed notes, see **"RF Zone Soft Keys for Generate Mode" on page 391**.

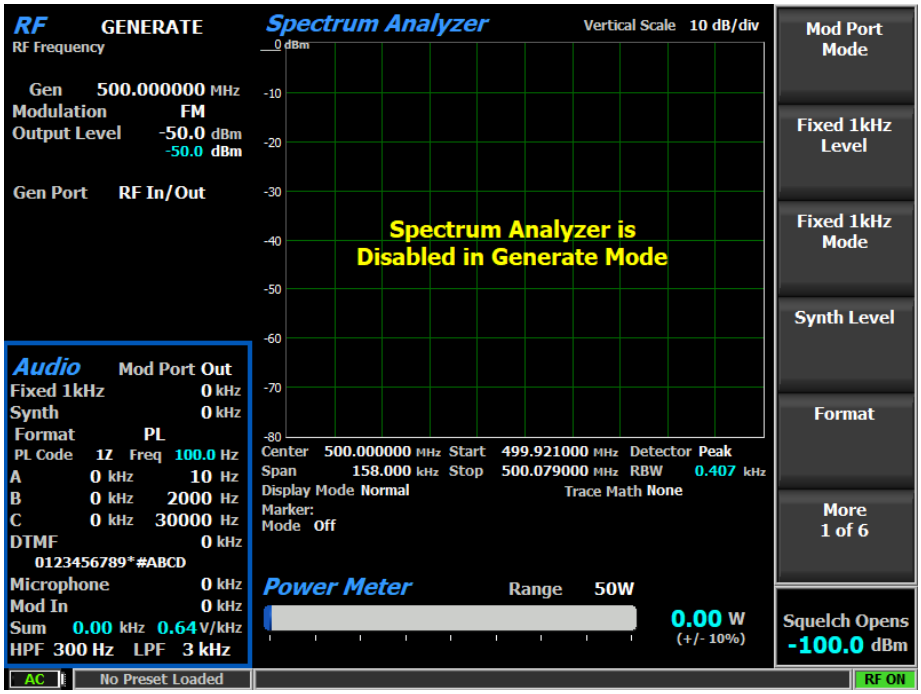
DISPLAY Zone



In Generate Mode, the DISPLAY Zone in the upper right-hand screen is activated by pressing the top-level **DISPLAY Zone** soft key or Hot Key 2. It contains the graticule for the graphical display of the current time-based signal of interest (frequency based instrument displays such as Spectrum Analyzer and bar graphs are disabled). The instrument type (Modulation Scope or Oscilloscope) is shown at the top of the screen along with the vertical and horizontal scale-per-division. When Oscilloscope is selected, Maximum Recommended Input frequency is also displayed at the top of the screen. Vertical scale in voltage/div is shown on the Y-axis. Horizontal scale in time/div is shown on the X-axis. The yellow measurement trace is displayed on the graticule.

For DISPLAY Zone soft key definitions, ranges, discrete and default values, and detailed notes, see **"DISPLAY Zone Soft Keys for Generate Mode" on page 421**.

AUDIO Zone



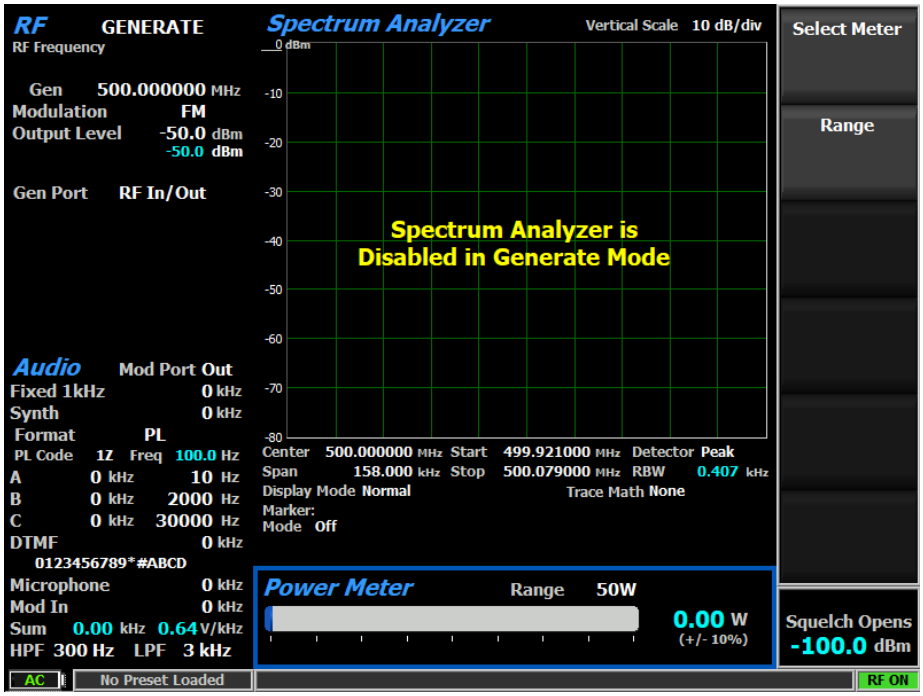
The AUDIO Zone in the lower left-hand screen is activated by pressing the top-level **AUDIO Zone** soft key or **Hot Key 4**. It contains audio and baseband filter settings for encoding test signals and a display of the current encoding format and voltage level.

The AUDIO Zone parameters in Generate Mode replicate those in Monitor Mode *with two key differences*.

- In Generate Mode, the audio signal is applied simultaneously, as modulation to the RF carrier, and as a base band signal at the Mod In/Out connector.
- In Generate Mode, (Mod) Sum level is shown in units of FM deviation (kHz) or AM modulation depth (%), depending on the current Modulation Type (FM or AM, respectively) displayed in the RF Zone.

For AUDIO Zone soft key definitions, ranges, discrete and default values, and detailed notes, see **"AUDIO Zone Soft Keys for Generate Mode" on page 393**.

METER Zone



The METER Zone in the lower right-hand screen is activated by pressing the top-level **METER Zone** soft key or **Hot Key 5**. It contains the metering display for the receiver. The R8200 offers a Power Meter, Voltmeter, SINAD/Distortion, Decoder, Frequency Counter, RF Scan, and SNR meter to provide detailed analysis of the RF carrier as well as the recovered baseband content. For individual meter descriptions, see **"Introducing the Meters" on page 96**.

For METER Zone soft key definitions, ranges, discrete and default values, and detailed notes, see **"METER Zone Soft Keys for Generate Mode" on page 430**.

See the following section, **"Producing LMR Signals in Generate Mode" on the next page** for a simple procedure verifying the basic analog functionality of the radio's RF receiver and physical layer protocol using the R8200 in Generate Mode.

Producing LMR Signals in Generate Mode

This section provides an example verification measurement of a portable radio's digital signal processing without the need for specialized power supplies, test boxes, or radio service software. It can be completed using only the radio, a single BNC cable, and two adapters. This section describes a simple procedure for verifying the basic analog functionality of the radio's RF receiver and physical layer protocol using the R8200 in Generate Mode. Follow these steps to connect the radio to the R8200 and configure your measurement.

NOTE

This procedure begins at the where **"Measuring LMR Signals in Monitor Mode" on page 60** ends.

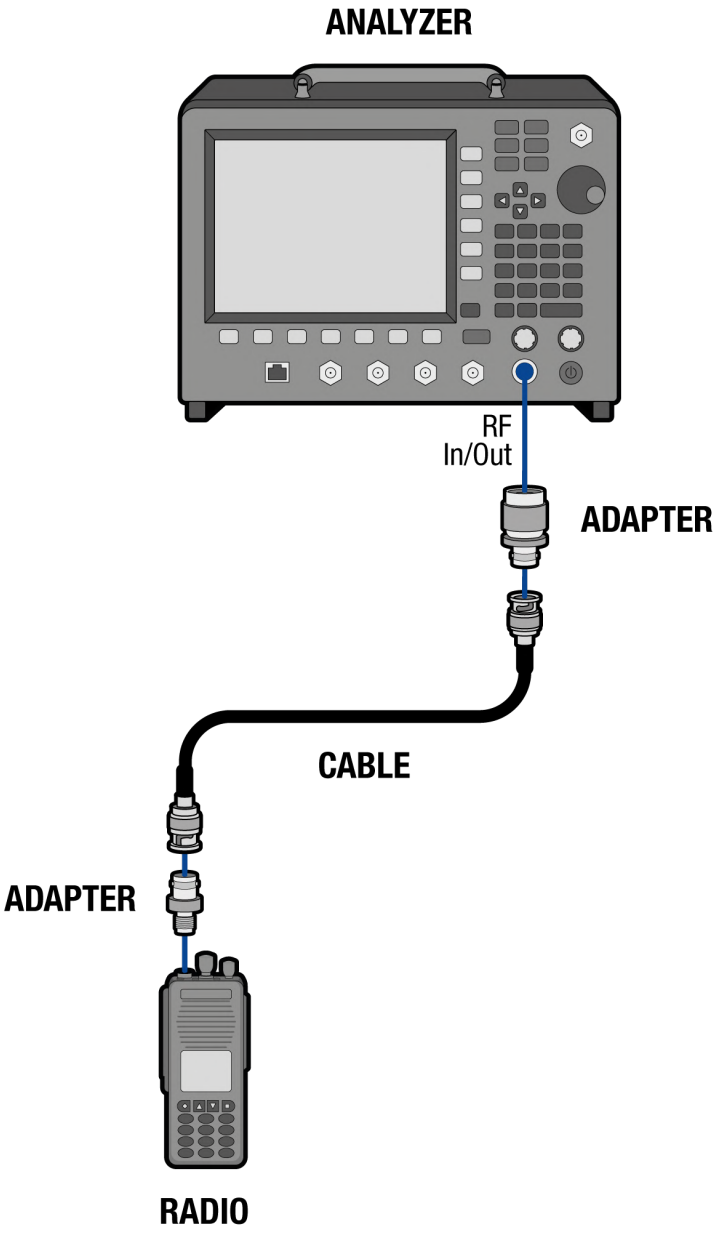
Required Equipment

- Freedom R8200 Communications System Analyzer
- Portable Radio, programmed for Project 25 (i.e., Motorola APX 6000 or similar)
- Cable, coax, BNC (m-m)
- Adapter, Type N(f)-to-BNC(f)
- Adapter, SMA(f)-to-BNC(f)

Video Support

A video of this receiver verification procedure is available on the Freedom Communication Technologies YouTube channel at https://youtu.be/tJsqkOedFQU.

Test Setup



Procedure

Steps	Actions	Notes
1. Configure the R8200	**a.** While still in Monitor Mode, to quickly set the generator output to the proper frequency, press **Copy Frequency to Generator**. **b.** To do the same with the NAC parameter, press **Hot Key 4** > **Copy NAC to Generator**. **c.** To begin transmitting RF from the R8200, press **Generate**. **d.** To generate a standard P25 test pattern, press **Gen Test Pattern** > **1011 Hz Tone**. **e.** To modulate the RF carrier, press **Modulation Mode** > **Continuous**.	
2. Listen for the 1 kHz tone broadcast from the radio's speaker.	**a.** Adjust the volume of the 1011 Hz tone using the radio's On/Off/Volume Knob.	This verifies that the radio correctly decodes the PROJECT 25 baseband content.
3. Test the sensitivity of the radio.	**a.** To adjust the Output Level of the R8200, press **Hot Key 1** > **Output Level**. **b.** Decrease the Output Level until the tone is no longer heard. **c.** Confirm the RF Output Level is less than –120 dBm when the tone disappears.	This confirms that the radio receiver is sensitive to transmissions as weak as –120 dBm.

Having confirmed these reception parameters, you can verify this radio is working in PROJECT 25 Test Mode.

4 Using Duplex Mode

This chapter explains how to use the analyzer as a stand-alone transceiver for testing LMR radios. It includes an overview of Duplex Mode, its use model and display features, with links to the detailed soft key reference and an example measurement configuration.

See **"Introducing Duplex Mode" on the next page** for an introduction to the Duplex Mode display and use model.

See **"Verifying LMR Performance in Duplex Mode" on page 84** for step-by-step instructions on configuring the R8200, connecting it to the radio, and configuring the radio to make an initial measurement of the entire RF signal path of the radio.

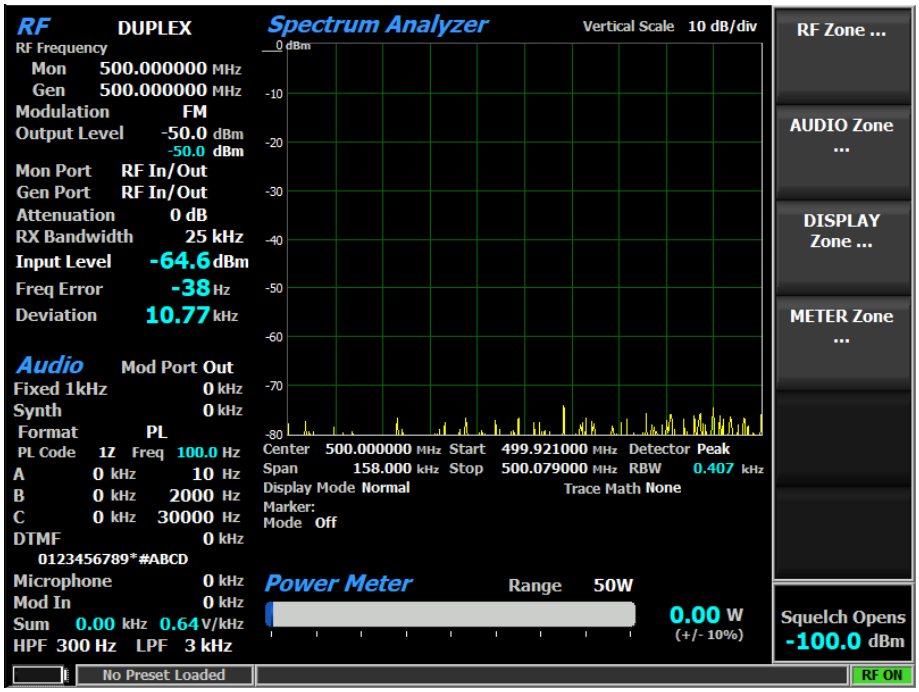
Introducing Duplex Mode

Duplex Mode combines the functionality of the Monitor and Generator modes. The analyzer operates as a stand-alone RF transceiver for testing LMR portables, mobiles, and system infrastructure. It provides simultaneous generator and monitor operation for testing radio transceivers with full duplex capability or radio systems with offset transmit and receive frequencies. All Generate and Monitor Mode RF parameters are independently adjustable in Duplex Mode except the shared functions of modulation type and bandwidth. Duplex Mode provides offset frequency operation of the generator and monitor over the full frequency range of the R8200.

NOTE If RF Level Offset is enabled, the Gen Port and Mon Port labels are cyan-colored, indicating that Output Level amplitudes and RX measurements are adjusted by the Gen Port and Mon Port-specific offsets. See .

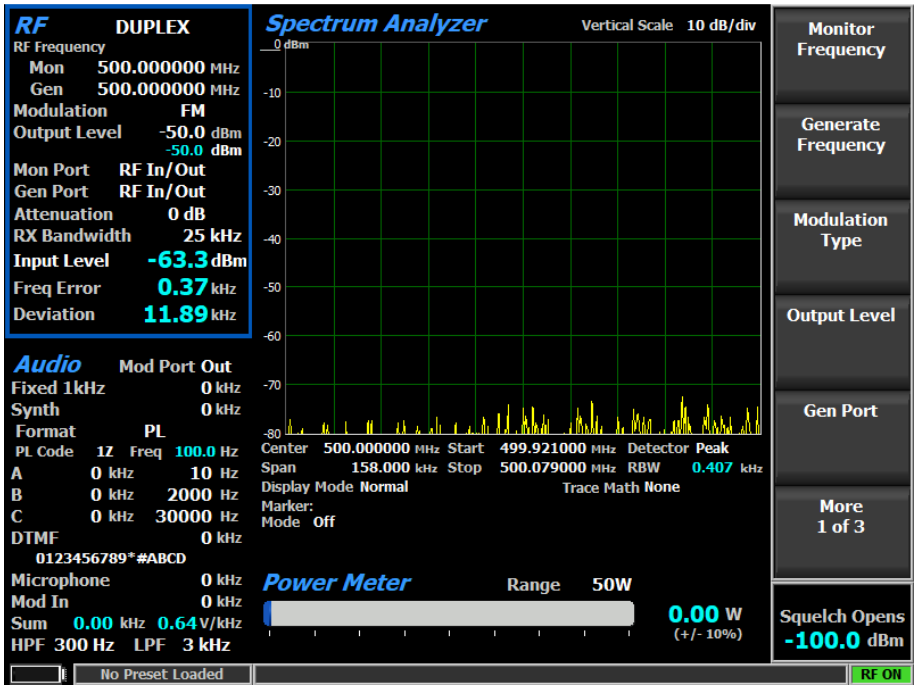
Its receiver is capable of monitoring over the air (OTA) RF signals through its Antenna port or via direct connection to the transmitter through the RF In/Out port. Its transmitted RF carrier is accessible through the RF Gen Out or RF In/Out ports for over the air (OTA) operation via antenna broadcast or direct coupling via cabling to a receiver. 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. The operating frequency range is 250 kHz to 3 GHz in 1 Hz increments with selectable bandwidths between 6.25 kHz and 200 kHz.

The transmitter produces AM and FM carriers and a variety of baseband encoding formats. Its receiver provides signal strength, frequency accuracy, and other metering results while decoding the messages on incoming RF carriers to produce a recovered baseband signal. Additional analysis is provided by a Spectrum Analyzer, a Modulation Scope, a Dual Display (combined display of the aforementioned), an Oscilloscope, a Tracking Generator, a Cable Fault Locator and a Single-Port Vector Network Analyzer. When activated by pressing the blue mode key, the Duplex Mode is displayed as shown.



The following sections explain the functional parameters associated with the RF, DISPLAY, AUDIO, and METER Zones, respectively.

RF Zone



The RF Zone in the upper left-hand screen is activated by pressing the top-level **RF Zone** soft key or **Hot Key 1**. It displays the following adjustable parameters: Mon (receiver center frequency), Gen (transmitter center frequency), Duplex Offset, Modulation (type), (transmitter) Output Level (RF output power/voltage), Output Units, Mon Port (receiver input), Input Source, Input Units, Gen Port (transmitter output), Attenuation, Pre-Amplifier, and RX (receiver) Bandwidth. It also displays three fields of automated carrier measurements: Input Level, Freq Error (frequency error), and (frequency) Deviation.

NOTE

When the RF input power on the RF In/Out port is above +20 dBm (100 mW), the R8200 utilizes a broadband power detector for the measurement. The Input Level field in the RF Zone changes to Watt Meter to indicate broadband power measurement.

Input Level – Displays the RF input level of the received carrier. Different units may be selected using the Input Level Units soft key.

Watt Meter – Displays the level of broadband power applied to the RF In/Out port. For increased Watt Meter accuracy, disable the Pre-amplifier in Monitor Mode (press **Settings** > **System Settings** > **More** × 2 > **Pre-Amplifier Auto Off** > **Enable**), and in Generate Mode, set the Gen Port to RF In/Out (press **Generate** > **Gen Port** > **RF In/Out**).

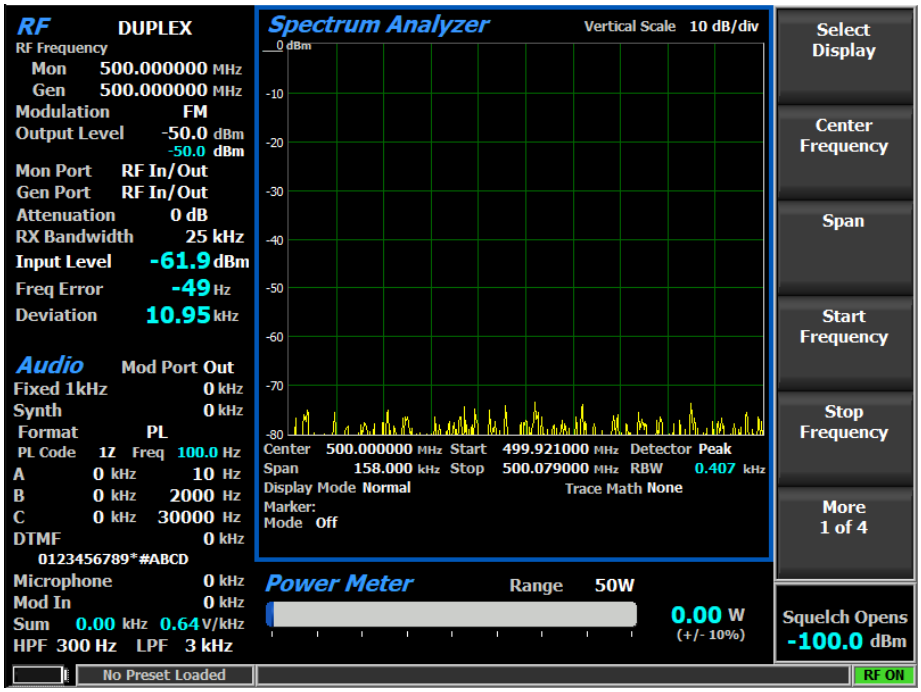
Freq Error – Displays the frequency difference between the received carrier frequency and the R8200 current Monitor Center Frequency.

Deviation – When the selected modulation type is FM, displays the positive peak frequency deviation of the received modulated carrier (i.e., from the Frequency Error mean). Negative peak frequency deviation can be observed by selecting Bar Graphs in the DISPLAY Zone (press **DISPLAY Zone** > **Select Display** > **Bar Graphs**).

%AM – When the selected modulation type is AM, displays the positive peak AM percentage of the received modulated carrier.

For RF Zone soft key definitions, ranges, discrete and default values, and detailed notes, see **"RF Zone Soft Keys for Monitor Mode" on page 331**.

DISPLAY Zone



The DISPLAY Zone in the upper right-hand screen is activated by pressing the top-level **DISPLAY Zone** soft key or **Hot Key 2**. It contains the graticule for the graphical display of the current signal of interest providing a visual presentation of received RF signal measurements, recovered audio, internally-generated audio, and externally-measured audio signals. These include a Spectrum Analyzer, Modulation Scope, and Oscilloscope, along with Bar Graphs for RF signal deviation, frequency error and input level. The instrument type is shown at the top of the screen along with the vertical scale-per-division. Vertical scale and reference level are shown on the Y-axis. Frequency, Marker, and Trace Math parameters are shown below the X-axis. The yellow measurement trace is displayed on the graticule.

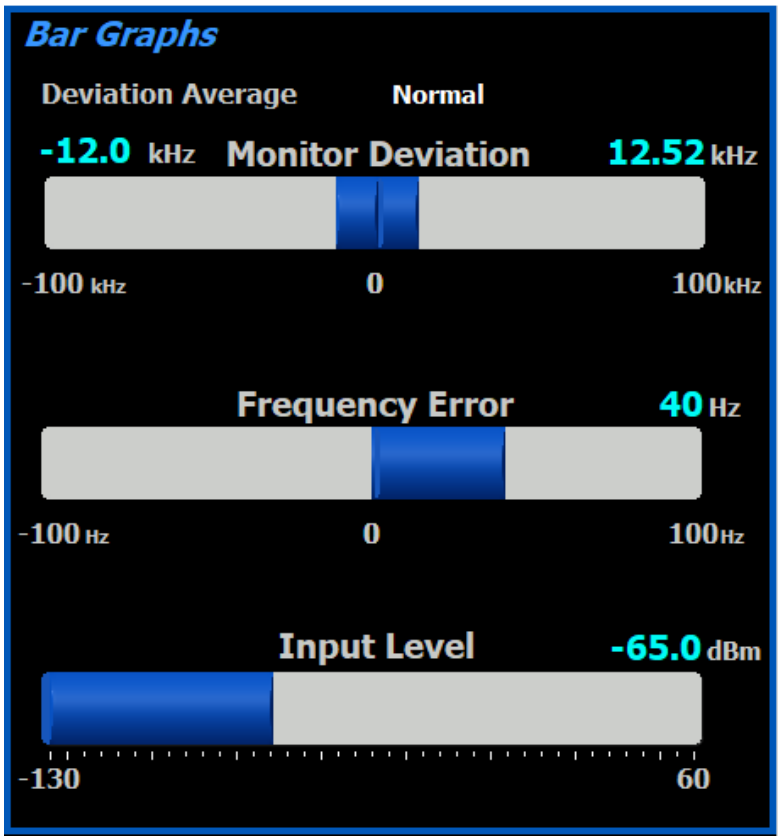
For individual bar graphs, see **"Bar Graphs" below**. For General Sequence, see **"General Sequence" on page 80**.

For details regarding the individual instrument displays, see:

- **"Introducing the Spectrum Analyzer" on page 90**
- **"Introducing the Modulation Scope" on page 91**
- **"Introducing the Oscilloscope" on page 92**
- **"Introducing the Dual Display" on page 93**
- **"Introducing the Tracking Generator" on page 94**
- **"Introducing the Cable Fault Locator" on page 95**
- **"Introducing the Meters" on page 96**

Bar Graphs

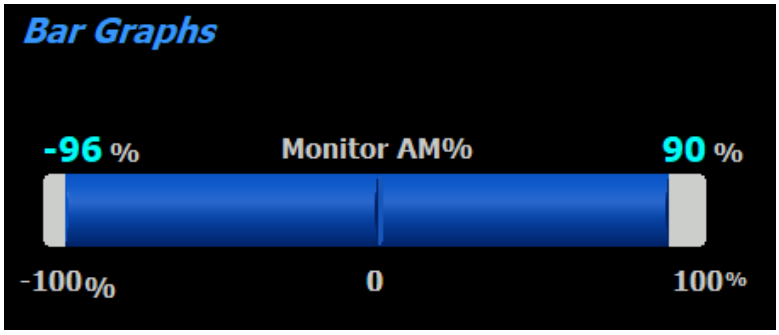
The Bar Graphs display provides a simultaneous analog and digital readout of critical signal characteristics. The analog display facilitates real time tuning adjustments of two-way radios while the digital reading provides precision in the measured result. The graph response can be smoothed using peak, power-weight, and RMS averaging. Press **Select Display** to enable a horizontal soft key menu of bar graph choices. Three bar graphs are displayed for the received carrier while in Monitor and Duplex Modes, as shown here when FM is selected as the Modulation Type.



Monitor Deviation

This graph displays the negative and positive peak frequency deviation of a modulated carrier (i.e., from the Frequency Error mean), available when Modulation Mode is FM.

Monitor AM%



When Modulation mode is AM, this graph displays the negative and positive peak AM percentages of a modulated carrier.

Frequency Error

Represents the frequency difference (error) of the input carrier minus the current center frequency setting of the receiver (i.e., Monitor Frequency).

Input Level

Displays the RF input level of the carrier. Indicated units are Volts, Watts, or dBm as defined by the Input Level Units parameter in the RF Zone.

NOTE

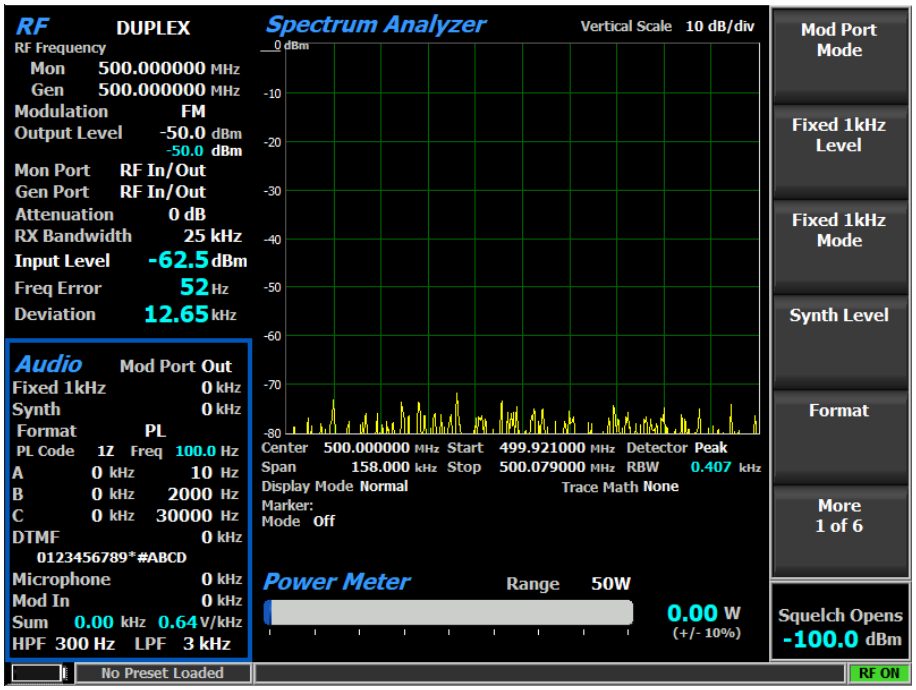
When the RF input power on the RF In/Out port is above +20 dBm (100 mW), the R8200 utilizes a broadband power detector for the measurement. The Input Level field in the RF Zone changes to Watt Meter to indicate this measurement mode.

General Sequence

When General Sequence is selected as the Decoder in the METER Zone, the DISPLAY Zone is occupied by the General Sequence display which shows the current Tone Standard detected by the meter, as well as the frequency and duration of its 20 Tone Codes (0 to 9 and A to J).

For DISPLAY Zone soft key definitions, ranges, discrete and default values, and detailed notes, see **"DISPLAY Zone Soft Keys for Monitor Mode" on page 362**.

AUDIO Zone



The AUDIO Zone in the lower left-hand screen is activated by pressing the top-level **AUDIO Zone** soft key or **Hot Key 4**. In Duplex Mode, the AUDIO Zone contains audio and baseband filter settings for encoding and retrieving baseband signals and a display of the current encoding/decoding format and voltage level.

NOTE

AUDIO Zone menu screens display common settings along with menu choices that change to reflect the Format (signal type) chosen for the audio synthesizer. Different submenu screens and settings appear when other encoding types such as DPL, A/B Sequence, or 5/6 Tone are selected with the Format soft key.

The AUDIO Zone parameters in Duplex Mode replicate those in Monitor Mode *with two key differences*.

- In Duplex Mode, the audio signal is applied simultaneously, as modulation to the RF carrier, and as a base band signal at the Mod In/Out connector.
- In Duplex Mode, (Mod) Sum level is shown in units of FM deviation (kHz) or AM modulation depth (%), depending on the current Modulation Type (FM or AM, respectively) displayed in the RF Zone.

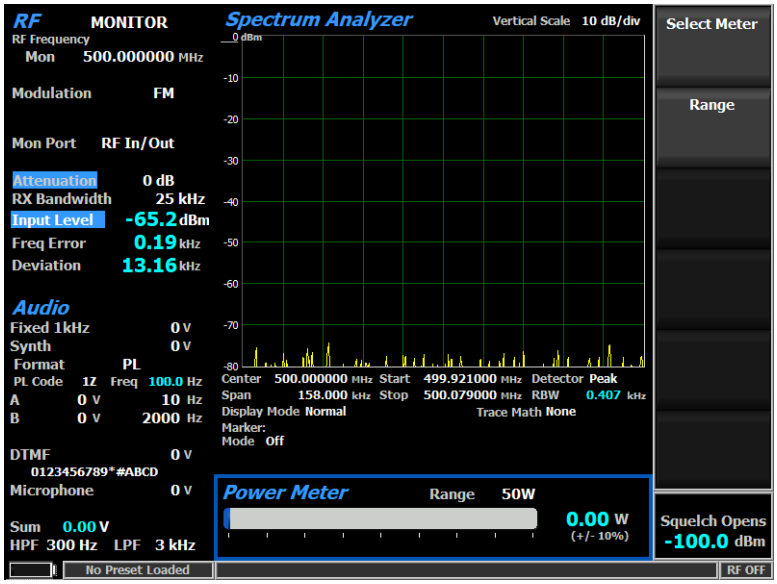
Sum – displays the composite sum of all audio sources enabled in volts.

NOTE

Decoding parameters for the carrier-recovered audio are primarily located in the METER Zone. See **"Decoder" on page 98**.

For AUDIO Zone soft key definitions, ranges, discrete and default values, and detailed notes, see **"AUDIO Zone Soft Keys for Duplex Mode" on page 446**.

METER Zone



The METER Zone in the lower right-hand screen is activated by pressing the top-level **METER Zone** soft key or **Hot Key 5**. It contains the metering display for the receiver, represented in a dedicated area on the LCD screen below the DISPLAY Zone. The R8200 offers a Power Meter, Voltmeter, SINAD/Distortion, Decoder, Frequency Counter, RF Scan, and SNR meter to provide detailed analysis of the RF carrier as well as the recovered baseband content. For individual meter descriptions, see **"Introducing the Meters" on page 96**.

For METER Zone soft key definitions, ranges, discrete and default values, and detailed notes, see **"METER Zone Soft Keys for Duplex Mode" on page 492**.

See the following section, **"Verifying LMR Performance in Duplex Mode" on the next page** for instructions on configuring a simple FM transmitter test using Duplex Mode.

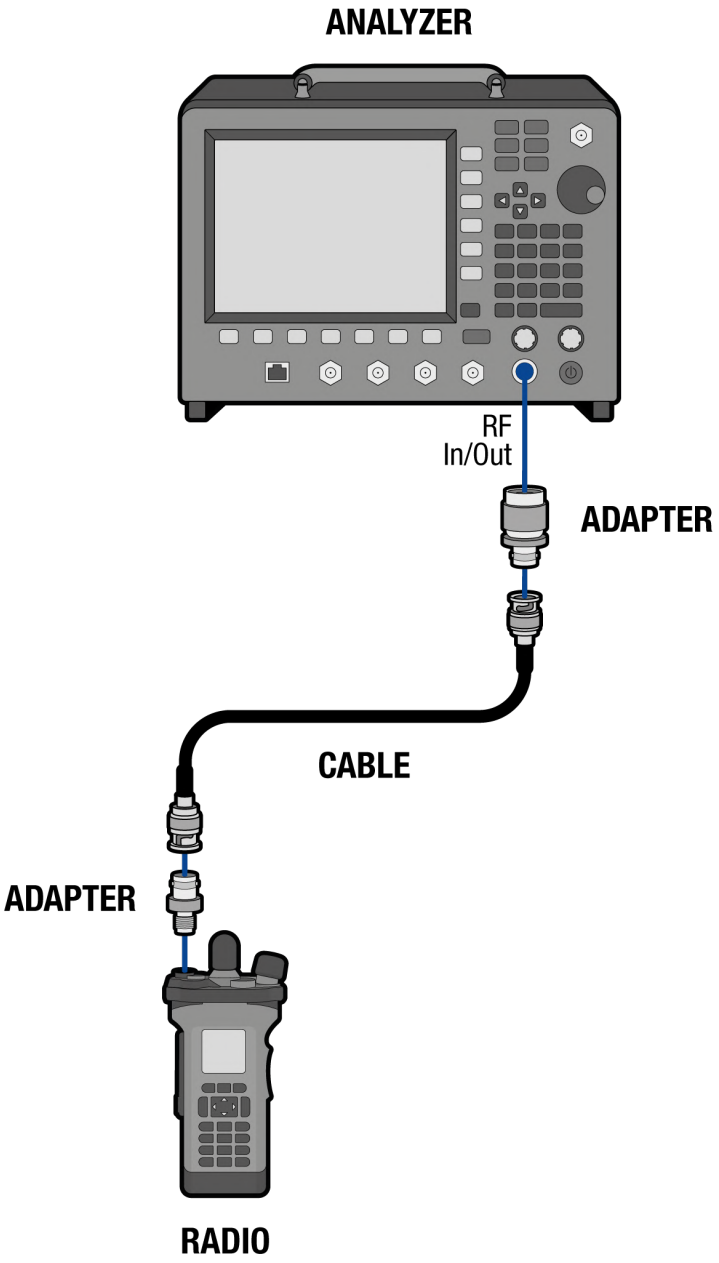
Verifying LMR Performance in Duplex Mode

This section provides an example measurement using the analyzer's Duplex Mode. Complete this procedure to make an initial verification measurement of a portable radio transceiver's FM analog signal processing without the need for specialized power supplies, test boxes, or radio service software. It can be completed using only the radio, a single BNC cable, and two adapters. This section describes a simple procedure for verifying the basic functionality of the radio's RF transceiver and physical layer protocol using the R8200 in Duplex Mode. Follow these steps to connect the radio to the R8200 and configure your measurement.

Required Equipment

- Freedom R8200 Communications System Analyzer
- Portable Radio
- Cable, coax, BNC (m-m)
- Adapter, Type N(f)-to-BNC(f)
- Adapter, SMA(f)-to-BNC(f)

Test Setup



Procedure

Steps	Actions	Notes
1. Configure the test setup.	**a.** Connect the Type N(f)-to-BNC(f) adapter to the R8200 RF In/Out port.	
	b. Remove the antenna from the radio.	
	c. Connect the SMA(f)-to-BNC(f) adapter to the Antenna port of the radio.	
	d. Connect the BNC cable between the radio and the R8200.	
2. Configure the R8200.	**a.** Press **Duplex**.	
	b. To set the receiver Center Frequency, press **Hot Key 1** > **Monitor Frequency** > **403** > **MHz**.	Alternatively, press **RF Zone** > > **Monitor Frequency** > **403** > **MHz**.
	c. To set the transmit frequency to match the radio receiver press **Generate Frequency** >**403** > **MHz**.	
	d. To disable transmission from the R8200, press **RF On/Off**.	
	e. In the RF Zone, confirm that Mon Port displays **RF In/Out** as the receiver's input.	If not, press **Mon Port** > **RF In/Out** > **Enter**.
	f. In the RF Zone, confirm that Gen port displays **RF In/Out** as the Gen Port.	If not, press **Gen Port** > **RF In/Out** > **Enter**.
	g. Confirm in RF Zone that Mod-	

Steps	Actions	Notes
	ulation displays FM.	By default, the R8200 starts in FM modulation. If not, press **Modulation Type** > **FM**.
3. Activate and key the radio.	**a.** Turn the On/Off/Volume Knob clockwise to activate the radio. **b.** Press **PTT** on the portable. **c.** Speak into the radio microphone.	This initiates a broadcast of the voice content input from the radio microphone. It may be necessary to adjust the volume to hear the demodulated voice on the R8200 speaker.
4. Observe the DISPLAY Zone.	**a.** Confirm that the Spectrum Analyzer displays the radio's transmitted carrier signal.	You should observe a jump in signal on Spectrum Analyzer. Allow time for auto attenuation to activate and stabilize the Spectrum Analyzer level.
5. Observe the RF Zone.	**a.** Confirm that the Input Level displays the radio's output power. **b.** Verify measured power is at the level expected for radio. **c.** Confirm that Freq Error displays the radio's frequency error as **less than 100 Hz**.	This verifies the operation of the radio's RF FM transmitter.
6. Configure the R8200.	**a.** To set a 1 kHz test tone, press **Hot Key 4** > **Fixed 1 kHz Level** > **2.500** > **Enter**. **b.** To output the test tone, press **Fixed 1 kHz Tone** > **Continuous**. **c.** Press **RF On/Off** until **RF ON** is displayed in the lower right hand corner of the display.	If generate frequency set above then no need to duplicate.
7. Listen for the 1 kHz tone broadcast from the radio's speaker.	**a.** Adjust the volume of the 1 kHz tone using the radio's On/Off/Vo-	This verifies that the radio correctly decoding the FM transmission from

Steps	Actions	Notes
	Iome Knob.	the R8200.
8. Test the sensitivity of the radio.	**a.** To adjust the Output Level of the R8200, press **Hot Key 1** > **Output Level**. **b.** Use the arrow keys or the tuning knob to decrease the Output Level until the 1 kHz tone is no longer broadcast from the radio speaker. **c.** Confirm that the RF Output Level on the R8200 is less than –120 dBm when the tone disappears.	This confirms that the radio receiver is sensitive to transmissions as weak as –120 dBm.

Having confirmed these parameters, you can verify that the transceiver on this radio is operating correctly in Analog FM Duplex Mode.

5 Using Instrument Mode

This chapter introduces Instrument Mode which provides full-screen versions of a variety of test equipment employed in the verification and maintenance of LMR portables, mobiles, and infrastructure systems. Instrument Mode provides frequency- and time-based analytical instruments, making detailed visual analysis of waveforms easier while providing additional measurement specific data fields. These instruments include a Spectrum Analyzer, Modulation Scope, Oscilloscope, and a Single-Port Vector Network Analyzer. Optional instruments include a Dual Display (combining a Spectrum Analyzer and Modulation Scope), Tracking Generator, and Cable Fault Locator. The metering devices available in the R8200's METER Zone are also offered from Instrument Mode.

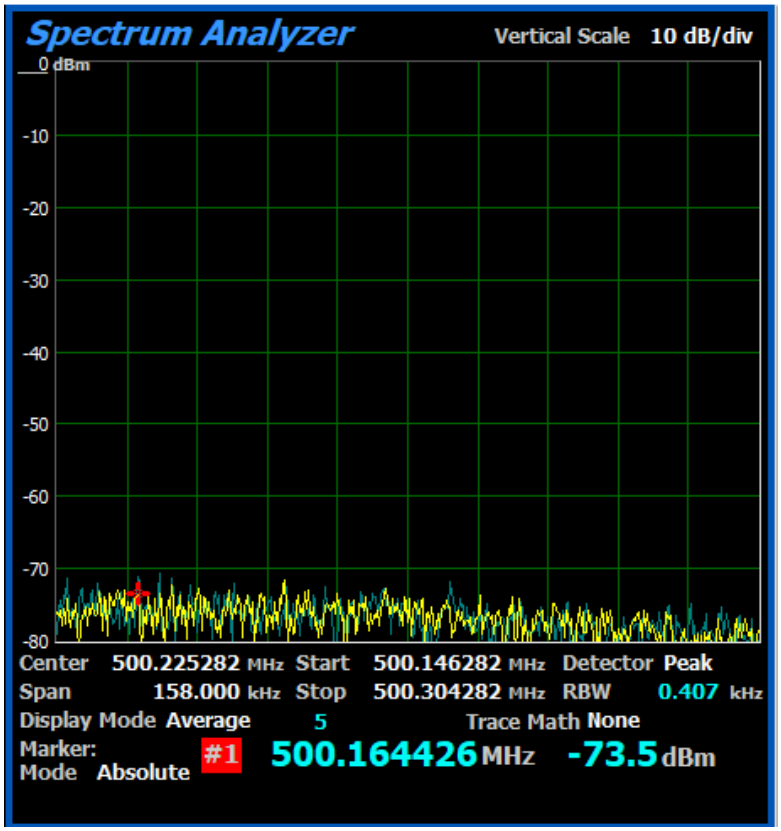
NOTE

Enabling a full screen display in Instrument Mode suspends the standard operation of the R8200 (i.e., RF Zone, AUDIO Zone, etc.). To restore standard operation, press **Monitor**, **Generate**, or **Duplex.**

The following sections feature an overview of each individual instrument with a description of the display user interface followed by links to each instrument's soft key reference.

Introducing the Spectrum Analyzer

The R8200 Instrument Mode is equipped with a stand-alone full-screen Spectrum Analyzer capable of analysis between 1 MHz and 3 GHz with +2 dB level accuracy and –140 dBm typical noise floor performance. It offers two absolute and delta markers frequency/power markers a well as a variety of measurement trace types. The Spectrum Analyzer display is shown below with an active marker.



The instrument type is shown at the top of the screen along with the vertical scale-per-division. Vertical scale and reference level are shown on the Y-axis. Frequency, Resolution Bandwidth, Display Mode, Marker, and Trace Math parameters are shown below the X-axis. The yellow measurement trace as well as the blue reference trace are displayed on the graticule.

Display Mode Average – Displays the number of sweeps currently averaged to create the displayed measurement trace when the Display Mode is set to Averaging.

RBW – Displays the optimized resolution bandwidth based on the current frequency span and sweep time.

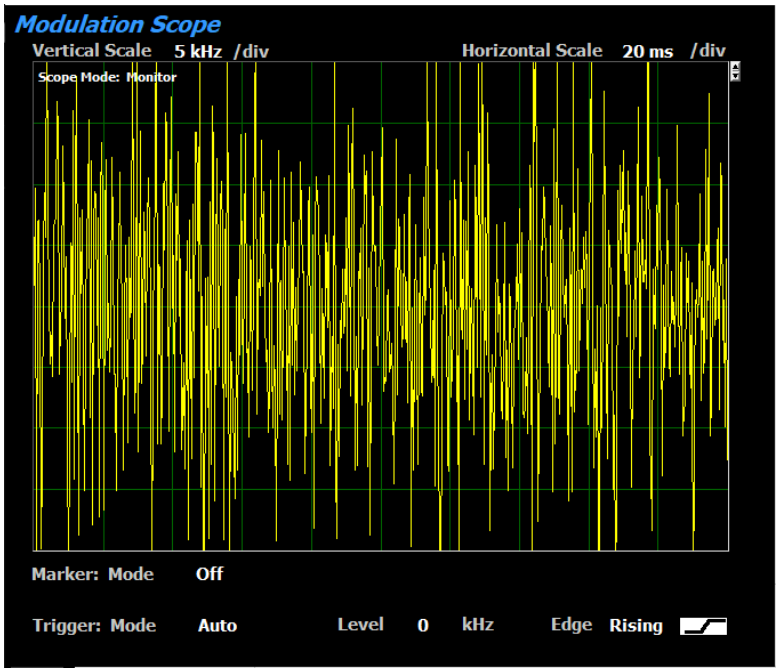
With the Enhanced Spectrum Analyzer option, up to seven markers and associated data can be activated on the Spectrum Analyzer display.

NOTE For an R8200 without the Enhanced Spectrum Analyzer option, the Toggle Marker soft key activates the two available markers.

For Spectrum Analyzer soft key definitions, ranges, discrete and default values, and detailed notes, see **"Spectrum Analyzer Soft Keys" on page 503**.

Introducing the Modulation Scope

The R8200 Instrument Mode is equipped with a stand-alone full-screen Modulation Scope. It also appears as an available display in the DISPLAY Zone as well as one half of the Dual Display instrument. The Modulation Scope display is shown below.

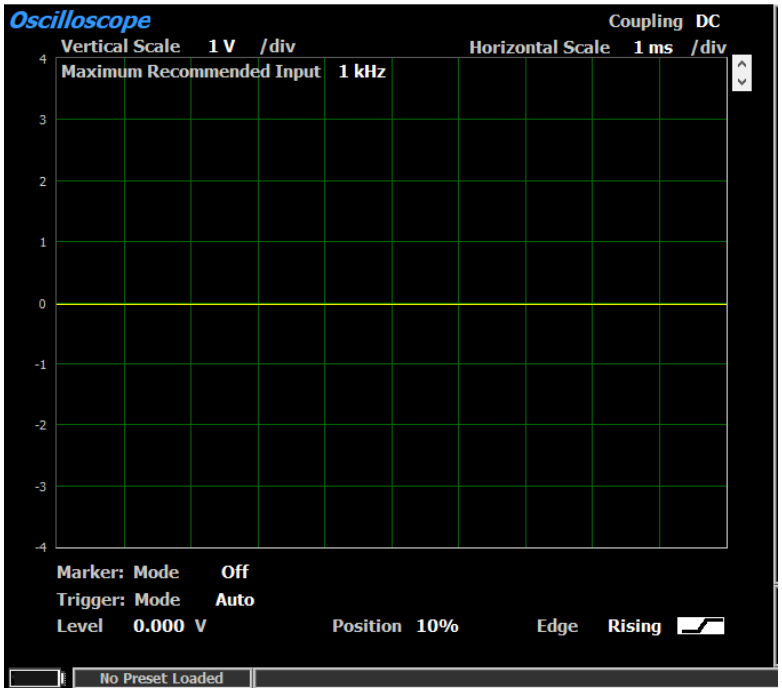


The Modulation Scope displays the internally-processed RF modulation waveforms. It automatically switches between Generator and Monitor modulation depending on which mode is selected. In Duplex Mode an additional soft key allows manual selection of the Monitor or Generator modulation waveform. Vertical and Horizontal Scale as well as Scope Mode are shown at the top of the screen. Marker Mode and Trigger parameters are shown below the X-axis. The yellow measurement trace is displayed on the graticule.

For Modulation Scope soft key definitions, ranges, discrete and default values, and detailed notes, see **"Modulation Scope Soft Keys" on page 512**.

Introducing the Oscilloscope

The R8200 Instrument Mode is equipped with a stand-alone full-screen Oscilloscope. It also appears as an available display in the DISPLAY Zone.



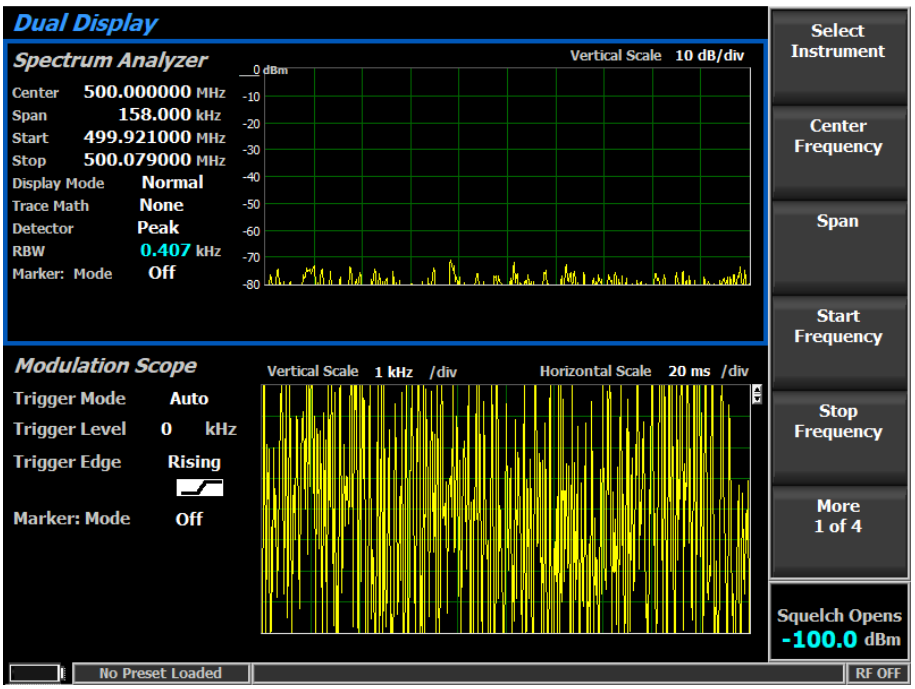
This general-purpose Oscilloscope features calibrated vertical input sensitivities and automatic or triggered horizontal sweep rates. Use the Oscilloscope to analyze waveforms, detect asymmetric modulation or audio distortion, trace signals, and troubleshoot subsystems or circuits. The Meter In port serves as the vertical input for the

Oscilloscope. Coupling, Vertical and Horizontal Scale as well as Maximum Recommended Input are shown at the top of the screen. Marker Mode and Trigger parameters are shown below the X-axis. The yellow measurement trace is displayed on the graticule.

For Oscilloscope scope soft key definitions, ranges, discrete and default values, and detailed notes, see **"Oscilloscope Soft Keys" on page 516**.

Introducing the Dual Display

The R8200 Instrument Mode is equipped with a stand-alone full-screen Dual Display. It also appears as an available display in the DISPLAY Zone.



The optional Dual Display provides a convenient one screen presentation of two instruments often used together, the Spectrum Analyzer and Modulation Scope. This gives a user control and a simultaneous view of the results from both measurement functions. In Dual Display Mode the submenus, control, and parameter entry are unchanged from the full screen versions of each instrument.

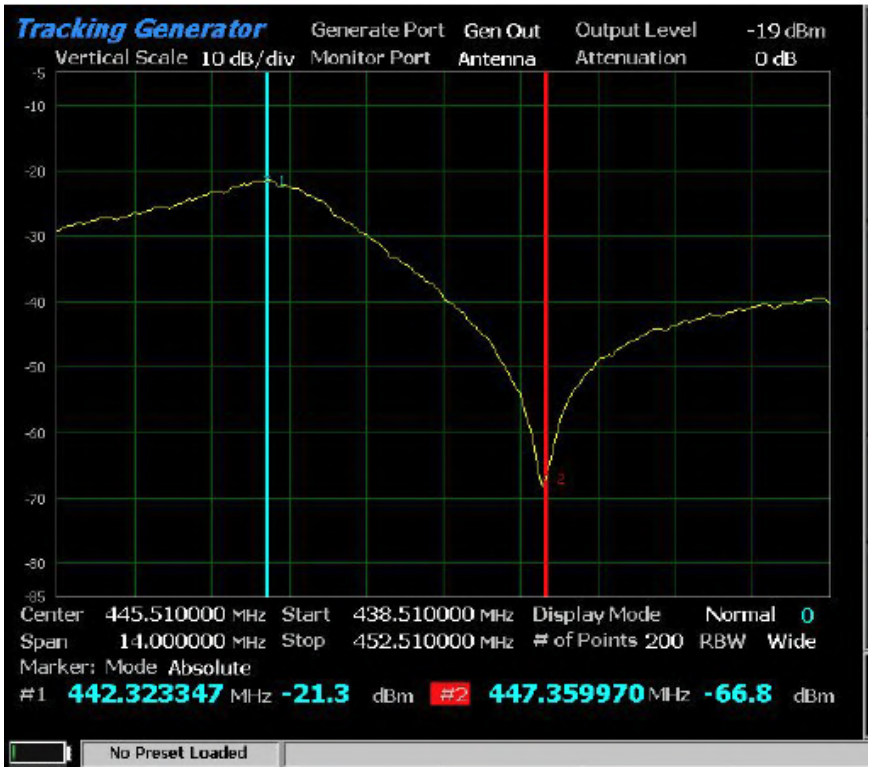
For the upper portion of the Dual Display, the Spectrum Analyzer, the instrument type is shown at the top left of the screen along with the vertical scale-per-division and display mode. Vertical scale and reference level are shown on the Y-axis. Frequency, Resolution Bandwidth, Display Mode, Marker, and Trace Math parameters are shown to the left of the Y-axis. The yellow measurement trace as well as the blue reference trace are displayed on the graticule.

For the lower portion of the Dual Display, the Modulation Scope, the instrument type is shown at the top left of the screen along with Vertical and Horizontal Scale as well as Scope Mode. Marker Mode and Trigger parameters are shown to the left of the Y-axis. The yellow measurement trace is displayed on the graticule.

For Dual Display soft key definitions, ranges, discrete and default values, and detailed notes, see **"Dual Display Soft Keys" on page 521**.

Introducing the Tracking Generator

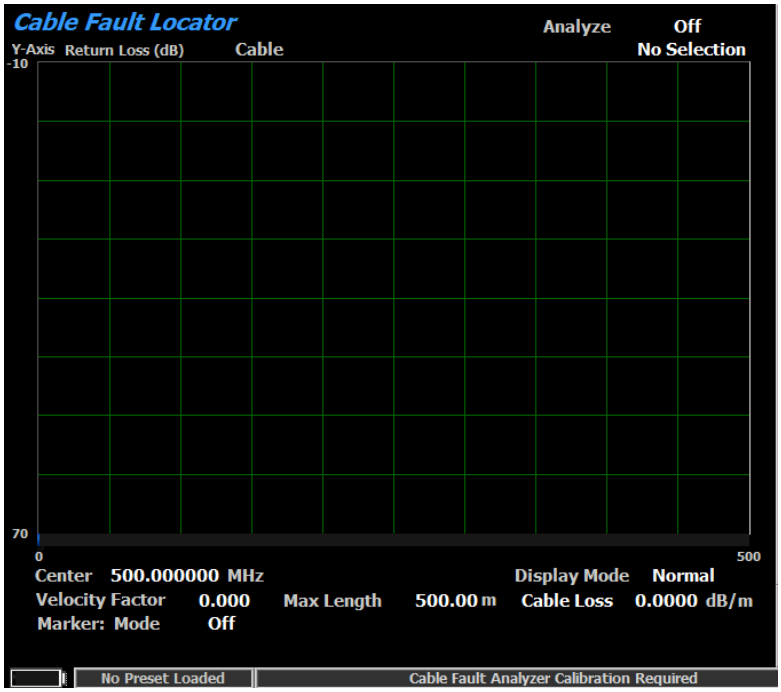
The R8200 Instrument Mode is equipped with an optional stand-alone full-screen Tracking Generator, as shown below.



The optional Tracking Generator function sets up the R8200 RF generator in a sweeping mode for simultaneous use with the Spectrum Analyzer display. This delivers a valuable capability for measuring and servicing a wide variety of RF filtering and combining networks. The instrument type is shown at the top left of the screen along with the Vertical Scale, Generate Port, Output Level, Monitor Port, and Attenuation. Vertical scale and reference level are shown on the Y-axis. Frequency, Resolution Bandwidth, Display Mode, Marker, and Trace Math parameters are shown to the left of the Y-axis. The yellow measurement trace is displayed on the graticule.

For Tracking Generator soft key definitions, ranges, discrete and default values, and detailed notes, see **"Tracking Generator Soft Keys" on page 534**.

Introducing the Cable Fault Locator



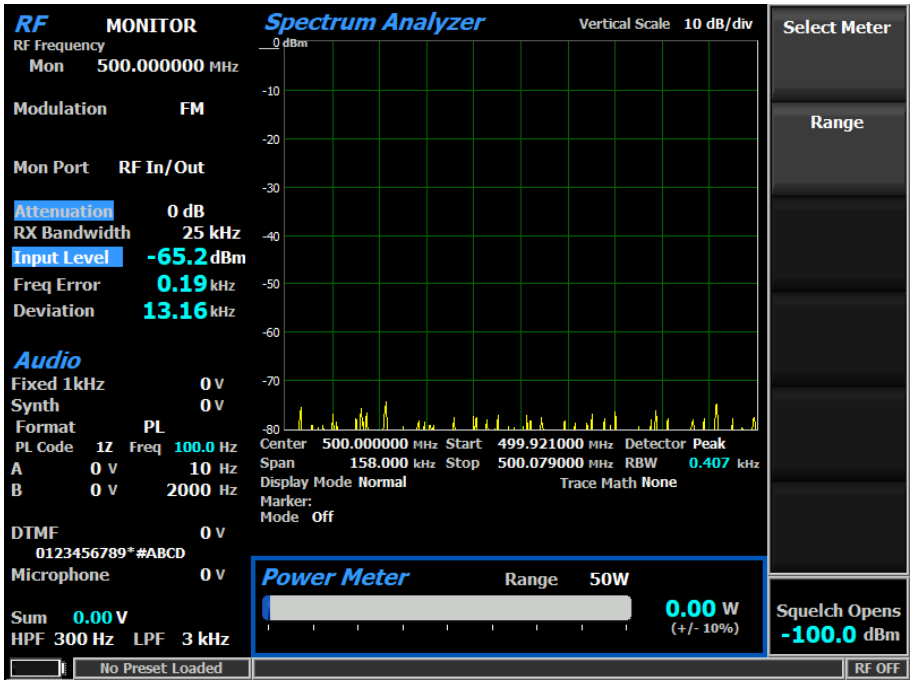
The optional Cable Fault Locator uses the R8200 Tracking Generator along with FFT analysis to determine distance to a fault or termination mismatch in RF cables. Pressing the Cable Fault Locator soft key provides the full screen display. The Cable Fault Locator is used with an optional directional coupler or splitter. The Cable Fault Locator has settings for entering cable parameters and display specifics. Several standard cable selections provide predetermined settings. You can also enter specific data for a cable under test and save these settings for future use. The instrument

type is shown at the top left of the screen along with the Vertical Scale, Return Loss, Cable Type, and Analysis Mode. Vertical scale and reference level are shown on the Y-axis. Center Frequency, Display Mode, Maximum Length, Cable Loss, and Marker parameters are shown below the graticule. The yellow measurement trace is displayed on the graticule.

For Cable Fault Locator soft key definitions, ranges, discrete and default values, and detailed notes, see **"Cable Fault Locator Soft Keys" on page 569**.

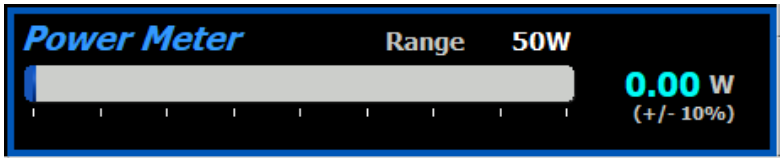
Introducing the Meters

The Instrument Mode is also equipped with access to all of the metering capabilities offered by the R8200. These are the same devices available by pressing either **METER Zone** or **Hot Key 5**.



From the Instrument Mode main menu, access the metering devices by pressing **More** > **Other Meters**. This opens a horizontal soft key menu where you can select a Power Meter, Voltmeter, SINAD/Distortion, Decoder, Frequency Counter, RF Scan, and SNR meter to provide detailed analysis of the RF carrier as well as the recovered baseband content.

Power Meter

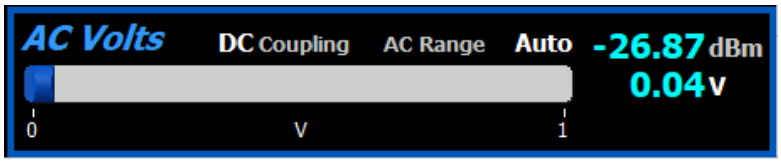


Provides a bar graph display and numeric readout in Watts of the broadband input power applied to the RF In/Out port. For a detailed reference of its parameter settings, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

NOTE

For increased Power Meter accuracy, disable the Pre-amplifier in Monitor Mode (press **Settings** > **System Settings** > **More** × 2 > **Pre-Amplifier Auto Off** > **Enable**). In Generate Mode, set the Gen Port to RF In/Out (press **Generate** > **Gen Port** > **RF In/Out**).

Voltmeter

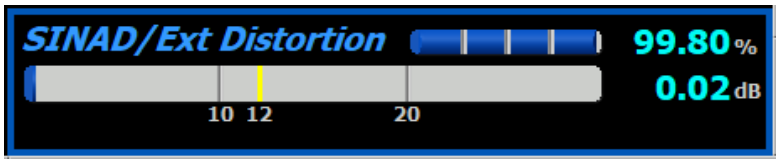


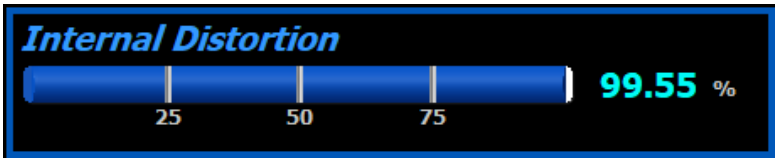
Measures the amplitude of AC and DC voltages at the Meter In port with adjustable range and dBr (normalized measurement between reference voltage and current input voltage; AC only). For a detailed reference of its parameter settings, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

NOTE

The range on AC and DC must be set to 1 or 10 Volts to use 600 Ohm Input Impedance.

SINAD/Distortion Meter





Provides Signal in Noise and Distortion (SINAD)/external distortion and internal distortion audio measurements. For a detailed reference of its parameter settings, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

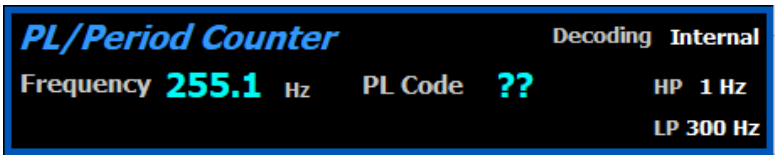
In Monitor Mode, Internal Distortion measures the distortion in percent of the internally-recovered audio from a transmitter modulated with a 1 kHz sine wave.

In Generate and Duplex Modes, SINAD/Ext Distortion provides a SINAD and External Distortion measurement of the recovered audio signal applied to the Meter In port from an external radio. The test is performed using a 1 kHz modulated RF carrier applied to the radio's antenna port by the R8200. The RF level is adjusted in the RF Zone while monitoring the SINAD meter to determine the receiver sensitivity per EIA (12 dB yellow tick mark) and other standards.

Decoder

Provides a horizontal soft key menu enabling a suite of tone decoding functions, including PL/Period Counter, DPL Decode, DTMF Decode, 2-Tone Decode, 5/6 Decode, and General Sequence. For a detailed reference of its parameter settings, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

PL/Period Counter



Displays the frequency and numeric code of the recovered audio from a radio modulated with the Motorola Private-Line (PL) format. The period counter allows rapid high resolution measurements of non-PL low frequency modulation without the long gate times associated with frequency counting. Horizontal soft key menus provide adjustment of the Low and High Pass filters to reduce noise for more accurate measurements. Recommended filter settings for PL: HP= 1 Hz; LP = 300 Hz. For a detailed reference of its parameter settings, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

DPL Decode

Displays a numeric code from the recovered audio modulated with the Motorola Digital Private-Line (DPL) format. Horizontal soft key menus provide adjustment of the Low and High Pass filters to reduce noise for more accurate measurements. Recommended filter settings for DPL: HP= 1 Hz; LP = 3 kHz.

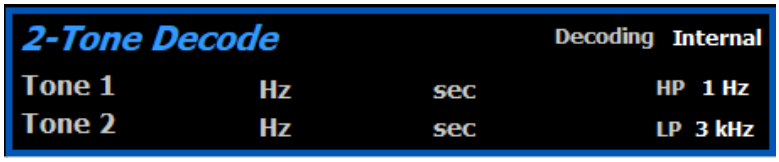
DTMF Decode

Decodes DTMF (Dual Tone Multi-Frequency) signals used in testing telephone interfaced systems. Horizontal soft key menus adjustment of the Low and High Pass filters to reduce noise for more accurate measurements. Recommended filter settings for DTMF: HP= 1 Hz; LP = 3 kHz.

NOTE

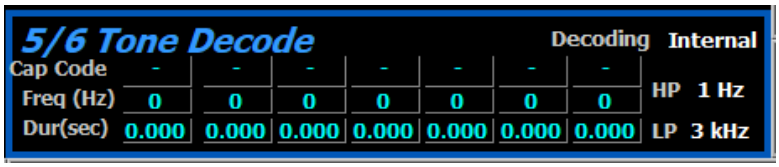
The R8200 displays the history of previously decoded DTMF codes, with the right-most code digit being replaced by the most recently decoded tone. The DTMF Code field appears static when the transmitted code is not changing or nothing is being decoded. Press **Reset** to clear the history.

2-Tone Decode



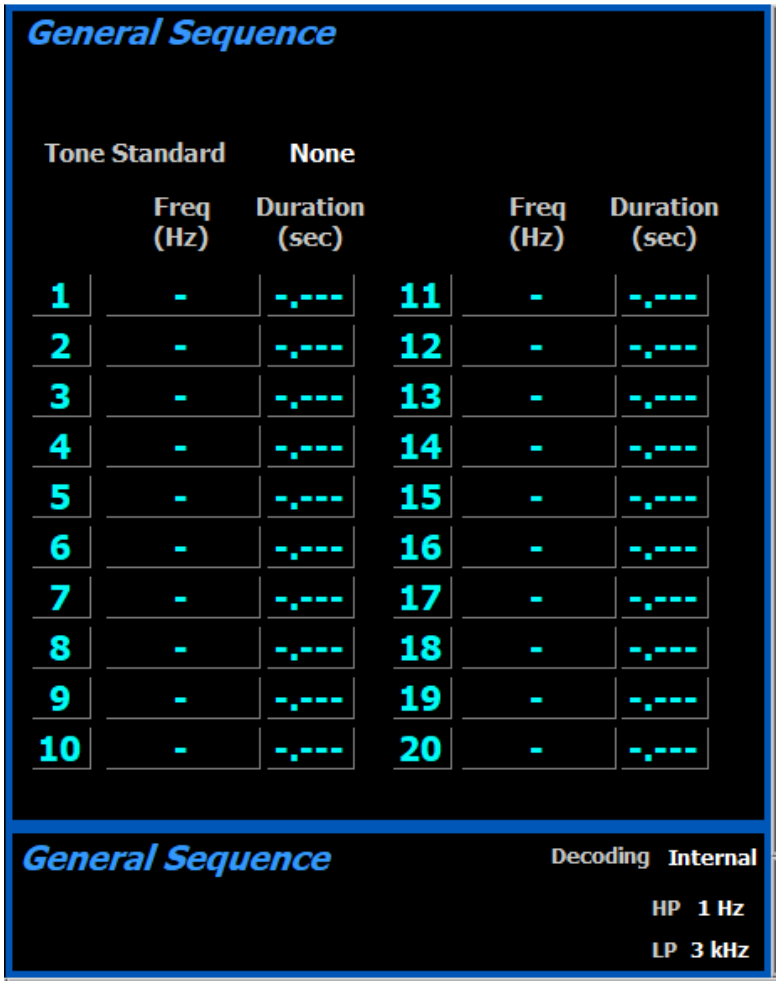
Decodes the two-tone sequential paging format. The meter displays the Tone A/Tone B (Tone 1 and Tone 2) frequencies and durations. Horizontal soft key menus provide adjustment of the Low and High Pass filters to reduce noise for more accurate measurements. Press **Decode** to start or stop decoding. Recommended filter settings for 2-Tone Decode: HP= 1 Hz; LP = 3 kHz.

5/6 Tone Decode



Decodes the 5/6 tone sequential paging format. The meter displays a table with the decoded cap code along with the individual tone frequencies and durations. A horizontal soft key menu enables selection of the meter sensitivity from MIN to MAX via the tuning knob, arrow keys, or repeated presses of **Sensitivity**. A horizontal soft key menu enables adjustment of the Low and High Pass filters to reduce noise for more accurate measurements. Recommended filter settings for 5/6 Tone: HP= 1 Hz; LP = 3 kHz.

General Sequence



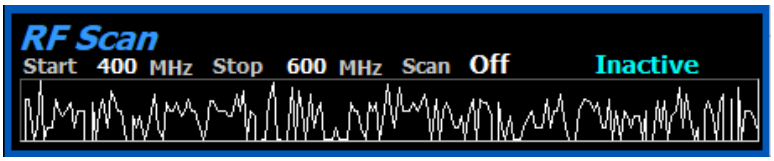
Decodes the individual frequency and time duration for up to 20 tones in a tone sequence. This table occupies the entire DISPLAY Zone and provides a detailed representation of the frequency and duration of the SelCall codes, as shown above. A horizontal soft key menu enables adjustment of the Low and High Pass filters to reduce noise for more accurate measurements, an Input Decoding selection key to select internal or external decoding, a Decode key with start and stop settings to control the decode function, and a selection window to choose the SelCall standard (or none) used for decoding. When a standard is selected, the decoded tones are mapped to the selected standard, and the Tone Code is listed with each tone in the table. When no standard is selected, the decoded tones are listed in numerical order. The recommended filter settings on the R8200 are: HP= 1 Hz; LP = 3 kHz.

NOTE For correct operation, input tones should have a duration of 0.5 seconds or less.

Frequency Counter

In Monitor Mode, a general-purpose frequency counter with adjustable resolution for the recovered baseband audio or IF frequency displayed in the Modulation Scope. In Generate 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.

RF Scan



Searches for the strongest RF signal above the Squelch threshold setting on the active RF input port. The R8200 locks onto and automatically centers its operating frequency on this carrier. The search frequency range in MHz is entered using Start Frequency and Stop Frequency soft keys. Scanning begins when you press **Scan** > **Start**. Scanning is terminated by pressing **Scan** > **Off**. The meter graph displays an automatically-scaled spectrum of the entire scan range. Once a signal is acquired, the RF Scan meter stays locked on that frequency even if the carrier disappears. It resumes scanning once the **Scan** > **Single** or **Auto** are pressed. The RF Scan meter operates only when it is highlighted; otherwise, it becomes inactive.

SNR

Measures signal-to-noise ratio at the selected Monitor port.

For METER Zone soft key definitions, ranges, discrete and default values, and detailed notes, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

Using the Single-Port VNA

This section describes the Single-Port Vector Network Analyzer featured in the R8200 Communications System Analyzer and explains how to use it to perform common verification and measurement tasks for LMR portables, mobiles, and infrastructure systems.

"Introducing the Single-Port Vector Network Analyzer" on the next page describes the instrument's display and covers important aspects of its use, including its calibration kit and common cables libraries.

"Calibrating the VNA" on page 111 explains how to maintain critical measurement accuracy by keeping the instrument calibrated.

"Measuring Return Loss and VSWR" on page 124 offers step-by-step instructions for measuring Return Loss or Voltage Standing Wave Ratio, an important part of maintaining high performance signal transmission lines.

"Measuring Distance To Fault" on page 135 offers step-by-step instructions for using the Distance To Fault display to quickly characterize and locate damaged cables and transmission lines.

"Measuring Normalized Impedance" on page 131 contains step-by-step instructions for using the Smith Chart display to quickly characterize a bandpass filter.

"Using the Calibration Kit Library" on page 119 explains how to use stock calibration kits as well as custom calibration kits.

"Using the Cable List" on page 139 offers step-by-step instructions for using the Cable List to increase your measurement accuracy.

Introducing the Single-Port Vector Network Analyzer

The R8200 offers a Single-Port VNA designed to analyze forward reflected power for RF sub-assemblies, circuits, and components from 1 MHz to 6 GHz. The Single-Port VNA display includes a magnitude plot and a Smith chart. It features up to seven absolute and/or delta markers simultaneously viewable within the magnitude plot, as well as a peak search threshold setting to clarify signals of interest prior to marker assignment. Sweep sampling is configurable up to 10001 measurement points with trace smoothing, averaging, scaling and adjustable IF bandwidths, start/stop or center/span frequency entry, as well as libraries containing preset characterization data for many industry standard cal kits and common cable assemblies. Error correction improves high frequency measurement accuracy. The R8200 has two error correction modes: the default mode using a calibration data set generated by a factory calibration, and a user-defined mode which generates a custom calibration data set based on the measurement at hand using the supplied Open/Short/Load (OSL) calibration kit. For details, see **"Error Correction" on the next page**.

Use the VNA to make near-instantaneous measurements of Return Loss (RL) and Voltage Standing Wave Ratio (VSWR) for cables and antennae. Use Distance To Fault (DTF) to pinpoint impedance problems by first entering the length of the cable under test and cable type (i.e., velocity factor and frequency response), then calibrating the measurement plane before connecting the cable to it and inspecting different sections of the cable for RL anomalies. The DTF function employs a time domain transformation of a Frequency Domain Reflectometer (FDR) to display RL between any two points (the start distance and the stop distance) on a transmission line. The DTF display can clearly represent impedance discontinuities at discrete points along the signal path, enabling quick recognition and accurate pinpointing of compromised locations along transmission lines. The DTF display can also locate incoherence generated by other component irregularities in the signal path to significantly reduce troubleshooting and repair time. Use the Smith chart to measure normalized impedance to investigate the nature of reflection coefficients between different components of your LMR portable, mobile, or infrastructure system.

For detailed information on each adjustable measurement parameter including default value, range, and saved state, see **"Single-Port VNA Soft Keys" on page 544**.

Display

The VNA features a RL/VSWR display (a magnitude plot) and a DTF display (RL versus distance) both with up to 6 trace markers configurable as Absolute or Delta representations of signal frequency and power, as well as a Smith Chart, an editable Cable List, and Calibration Kit Library. Measurements and measurement parameters are accessed and adjusted via soft key selections or dialog and data field entries.

Depending on the current measurement display, important measurement parameters are displayed above the status bar below the graticule. Frequency span information and other parameters associated with a particular measurement are displayed closest to the graticule, while other common parameters are displayed below. These include Error Correction status, Number of Points sampled, IFBW, Output Level, Trigger Mode, Averaging, Averaging Factor, Smoothing, and Smoothing Aperture.

Error Correction

The VNA has two error correction modes: factory calibration based mode and a measurement calibration based mode. Factory error correction is the default mode. One of the two modes is always enabled.

Default Calibration Error Correction – the calibration data set was generated by a default calibration at the factory using 10001 samples (the maximum number or points) at 10 kHz IF bandwidth from 1 MHz to 6 GHz (the full frequency range of the VNA).

User Calibration Error Correction – the calibration data set was generated by the most recent measurement calibration using the number of points and frequency range defined by the user.

NOTE

The Default factory calibration is performed at the Type N(f) connector of the TNC(m) to Type N(f) adapter attached to the VNA port. This makes the plane of reference for the Default error correction the Type N(f) connector of the TNC(m) to Type-N(f) adapter attached to the VNA port. Connect your DUT directly to the TNC(m) to Type N(f) adapter when using Default Error Correction. If a supplementary transmission line is necessary to connect the DUT to the VNA port, perform a user-defined calibration prior to device measurement.

The Correction field located in the lower left-hand corner of every VNA display reports the current source and status of error correction in regard to the validity of the measurement trace. See the following table.

Correction Field	Error Correction State
Def	Default Error Correction, based on the calibration data set generated by the factory default calibration over 10001 points, at 10 kHz IFBW, from 1 MHz to 6 GHz.
User	User-Defined Error Correction, based on the calibration data set generated by the most recent measurement calibration configured and performed by the user.
Ext (Extrapolated)	User-Defined Error Correction is currently *extrapolated* because one or more of the display settings (typically a frequency or distance setting) exceeds the integer boundaries of the user-defined measurement calibration data set.
Int (Interpolated)	User-Defined Error Correction is currently *interpolated* because two or more of the display settings (typically a frequency or distance setting) falls between two consecutive data points sampled during user-defined measurement calibration as circumscribed by the value set for the Number of Points parameter.

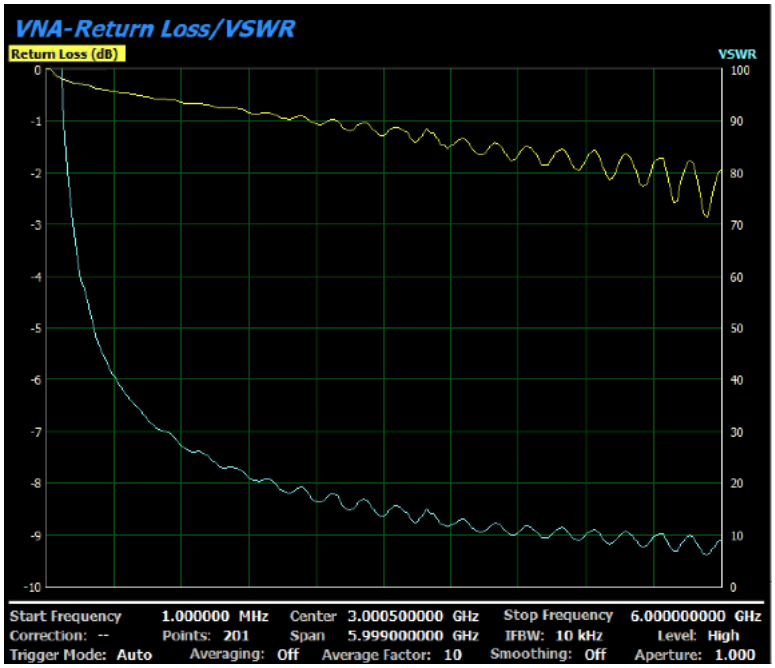
For example, if you configure a return loss measurement with a start frequency at 1 GHz, stop frequency at 2 GHz, and the number of points sampled was 1001, and then perform a calibration, your calibration would store the frequency response for 1.00 GHz, 1.01 GHz, 1.02 GHz, 1.03 GHz ... continuing in 10 MHz steps up to 2.00 GHz correcting for measurement error at every point in the data set.

Once your device is connected with the Trigger Mode set to Auto, the return loss is displayed as a yellow trace on the magnitude plot while the Correction field below the graticule would display User. If the stop frequency is increased to 3 GHz, the Correction field would display Ext. This indicates that the portion of the current display between 2 GHz and 3 GHz is being extrapolated or predicted from the lower frequency values contained in the calibration data set, and therefore it may not be a valid representation of the device's actual return loss between 2 GHz and 3 GHz.

If the start frequency is changed to 1.001 GHz and the stop frequency is changed to 1.009 GHz, the Correction field would display Int. This indicates that the portion of the current display between 1.001 GHz and 1.009 GHz is being interpolated or predicted from the lower (1 GHz) and upper (1.01 GHz) point (representing RL values) contained in the calibration data set, and therefore it may not be a valid representation of the device's actual return loss between 1.001 GHz and 1.009 GHz.

Return Loss/VSWR

The magnitude plot is designed to characterize the RL/VSWR of your device under test (DUT). To measure RL/VSWR, enter the desired frequency range and number of points for the measurement sample, then calibrate the measurement plane before connecting your DUT to display the measurement. The RL/VSWR display is shown below.



The vertical scale displays RL in dB. The horizontal scale of the magnitude plot always displays the frequency span of the current measurement with start frequency on the left, center frequency (above) and span (below) in the middle, and stop frequency on the right. Graph dimensions are updated by changes to the start frequency, stop frequency, center frequency, or span on the horizontal scale or changes to the reference power level or scaling on the vertical scale.

The yellow Return Loss (dB) label is displayed above the left vertical graticule. It represents the current reference level scale in deciBels. Measured RL is displayed as a yellow trace indicating the frequency response of the DUT to a theoretically flat (i.e., constant power) stimulus swept between the start and stop frequencies.

The cyan VSWR label is shown above the right graticule. It displays the ratio of maximum to minimum voltage for the standing wave. The standing wave is created by the additive and subtractive aspects of the incident and reflected potentials on the transmission line. The VSWR scale displays ratios from 0:1 to 100:1 on the vertical scale across the current frequency span displayed on the horizontal scale.

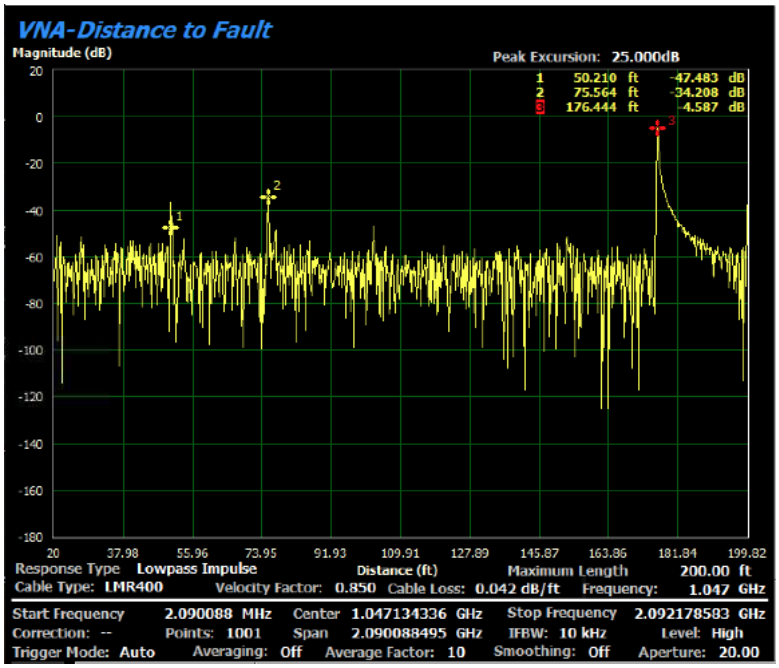
Important RL/VSWR measurement parameters are displayed above the status bar below the graticule. In addition to frequency span information, these include Error Correction status, Number of Points sampled, IFBW, Output Level, Trigger Mode, Averaging, Averaging Factor, Smoothing, and Smoothing Aperture.

Up to seven markers can be employed to simultaneously monitor the frequency and amplitude at an array of points along the DUT.

See **"Measuring Return Loss and VSWR" on page 124** for step-by-step measurement instructions.

Distance To Fault

The return-loss-versus-distance plot comprising the Distance To Fault display is shown below.

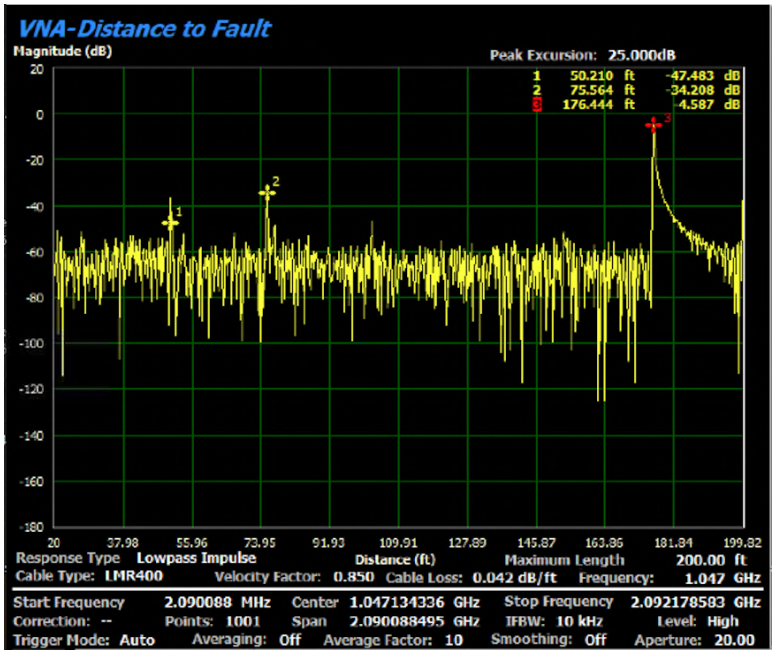


The vertical scale measures the RL of the DUT in dB. The DTF display's horizontal scale measures distance in feet or meters. It is defined by the start and stop distance. These values display the RL for a particular section of cable as defined by these two parameters. The start distance displays the RL for the DUT at a point measured in feet (or meters) from the plane of reference (typically the input connector on the transmission line). The stop distance displays the return loss for the DUT at a second point measured in feet or meters from the plane of reference. The horizontal scale of the Distance To Fault display typically depicts the incremental points between the start distance on the left and the stop distance on the right, showing the return loss for a subsection of the transmission line.

The *measurement* plane (i.e., the plane of reference for both the calibration and the device measurement) on the other hand is defined by the velocity factor and frequency response of the transmission line and Maximum Length value (i.e., the transmission line's total length). The transmission line's length, velocity factor, and frequency response determine the optimal frequency sweep. This optimized sweep is employed for both the calibration and the subsequent device measurement. After calibration, error correction is enabled to increase measurement accuracy across the length of the cable defined by the Maximum Length parameter during the critical DUT measurements.

In essence, the start and stop distances (along with vertical scaling via the Scale and Ref Value soft keys) enable zooming in and out on different sections of the cable for increased measurement resolution. Zooming is helpful when investigating suspect areas of relatively small but sudden changes in return loss associated with impedance discontinuities that imply faults or other damage to the DUT.

Up to seven markers can be employed to simultaneously monitor the distance from the reference plane peak and magnitude of return loss at an array of points along the DUT.

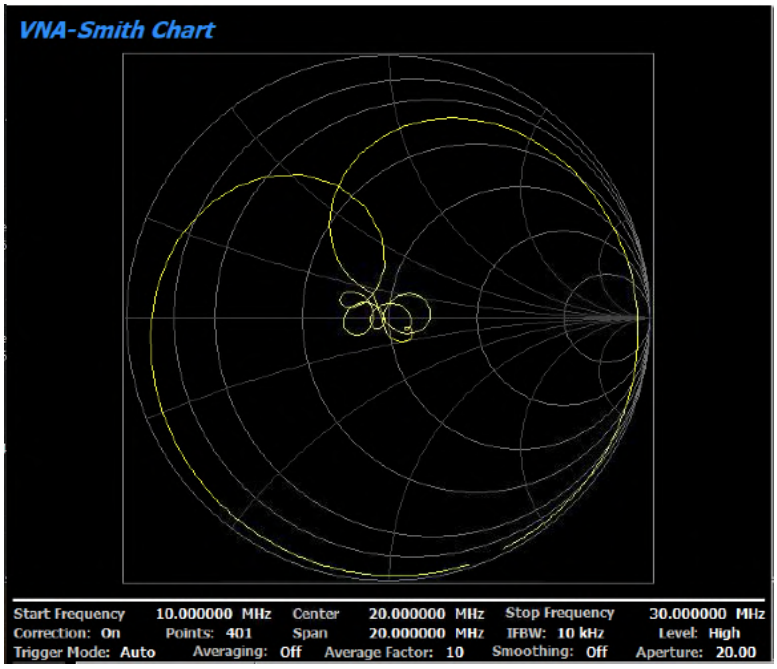


Important DTF measurement parameters are displayed above the status bar below the graticule. These include Response Type, Maximum Length, Cable Type, Velocity Factor, Cable Loss, Cable Loss Frequency, Frequency Values, Error Correction status, Number of Points sampled, IFBW, Output Level, Trigger Mode, Averaging, Averaging Factor, Smoothing, and Smoothing Aperture.

See **"Measuring Distance To Fault" on page 135** for step-by-step measurement instructions.

Normalized Impedance

The Smith Chart display is designed to characterize the Normalized Impedance (NI) of your device under test (DUT). The NI of a 20 MHz bandpass filter sampled across 401 frequencies from 10 MHz to 30 MHz using an IFBW of 10 kHz is shown below.



The Smith Chart displays a polar plot of the complex reflection coefficient of your device. Use the Smith Chart to determine how capacitive or inductive your device is over its designated frequency range. Enter the frequency range and power level for your device, calibrate the measurement plane, then connect the DUT. The VNA performs an S-11 measurement and presents the results in the Smith Chart display.

Important impedance measurement parameters are displayed above the status bar below the graticule. These include Start Frequency, Center Frequency (above) and Span (below), Stop Frequency, Error Correction source and status, Number of Points sampled, IFBW, Output Level, Trigger Mode, Averaging, Averaging Factor, Smoothing, and Smoothing Aperture.

See **"Measuring Normalized Impedance" on page 131** for step-by-step measurement instructions.

Calibrating the VNA

Measurement calibration characterizes the cables, adapters, and test fixtures over the same specified range of frequencies at the specified power level of the subsequent device measurement. The point in the signal path where the Device Under Test (DUT) receives the measurement stimulus from the VNA is known as the *reference plane* or the *plane of reference*. Optimally, this would be the VNA port on the front panel of the R8200. But in typical applications, other structures such as adapters, transmission lines, or test fixtures are necessary to connect the VNA to the DUT. In this case, the plane of measurement is no longer located at the VNA port, but at the point in the signal path where the DUT connects to the measurement stimulus (i.e., the adapter, transmission line, or test fixture).

Measurement calibration is achieved using a calibration kit or *cal kit* containing standardized devices (a Standard Open, Standard Short, and a Standard Load). A theoretically *flat* or constant-power RF source is swept across the frequency span planned for the subsequent (post-calibration) device measurement. These device standards qualify the plane of measurement over this range of frequencies in order to characterize the impedance discontinuities introduced by any cables, adapters, or test fixtures propagating the signal to the DUT. This data (reflection coefficients or fluctuations in reflected energy across the frequency span) is stored as a *calibration data set*. This data set drives an algorithm which mathematically compensates for the aforementioned impedance discontinuities during the subsequent device measurement, thereby increasing measurement accuracy.

NOTE

Error correction is based on the transmitted power as well as the specific number of points sampled during the frequency sweep (i.e., the frequency span of the measurement), as these data points form the equivalent reflection coefficients stored in the calibration data set. Therefore, *you must configure the number of points, power level, and frequency span for your device measurement prior to performing the calibration procedure*. Furthermore, this calibration procedure should be performed prior to all critical device measurements in order to maintain the highest measurement accuracy.

To maintain the utmost measurement accuracy, calibrate your plane of measurement before attempting any device measurement using the VNA. If this is impractical, you should consider calibrating the measurement whenever a new DUT is introduced or whenever there are *changes* in:

- the frequency span, power level, or number of points in a measurement sweep
- signal path components (i.e., transmission lines, adapters, or test fixtures)
- environmental temperature or humidity

The Device Under Test (DUT)

Like all calibrations, this example calibration procedure is performed to ensure the accuracy of a subsequent device measurement. In the following Return Loss/VSWR and Distance To Fault example measurement procedures, the DUT is an *ad hoc* composite transmission line tasked with maintaining the operation of a trunked radio system base station until the damaged original 175 ft transmission line can be replaced. This ad hoc transmission line is comprised of three sections of LMR400 cable varying in length, measuring 25, 50, and 100 feet. They are connected using Type N female-to-female adapters to form a single 175-foot replacement transmission line. This transmission line connects the output of a LMR receiving antenna to the input of a multicoupler and is expected to perform over a frequency range of 1 to 2 GHz.

All example procedures in this chapter use this transmission line as the DUT. Therefore, this example calibration procedure as well as the measurement examples are tailored to it.

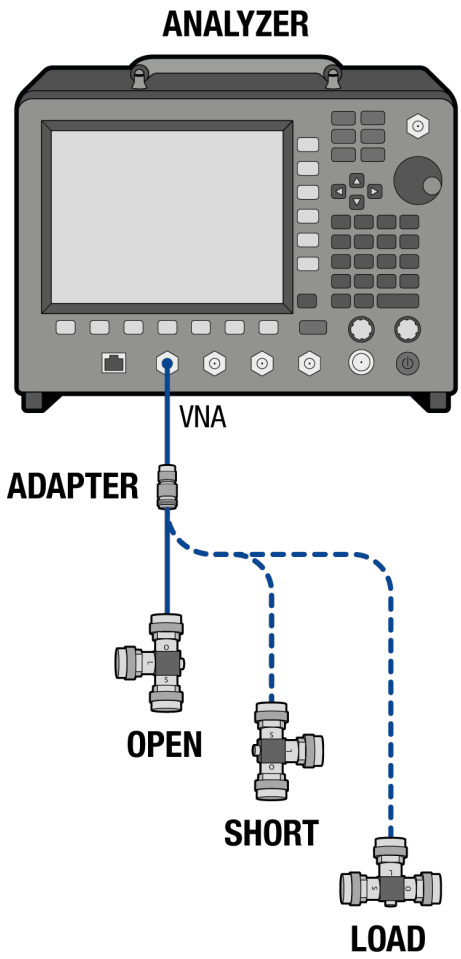
NOTE A calibration procedure should always be carried out using the same number of points, power level and frequency span as the subsequent critical device measurement it is intended to calibrate.

This section offers step-by-step instructions for calibrating your plane of measurement including required equipment, test setup, and procedure.

Required Equipment

- Freedom R8200 Communications System Analyzer
- Adapter, TNC(m) to Type N(f)
- Calibration Kit, 6550Y06-M

Test Setup

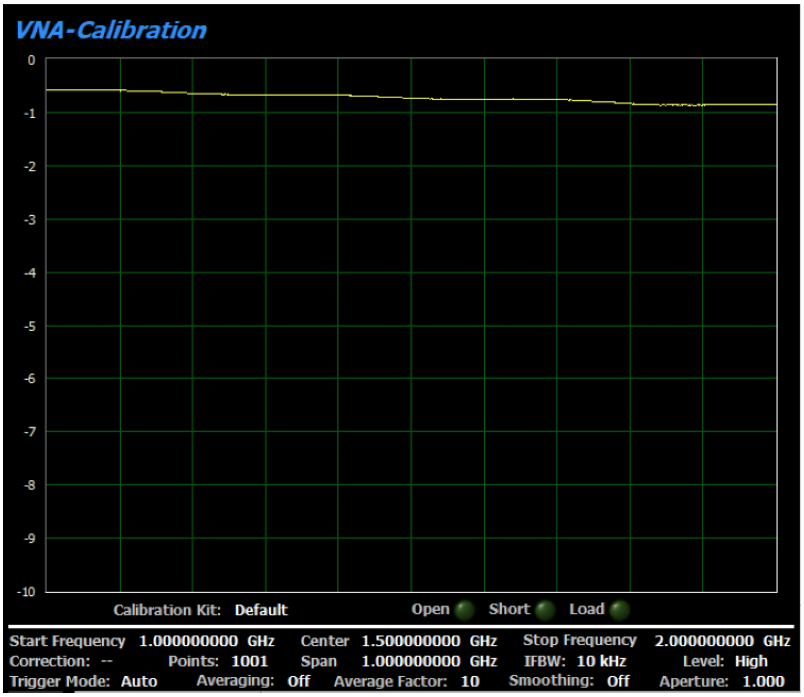


Procedure

Using the 6550Y06-M calibration kit, follow these steps to perform a 1-port OSL (Open, Short, Load) measurement calibration in preparation for a subsequent 1001-point device characterization from 1 GHz to 2 GHz.

Steps	Actions	Notes
1. Configure your sample points and	**a.** Press **Select Display** > **Return Loss/VSWR.**	This example uses a 1001 point

Steps	Actions	Notes
frequency span for your subsequent device measurement (for example **"Measuring Return Loss and VSWR" on page 124**).	**b.** To set start frequency, press **Start Frequency** > **1** > **GHz**. **c.** To set stop frequency, press **Stop Frequency** > **2** > **GHz**. **d.** To set number of points in the measurement sweep, press **# of Points** > **1001** > **Enter**.	sample between 1 GHz and 2 GHz for a subsequent Return Loss measurement to create the calibration data set for error correction.
2. Select the Calibration display.	**a.** Press **More** until you return to the main VNA menu. **b.** Press **Select Display** > **Calibration**.	This opens the Calibration display, which will remain open until either **Save** or **Cancel** is pressed.
3. Select the calibration kit.	**a.** Press **Calibration Kit**. **b.** Use the arrow keys or the tuning knob to highlight the **6550Y06-M** cal kit. **c.** Press **Select**.	This opens the Calibration Kit library. It will remain open until a cal kit is selected by pressing **Select**, or until **Return** is pressed.

Steps	Actions	Notes
		The active Calibration Kit is shown below the graticule.

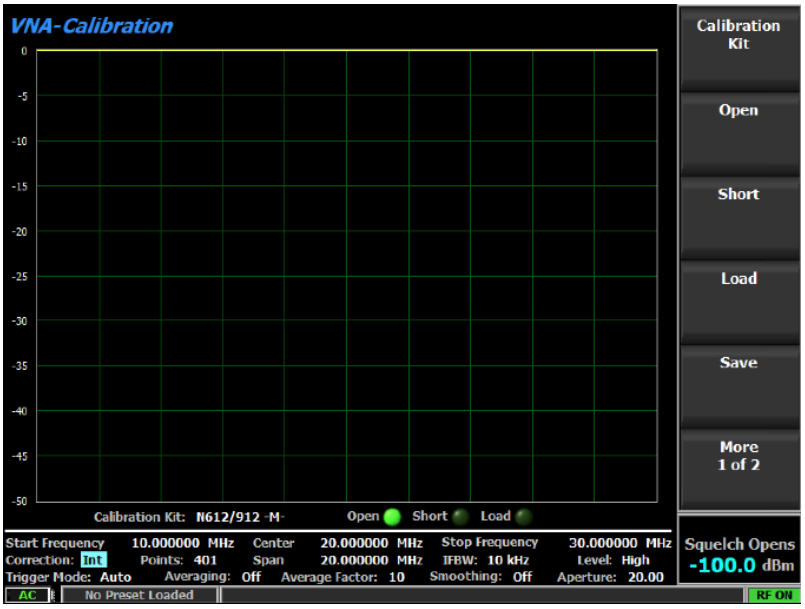
NOTE

The next step assumes your device under test cannot be connected directly to the adapter on the VNA port due to the physical limitations of the device or the measurement environment. In this example, a short transmission line is attached to the VNA port.

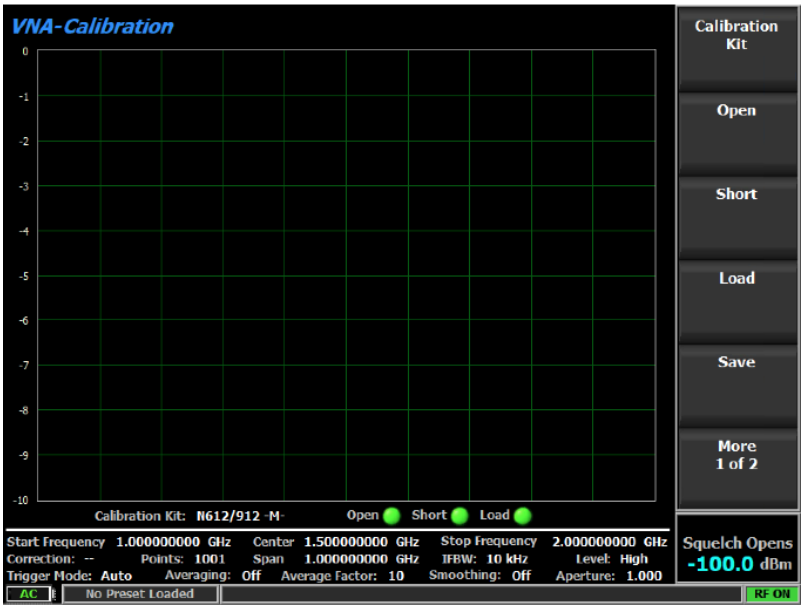
Adding this transmission line results in an assembly (VNA port + adapter + transmission line). This assembly must be characterized to ensure that the calibration standard, and later the device input, is the reference plane when subsequently applying user-defined error correction generated by this calibration procedure.

4. Firmly connect the adapter to the VNA port.	**a.** Thread the adapter onto the VNA port.	
	b. Optionally, torque to 3 ft·lbf[1] with	Torquing ensures consistent con-

[1]foot-pound force as defined by IEEE Std 260.1™-2004, IEEE Standard Letter Symbols for Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units)

Steps	Actions	Notes
	wrench.	nections.
5. Firmly connect the adapter to the Standard Open and characterize the reference plane at the adapter (the subsequent point of connection of the DUT).	**a.** Remove the calibration kit from its container. **b.** Attach the Standard Open to the adapter on the VNA port. **c.** Torque to 3 ft·lbf with wrench. **d.** To characterize the Standard Open, press **Open**. **e.** When the green *Open* indicator below the graticule illuminates, remove the Standard Open from the adapter.	
		This enters one half of the data necessary to calculate phase error associated with transmission line into the calibration data set.
6. Firmly connect the Standard Short to the adapter and characterize the assembly.	**a.** Rotate the calibration kit and attach the Standard Short to the adapter on the VNA port. **b.** Torque to 3 ft·lbf with wrench.	

Steps	Actions	Notes
	c. To characterize the Standard Short, press **Short**. **d.** When the green *Short* indicator below the graticule illuminates, remove the Standard Short from the adapter.	
		This enters the other half of the data necessary to calculate phase error associated with your transmission line into the calibration data set.
7. Firmly connect the Standard Load to the adapter and characterize the assembly.	**a.** Rotate the calibration kit and attach the Standard Load to the adapter on the VNA port. **b.** Torque to 3 ft·lbf with wrench. **c.** To characterize the Standard Load, press **Load**. **d.** When the green *Load* indicator below the graticule illuminates, remove the Standard Load from the adapter.	

Steps	Actions	Notes
		This enters the impedance errors associated with your adapter into the calibration data set.
8. Apply the error correction generated by this calibration procedure to your subsequent measurement.	**a.** To apply error correction, press **Save.**	This activates error correction and closes the Calibration display and completes the calibration procedure. You are now prepared to make a calibrated device measurement. For an example measurement procedure, see **"Measuring Return Loss and VSWR" on page 124**.

Guidelines for Recalibrating

Repeat this calibration procedure if there are *changes* in:

- The number of points in a measurement
- The frequency span or power level of a measurement
- Environmental temperature or humidity
- Any signal path component between the VNA port and the DUT

See **"Calibration Soft Keys" on page 566** for detailed descriptions of the soft keys in this menu. Each soft key is defined, along with its range, discrete, default, and saved state values.

See **"Measuring Distance To Fault" on page 135** for an alternative subsequent measurement procedure.

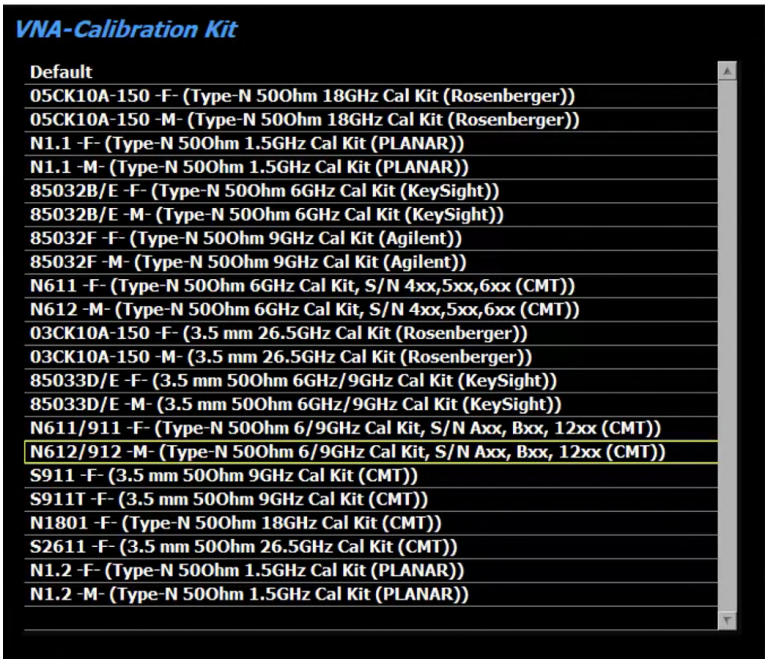
Using the Calibration Kit Library

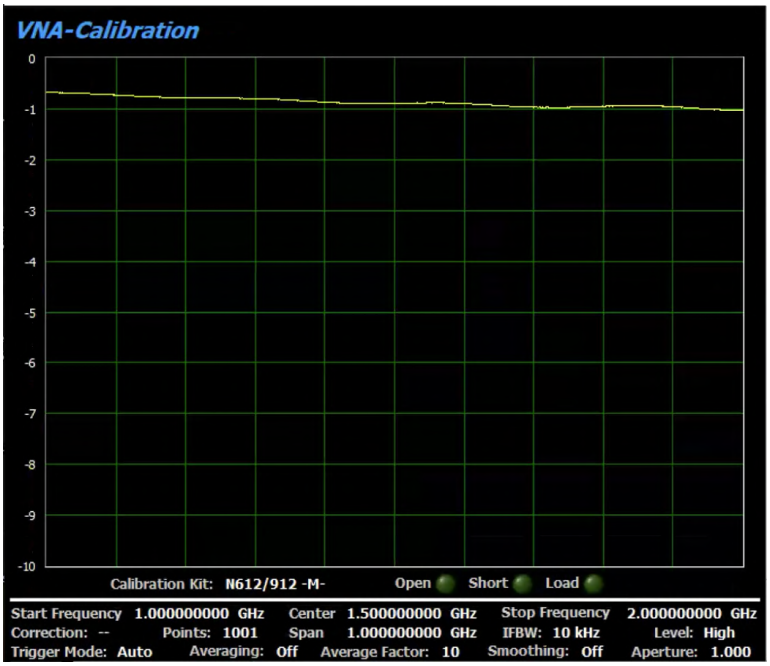
Though the R8200 is equipped with an N612/912-M calibration kit from the factory, you may use alternative calibration kits. To use an alternative calibration kit, review the Calibration Kit Library and select your preferred calibration kit. If your preferred kit is unlisted, you can add it to the Calibration Kit Library by entering the required device characteristics into the Calibration Kit Library Editor.

Selecting a Predefined Cal Kit from the Library

To select a common calibration kit from predefined models listed in the Calibration Kit Library, follow these steps.

Steps	Actions	Notes
1. Select the Calibration display to enter the Calibration Kit Library.	**a.** From the main VNA menu, press **Select Display > Calibration**. **b.** Press **Calibration Kit**.	This opens the Calibration display, which will remain open until either **Save** or **Cancel** is pressed.
2. Highlight the stock calibration kit.	**a.** Use the tuning knob or the arrow keys to highlight the **6550Y06-M** calibration kit. **b.** Press **Select**.	This selects the **6550Y06-M** calibration kit and returns to the Calibration display.

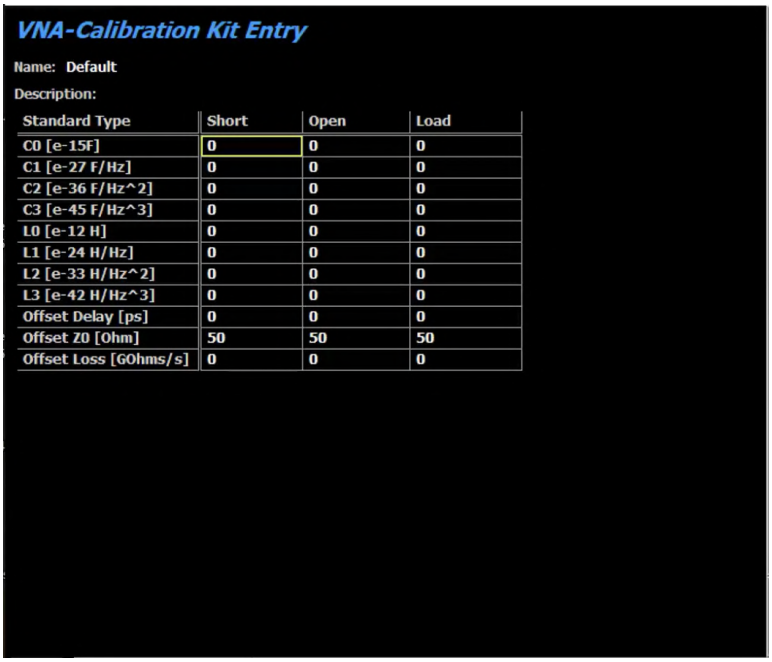
Steps	Actions	Notes
		
3. Select the stock calibration kit.	**a.** Press **Select**.	This selects the N612/912-M calibration kit and returns to the Calibration display.

Steps	Actions	Notes
		The active calibration kit is displayed below the graticule on the left.

Adding a New Cal Kit to the Calibration Kit Library

To add a new calibration kit into the R8200's Calibration Kit Library, following these steps.

Steps	Actions	Notes
1. Select the Calibration display to enter the Calibration Kit Library and open the Calibration Kit Entry Editor.	**a.** From the main VNA menu, press **Select Display > Calibration**. **b.** Press **Calibration Kit**. **c.** To open the Calibration Kit Entry Editor, press **New**.	This opens the Calibration display, which will remain open until either **Save** or **Cancel** is pressed.

Steps	Actions	Notes
		
2. Describe, characterize, and save the new cal kit.	**a.** To identify the new cal kit, press **Name** and use the alphanumeric keypad to enter a name. **b.** To depict the new cal kit, press **Description** and use the alphanumeric keypad to describe it. **c.** Use the tuning knob or the arrow keys to highlight the first field for the Standard Short (C0 [e-15F]), and press **Edit Field**. **d.** Use the alphanumeric keypad to enter the value, then press **Enter**. **e.** Repeat **c** and **d** until all cal kit parameters have been entered for the new cal kit.	Value for your cal kit's open and short capacitance, inductance, offset delay, offset Z0, and offset loss can be found on the product's data sheet.

VNA-Calibration Kit Entry

Name: Default

Description:

Standard Type	Short	Open	Load
C0 [e-15F]	0	0	0
C1 [e-27 F/Hz]	0	0	0
C2 [e-36 F/Hz^2]	0	0	0
C3 [e-45 F/Hz^3]	0	0	0
L0 [e-12 H]	0	0	0
L1 [e-24 H/Hz]	0	0	0
L2 [e-33 H/Hz^2]	0	0	0
L3 [e-42 H/Hz^3]	0	0	0
Offset Delay [ps]	0	0	0
Offset Z0 [Ohm]	50	50	50
Offset Loss [GOhms/s]	0	0	0

Steps	Actions	Notes
	f. Press **Save** to enter the new cal kit and return to the Calibration Kit Library, or press **Cancel** to exit the Calibration Kit Entry Editor without saving the information you have entered.	

See **"Single-Port VNA Soft Keys" on page 544** for detailed descriptions of the soft keys in this menu. Each soft key is defined, along with its range, discrete, default, and saved state values.

Measuring Return Loss and VSWR

This section offers step-by-step instructions for measuring Return Loss (RL) and Voltage Standing Wave Ratio (VSWR) at 1001 points between 1 GHz and 2 GHz. The device under test in this example is an *ad hoc* transmission line. The required equipment, test setup, and procedure are included below.

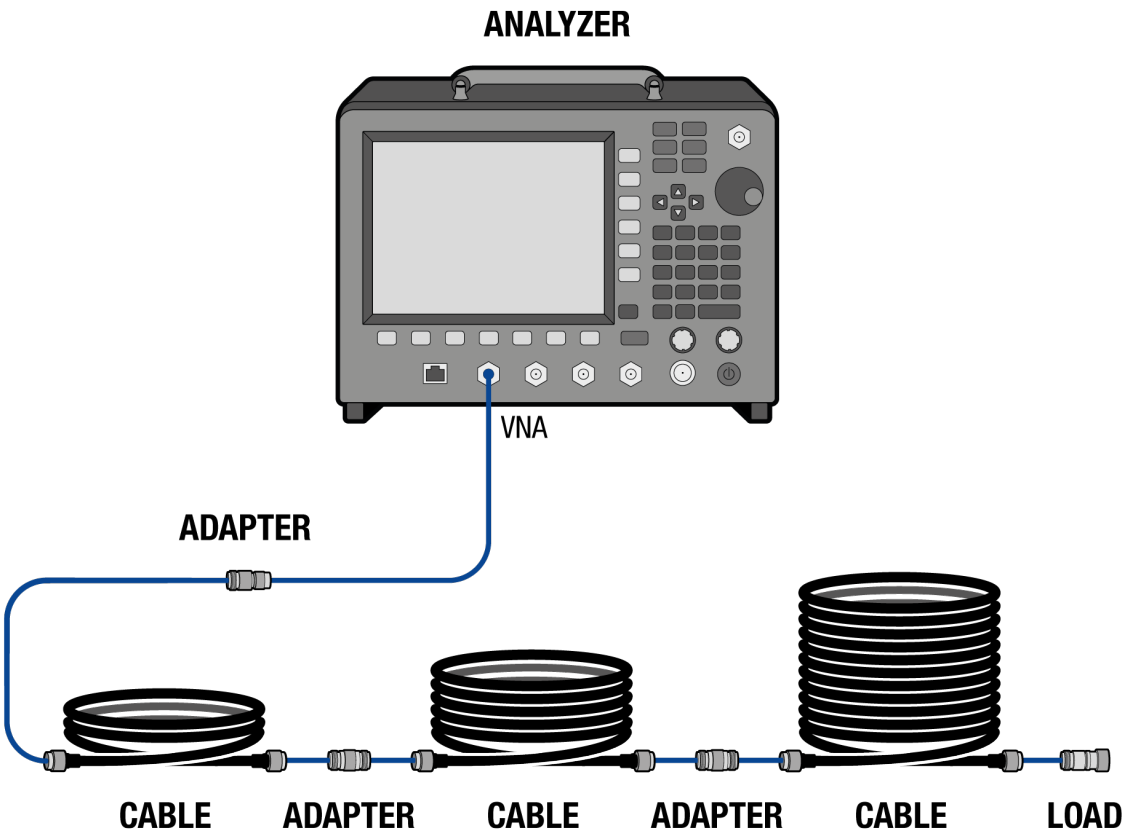
NOTE

The following RL/VSWR measurement assumes the device under test (DUT) is connected through the TNC(m) to Type N(f) adapter which is connected directly to the VNA port, making the transmission line input connector the plane of reference. Calibrate the VNA to the reference plane with the calibration standards connected to the Type N(f) adapter on the VNA port to ensure the accuracy of your RL/VSWR measurement. See **"Calibrating the VNA" on page 111** for step-by-step instructions.

Required Equipment

- Freedom R8200 Communications System Analyzer
- Cable, LMR400, Type N(m), 100 feet
- Cable, LMR400, Type N(m), 50 feet
- Cable, LMR400, Type N(m), 25 feet
- Adapter, TNC(m) to Type N(f)
- Adapters, Type N(f) to Type N(f) (2)
- Load, 50 Ω, Type N(f)

Test Setup

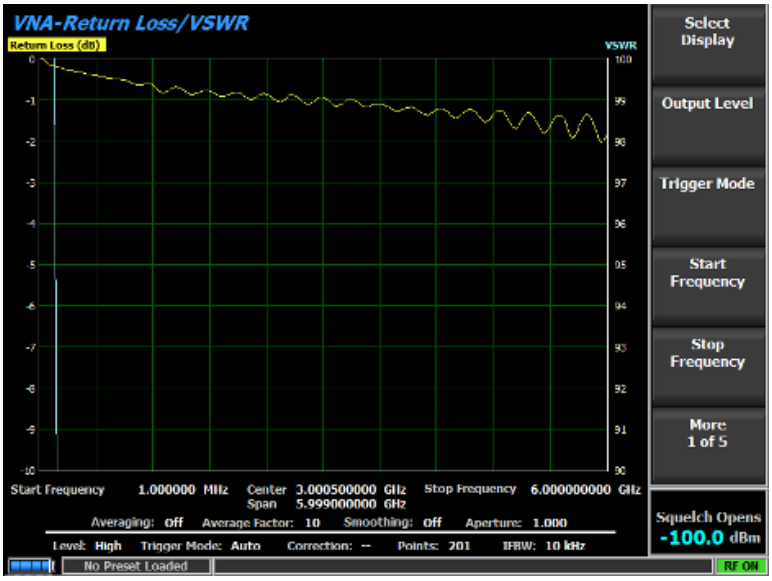


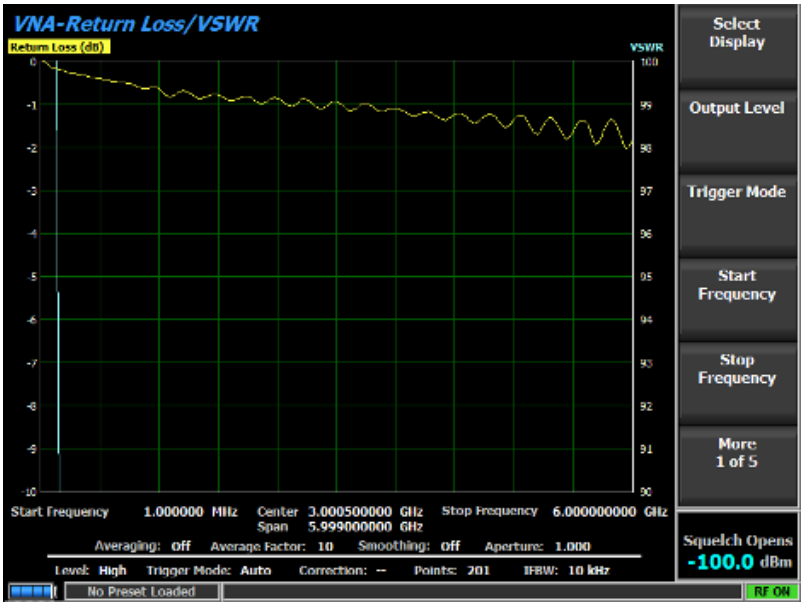
Procedure

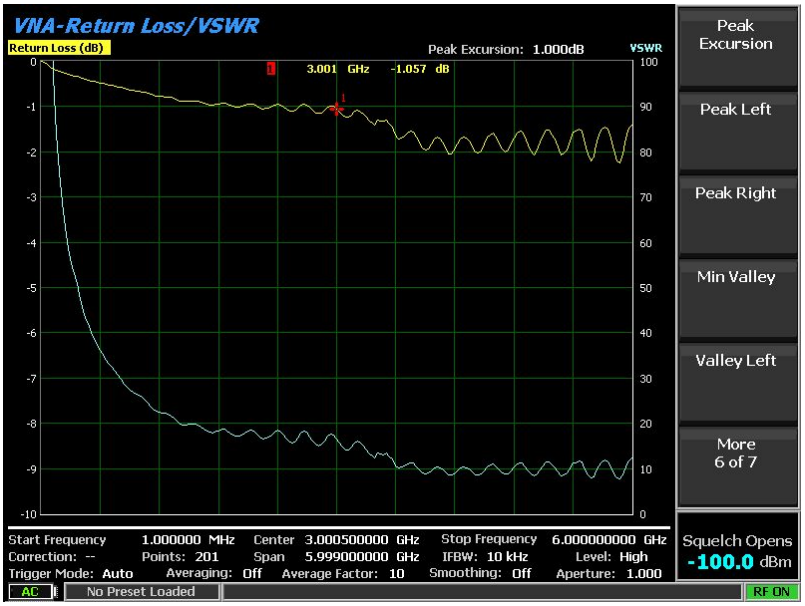
Follow these steps to measure the RL/VSWR of the *ad hoc* transmission line at 1001 points between 1 GHz and 2 GHz.

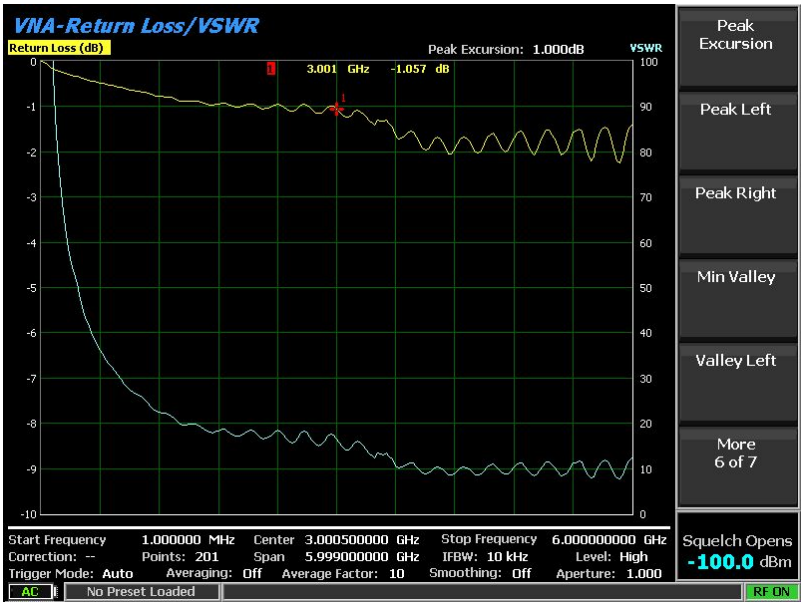
Steps	Actions	Notes
1. Configure the R8200 to measure RL/VSWR.	**a.** Press **Select Display** > **Return Loss/VSWR.**	This enables the Return Loss/VSWR display.
2. Configure the RL/VSWR measurement parameters.	**a.** Press **Start Frequency** > **1** > **GHz**. **b.** Press **Stop Frequency** > **2** >	Sets the frequency range of the measurement sweep from 1 to 2 GHz.

Steps	Actions	Notes
	GHz. **c.** Press **# of Points** > **1001** > **Enter**.	Defines a 1001-point measurement sample over the frequency range.
3. Connect the adapter to the VNA port.	**a.** Connect the TNC(m) to Type N (f) adapter to the VNA port. **b.** Torque to 3 ft·lbf with wrench.	This is necessary to ensure that the calibration is performed at the reference plane (the transmission line input connector), as opposed to the VNA port.
4. Calibrate the RL/VSWR measurement.	**a.** Follow the steps outlined in **"Calibrating the VNA" on page 111.**	Measurement calibration ensures the highest accuracy analysis based on the output level and number of points sampled across the frequency range of the measurement.
5. Connect and terminate the transmission line.	**a.** Connect the TNC(m) to Type N (f) adapter on the VNA port to the transmission line input. **b.** Torque to 3 ft·lbf with wrench. **c.** Connect the 50Ω load to the transmission line output. **d.** Torque to 3 ft·lbf with wrench.	
6. Scale the vertical axis of the RL display.	**a.** Press **More** × 4 > **Return Loss Auto Scale**.	Automatically scales the RL trace for an optimum view of the peaks and valleys.
7. Scale the vertical axis of the VSWR display.	**a.** Press **VSWR Auto Scale**.	Automatically scales the VSWR trace for an optimum view of its peaks and valleys.
8. Adjust the Scale and Reference Level for both RL and VSWR to optimize the trace displays.	**a.** Press **Return Loss Scale** and enter a value that produces your desired trace height. **b.** Press **Return Loss Reference**	

Steps	Actions	Notes
	Value and enter a value that moves the RL trace to the optimal position on the display. **c.** Press **VSWR Scale** and enter a value that produces your desired trace height. **d.** Press **VSWR Reference Value** and enter a value that moves the VSWR trace to the optimal position on the display.	
		
9. Adjust enable smoothing and adjust the aperture to optimize the RL trace.	**a.** Press **Smoothing** > **On**. **b.** Press **Smoothing Aperture** and adjust the value to optimize the RL trace.	Smoothing and Smoothing Aperture affects both measurement traces.

Steps	Actions	Notes
		
10. Ensure RL is the active trace, then use delta markers to analyze the maximum difference in RL over the operational range of the transmission line.	**a.** To ensure RL is the active trace, press **Active Trace** and ensure Return Loss is selected. **b.** To place a reference marker on the RL trace, press **Marker Mode** > **Delta**. **c.** To place the reference marker on the highest peak, press **Select Marker** > **Ref** > **Max Peak**. **d.** To add a delta marker, press **Select Marker** > **1**. **e.** To move the delta marker to the lowest valley, press **Min Valley**.	Marker 1 now displays the difference in amplitude and frequency between the highest peak and the and the lowest valley on the RL trace.

Steps	Actions	Notes
		
11. Document the displayed analysis of RL/VSWR.	**a.** Insert a thumb drive into the USB port. **b.** On the alphanumeric keypad, press **Shift** > **1** and follow the prompts.	This saves a screenshot of the current DISPLAY Zone to the thumb drive.

Steps	Actions	Notes
		

See **"Single-Port VNA Soft Keys" on page 544** for detailed descriptions of the soft keys in this menu. Each soft key is defined, along with its range, discrete, default, and saved state values.

Measuring Normalized Impedance

This section offers step-by-step instructions for measuring Normalized Impedance (NI) at 1001 points between 10 MHz and 30 MHz. The device under test in this example is an assembly comprised of a bandpass filter centered at 20 MHz and a transmission line. The required equipment, test setup, and procedure are included below.

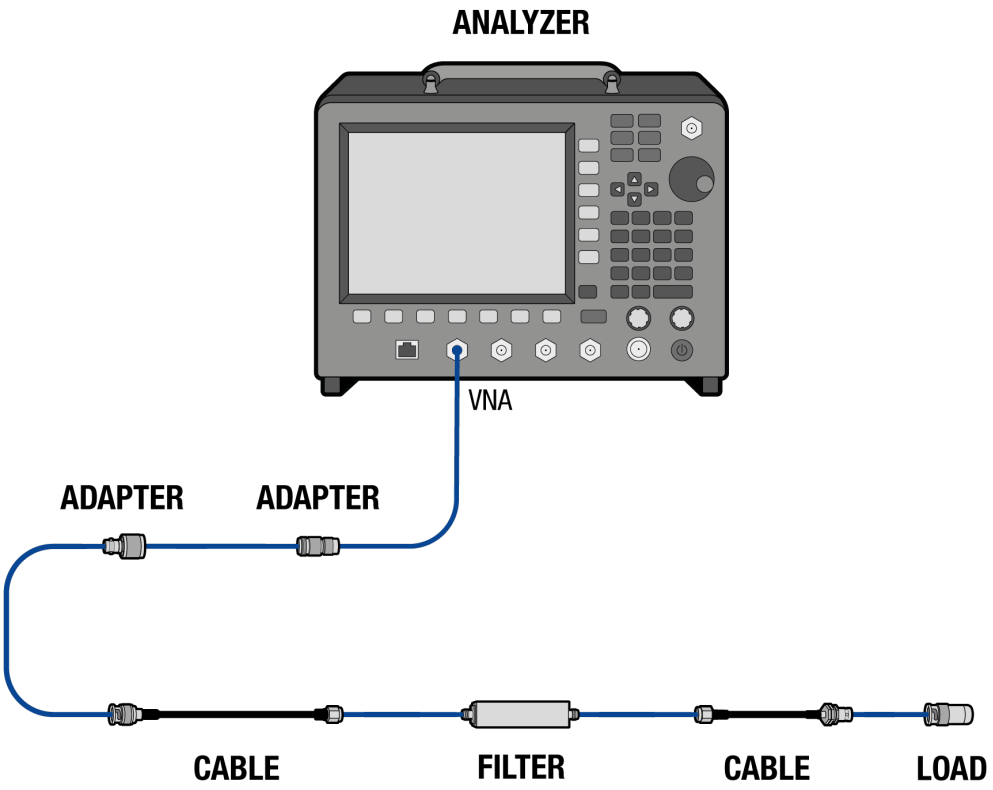
NOTE

The following NI measurement assumes the device under test (DUT) is connected through the TNC (m) to Type N(f) adapter which is connected directly to the VNA port, making the transmission line input connector the plane of reference. Calibrate the VNA to the reference plane with the calibration standards connected to the Type N(f) adapter on the VNA port to ensure the accuracy of your NI measurement. See **"Calibrating the VNA" on page 111** for step-by-step instructions.

Required Equipment

- Freedom R8200 Communications System Analyzer
- Filter, SMA(f), 20 MHz Bandpass
- Cable, coaxial, BNC(m) to SMA(m), 1 foot
- Cable, coaxial, BNC(f) to SMA(m), 1 foot
- Adapter, TNC(m) to Type N(f)
- Adapter, Type N(m) to BNC(f)
- Load, 50Ω, BNC(m)

Test Setup

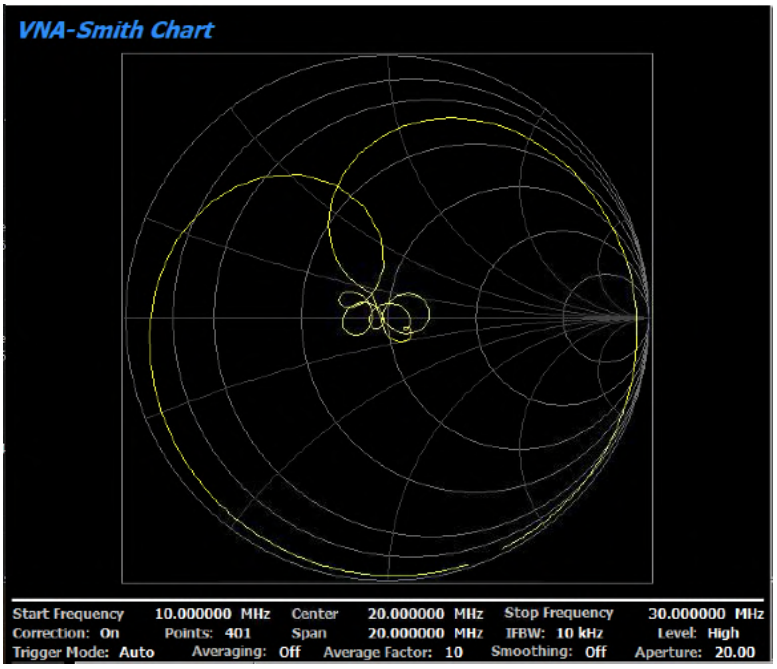


Procedure

Follow these steps to measure the NI of a bandpass filter assembly at 1001 points between 10 MHz and 30 MHz.

Steps	Actions	Notes
1. Configure the R8200 to measure NI.	**a.** To open the Smith Chart display, press **Select Display** > **Smith Chart**.	This enables the Smith Chart display.
2. Configure the NI measurement parameters.	**a.** To set the start frequency, press **Start Frequency** > **10** > **MHz**. **b.** To set the stop frequency, press	Sets the frequency range of the measurement sweep from 10 to 30 MHz.

Steps	Actions	Notes
	Stop Frequency > **30** > **MHz.** **c.** To set the number of points in the measurement sample, press **# of Points** > **1001** > **Enter**. **d.** To set the intermediate frequency bandwidth, press **IFBW** > **1 kHz**.	Defines a 1001-point measurement sample over the frequency range.
3. Connect the adapter to the VNA port.	**a.** Connect the TNC(m) to Type N (f) adapter to the VNA port. **b.** Torque to 3 ft·lbf with wrench.	This is necessary to ensure that the calibration is performed at the reference plane (the transmission line input connector), as opposed to the VNA port.
4. Calibrate the NI measurement.	**a.** Follow the steps outlined in **"Calibrating the VNA" on page 111.**	Measurement calibration ensures the highest accuracy analysis based on the output level and number of points sampled across the frequency range of the measurement.
5. Connect the bandpass filter assembly.	**a.** Connect the TNC(m) to Type N (f) adapter on the VNA port to the Type N(m) to BNC(f) adapter. **b.** Connect he BNC(f) adapter to the BNC(m) connector on the input cable. **c.** Attach the input cable's SMA connector to the bandpass filter input. **d.** Torque to 3 ft·lbf with wrench. **e.** Connect the output of the bandpass filter to the output cable. **f.** Torque to 3 ft·lbf with wrench.	

Steps	Actions	Notes
	g. Attach the opposite end of the output cable to the BNC 50Ω load.	
		Once the circuit is closed, the VNA sweeps the frequency range to produce a measure of the bandpass filter's NI, as shown.

See **"Single-Port VNA Soft Keys" on page 544** for detailed descriptions of the soft keys in this menu. Each soft key is defined, along with its range, discrete, default, and saved state values.

Measuring Distance To Fault

This section offers step-by-step instructions for measuring Distance to Fault at 1001 points between 1 GHz and 2 GHz. The device under test is an *ad hoc* transmission line. The required equipment, test setup, and procedure are included below.

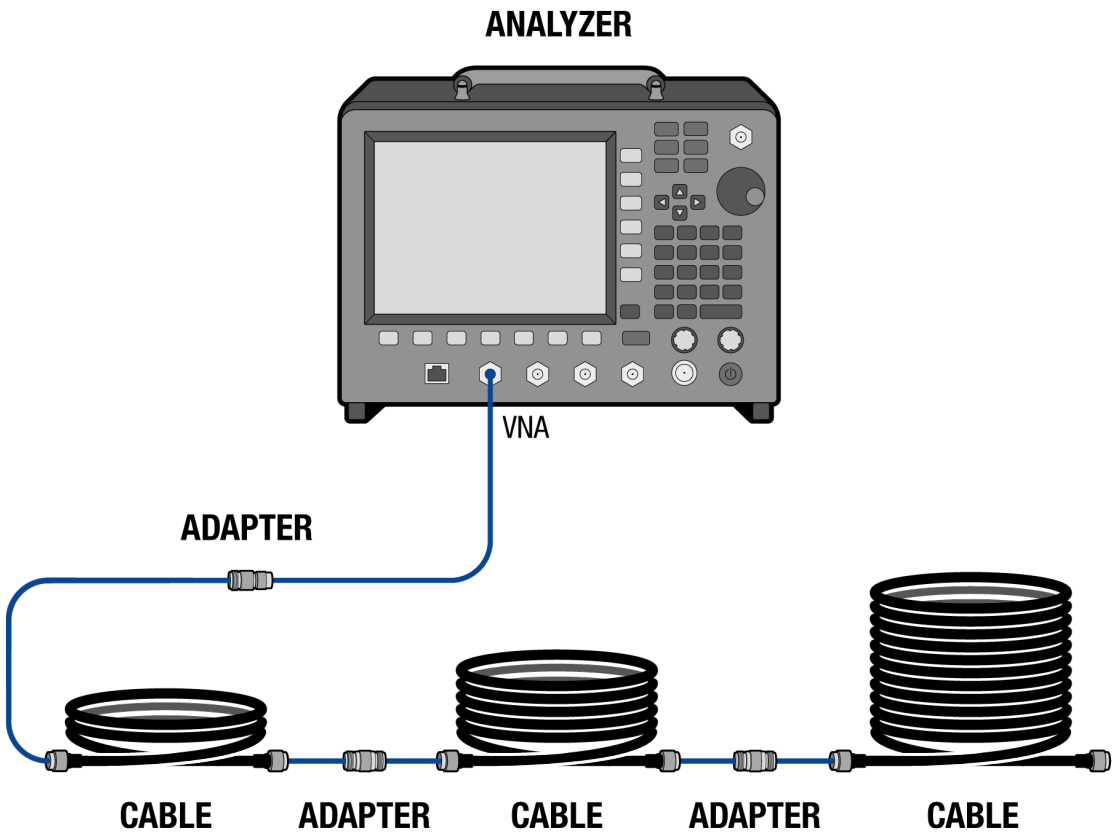
NOTE

The following Distance To Fault measurement assumes the device under test is connected through the TNC(m) to Type N(f) adapter which is connected directly to the VNA port, making the transmission line input connector the plane of reference. Calibrate the VNA to the reference plane with the calibration standards connected to the Type N(f) connector on the adapter to ensure the accuracy of your Distance To Fault measurement. See **"Calibrating the VNA" on page 111** for step-by-step instructions.

Required Equipment

- Freedom R8200 Communications System Analyzer
- Cable, LMR400, Type N(m), 100 feet
- Cable, LMR400, Type N(m), 50 feet
- Cable, LMR400, Type N(m), 25 feet
- Adapter, TNC(m) to Type N(f)
- Adapters, Type N(f) to Type N(f) (2)

Test Setup

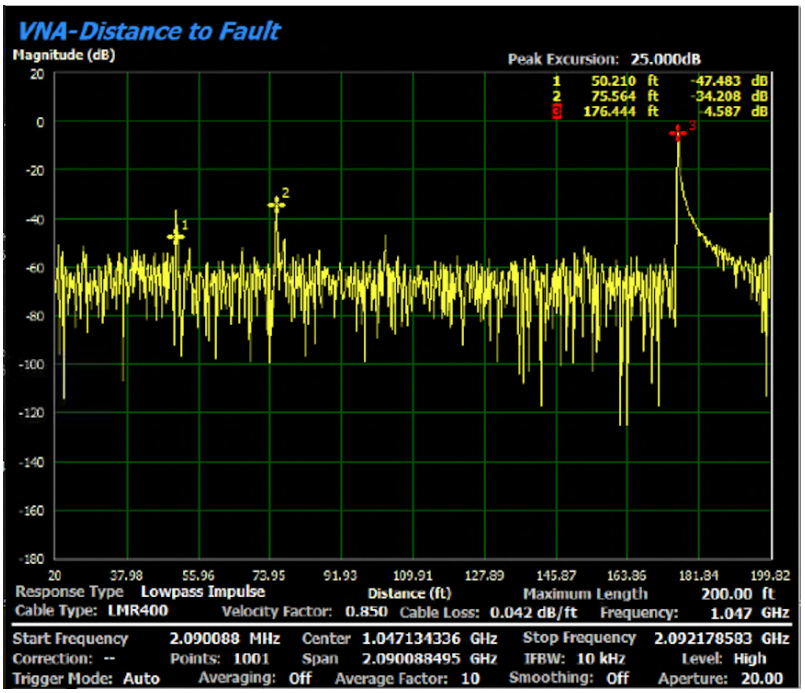


Procedure

Follow these steps to measure Distance To Fault for an ad hoc transmission line.

Steps	Actions	Notes
1. Configure the R8200 to measure Distance To Fault.	**a.** Press **Instrument** > **More 1 of 2** > **Single-Port VNA.** **b.** Press **Select Display** > **Distance To Fault**.	This enables the Distance To Fault display.
2. Define the DTF measurement para-	**a.** To define the distance units,	Sets the frequency range of the

Steps	Actions	Notes
meters.	press **More** × 2 > **Distance Units** > **ft**. **b.** To define the length of the transmission line, press **More** × 2 > **Maximum Length** > **200**. **c.** To define the size of the measurement sample, press **# of Points** > **1001** > **Enter**. **d.** To instantiate the velocity factor and frequency response of the DUT, press **More** × 2 > **Cable Type** > **LMR400.**	measurement sweep from 1 to 2 GHz. Maximum Length defines the length of the measurement. Number of points defines how many RL/distance data points are sampled for calibration and measurement.
3. Define the DTF display parameters.	**a.** To define the trace display type, press **Response Type** > **Low-pass Impulse**. **b.** To define the position of the beginning of the display trace, press **Start Distance** > **0**. **c.** To define the position of the end of the display trace, press **Stop Distance** > **200**.	Start and stop distance define the span of the display.
4. Connect the adapter to the VNA port.	**a.** Connect the TNC(m) to Type N (f) adapter to the VNA port. **b.** Torque to 3 ft·lbf with wrench.	This is necessary to ensure that the calibration is performed at the reference plane (the transmission line input connector), as opposed to the VNA port.
5. Calibrate the DTF measurement.	**a.** Follow the steps outlined in **"Calibrating the VNA" on page 111**.	Measurement calibration ensures the highest accuracy analysis based on the cable type, maximum length, output level and number of points sampled across the frequency range

Steps	Actions	Notes
		of the measurement.
6. Add Smoothing, Smoothing Aperture, Scalings, and Markers.	**a.** To smooth the trace, press **Smoothing** > **Enable**. **b.** To alter the extent of smoothing, press **Smoothing Aperture**. **c.** To scale the DTF trace, press **Scale**. **d.** To place markers at the discontinuities, press **Marker Mode** > **Absolute**.	
		Your display should look similar to the measurement shown here.

See **"Distance To Fault Soft Keys" on page 554** for detailed descriptions of the soft keys in this menu. Each soft key is defined, along with its range, discrete, default, and saved state values.

Using the Cable List

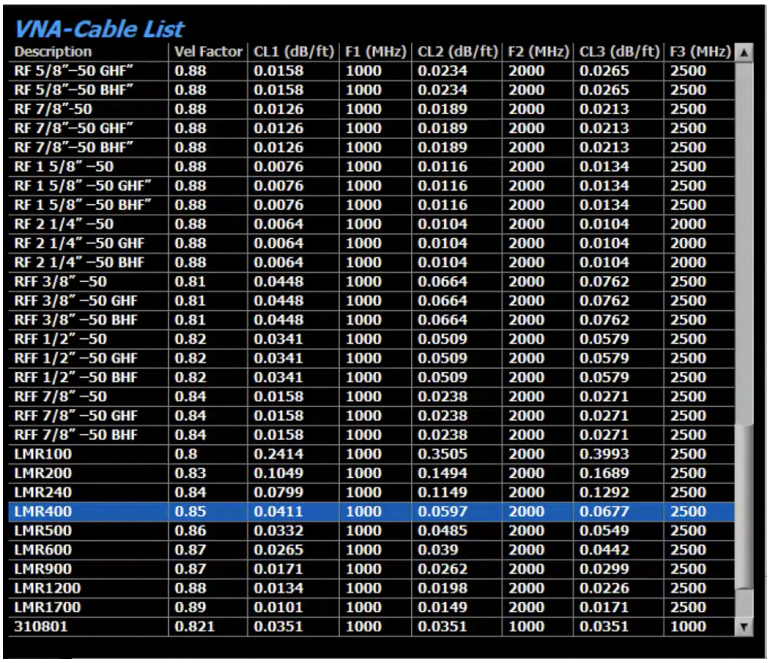
In many working environments, a direct connection between the R8200 and the DUT is impractical or impossible. It these situations, it may be necessary to use an available cable as an intermediary transmission line between the VNA and the DUT. The R8200 comes equipped with a predefined Cable List that contains descriptions and critical physical characteristics (velocity factor, dB-per-foot-loss at three frequencies) for an array of common RF cable types. This enables you to connect your DUT to the VNA using a variety of common cable types without forfeiting measurement accuracy due to the use of an uncharacterized transmission line between the VNA and the DUT when performing Distance to Fault measurements with the R8200.

Selecting a Cable from the Cable List

To select an LMR400 cable from the R8200's Cable List, follow these steps.

Steps	Actions	Notes
1. Open the Cable List.	**a.** To open the Cable List from the Distance To Fault display, press **More** × 3 > **Cable List**.	Alternatively, to open the Cable List from the default factory configuration, press **Instrument** > **More** > **Single-Port VNA** > **Select Display** > **Distance To Fault** > **Cable List.**
2. Locate the LMR400 cable.	**a.** Use the tuning knob or the arrow keys to locate and highlight the LMR400 cable in the Cable List.	

Steps	Actions	Notes

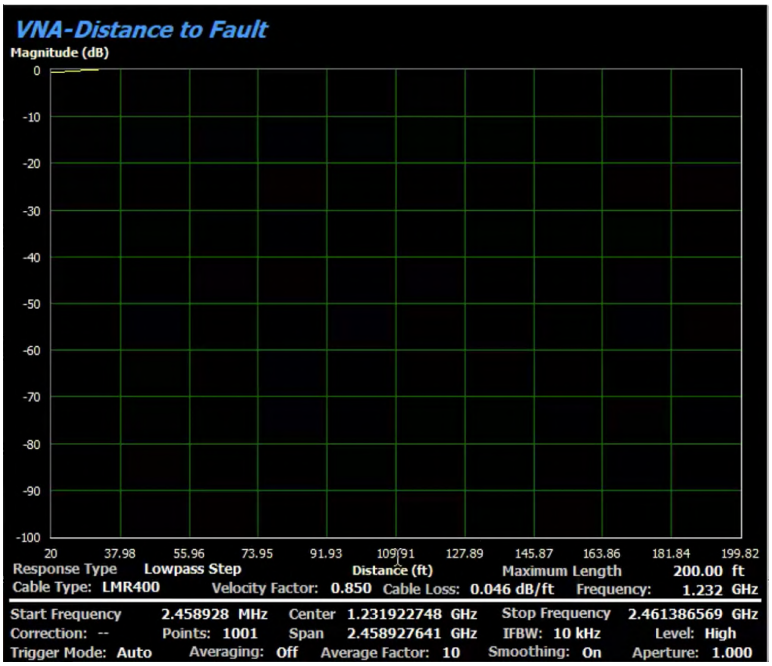


VNA-Cable List

Description	Vel Factor	CL1 (dB/ft)	F1 (MHz)	CL2 (dB/ft)	F2 (MHz)	CL3 (dB/ft)	F3 (MHz)
RF 5/8"–50 GHF"	0.88	0.0158	1000	0.0234	2000	0.0265	2500
RF 5/8"–50 BHF"	0.88	0.0158	1000	0.0234	2000	0.0265	2500
RF 7/8"-50	0.88	0.0126	1000	0.0189	2000	0.0213	2500
RF 7/8"–50 GHF"	0.88	0.0126	1000	0.0189	2000	0.0213	2500
RF 7/8"–50 BHF"	0.88	0.0126	1000	0.0189	2000	0.0213	2500
RF 1 5/8" –50	0.88	0.0076	1000	0.0116	2000	0.0134	2500
RF 1 5/8" –50 GHF"	0.88	0.0076	1000	0.0116	2000	0.0134	2500
RF 1 5/8" –50 BHF"	0.88	0.0076	1000	0.0116	2000	0.0134	2500
RF 2 1/4" –50	0.88	0.0064	1000	0.0104	2000	0.0104	2000
RF 2 1/4" –50 GHF	0.88	0.0064	1000	0.0104	2000	0.0104	2000
RF 2 1/4" –50 BHF	0.88	0.0064	1000	0.0104	2000	0.0104	2000
RFF 3/8" –50	0.81	0.0448	1000	0.0664	2000	0.0762	2500
RFF 3/8" –50 GHF	0.81	0.0448	1000	0.0664	2000	0.0762	2500
RFF 3/8" –50 BHF	0.81	0.0448	1000	0.0664	2000	0.0762	2500
RFF 1/2" –50	0.82	0.0341	1000	0.0509	2000	0.0579	2500
RFF 1/2" –50 GHF	0.82	0.0341	1000	0.0509	2000	0.0579	2500
RFF 1/2" –50 BHF	0.82	0.0341	1000	0.0509	2000	0.0579	2500
RFF 7/8" –50	0.84	0.0158	1000	0.0238	2000	0.0271	2500
RFF 7/8" –50 GHF	0.84	0.0158	1000	0.0238	2000	0.0271	2500
RFF 7/8" –50 BHF	0.84	0.0158	1000	0.0238	2000	0.0271	2500
LMR100	0.8	0.2414	1000	0.3505	2000	0.3993	2500
LMR200	0.83	0.1049	1000	0.1494	2000	0.1689	2500
LMR240	0.84	0.0799	1000	0.1149	2000	0.1292	2500
LMR400	0.85	0.0411	1000	0.0597	2000	0.0677	2500
LMR500	0.86	0.0332	1000	0.0485	2000	0.0549	2500
LMR600	0.87	0.0265	1000	0.039	2000	0.0442	2500
LMR900	0.87	0.0171	1000	0.0262	2000	0.0299	2500
LMR1200	0.88	0.0134	1000	0.0198	2000	0.0226	2500
LMR1700	0.89	0.0101	1000	0.0149	2000	0.0171	2500
310801	0.821	0.0351	1000	0.0351	1000	0.0351	1000

3. Select the LMR400 cable.

a. Press **Select**.



The current Cable Type is displayed below Response Type below the Distance To Fault graticule.

See **"Distance To Fault Soft Keys" on page 554** for detailed descriptions of the soft keys in this menu. Each soft key is defined, along with its range, discrete, default, and saved state values.

6 Using Test Mode

This chapter contains step-by-step instructions for utilizing the analyzer's Test Mode. This mode offers access to the R8200's Preset menu where you can save and recall global instrument configurations, as well as submenus for configuring optional advanced radio protocols using digital modulation such as DMR, P25, NXDN, dPMR and TETRA. Test Mode also offers AutoTune and AutoScript which enable the test and alignment of a variety of radio makes and models (AutoTune), as well as scripted control and monitoring of the R8200 (AutoScript), eliminating the need for an external computer to manage complex verification procedures. Each section includes an overview with a detailed description of the display user interface, as well as step-by-step instructions for using each feature.

"Introducing Presets" on page 144 and **"Using Presets" on page 145** explains how to store, recall, import, export and delete complex instrument configurations.

"Introducing DMR Test Mode" on page 147 explains how to use DMR Test Mode, including an overview of the DMR Zone, as well as **"Using DMR Test Mode" on page 158**.

"Introducing PROJECT 25 Test Mode" on page 163 explains how to use PROJECT 25 Test Mode, including an overview of the PROJECT 25 Zone, as well as **"Using PROJECT 25 Test Mode" on page 178**.

"Introducing P25 Trunk Mode" on page 183 explains how to use the P25 Trunk Test Mode, including an overview of the P25 Trunk Zone, as well as its RF, DISPLAY, and METER Zones.

"Introducing NXDN™ Test Mode" on page 191 explains how to use the NXDN™ Test Mode, including an overview of the NXDN™ Zone, as well as **"Using NXDN™ Test Mode" on page 198**.

"Introducing NXDN™ Trunk Mode" on page 203 explains how to use the NXDN™ Trunk Test Mode, including an overview of the NXDN™ Zone, as well as **"Using NXDN™ Trunk Test Mode" on page 210**.

"Introducing TETRA Base Station Test Mode" on page 215 includes an overview of the TETRA Base Station Zone, as well as **"Using TETRA Base Station Test Mode" on page 231**.

"Introducing TETRA DMO Test Mode" on page 238 includes an overview of the TETRA DMO Zone, as well as **"Using TETRA DMO Test Mode" on page 248**.

"Introducing TETRA TMO Test Mode" on page 253 explains how to use the TETRA TMO Test Mode, including an overview of the TETRA TMO Zone, as well as **"Using TETRA TMO Test Mode" on page 268**.

"Introducing dPMR Test Mode" on page 273 explains how to use the dPMR Test Mode, including an overview of the dPMR Zone, as well as **"Using dPMR Test Mode" on page 280**.

"Introducing P25 Phase 2 Mode" on page 285 includes an overview of the P25 II Zone as well as its RF, DISPLAY, and METER Zones.

"Introducing PTC-ITCR Mode" on page 293 explains how to use the PTC-ITCR Test Mode, including an overview of the PTC-ITCR Zone and **"Using PTC-ITCR Test Mode" on page 300**.

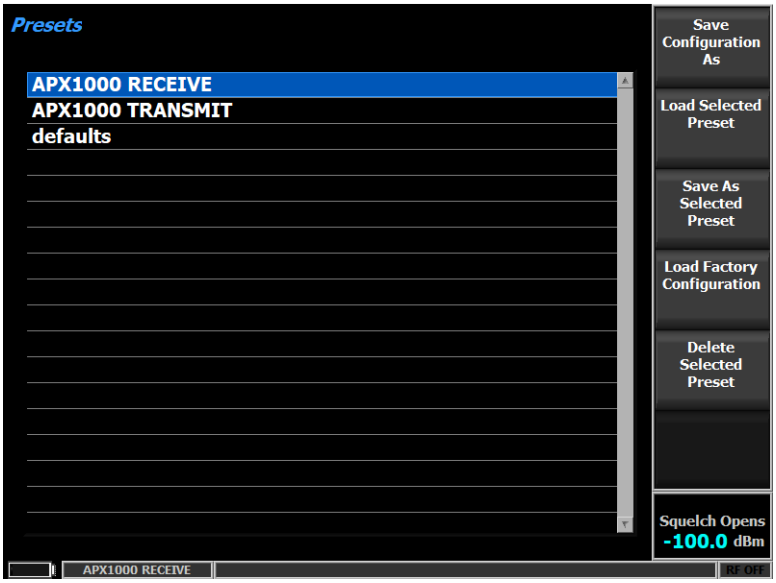
"Introducing PTC-ACSES Test Mode" on page 303 explains how to use the PTC-ACSES Test Mode, including an overview of the PTC-ACSES Zone and **"Using PTC-ACSES Test Mode" on page 312**.

"Introducing AutoTune" on page 316 explains how to use AutoTune, including an overview of the AutoTune display, as well as **"Using AutoTune" on page 318**.

Introducing Presets

Presets are a convenient tool for storing and recalling R8200 operational configurations and parameter settings. The Presets menu enables storing, loading, sharing and deletion of user-defined configurations as well as quickly returning the analyzer to its factory default configuration. They are especially useful when several unique or complex operating configurations are repeatedly required in a test environment.

Presets ensure a fast and accurate method of configuring the analyzer for multiple test applications. To save time and avoid errors, the R8200 can store over 100 preset operating configurations. The Presets menu can display up to 47 characters, allowing you to describe the configuration in great detail. Presets can be shared between analyzers by exporting them to a thumb drive and importing them on an alternate analyzer, allowing you to quickly configure a new or replacement instrument for a specific set of verification and maintenance tasks. The Presets display with its top level soft key menu is shown below.



If no presets are present, the R8200 powers up in the default factory configuration. Otherwise, the analyzer powers up according to the last Preset loaded or saved before the unit was powered down.

For Preset soft key definitions, ranges, discrete and default values, and detailed notes, see **"Presets Soft Keys" on page 579**.

To learn how to use Presets, **"Using Presets" on the next page**.

Using Presets

The Presets menu enables storing, loading, importing, exporting, and deletion of custom communication systems analyzer configurations as well as loading the R8200 factory default configuration. To store, load, import, export, and delete global analyzer configurations, as well as return the analyzer to its factory default configuration, follow the steps below.

NOTE

A thumb drive must be inserted into the R8200 USB connector in order to display the **Export Presets** key. A Preset configuration must be saved to the thumb drive in order to display the **Import Presets** soft key.

For Preset soft key definitions, ranges, discrete and default values, and detailed notes, see **"Presets Soft Keys" on page 579**.

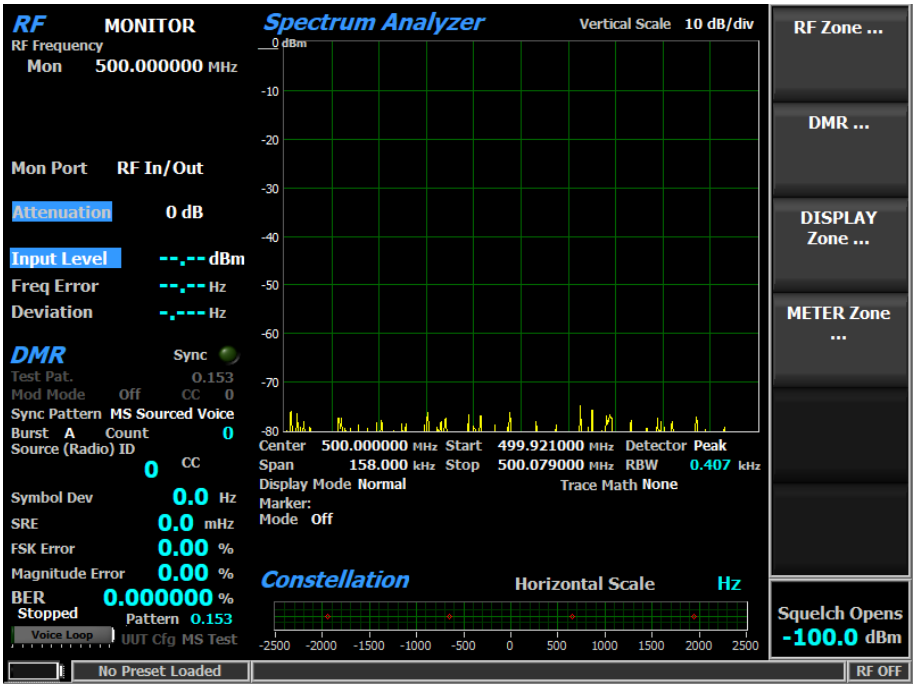
Steps	Actions	Notes
1. Save your current configuration as a Preset.	**a.** Press **Test** > **Preset**. **b.** Press **Save Configuration As**. **c.** Use the arrow keys and the alphanumeric keypad to enter name (up to a 47 characters) for your Preset. **d.** Press **Enter**.	
2. Load a Preset to configure a measurement or stimulus.	**a.** Press **Test** > **Preset**. **b.** Use the arrow keys to highlight the desired Preset. **c.** Press **Enter**.	
3. Export a Preset to an external thumb drive.	**a.** Insert a thumb drive into a USB connector on the R8200. **b.** Press **Test** > **Preset**. **c.** Press **Export Presets**. **d.** Use the arrow keys or the tuning	

Steps	Actions	Notes
	knob to select the desired Preset for export. **e.** Press **Enter**.	
4. Delete a Preset.	**a.** Press **Test** > **Preset**. **b.** Select the Preset that you just exported to the thumb drive. **c.** Press **More** > **Delete Selected Preset**. **d.** Press **Continue.**	
5. Import a Preset from an external thumb drive.	**a.** Press **Test** > **Preset**. **b.** Press **Import Presets.** **c.** Select the Preset that you want to import from the thumb drive. **d.** Press **Enter**.	
6. Load the analyzer factory default configuration.	**a.** Press **Test** > **Preset**. **b.** Press **More** > **Load Factory Configuration**.	

See **"Presets Soft Keys" on page 579** for detailed descriptions of the soft keys in this menu. Each soft key is defined, along with its range, discrete, default, and saved state values.

Introducing DMR Test Mode

The R8200 DMR Test Package option DMR Test Mode allows testing of repeater/subscriber radios compliant with the ETSI Digital Mobile Radio (DMR) Tier 2 conventional (non-trunked) radio transmission protocol. DMR radios use a digital transmission format employing Four-Level Frequency Shift Keying (4FSK) modulation with Time Division Multiple Access (TDMA) channeling with two timeslots per frame.



Pressing **Test** > **Test Mode** > **DMR** configures the R8200 for DMR protocol testing, as shown above. The default mode's AUDIO Zone and associated soft keys on the R8200 display are replaced by the DMR Zone and DMR-specific soft keys (accessed by pressing the **DMR** soft key).

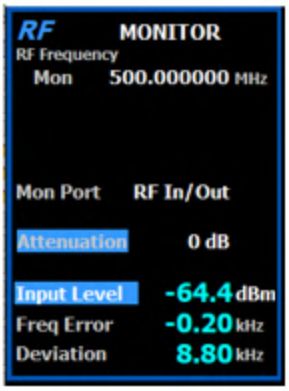
NOTE

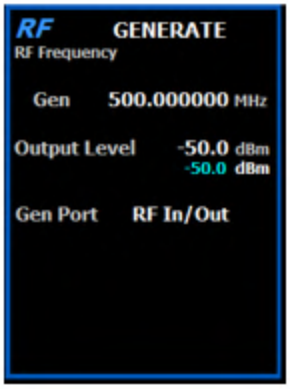
The manufacturer's Radio Service Software (RSS), Motorola MOTOTRBO™ Radio Tuner software, is required to perform some tests in DMR Test mode because certain measurements (BER) require placing the radio in a special test mode. The Tuner software places the radio in specific test modes, while the role of the R8200 service monitor is to transmit and receive test patterns compliant with the DMR physical layer. Tests that do not require RSS include

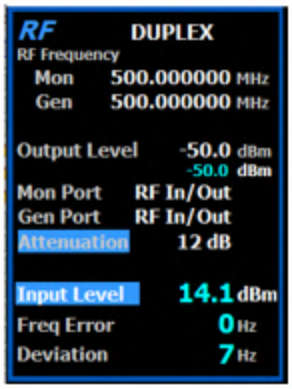
Subscriber Slot Power, Frequency Error, Symbol Deviation, FSK Error, Magnitude Error, Power Profile, and Constellation. Averaging can be applied to some measurements by configuring it in the System Settings.

The RF Zone

The RF Zone during DMR transmitter testing (with the R8200 in Monitor Mode) is shown on the left while the RF Zone during DMR receiver testing (with the R8200 in Generate Mode or Duplex Mode) is shown in the center and on the right, below.







In DMR Test Mode, the RF Zone displays parameters associated with the DMR carrier generated by the R8200 as well as RF measurements of the radio transmissions. During DMR Test Mode, the RF Zone offers the following measurement displays:

Input Level – Displays the average power in the specified Burst of the synchronized TDMA slot of the received signal.

NOTE

Although Input Level is used for Squelch, Squelch has no effect on measurement updates.

When the RF input power on the RF In/Out port is above +20 dBm (100 mW), the R8200 utilizes a broadband power detector for the measurement. The Input Level field in the RF Zone changes to Watt Meter to indicate this measurement mode. For best accuracy, disable the Pre-amplifier in Monitor Mode and set the Gen Port in Generate Mode to RF In/Out.

The TDMA transmission alternates between a used and unused time slot, so the RF Zone field

will switch between the two. An unused slot has no power, so the display will flash between Input Level and Watt Meter. In this condition the Input Level reading should be used since null slots can cause the Watt Meter indication to read approximately 3 dB less than the power in the used slots. The Input Source parameter can be used to force narrow or broadband power. That is useful for TDMA protocols whose on and off slots can cause the indicator to toggle between them.

Watt Meter – Displays the level of broadband power applied to the RF In/Out port when the RF input power on the RF In/Out port is above +20 dBm (100 mW).

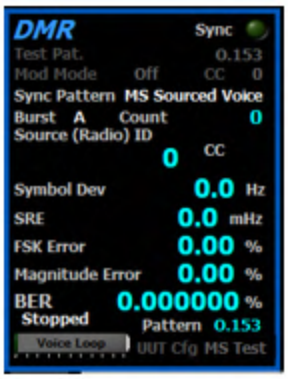
Freq Error – Displays the difference between the received DMR carrier frequency and the R8200 Monitor Frequency.

Deviation – Displays the negative and positive peak frequency deviation of a modulated carrier (i.e., from the Frequency Error mean), available when Modulation Mode is FM.

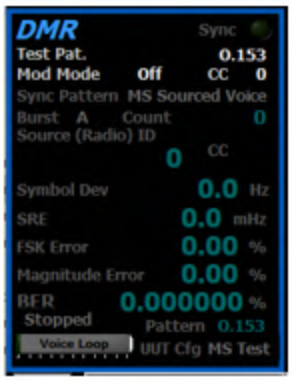
While the analyzer is operating in DMR Test Mode, the RF Zone soft key menus contain all of the parameter settings for the controlling the R8200 RF output. For a complete soft key reference for the RF Zone, see **"RF Zone Soft Keys for Duplex Mode" on page 441**.

The DMR Zone

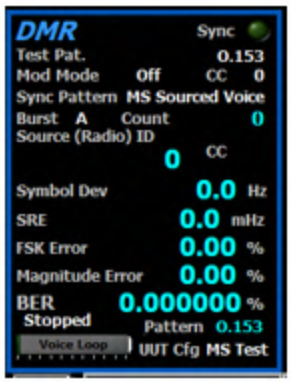
While operating in DMR Test Mode, the AUDIO Zone and associated soft keys are replaced by the DMR Zone and DMR-specific soft keys. The DMR Zone displays the physical layer parameters that can be configured to encode and decode DMR content. The DMR Zone is shown in Monitor Mode on the left, Generate Mode in the middle, and Duplex Mode on the right, below.



DMR Sync
Test Pat. 0.153
Mod Mode Off CC 0
Sync Pattern MS Sourced Voice
Burst A Count 0
Source (Radio) ID
0 CC
Symbol Dev 0.0 Hz
SRE 0.0 mHz
FSK Error 0.00 %
Magnitude Error 0.00 %
BER 0.000000 %
Stopped Pattern 0.153
Voice Loop UUT Cfg MS Test



DMR Sync
Test Pat. 0.153
Mod Mode Off CC 0
Sync Pattern MS Sourced Voice
Burst A Count 0
Source (Radio) ID
0 CC
Symbol Dev 0.0 Hz
SRE 0.0 mHz
FSK Error 0.00 %
Magnitude Error 0.00 %
BER 0.000000 %
Stopped Pattern 0.153
Voice Loop UUT Cfg MS Test



DMR Sync
Test Pat. 0.153
Mod Mode Off CC 0
Sync Pattern MS Sourced Voice
Burst A Count 0
Source (Radio) ID
0 CC
Symbol Dev 0.0 Hz
SRE 0.0 mHz
FSK Error 0.00 %
Magnitude Error 0.00 %
BER 0.000000 %
Stopped Pattern 0.153
Voice Loop UUT Cfg MS Test

The DMR Zone offers the following measurement displays:

Count – Displays increments each time the specified SYNC Pattern is detected; thus, the R8200 synchronizes to that TDMA slot. The green Sync indicator also illuminates.

NOTE Test measurements are only displayed if two consecutive SYNC patterns are detected; this maximizes the accuracy of the measurement.

Source (Radio) ID – Displays the Source Identifier (ID), which identifies the individual address of the transmitter. This is obtained from bytes 7–9 of the Full Link Control message composed by four 32-bit embedded signaling fields at the center of bursts B to F of a voice super frame. The Source ID is displayed in base 10 and base 16 format.

CC – Displays the four-bit color code (0 to 15) of the synchronized TDMA slot of the received signal transmission. CC is digital ID information equivalent to CTCSS/PL and CDCSS/DPL of analog FM radio systems.

Symbol Dev – Displays the symbol deviation estimated by averaging the normalized frequency deviations at symbol times in the specified burst of the synchronized TDMA slot of the received signal and then scaling by the maximum symbol value. The normalized frequency deviation is computed as the ratio of the actual frequency measurement at a given symbol or deviation state by the corresponding symbol value. The target frequency deviations representing the four symbols are listed below.

Bit 1	Bit 0	Symbol	Carrier Frequency Deviation
0	1	+3	+1944 Hz
0	0	+1	+648 Hz
1	0	–1	–648 Hz
1	1	–3	–1944 Hz

SRE – Displays the Symbol Rate Error (SRE; in milliHertz). SRE is a measurement of transmitter symbol rate accuracy, the difference of the actual minus the ideal. Thus, a positive error indicates that the transmitter clock is too fast.

FSK Error – Displays the percentage computed from the symbols in the specified Burst of the synchronized TDMA slot of the received signal. The FSK Error is computed relative to the Symbol Deviation measurement.

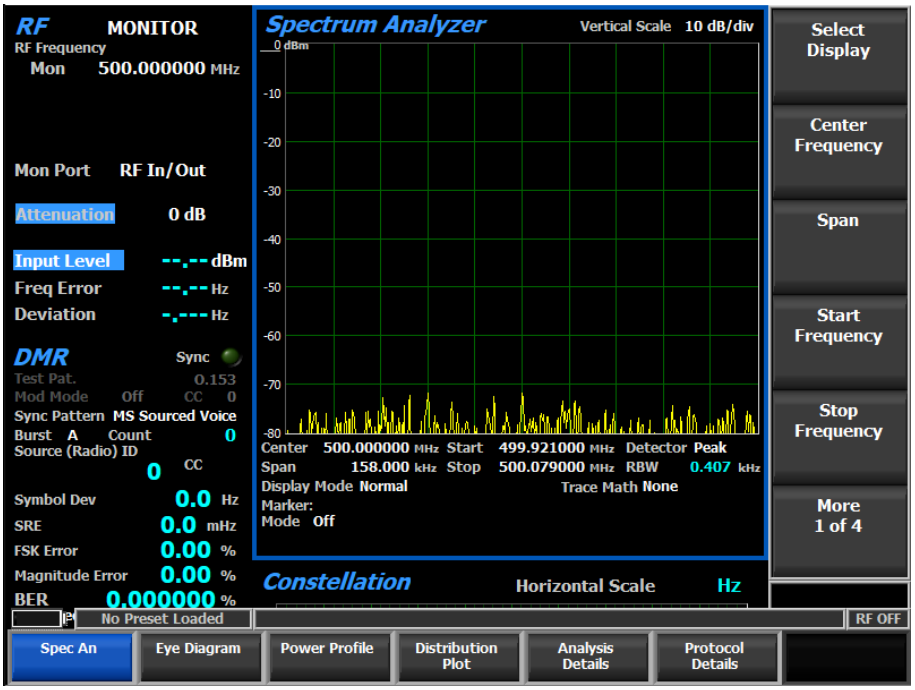
Magnitude Error – Displays the percentage computed from the symbols in the specified Burst of the synchronized TDMA slot of the received signal.

BER – Displays the bit error rate percentage of bit differences between the O.153 pattern and the bits of the synchronized TDMA slot of the received signal. For example, if 13 of the 1296 super frame payload bits do not match the predefined pattern, the rate will be 1.0030864% (13/1296×100%). Assurance of the computation may be gained by transmitting a different calibration test pattern (e.g., BER of 1031 Hz vs. O.153 is 47.299381%).

While the analyzer is operating in DMR Test Mode, the DMR Zone soft key menus contain all of the R8200 parameter settings for the controlling the DMR physical layer. For a complete soft key reference for the DMR Zone, see **"DMR Zone Soft Keys" on page 583**.

The DISPLAY Zone

During DMR Test Mode, the DISPLAY Zone offers a Spectrum Analyzer, Eye Diagram, Power Profile, Distribution Plot, and tables of analysis and protocol details, accessed by pressing **Select Display**, as shown in the horizontal soft key menu below.

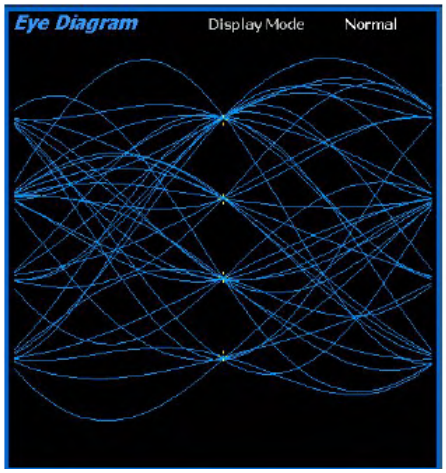


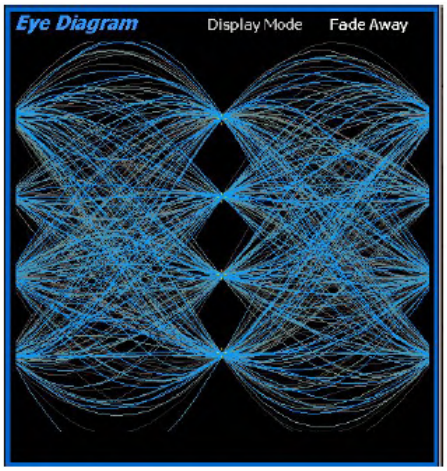
Spectrum Analyzer

In various digital protocol Test Modes, access to the Spectrum Analyzer is offered via the DISPLAY Zone. For an overview of its functionality, see **"Introducing the Spectrum Analyzer" on page 90**. For a detailed reference of its parameter settings, see **"Spectrum Analyzer Soft Keys" on page 503**.

Eye Diagram

In various digital protocol Test Modes, access to the Eye Diagram is offered via the DISPLAY Zone. This specialized configuration of the Oscilloscope provides a visual display of the received digital modulation signal and overlays the modulation response during two symbol periods over the four target crossing points of an ideal signals, as shown on the left below. The diagram indicates whether a transmitter has significant unbalances or offsets in the modulation circuitry by noting how tightly grouped the waveform is around the crossing points. Be sure that the Monitor Modulation Type in the digital Test Mode Zone is set for the expected transmitted digital modulation signal in order to establish the appropriate symbol timing used to position the diagram on the horizontal axis.





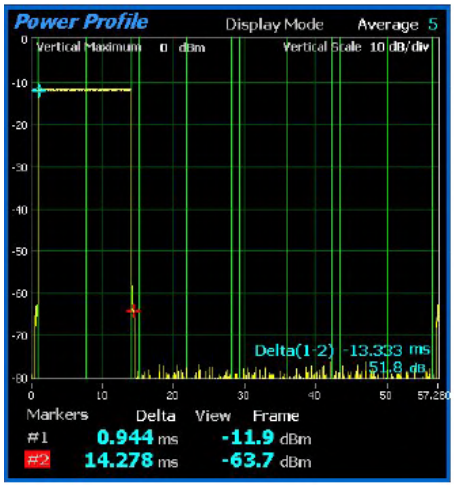
The display includes a Fade Away setting that is similar to the Persistence Mode on an oscilloscope, shown on the right above. The intensity of each trace fades away or decays as new traces are received. The effect is to intensify the display in the area where the waveform spends most of its time.

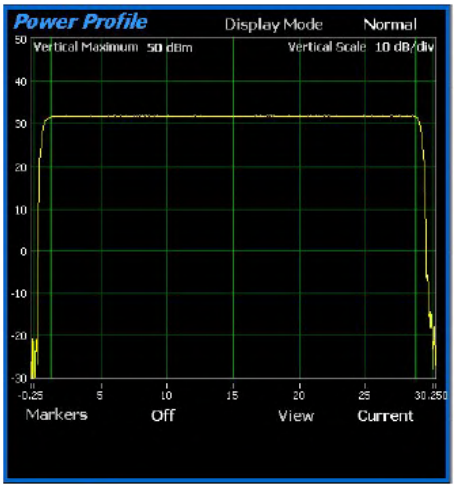
NOTE Whenever the Display Mode is changed, the R8200 reconfigures the presentation. This process takes approximately 10 seconds and is complete when the new setting appears in the Display Mode field.

Power Profile

The Power Profile display provides a power versus time plot of the transmitted timeslots. This specialized Oscilloscope display is useful for ensuring that near-far situations will not result in co-channel inter-slot interference on the alternate or non-transmission slot and that the power level will be adequate for acceptable BER performance. For more information, see ETSI TS 102 361-1 Electromagnetic compatibility and Radio Spectrum Matters (ERM); Digital Mobile Radio (DMR) Systems; Part 1: "DMR Air Interface (AI) protocol," section 10.2.3 Burst timing on page 114.

The scaling and position of the vertical power axis can be adjusted to inspect greater range or detail. The horizontal axis can be changed to view one or both slots including the additional ramp up/down time. Advanced display functions are available: two markers for advanced analysis, shown on the left below as well as overlays of slot centers and burst time regions, shown on the right.



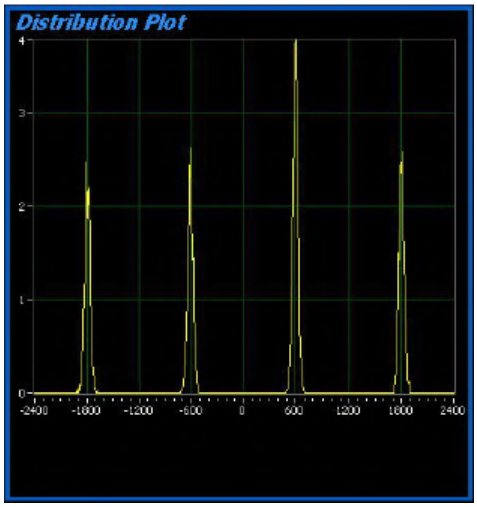


Advanced sweep display modes are also available in the Power Profile display to enhance the usefulness of the measurement trace. Freeze mode provides a snapshot of the current display and terminates the display sweep. Max Hold mode retains the highest peak signal amplitudes measured during continuous successive sweeps. In Average mode, the displayed trace is a rolling average of peak amplitude measured on up to five successive sweeps.

Distribution Plot

This selection displays a graph showing the distribution of symbol deviations of the received signal grouped into frequency bins of 10 Hz or less (i.e., the frequency offset versus the rate of occurrence of that frequency). Each plot consists of at least a second of the most current data available. The protocol consists of four symbol values at

proportional carrier deviations. The four ideal symbol deviations are labeled at gridlines. Additional gridlines half way between labels divide the plot into four equal regions and mark the thresholds where symbol decisions change from one to the other, as shown below.

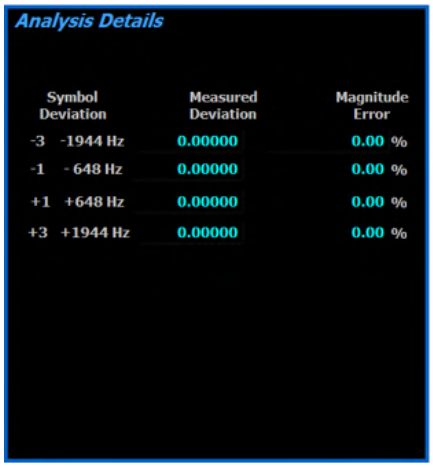


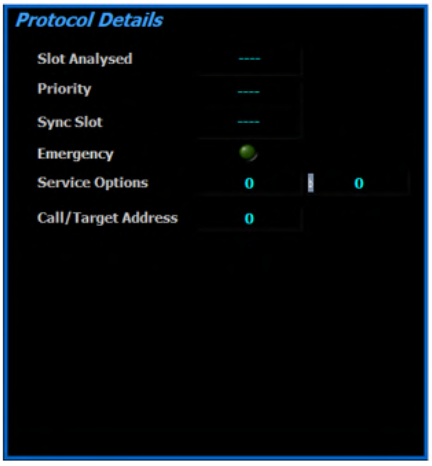
For example, in low power conditions, noise may cause a symbol's deviation to appear in the adjacent region, thus causing a bit error. All distribution amounts are displayed by automatic adjustment of the vertical axis scaling to show the full amount of symbols falling into each bin. Distribution amounts are the percentage of the number of symbols whose deviation falls within that point's frequency bin based on the number of symbols in the analysis population. The better a signal is, the more symbols will actually land in the ideal bin to increase its percentage. Deviations that are past the graph edge limits (e.g., for noise if no signal exists) are collected and shown in the bin at the limit.

NOTE Sample timing is dependent on the modulation time imposed by a particular digital protocol. For example, sampling is at symbol times for HDQPSK but halfway between symbol times for HCPM. Intersymbol interference inherent in the modulations causes some overshoot exhibited by groups being further from center and having multiple peaks.

Analysis and Protocol Details

The DMR Test Mode includes specialized displays of analysis and protocol details, as shown on the left and right respectively below.





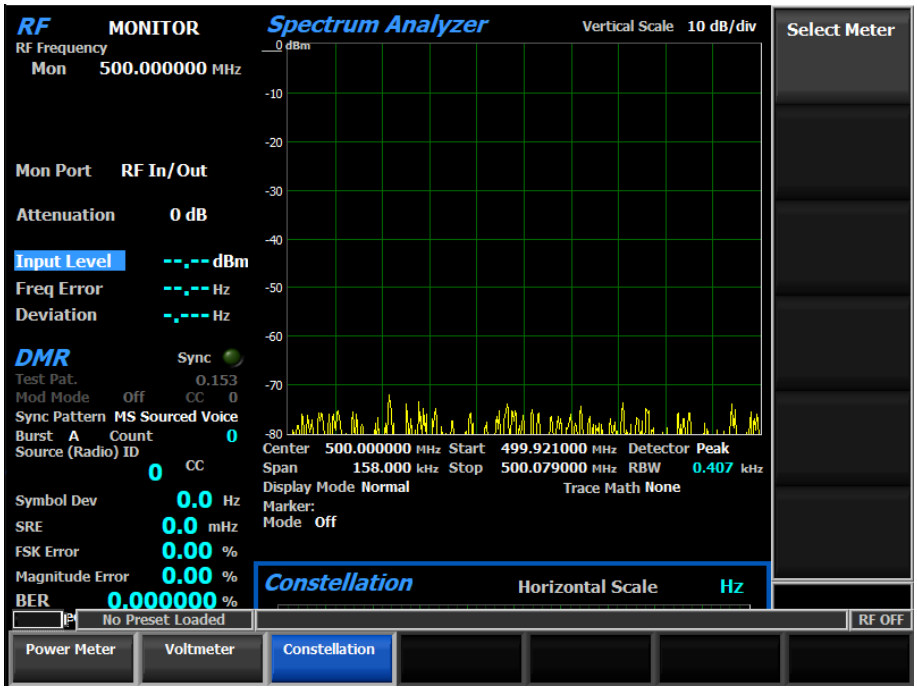
Analysis Details offers the measured deviation and error magnitude for each of the four symbol deviation frequencies. Protocol Details offers details of the configuration during performance verification testing for documentation purposes.

While the analyzer is operating in DMR Test Mode, the DISPLAY Zone soft key menus contain the parameter settings for RF measurement and baseband configuration and measurement.

For DISPLAY Zone soft keys unique to DMR Test Mode, see **"DISPLAY Zone Soft Keys for DMR Transmitter Test" on page 587**. For a complete soft key reference for the DISPLAY Zone, see **"DISPLAY Zone Soft Keys for Duplex Mode" on page 474**.

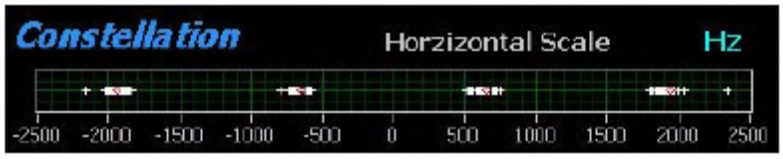
The METER Zone

In DMR Test Mode, the METER Zone is preloaded with a Constellation Meter. A Power Meter and a Voltmeter are also available by pressing **Hot Key 5** > **Select Meter** and choosing the desired selection, as shown.



Constellation Meter

The Constellation Meter provides a visual representation of overall transmitter performance, as shown below.



Several digital radio protocols broadcast voice and data using four frequency shift deviations of the carrier to represent symbols containing two data bits. Four red tick marks on the display represent the ideal target frequencies for the deviation states when the radio is transmitting data bit symbols. White tick marks show the measured frequency deviation at symbol decision times. A tighter grouping of white tick marks around the red targets indicates increased transmitter performance.

Power Meter

See **"Power Meter" on page 97**.

Voltmeter

See **"Voltmeter" on page 97**.

While the analyzer is operating in DMR Test Mode, the METER Zone soft key menus contain all of the parameter settings for RF and baseband measurement metering. For METER Zone soft keys unique to DMR Test Mode, see **"METER Zone Soft Keys for DMR Transmitter Test" on page 593**. For a complete soft key reference for the METER Zone, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

To learn about using the R8200 to service portables, mobiles, and system infrastructure employing the DMR protocol, turn to **"Using DMR Test Mode" on the next page**.

Using DMR Test Mode

This section provides an example measurement using the analyzer's DMR Mode. Complete this procedure to make an initial verification of a portable radio's digital signal processing without the need for specialized power supplies, test boxes, or radio service software. It can be completed using only the radio, a single BNC cable, and two adapters.

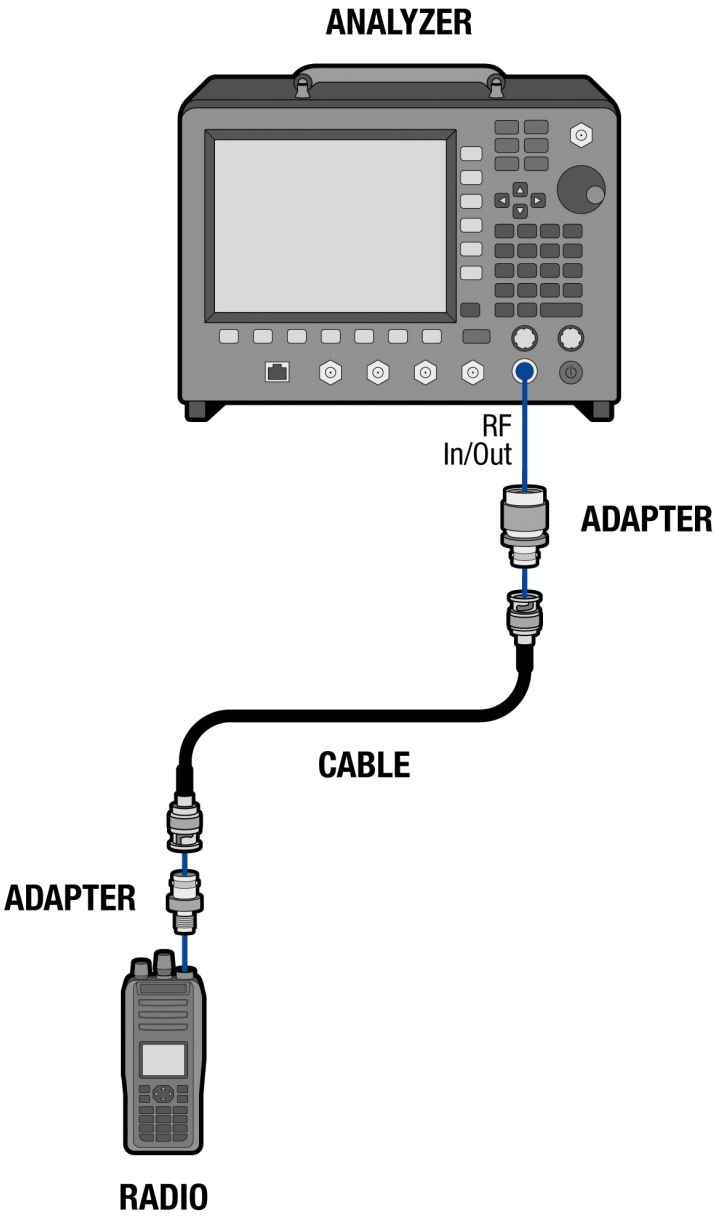
Transceiver Verification

This section describes a simple procedure for verifying the basic functionality of the radio's RF transceiver and physical layer protocol using the R8200 in DMR Mode. Follow these steps to connect the radio to the R8200 and configure your measurement.

Required Equipment

- Freedom R8200 Communications System Analyzer
- Portable Radio, programmed for DMR (i.e., Motorola XPR7550E or Kenwood NX5000 or similar)
- Cable, coax, BNC (m-m)
- Adapter, Type N(f)-to-BNC(f)
- Adapter, SMA(f)-to-BNC(f)

Test Setup



Procedure

Steps	Actions	Notes
1. Configure the test setup.	**a.** Connect the Type N(f)-to-BNC(f) adapter to the R8200's RF In/Out port. **b.** Remove the antenna from the radio. **c.** Connect the SMA(f)-to-BNC(f) Adapter to the Antenna port of the radio. **d.** Connect the BNC cable between the radio and the R8200.	
2. Configure the R8200.	**a.** To access the DMR test mode press **Test** > **Test Mode** > **DMR.** **b.** Press **Monitor**. **c.** To set the receiver Center Frequency to match the radio transmitter, press **Hot Key 1** > **Monitor Frequency** > **851** > **MHz.** **d.** In the RF Zone, confirm that Mon Port displays **RF In/Out** as the receiver's input.	Alternatively, press **RF Zone** > > **Monitor Frequency** > **851** > **MHz**. If not, press **Mon Port** > **RF In/Out** > **Enter.**
3. Activate and key the radio.	**a.** Turn the On/Off/Volume Knob clockwise to activate the radio. **b.** Press **PTT** on the portable.	This initiates a broadcast of the voice content picked up by the radio microphone.
4. Observe the DISPLAY Zone.	**a.** Confirm that the Spectrum Analyzer displays the radio's transmitted carrier signal.	You should observe a jump in signal on Spectrum Analyzer. Allow time for auto attenuation to activate and sta-

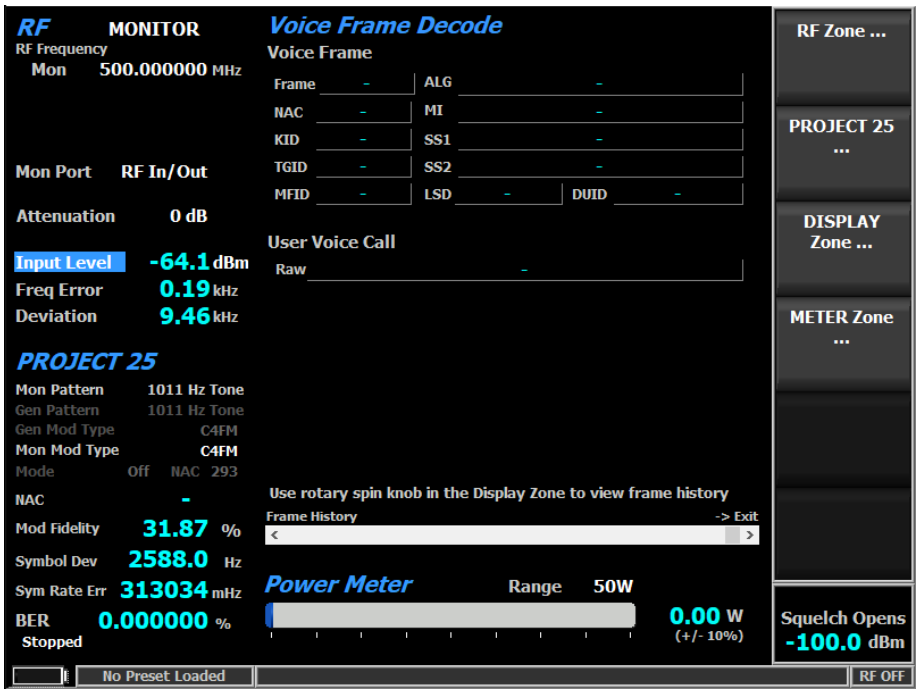
Steps	Actions	Notes
		bilize the Spectrum Analyzer level.
5. Observe the RF Zone**.**	**a.** Confirm that the Input Level displays the radio's output as approximately **3 W**. **b.** Confirm that the Freq Error displays the radio's frequency error as **less than 100 Hz**.	This verifies the performance of the radio's RF transmitter.
6. Observe the DMR Zone.	**a.** Note the SYNC LED is illuminated. Confirm that CC displays a valid Color Code. **b.** Confirm that **FSK error** displays **less than 5%**. **c.** Confirm that **Magnitude Error** displays **less than 1%**.	This verifies that the radio correctly encoding the DMR message content. Having confirmed these transmission parameters, you can verify that the transmitter on this radio is working properly in DMR Test Mode.
7. Configure the R8200.	**a.** To set the transmitter Generate Frequency to match the radio receiver, press **Duplex** > **Hot Key 1** > **Generate Frequency** > **851** > **MHz**. **b.** To Copy the CC to the Generator, press **Hot Key 4** > **More** > **Copy CC to Generator**. **c.** To generate a standard DMR test pattern, press **Hot Key 4** > **Test Pattern** > **1031 Hz Tone**. **d.** To modulate the RF carrier, press **Modulation Mode** > **Continuous**.	Alternatively, press **Hot Key 1** > **Copy Frequency to Generator**.
8. Listen for the 1031 Hz tone broadcast from the radio's speaker.	**a.** Adjust the volume of the 1031 Hz tone using the radio's	This verifies that the radio correctly decodes the DMR baseband content.

Steps	Actions	Notes
	On/Off/Volume Knob.	
9. Test the sensitivity of the radio.	**a.** To adjust the Output Level of the R8200, press **Hot Key 1** > **Output Level**.	
	b. Use the arrow keys and the tuning knob to decrease the Output Level until the 1031 Hz tone is no longer broadcast from the radio speaker.	
	c. Confirm that the RF Output Level on the R8200 is less than –120 dBm when the tone disappears.	This confirms that the radio receiver is sensitive to transmissions as weak as –120 dBm.

Having confirmed these parameters, you can verify that the transceiver on this radio is working properly in DMR Test Mode.

Introducing PROJECT 25 Test Mode

The optional R8200 PROJECT 25 (P25) Test Mode allows testing of conventional (non-trunked) APCO Project 25 phase 1 (P25) compliant mobile stations (radios) and base stations (repeaters) in simplex and duplex modes. P25 radios use a digital transmission format employing Continuous 4 level FM (C4FM) modulation. P25 repeaters may also transmit LSM (Linear Simulcast Modulation) and WCQPSK (wide Continuous Quadrature Phase Shift Keying) modulation schemes, which are compatible with C4FM receivers. The R8200 PROJECT 25 Test Mode provides test functions compliant with the TIA/EIA-102.CAAA measurement standard. These include Modulation Fidelity, Symbol Deviation, Symbol Rate Error, Bit Error Rate (BER) test patterns, Frequency Error, and Power. A means is provided to change the Network Access Code (NAC) and edit the P25 Voice Frame to adapt to the system under test. In addition, the PROJECT 25 Test Mode is equipped with a Spectrum Analyzer, Oscilloscope, Bar Graphs, Eye Diagram, Voice Frame Decode, Constellation Plot and Distribution Plot as well as a Voice Loopback function that enables the Voice Loop feature (U.S. patent 5703479) for audio verification of the radio's end-to-end operation.



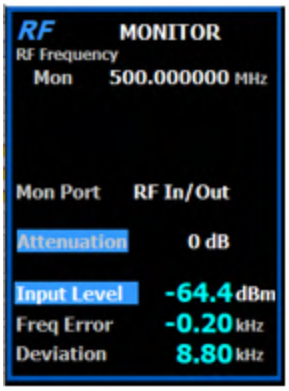
Pressing **Test** > **Test Mode** > **PROJECT 25** configures the R8200 for PROJECT 25 protocol testing, as shown above. On the R8200 main display, the Standard Mode AUDIO Zone and associated soft keys are replaced by the PROJECT 25 Zone and PROJECT 25-specific soft keys (accessed by pressing the **PROJECT 25** soft key).

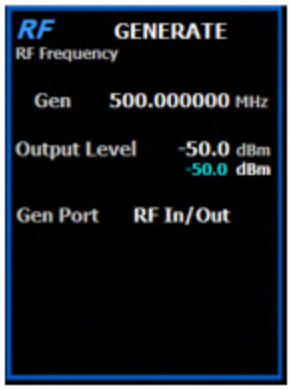
NOTE

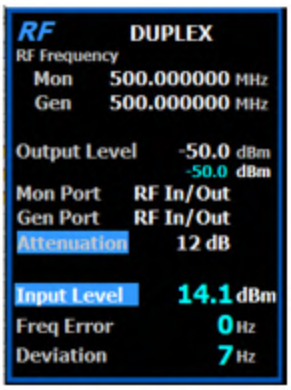
The manufacturer's Radio Service Software (RSS) is required to perform some tests in P25 Mode because certain measurements (BER) require placing the radio in a special test mode. Tests that do not require RSS include Power, Frequency Error, Modulation Fidelity, Symbol Deviation, and Symbol Rate Error. Averaging can be applied to some measurements via the System Settings. The Eye Diagram, Constellation Plot, Distribution Plot, and Voice Loopback also provide qualitative indication of the radio's performance.

The RF Zone

In PROJECT 25 Test Mode, the RF Zone displays parameters associated with the PROJECT 25 carrier stimulus generated by the R8200 as well as measurements of the RF transmissions received from the radio under test. The RF Zone during PROJECT 25 transmitter testing with the R8200 in Monitor (below left) and Duplex Mode (below right), while the RF Zone during PROJECT 25 receiver testing (with the R8200 in Generate Mode) is shown in the center below.







During PROJECT 25 Test Mode, the RF Zone offers the following measurement displays:

Input Level – Displays the average power in the specified Burst of the synchronized TDMA slot of the received signal.

NOTE

Although Input Level is used for Squelch, Squelch has no effect on measurement updates.

When the RF input power on the RF In/Out port is above +20 dBm (100 mW), the R8200 utilizes a broadband power detector for the measurement. The Input Level field in the RF Zone changes to Watt Meter to indicate this measurement mode. For best accuracy disable the Pre-amplifier in Monitor Mode, and set the Gen Port in Generate Mode to RF In/Out.

Watt Meter – Displays the level of broadband power applied to the RF In/Out port when the RF input power on the RF In/Out port is above +20 dBm (100 mW).

Freq Error – Displays the difference between the received PROJECT 25 carrier frequency and the R8200 Monitor Frequency.

Deviation – Displays the negative and positive peak frequency deviation of a modulated carrier (i.e., from the Frequency Error mean), available when Modulation Mode is FM.

While the analyzer is operating in PROJECT 25 Test Mode, the RF Zone soft key menus contain all of the parameter settings for the controlling the R8200 RF output. For a complete soft key reference for the RF Zone, see **"RF Zone Soft Keys for Duplex Mode" on page 441**.

The PROJECT 25 Zone

While operating in PROJECT 25 Test Mode, the AUDIO Zone and associated soft keys are replaced by the PROJECT 25 Zone and PROJECT 25-specific soft keys. The PROJECT 25 Zone displays the physical layer parameters that can be configured to encode and decode PROJECT 25 content. The PROJECT 25 Zone is shown in Monitor Mode on the left, Generate Mode in the middle, and Duplex Mode on the right, below.

The PROJECT 25 Zone offers the following measurement displays:

NAC – The Network Access Code is displayed as hexadecimal 000 to FFF and decoded from the P25 embedded signaling data in the voice frames of the radio or system under test. NAC is digital ID information equivalent to CTCSS/PL and CDCSS/DPL in analog FM radio systems. The R8200 can receive transmissions from a radio under test pro-

grammed with any NAC, but the radio requires the R8200 to transmit the specific NAC programmed into the radio. See **"Copy NAC to Generator (Project 25 submenu)" on page 606** to configure the R8200 to transmit back to that radio.

Mod Fidelity – Modulation Fidelity (FSK error) represents how accurately a P25 transmitter reproduces an ideal theoretical modulation waveform. The measurement is performed by first removing frequency error and symbol deviation gain error from the received signal, then computing the RMS difference between the deviation of the resulting signal at each symbol decision point and the ideal deviations of those symbols; no bit errors should be detected. On the R8200 this is computed over a 72 symbol interval and reported as an RMS error in % relative to the mean deviation across symbols.

Symbol Dev – Provides the deviation measurement at symbol decision times. P25 radios broadcast voice and data using a four level frequency deviation of the carrier to represent symbols containing data bits as shown in the table below. The nominal deviation value for a Project 25 radio using C4FM modulation is 1800 Hz. Since the deviation of a Project 25 C4FM signal is data dependent, that aspect is factored when measuring overall carrier deviation.

Bits	Symbol	Carrier Frequency Deviation
01	+3	+1800 Hz
00	+1	+600 Hz
10	–1	–600 Hz
11	–3	–1800 Hz

Sym Rate Err – Provides a measurement of the transmitter symbol rate accuracy, the difference of the actual minus the ideal. Thus, a positive error indicates that the transmitter clock is too fast. P25 standard TIA-102.CAAB-B 3.2.17 Symbol Rate Accuracy states that the symbol rate error shall not exceed 10 PPM, which is ± 48 mHz given the ideal symbol rate of 4800 baud. The measurement is designed to provide much better accuracy by continually refining the measurement over time. A Reset Symbol Rate Error soft key is provided to restart the measurement.

BER – Displays the percentage of bit differences between the bits of the Test Pattern and the bits from the received synchronized TDMA signal. This bit error rate test checks the modulation, encoding, and timing of the transmit signal during the data transmission period. When performing the BER Test, the radio transmitter under test must be placed into a test diagnostic mode with the correct TX test pattern selected using the manufacturer's Radio Service Software (RSS). The test is done at nominal power with the radio transmitting the test pattern into the service monitor. It is acceptable to have an attenuator between the radio under test and the service monitor.

While the analyzer is operating in PROJECT 25 Test Mode, the PROJECT 25 Zone soft key menus contain all of the R8200 parameter settings for the controlling the PROJECT 25 physical layer. For a complete soft key reference for the PROJECT 25 Zone, see **"PROJECT 25 Zone Soft Keys" on page 602**.

The DISPLAY Zone

During PROJECT 25 Test Mode, the DISPLAY Zone is preconfigured with the Voice Frame Decode display, but also offers a Spectrum Analyzer, Oscilloscope, Bar Graphs, Eye Diagram, Voice Frame Decode, Constellation Plot, and Distribution Plot, accessed by pressing **Select Display**, as shown in the horizontal soft key menu below.

Spectrum Analyzer

See **"Introducing the Spectrum Analyzer" on page 90**.

Oscilloscope

See **"Introducing the Oscilloscope" on page 92**.

Bar Graphs

See **"Bar Graphs" on page 77**.

Eye Diagram

See **"Eye Diagram" on page 152**.

Voice Frame Decode

Provides the decoded data from the P25 embedded signaling. Rotate the tuning knob CCW to view the frame history in the DISPLAY Zone (Frame # indicates the position); Clockwise exits history. The Voice Frame fields are from the header word and interspersed status symbols.

NOTE

The Voice Frame header's TGID and MFID are not displayed; see the User Voice Call fields for the Link Control code word's Group Address and MFID, if applicable.

Although encryption is not supported, Header Word fields and the Link Control Format (LCF) will be displayed correctly because they are not subject to encryption. Therefore, if these fields indicate encryption, other fields will not be displayed correctly. Fields that are subject to encryption include the vocoder information and Link Control information content. See the table below.

Field	Mnemonic	Bits	Notes
Network Identifier	NID	16	
Network Access Code	NAC	12	
Data Unit ID	DUID	4	
Header Word		120	
Message Indicator	MI	72	Encryption is not supported
Manufacturer's ID	MFID	8	Not displayed
Algorithm ID	ALG	8	Encryption is not supported; 80 is unencrypted
Key ID	KID	16	Encryption is not supported
Talk-group ID	TGID	16	Not displayed
Link Control	LC	72	Format varies
Format	LCF	8	
Protected flag	P	1	Encryption is not supported
Standard Format	SF	1	
Opcode	LCO	6	
Content		56	
Low Speed Data	LSD	32	
Status Symbols (6)	SS	12	

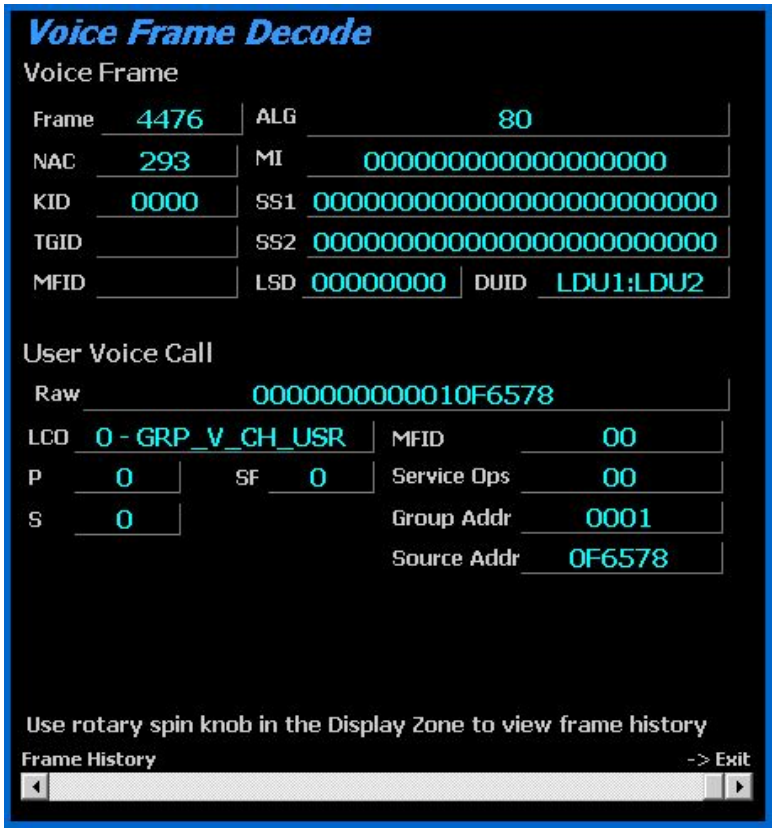
Status symbols are combined by concatenating their binary values but are displayed in hexadecimal. For example, an idle channel that just became busy is displayed as D5 (11010101). See the table below.

Value (binary)	Notes	Transmitter
00	Unknown, use for talk-around	subscriber
01	Inbound Channel is Busy	base station/repeater
10	Unknown, use for inbound or outbound	subscriber
10	Inbound Channel is Idle	base station/repeater

The DUID field is LDU1 if the frame contained just the first Logical Link Control Unit before the terminator. It is LDU1:LDU2 if the frame contains both the first and second before the terminator; they are combined to display the complete information together. See the table below.

Value	DUID	Note
0	HEADER	Header Data Unit
3	TERM	Terminator without LC
5	LDU1	Logical Link Data Unit 1
7	TSBK	Trunking Signaling Data Unit (block)
10 (and 5)	LDU1:LDU2	Logical Link Data Unit 2 (and 1)
12	PDU	Packet Data Unit
14	TERM(LC)	Terminator with LC
-	-	Reserved

The User Voice Call fields are from the Link Control code word.



Raw displays all nine bytes directly; subsequent fields display the same information in individual fields according to the Link Control opcode (LCO), if applicable. The **0 - GRP_V_CH_USR** (Group Voice Channel User) message indicates the user of this channel for group voice traffic on both inbound and outbound messages.

The **3 – LC_U2U_V_CH_USR** (Unit to Unit Voice Channel User) message indicates the user of this channel for unit to unit voice traffic, on both inbound and outbound messages and on conventional and trunked systems.

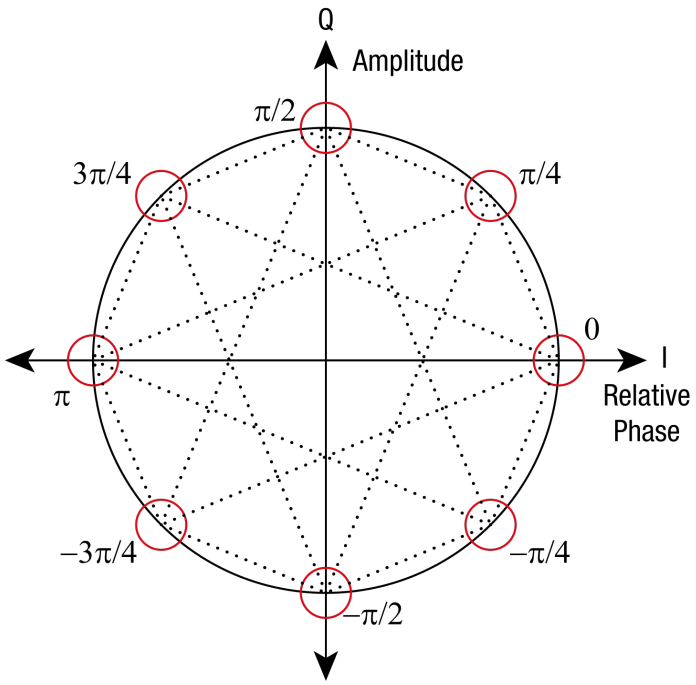
Service options are combined by adding their respective values. For example, Emergency, Duplex, and Highest Priority Level options combined have a value of A1. See the following table.

Name	Mnemonic	Bits	Value	Note
Emergency	E	1	80	
Protected	P	1	40	Encryption is not supported

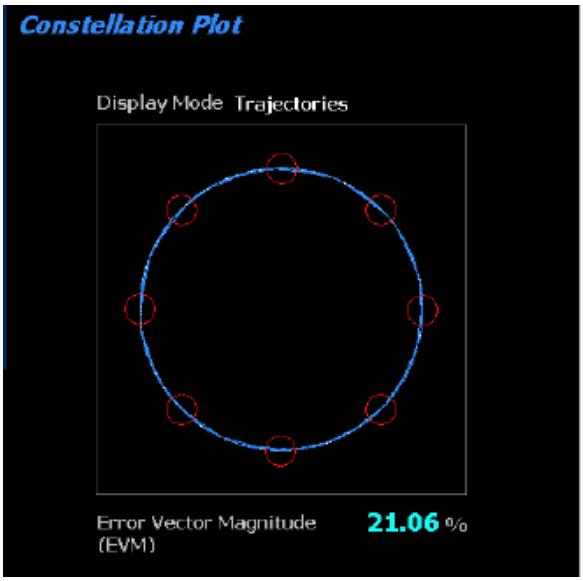
Name	Mnemonic	Bits	Value	Note
Duplex	D	1	20	
Mode	M	1	10	
Reserved	R	1	08	0 is specified
Priority Level		3	01 to 07	Highest to lowest

Constellation Plot

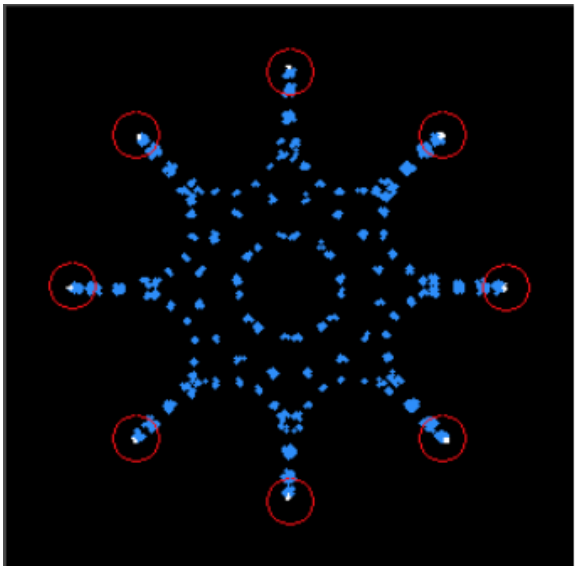
Displays the EVM measurement and a graph showing the symbol constellation on the complex I/Q plane. The display provides a visual representation of general transmitter performance when the Monitor Modulation Type is complex. P25 LSM/WCQPSK radios broadcast voice and data using eight differential phase shift deviations from the carrier to represent symbols containing three data bits. One of eight phase shifts relative to the carrier's current phase yields eight phase points. The phase trajectory never passes through the origin, ensuring that signal amplitude never falls to zero during data transmissions. An ideal constellation is shown below.

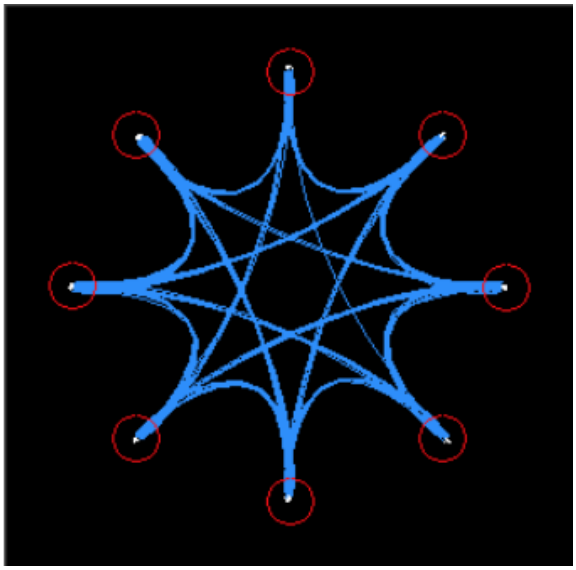


The center of the eight red circles on the display represent the expected locations for the deviation states when the radio is transmitting data bit symbols using the modulation. White dots show the actual deviation measurement at symbol decision times. A tighter grouping within the red circles indicates more accurate transmitter performance. The radius of the circles is the 10% EVM (Peak) limit.



The measurement is executed at the optimal symbol times and positions to exclude the adverse effects of frequency error and residual carrier. Its Display Mode setting enables the plotting of symbols, samples (left, below), or trajectories (right, below). The Error Vector Magnitude (RMS) display provides a quantitative representation of overall transmitter performance.



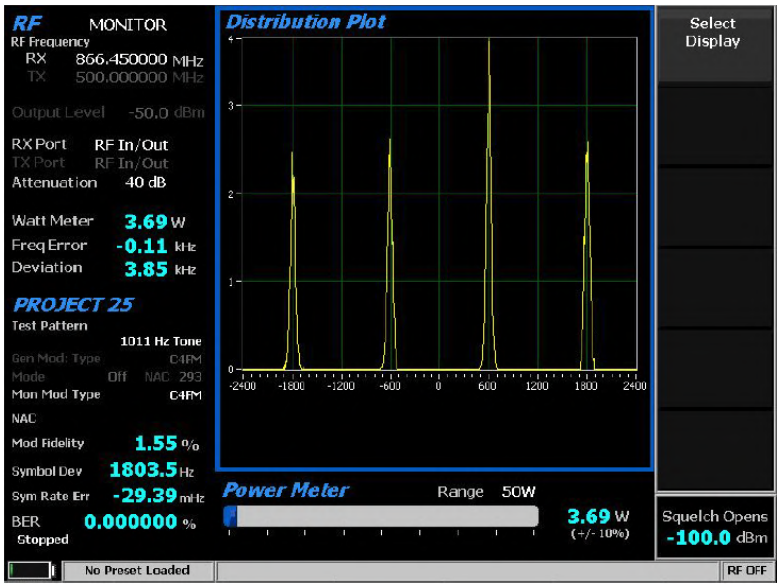


Distribution Plot

Displays a graph showing the distribution of symbol deviations of the received signal grouped into frequency bins of 10 Hz or less (i.e., the frequency offset versus the rate of occurrence of that frequency). Each plot consists of at least a second of the most current data available. The protocol consists of four symbol values (–3, –1, +1, +3) at proportional carrier deviations, as shown below.

Bits	Symbol	Carrier Frequency Deviation
01	+3	+1800 Hz
00	+1	+600 Hz
10	–1	–600 Hz
11	–3	–1800 Hz

The four ideal symbol deviations are labeled at gridlines. Additional gridlines half way between labels divide the plot into four equal regions and mark the thresholds where symbol decisions change from one to the other. A Distribution Plot of a 1011 Hz tone is shown below.

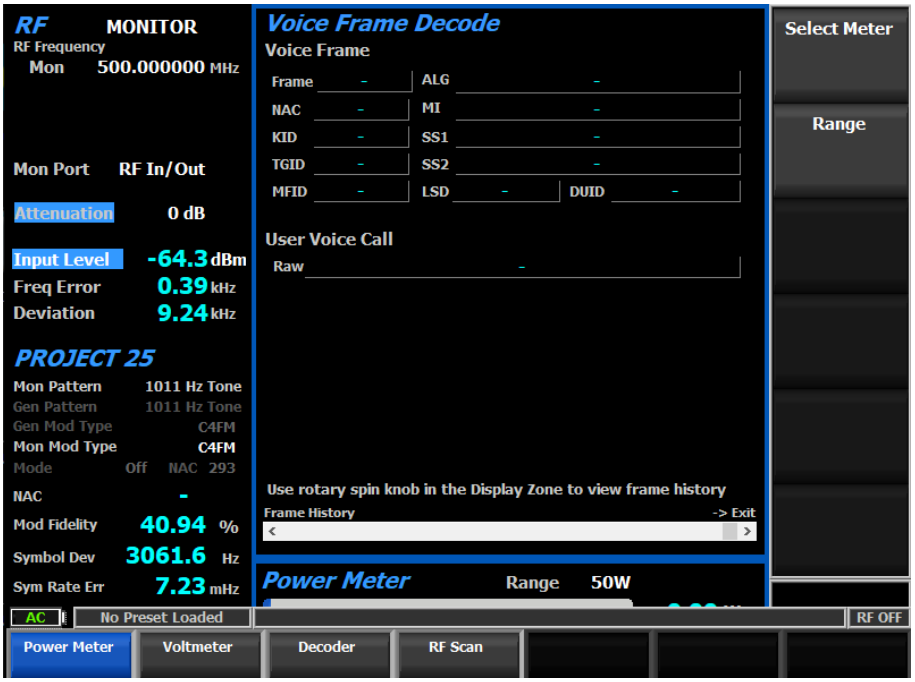


For example, in low power conditions, noise may cause a symbol's deviation to appear in the adjacent region, thus causing a bit error. All distribution amounts are displayed by automatic adjustment of the vertical axis scaling to show the full amount of symbols falling into each bin. Distribution amounts are the percentage of the number of symbols whose deviation falls within that point's frequency bin based on the number of symbols in the analysis population. The better a signal is, the more symbols will actually land in the ideal bin to increase its percentage. Deviations that are past the graph edge limits (e.g., for noise if no signal exists) are collected and shown in the bin at the limit.

While the analyzer is operating in PROJECT 25 Test Mode, the DISPLAY Zone soft key menus contain all of the parameter settings for RF and baseband measurement display. For DISPLAY Zone soft keys unique to PROJECT 25 Test Mode, see **"DISPLAY Zone Soft Keys for PROJECT 25 Transmitter Test" on page 606**. For a complete soft key reference for the DISPLAY Zone, see **"DISPLAY Zone Soft Keys for Duplex Mode" on page 474**.

The METER Zone

In PROJECT 25 Test Mode, the METER Zone is preloaded with a Power Meter, as shown.



A Voltmeter, Decoder and RF Scan Meter are also available by pressing **Hot Key 5** > **Select Meter** and choosing the desired selection.

Power Meter

See **"Power Meter" on page 97**.

Voltmeter

See **"Voltmeter" on page 97**.

Decoder

See **"Decoder" on page 98**.

RF Scan

"RF Scan" on page 102.

While the analyzer is operating in PROJECT 25 Test Mode, the METER Zone soft key menus contain all of the parameter settings for RF and baseband measurement metering. For METER Zone soft keys unique to PROJECT 25 Test Mode, see **"DISPLAY Zone Soft Keys for PROJECT 25 Transmitter Test" on page 606**. For a complete soft key reference for the METER Zone, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

To learn about using the R8200 to service portables, mobiles, and system infrastructure employing the PROJECT 25 protocol, turn to **"Using PROJECT 25 Test Mode" on the next page**

Using PROJECT 25 Test Mode

This section provides an example measurement using the analyzer's PROJECT 25 Test Mode. Complete this procedure to make an initial verification of a portable radio's digital signal processing without the need for specialized power supplies, test boxes, or radio service software. It can be completed using only the radio, a single BNC cable, and two adapters.

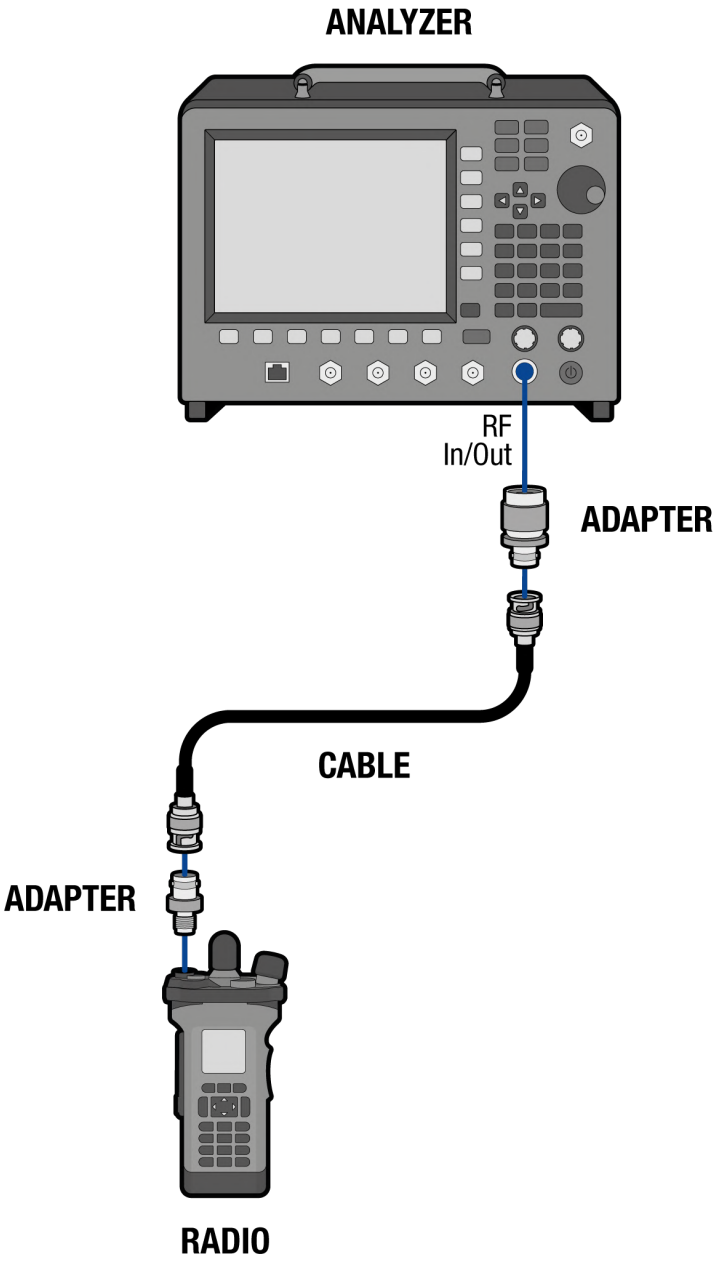
Transceiver Verification

This section describes a simple procedure for verifying the basic functionality of the radio's RF transceiver using the R8200 in PROJECT 25 Test Mode. Follow these steps to connect the radio to the R8200 and configure your measurement.

Required Equipment

- Freedom R8200 Communications System Analyzer
- Portable Radio, programmed for Project 25 (i.e., Motorola APX 6000 or similar)
- Cable, coax, BNC (m-m)
- Adapter, Type N(f)-to-BNC(f)
- Adapter, SMA(f)-to-BNC(f)

Test Setup



Procedure

Steps	Actions	Notes
1. Configure the test setup.	**a.** Connect the Type N(f)-to-BNC(f) adapter to the R8200's RF In/Out port.	
	b. Remove the antenna from the radio.	
	c. Connect the SMA(f)-to-BNC(f) Adapter to the Antenna port of the radio.	
	d. Connect the BNC cable between the radio and the R8200.	
2. Configure the R8200.	**a.** Press **Monitor**.	
	b. To set the receiver Center Frequency to match the radio transmitter, press **Hot Key 1** > **Monitor Frequency** > **851** > **MHz**.	Alternatively, press **RF Zone** > > **Monitor Frequency** > **851** > **MHz**.
	c. In the RF Zone, confirm that Mon Port displays **RF In/Out** as the receiver's input.	If not, press **Mon Port** > **RF In/Out** > **Enter.**
	d. Auto Attenuation is selected per system default. No need to adjust attenuation with Auto Attenuation.	
	e. To access the PROJECT 25 Test Mode, press **Test** > **Test Mode** > **PROJECT 25**.	This opens the PROJECT 25 Test menu.
3. Activate and key the radio.	**a.** Turn the On/Off/Volume Knob clockwise to activate the radio.	This initiates a broadcast of the voice content picked up by the radio micro-

Steps	Actions	Notes
	b. Press **PTT** on the portable.	phone.
4. Observe the DISPLAY Zone.	**a.** Confirm that the analyzer is decoding the radio's transmitted Voice Frame Data.	You should observe change in the Voice Frame Data display.
5. Observe the RF Zone**.**	**a.** Confirm that the Input Level displays the radio's output as approximately **3 W**. **b.** Confirm that the Freq Error displays the radio's frequency error as **less than 100 Hz**.	This verifies the performance of the radio's RF transmitter.
6. Observe the PROJECT 25 Zone.	**a.** Confirm that NAC displays a valid Network Access Code. **b.** Confirm that Mod Fidelity displays **less than 1%**. **c.** Confirm that Symbol Dev displays **less than 2 kHz**.	This verifies that the radio correctly encoding the PROJECT 25 message content. Having confirmed these transmission parameters, you can verify that the transmitter on this radio is working properly in PROJECT 25 Test Mode.
7. Configure the R8200.	**a.** To set the transmitter Generate Frequency to match the radio receiver, press **Hot Key 1** > **Generate Frequency** > **851** > **MHz**. **b.** To Copy the NAC to the Generator, press **Hot Key 4** > More > **Copy NAC to Generator**. **c.** To begin transmitting RF from the R8200, press **Hot Key 1** > **Gen Port RF In/Out.** **d.** To generate a standard P25 test pattern, press **Hot Key 4** > **Gen Test Pattern** > **1011 Hz Tone**.	

Steps	Actions	Notes
	e. To modulate the RF carrier, press **Modulation Mode** > **Continuous**.	
8. Listen for the 1 kHz tone broadcast from the radio's speaker.	**a.** Adjust the volume of the 1011 Hz tone using the radio's On/Off/Volume Knob.	This verifies that the radio correctly decodes the PROJECT 25 baseband content.
9. Test the sensitivity of the radio.	**a.** To adjust the Output Level of the R8200, press **Hot Key 1** > **Output Level**.	
	b. Use the arrow keys and the tuning knob to decrease the Output Level until the 1011 Hz tone is no longer broadcast from the radio speaker.	
	c. Confirm that the RF Output Level on the R8200 is less than –120 dBm when the tone disappears.	This confirms that the radio receiver is sensitive to transmissions as weak as –120 dBm.

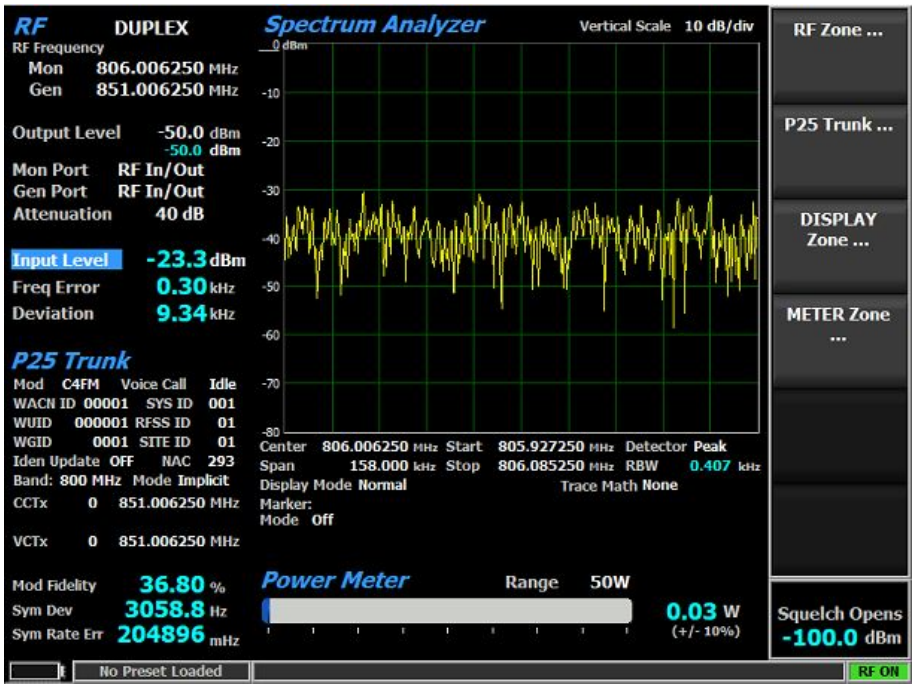
Having confirmed these parameters, you can verify that the transceiver on this radio is working properly in PROJECT 25 Test Mode.

Introducing P25 Trunk Mode

The optional R8200 P25 Trunk Test Mode allows testing of trunked APCO Project 25 (P25) compliant radios. P25 mobile stations (radios) use a digital transmission format employing Continuous 4 level FM (C4FM) modulation. The R8200 P25 Trunk Mode simulates the functions of a Project 25 central controller with the control and voice channel protocols needed for various tests. The simulation can be configured to generate C4FM as well as LSM (Linear Simulcast Modulation) and WCQPSK (wide Continuous Quadrature Phase Shift Keying). The R8200 P25 Trunk Test Mode provides test functions compliant with the trunked APCO Project 25 measurement standard. These include Modulation Fidelity, Symbol Deviation, Symbol Rate Error, TIA/EIA-102.CAAA compliant Bit Error Rate (BER) test patterns, Frequency Error, and Power. Also included are Frequency Error and Power meters, a Spectrum Analyzer, Oscilloscope, Eye Diagram, and Distribution Plot with graphical representation of the P25 signal, and modulation signal quality meters.

A Voice Loop feature (U.S. patent 5703479) is engaged for audio verification of the radio's end-to-end operation after the subscriber unit transmits. During a Voice Call, the R8200 automatically records voice channel data while the subscriber unit PTT is pressed then retransmits it to provide audio verification of the radio's end-to-end operation.

NOTE The manufacturer's Radio Service Software (RSS) is required to perform some tests in P25 Trunk Mode because certain measurements (BER) require placing the radio in a special test mode.



Pressing **Test** > **Test Mode** > **P25 Trunk** configures the R8200 for P25 Trunk protocol testing, as shown above. On the R8200 main display, the Standard Mode AUDIO Zone and associated soft keys are replaced by the P25 Trunk Zone and P25 Trunk-specific soft keys (accessed by pressing the **P25 Trunk** soft key).

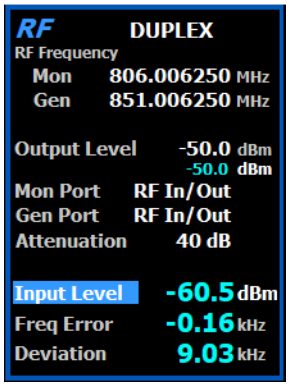
The RF Zone

When the P25 Trunk Test Mode is selected, the R8200 is automatically placed in Duplex Mode and begins transmitting idle messages on the control channel with no encryption. While the RF Zone is typically used to configure various settings such as input and output frequency, output level, attenuation, and ports, unlike the conventional PROJECT 25 Test Mode, the Monitor Frequency and Generate Frequency soft keys are not available in P25 Trunk Test Mode. These parameters are determined by settings displayed in the P25 Trunk Zone. They car be altered using the associated soft keys or via entries in the Bandplan Table.

NOTE

RF Zone Monitor and Generate frequency settings can be changed for the BER Test. Otherwise, they are read-only and updated in real-time to show the control channel frequencies or the voice channel frequencies that are in use.

The RF Zone during P25 Trunk transceiver testing (with the R8200 in Duplex Mode) is shown, below.



During P25 Trunk Test Mode, the RF Zone offers the following measurement displays:

Input Level – Displays the average power in the specified Burst of the synchronized TDMA slot of the received signal.

NOTE

Although Input Level is used for Squelch, Squelch has no effect on measurement updates.

When the RF input power on the RF In/Out port is above +20 dBm (100 mW), the R8200 utilizes a broadband power detector for the measurement. The Input Level field in the RF Zone changes to Watt Meter to indicate this measurement mode. For best accuracy, disable the Pre-amplifier in Monitor Mode and set the Gen Port in Generate Mode to RF In/Out.

Watt Meter – Displays the level of broadband power applied to the RF In/Out port when the RF input power on the RF In/Out port is above +20 dBm (100 mW).

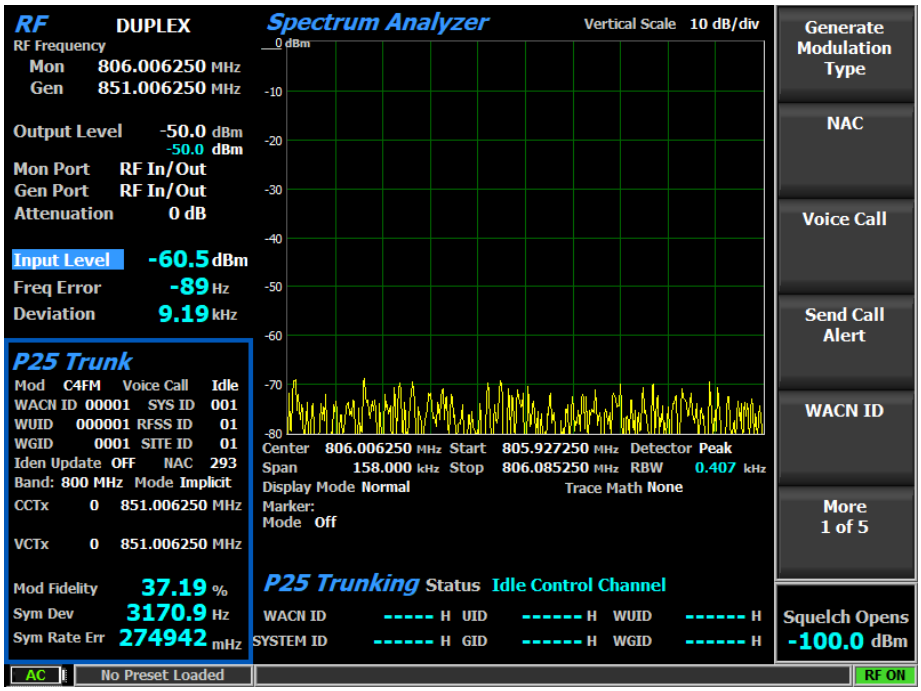
Freq Error – Displays the difference between the received PROJECT 25 Trunk carrier frequency and the R8200 Monitor Frequency.

Deviation – Displays the negative and positive peak frequency deviation of a modulated carrier (i.e., from the Frequency Error mean), available when Modulation Mode is FM.

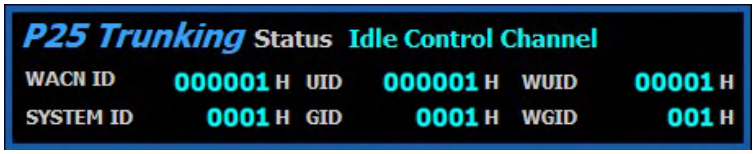
While the analyzer is operating in P25 Trunk Test Mode, the RF Zone soft key menus contain most of the parameter settings for the controlling the R8200 RF output, except for the Mon and Gen Frequencies which are controlled by parameters within the Bandplan Table. For a complete soft key reference for the RF Zone, see **"RF Zone Soft Keys for Duplex Mode" on page 441**.

The P25 Trunk Zone

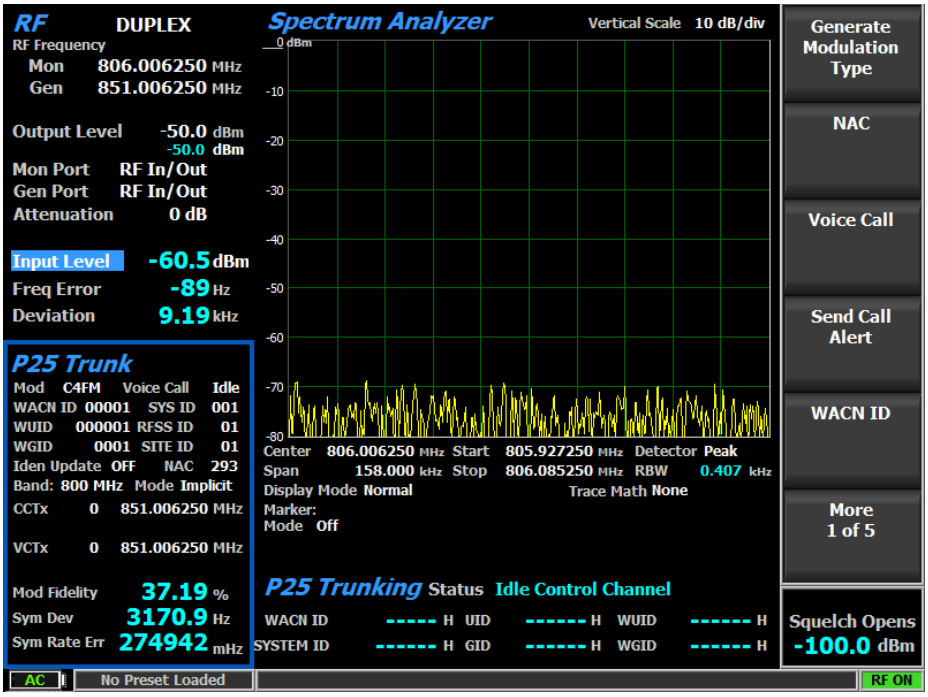
While operating in P25 Trunk Test Mode, the AUDIO Zone and associated soft keys are replaced by the P25 Trunk Zone and P25 Trunk-specific soft keys. The P25 Trunk Zone displays the physical layer parameters that can be configured to encode and decode P25 Trunk content. Pressing **P25 Trunk** displays a submenu with the following settings. The P25 Trunk Zone is shown below.



A P25 trunked radio connected to the R8200 and activated automatically registers with the analyzer if the Band Plan settings are configured for the system under test. The registration progress is shown in the METER Zone Status field, and the radio ID parameters are populated on the display, as shown below.



Once the radio is registered (see above), a voice test using the Voice Loop feature can be performed. Keying the radio under test transitions it to the voice channel, and the R8200 automatically records up to the last 10 seconds of conversation, as long as the signal is above the squelch level setting. Unlike other test modes, the Voice Loop feature is always enabled in P25 Trunk Test Mode. The maximum length of a recording is fixed at 10 seconds. The recording continues if the transmission is longer than this duration, but only the most recent is retained. When the radio is unkeyed, the R8200 initiates a voice call and replays the last recorded conversation; to play another conversation, another recording must be made. This provides a quick end-to-end test of the P25 radio transmitter and receiver. This Voice Loop feature can also be used to verify basic functionality of a P25 radio with an encrypted voice channel.



The P25 Trunk Zone offers the following measurement displays:

Mod Fidelity– Modulation Fidelity (FSK error) represents how accurate a P25 transmitter reproduces an ideal theoretical modulation waveform. The measurement is performed by first removing frequency error and symbol deviation gain error from the received signal, then computing the RMS difference between the deviation of the resulting signal at each symbol decision point and the ideal deviations of those symbols; no bit errors should be detected. On the R8200 this is computed over a 72 symbol interval and reported as an RMS error in % relative to the mean deviation across symbols.

Sym Dev – P25 radios broadcast voice and data using a four level frequency deviation of the carrier to represent symbols containing data bits as shown in the table below. The nominal deviation value for a Project 25 radio using C4FM modulation is 1800 Hz. Since the deviation of a Project 25 C4FM signal is data dependent, that aspect is factored when measuring overall carrier deviation. The Symbol Deviation field provides the deviation measurement at symbol decision times.

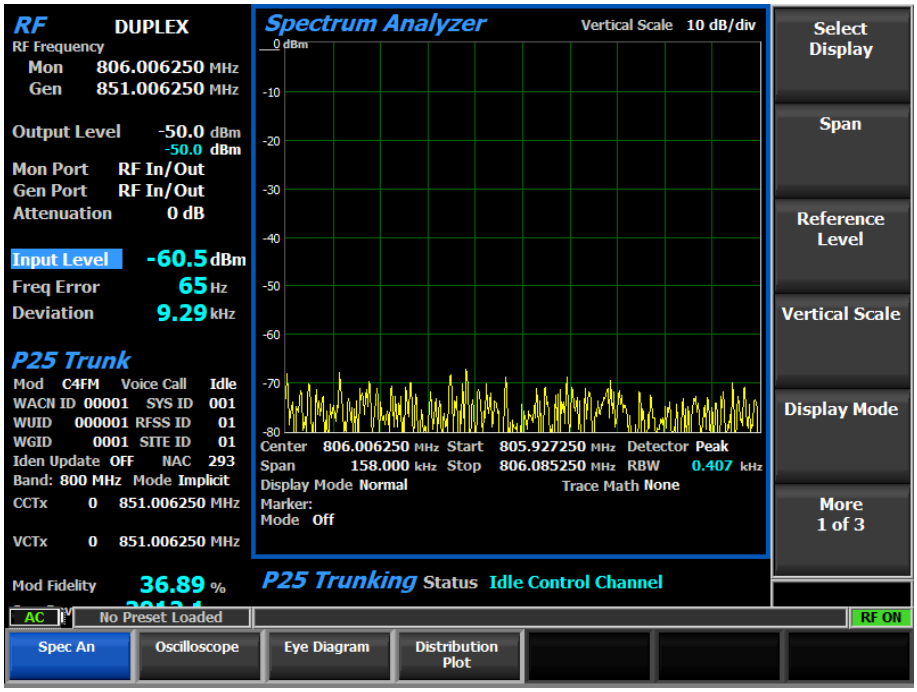
Bits	Symbol	Carrier Frequency Deviation
01	+3	+1800 Hz
00	+1	+600 Hz
10	–1	–600 Hz
11	–3	–1800 Hz

Sym Rate Err – The Symbol Rate Error is a measurement of the transmitter symbol rate accuracy, the difference of the actual minus the ideal. Thus, a positive error indicates that the transmitter clock is too fast. P25 standard TIA-102.CAAB-B 3.2.17 Symbol Rate Accuracy states that the symbol rate error shall not exceed 10 PPM, which is ± 48 mHz given the ideal symbol rate of 4800 baud. The measurement is designed to provide much better accuracy by continually refining the measurement over time. A Reset Symbol Rate Error soft key is provided to restart the measurement.

While the analyzer is operating in P25 Trunk Test Mode, the P25 Trunk Zone soft key menus contain all of the R8200 parameter settings for the controlling the P25 Trunk physical layer. For a complete soft key reference for the P25 Trunk Zone, see **"P25 Trunk Zone Soft Keys" on page 625**.

The DISPLAY Zone

During P25 Trunk Test Mode, the DISPLAY Zone offers the Spectrum Analyzer, Oscilloscope, Eye Diagram, and Distribution Plot, accessed by pressing **Select Display**, as shown in the horizontal soft key menu below.



Spectrum Analyzer

See **"Introducing the Spectrum Analyzer" on page 90**.

Oscilloscope

See **"Introducing the Oscilloscope" on page 92**.

Eye Diagram

See **"Eye Diagram" on page 152**.

Distribution Plot

See **"Introducing PROJECT 25 Test Mode" on page 163**.

While the analyzer is operating in P25 Trunk Test Mode, the DISPLAY Zone soft key menus contain all of the parameter settings for RF and baseband measurement display. For DISPLAY Zone soft keys unique to P25 Trunk Test Mode, see **"DISPLAY Zone Soft Keys for P25 Trunk for Transmitter Test" on page 637**. For a complete soft key reference for the DISPLAY Zone, see **"DISPLAY Zone Soft Keys for Duplex Mode" on page 474**.

The METER Zone

In P25 Trunk Test Mode, the METER Zone is preloaded with a P25 Trunking Meter.

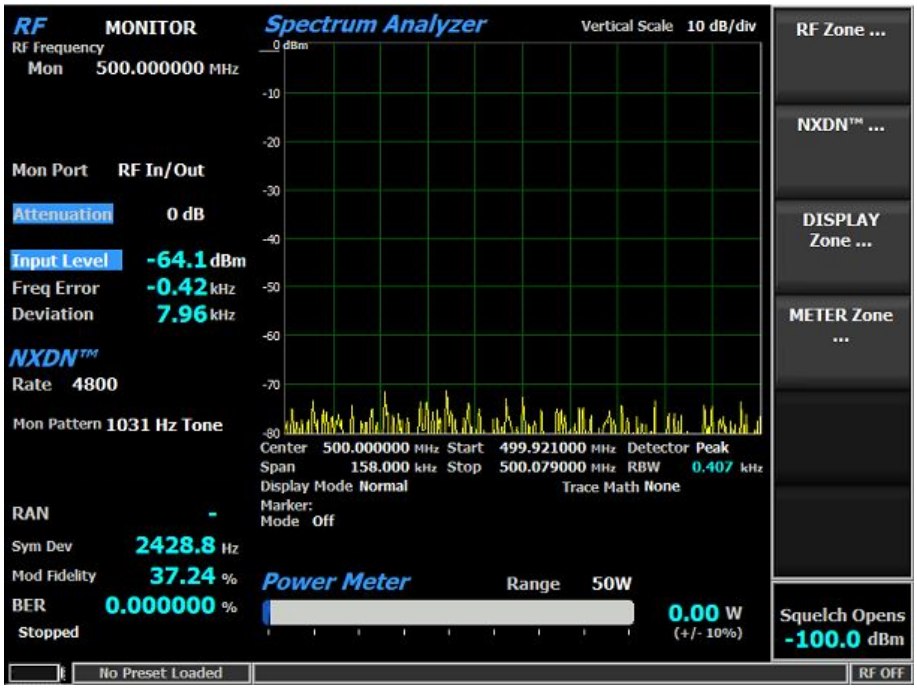
P25 Trunking Meter

A P25 trunked radio connected to the R8200 and activated automatically registers with the analyzer if the Bandplan settings are configured for the radio under test. This meter reports the status of these P25 Trunk Bandplan registration parameters after they have been received and decoded by the R8200.

While the analyzer is operating in P25 Trunk Test Mode, the METER Zone soft key menus contain all of the parameter settings for RF and baseband measurement metering. For METER Zone soft keys unique to P25 Trunk Test Mode, see **"METER Zone Soft Keys for P25 Trunk Transmitter Test" on page 638**. For a complete soft key reference for the METER Zone, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

Introducing NXDN™ Test Mode

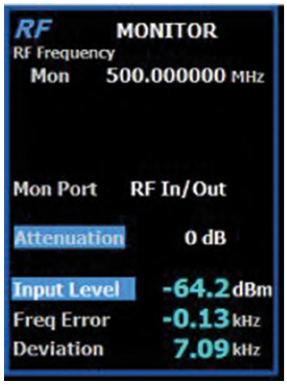
The R8200 NXDN™ Test Package option / NXDN™ Test Mode allows testing of radios compliant with the NXDN™ radio transmission protocol. NXDN™ radios use a digital transmission format employing Four-Level Frequency Shift Keying (4FSK) modulation in an RF spectrum managed by Frequency Division Multiple Access (FDMA) technology. Both 9600 bps and 4800 bps transmission rates are supported. The R8200 NXDN™ Mode provides a grouping of test functions compliant with the Conformance Test section of the NXDN™ Common Air Interface (CAI) standard. These include power, Frequency Error, Symbol Deviation, Modulation Fidelity (FSK Error), Radio Access Number (RAN), audio/test patterns, and Bit Error Rate (BER). BER tests require the manufacturer's Radio Service Software (RSS) to place the radio in a special test mode. In addition, an Eye Diagram with graphical representation of the NXDN™ signal exists as well as a Voice Loopback function that enables the Voice Loop feature (U.S. patent 5703479) for audio verification of the radio's end-to-end operation. Both provide qualitative indication of the radio's performance. Averaging can be applied to some measurements by the System Settings.

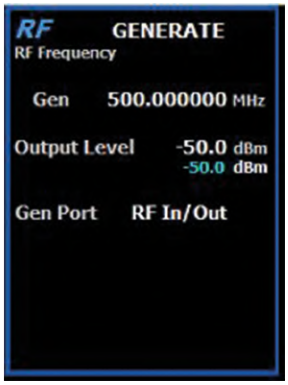


Pressing **Test** > **Test Mode** > **NXDN™** configures the R8200 for NXDN™ protocol testing, as shown above. On the R8200 main display, the Standard mode's AUDIO Zone and associated soft keys are replaced by the NXDN™ Zone and NXDN™-specific soft keys (accessed by pressing the **NXDN™** soft key).

The RF Zone

In NXDN™ Test Mode, the RF Zone displays parameters associated with the NXDN™ carrier stimulus generated by the R8200 as well as measurements of the RF transmissions received from the radio under test. The RF Zone during NXDN™ transmitter testing (with the R8200 in Monitor Mode) is shown on the left while the RF Zone during NXDN™ receiver testing (with the R8200 Generate Mode) is shown on the right, below.





During NXDN™ Test Mode, the RF Zone offers the following measurement displays:

Input Level – Displays the average power in the NXDN™ channel under test.

NOTE

When the RF input power on the RF In/Out port is above +20 dBm (100 mW), the R8200 utilizes a broadband power detector for the measurement. The Input Level field in the RF Zone changes to Watt Meter to indicate this measurement mode. For best accuracy, disable the Pre-amplifier in Monitor Mode and set the Gen Port in Generate Mode to RF In/Out.

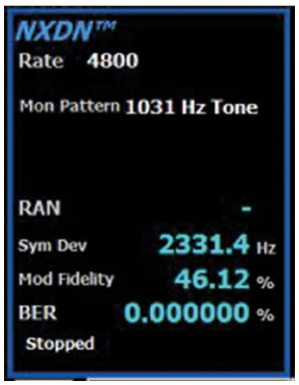
Freq Error – Displays the frequency difference of the received NXDN™ transmission carrier minus the R8200 Monitor Frequency.

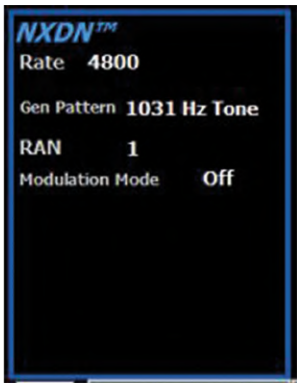
Deviation – Displays the positive peak FM frequency deviation of the received modulated carrier (i.e., from the Frequency Error mean). See negative peak frequency deviation with DISPLAY Zone Bar Graphs.

While the analyzer is operating in NXDN™ Test Mode, the RF Zone soft key menus contain all of the parameter settings for the controlling the R8200 RF output. For a complete soft key reference for the RF Zone, see **"RF Zone Soft Keys for Generate Mode" on page 391**.

The NXDN™ Zone

While operating in NXDN™ Test Mode, the AUDIO Zone and AUDIO Zone soft keys are replaced by the NXDN™ Zone and NXDN™ specific soft keys. The NXDN™ Zone displays the physical layer parameters that can be configured to encode and decode NXDN™ content. The NXDN™ Zone is shown in Monitor Mode on the left and Generate Mode on the right, below.





The NXDN™ Zone offers the following measurement displays:

RAN – Radio Access Number is a six-bit field for the NXDN™ conventional system protocol of the RTCH/RDCH frame in the SACCH field. The R8200 analyzes all NXDN™ transmissions regardless of the transmitted number. See **"NXDN™ Zone Soft Keys" on page 639** for more details.

Sym Dev – Provides the deviation measurement at symbol decision times. NXDN™ radios broadcast voice and data using a four-level frequency deviation of the carrier to represent symbols containing data bits as shown in the table below. The nominal symbol deviation value for an NXDN™ radio using 4FSK modulation is 1050 Hz in a 6.25 kHz channel and 2400 Hz in a 12.5 kHz channel. Since the deviation of an NXDN™ 4FSK signal is data dependent, that aspect is factored when measuring overall carrier deviation.

The NXDN48 (4800 bps) Mode ideal is 1050 Hz and the NXDN96 (9600 bps) Mode ideal 2400 Hz.

Bits	Symbol	NXDN48 (4800 bps) Mode Frequency Deviation	NXDN96 (9600 bps) Mode Frequency Deviation
01	+3	+1050 Hz	+2400 Hz

Bits	Symbol	NXDN48 (4800 bps) Mode Frequency Deviation	NXDN96 (9600 bps) Mode Frequency Deviation
00	+1	+350 Hz	+800 Hz
10	–1	–350 Hz	–800 Hz
11	–3	–1050 Hz	–2400 Hz

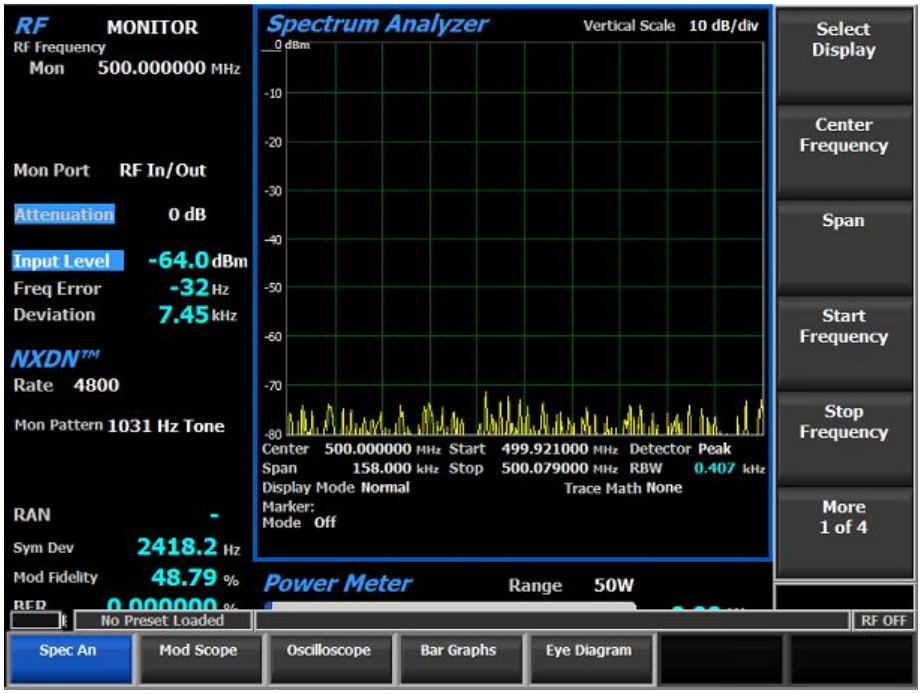
Mod Fidelity – Modulation Fidelity (FSK error) represents how accurate a transmitter reproduces an ideal theoretical modulation waveform. The measurement is performed by first removing frequency error and symbol deviation gain error from the received signal, then computing the RMS difference between the deviation of the resulting signal at each symbol decision point and the ideal deviations of those symbols; no bit errors should exist. On the R8200, this is reported as an RMS error in % relative to the mean deviation across symbols.

BER – Percentage of bit differences between the bits of the selected Test Pattern and the bits from the received synchronized FDMA signal are shown in this field. BER measures the modulation, encoding, and timing of the transmit signal during the data transmission period. When performing the BER Test, the radio transmitter under test must be placed into a test diagnostic mode with the correct TX test pattern selected using the manufacturer's Radio Service Software (RSS). The test is done at nominal power with the radio transmitting the test pattern into the service monitor. Placing an attenuator between the radio under test and the service monitor is acceptable.

While the analyzer is operating in NXDN™ Test Mode, the NXDN™ Zone soft key menus contain all of the R8200 parameter settings for the controlling the NXDN™ physical layer. For a complete soft key reference for the NXDN™ Zone, see **"NXDN™ Zone Soft Keys for Transmitter Test" on page 640**.

The DISPLAY Zone

During NXDN™ Test Mode, the DISPLAY Zone offers a Spectrum Analyzer, Modulation Scope, Oscilloscope, Bar Graphs, and an Eye Diagram, accessed by pressing **Select Display**, as shown in the horizontal soft key menu below.



Spectrum Analyzer

See **"Introducing the Spectrum Analyzer" on page 90**.

Modulation Scope

See **"Introducing the Modulation Scope" on page 91**.

Oscilloscope

See **"Introducing the Oscilloscope" on page 92**.

Bar Graphs

See **"Bar Graphs" on page 77**.

Eye Diagram

See **"Eye Diagram" on page 152**.

While the analyzer is operating in NXDN™ Test Mode, the DISPLAY Zone soft key menus contain all of the parameter settings for RF and baseband measurement display. For DISPLAY Zone soft keys unique to NXDN™ Test Mode, see **"DISPLAY Zone Soft Keys for NXDN™ Transmitter Test" on page 643**. For a complete soft key reference for the DISPLAY Zone, see **"DISPLAY Zone Soft Keys for Duplex Mode" on page 474**.

The METER Zone

In NXDN™ Test Mode, the METER Zone is preloaded with a Power Meter.

A Voltmeter and RF Scan are also available by pressing **Hot Key 5** > **Select Meter** and choosing the desired selection, as shown below.

Power Meter

See **"Power Meter" on page 97**.

Voltmeter

See **"Voltmeter" on page 97**.

Decoder

See **"Decoder" on page 98**.

RF Scan

See **"RF Scan" on page 102**.

While the analyzer is operating in NXDN™ Test Mode, the METER Zone soft key menus contain all of the parameter settings for RF and baseband measurement metering. For METER Zone soft keys unique to NXDN™ Test Mode, see **"METER Zone Soft Keys for NXDN™ Transmitter Test" on page 644**. For a complete soft key reference for the METER Zone, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

To learn about using the R8200 to service portables, mobiles, and system infrastructure employing the NXDN™ protocol, turn to **"Using NXDN™ Test Mode" on the next page**

Using NXDN™ Test Mode

This section provides an example measurement using the analyzer's NXDN™ Mode. Complete this procedure to make an initial verification of a portable radio's digital signal processing without the need for specialized power supplies, test boxes, or radio service software. It can be completed using only the radio, a single BNC cable, and two adapters.

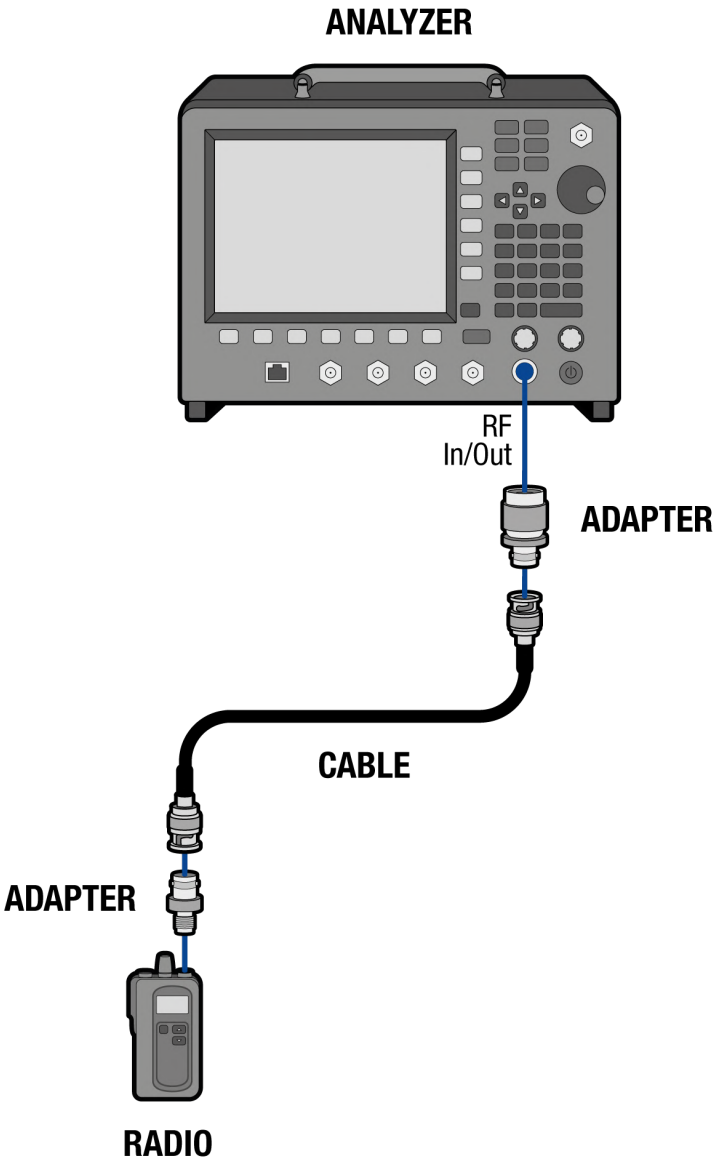
Transceiver Verification

This section describes a simple procedure for verifying the basic functionality of the radio's RF transceiver and physical layer protocol using the R8200 in NXDN™ Mode. Follow these steps to connect the radio to the R8200 and configure your measurement.

Required Equipment

- Freedom R8200 Communications System Analyzer
- Portable Radio, programmed for NXDN™ (i.e., Kenwood, ICOM, or similar)
- Cable, coax, BNC (m-m)
- Adapter, Type N(f)-to-BNC(f)
- Adapter, SMA(f)-to-BNC(f)

Test Setup



Procedure

Steps	Actions	Notes
1. Configure the test setup.	**a.** Connect the Type N(f)-to-BNC(f) adapter to the R8200's RF In/Out port. **b.** Remove the antenna from the radio. **c.** Connect the SMA(f)-to-BNC(f) Adapter to the Antenna port of the radio. **d.** Connect the BNC cable between the radio and the R8200.	
2. Configure the R8200.	**a.** To access the NXDN™ Test Mode, press **Test** > **Test Mode > NXDN.** **b.** Press **Monitor**. **c.** To set the receiver Center Frequency to match the radio transmitter, press **Hot Key 1 > Monitor Frequency > 851 > MHz.** **d.** In the RF Zone, confirm that Mon Port displays **RF In/Out** as the receiver's input.	This opens the NXDN™ Test Mode display. Alternatively, press **RF Zone** > **Monitor Frequency** > **851** > **MHz**. If not, press **Mon Port** > **RF In/Out** > **Enter.**
3. Activate and key the radio.	**a.** Turn the On/Off/Volume Knob clockwise to activate the radio. **b.** Press **PTT** on the portable.	This initiates a broadcast of the voice content picked up by the radio microphone.
4. Observe the DISPLAY Zone.	**a.** Press **Hot Key 2** > **Select Display** > **Eye Diagram**.	You should observe change in the deviation of the carrier at the 4 target symbol decision times as measured

Steps	Actions	Notes
	b. Confirm that the analyzer is decoding the tighter the transitions are to the “+” crossing points the better the modulator performance.	in the post detection filter.
5. Observe the RF Zone**.**	**a.** Confirm that the Input Level displays the radio's output as approximately **3 W**. **b.** Confirm that the Freq Error displays the radio's frequency error as **less than 100 Hz**.	This verifies the performance of the radio's RF transmitter.
6. Observe the NXDN™ Zone.	**a.** Confirm that RAN displays a valid Random Access Number. **b.** Confirm that Mod Fidelity displays **less than 1%**. **c.** Confirm that Symbol Dev displays **less than 2 kHz**.	This verifies that the radio correctly encoding the NXDN message content. Having confirmed these transmission parameters, you can verify that the transmitter on this radio is working properly in NXDN™ Test Mode.
7. Configure the R8200.	**a.** To prepare to broadcast to the radio, press **Generate.** **b.** To set the transmitter Generate Frequency to match the radio receiver, press **Hot Key 1** > **Generate Frequency** > **851** > **MHz**. **c.** To Copy the RAN to the Generator, press **Hot Key 4** > **More** > **Copy RAN to Generator**. **d.** To begin transmitting RF from the R8200, press **Hot Key 1** > **Gen Port RF In/Out.** **e.** To generate a standard NXDN™	

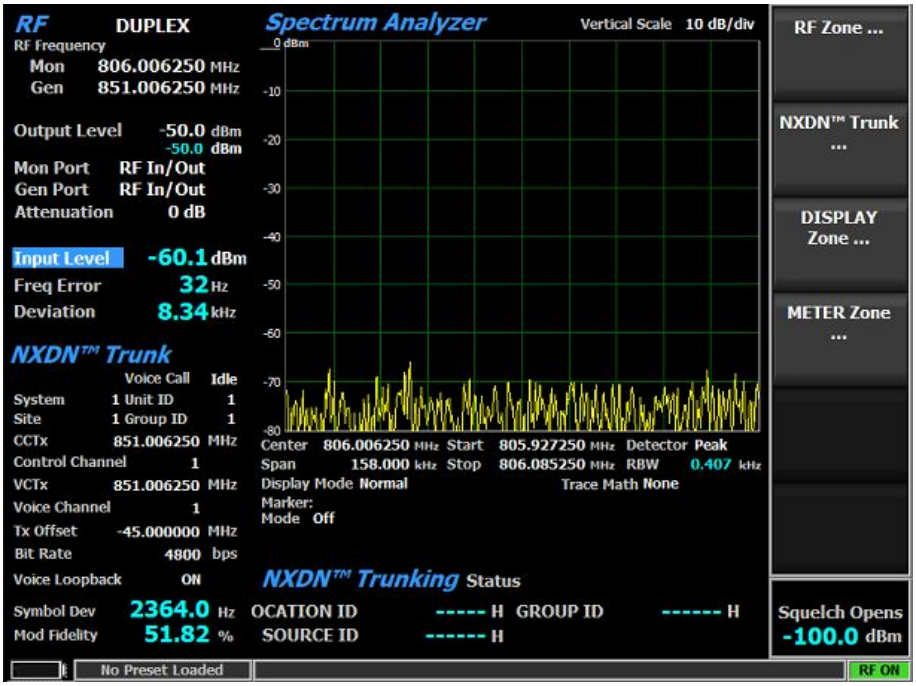
Steps	Actions	Notes
	test pattern, press **Hot Key 4** > **Gen Test Pattern** > **1031 Hz Tone**.	
	f. To modulate the RF carrier, press **Modulation Mode** > **Continuous**.	
8. Listen for the1031 Hz tone broadcast from the radio's speaker.	**a.** Adjust the volume of the 1031 Hz tone using the radio's On/Off/Volume Knob.	This verifies that the radio correctly decodes the NXDN™ baseband content.
9. Test the sensitivity of the radio.	**a.** To adjust the Output Level of the R8200, press **Hot Key 1** > **Output Level**.	
	b. Use the arrow keys and the tuning knob to decrease the Output Level until the 1031 Hz tone is no longer broadcast from the radio speaker.	
	c. Confirm that the RF Output Level on the R8200 is less than –120 dBm when the tone disappears.	This confirms that the radio receiver is sensitive to transmissions as weak as –120 dBm.

Having confirmed these parameters, you can verify that the transceiver on this radio is working properly in NXDN™ Test Mode.

Introducing NXDN™ Trunk Mode

The optional R8200 NXDN™ Type C Trunk Test Mode allows testing of trunked NXDN™ compliant radios. NXDN™ radios use a digital transmission format employing Continuous four level FM (C4FM) modulation. The R8200 NXDN™ Type C Trunk Mode simulates the functions of a NXDN™ central controller with the control and voice channel protocols needed for various tests. Also included are NXDN™ compliant test patterns for Bit Error Rate (BER) testing, RF Input Power, Frequency Error and Deviation measurements, a Spectrum Analyzer, Modulation Scope, Oscilloscope, and an Eye Diagram with graphical representation of the NXDN™ Trunk signal, and an NXDN™ Trunk Status meter.

A Voice Loop feature (U.S. patent 5703479) is engaged for audio verification of the radio's end-to-end operation after the subscriber unit transmits. During a Voice Call the R8200 automatically records voice channel data while the subscriber unit PTT is pressed, then retransmits it to provide audio verification of the radio's end-to-end operation.



Pressing **Test** > **Test Mode** > **NXDN™ Trunk** configures the R8200 for NXDN™ Trunk Test Mode, as shown above. On the R8200 main display, the Standard mode's AUDIO Zone and associated soft keys are replaced by the NXDN™ Trunk Zone and NXDN™ Trunk-specific soft keys (accessed by pressing the **NXDN™ Trunk** soft key).

NOTE

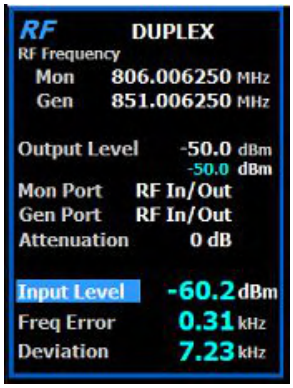
The manufacturer's Radio Service Software (RSS) is required to perform some tests in NXDN™ Type C Trunk Mode because certain measurements (BER) require placing the radio in a special test mode.

The RF Zone

As usual, the RF Zone can be used to configure various settings such as output level, attenuation, and ports, etc. However, the soft keys for Monitor and Generate frequencies are disabled. These frequencies are determined by settings in the NXDN™ Type C Trunk Zone, either the control/voice channel frequency settings or the control/voice channel number settings according to the Band Plan Table.

NOTE

RF Zone Monitor and Generate Frequency settings can be changed for the BER Test. Otherwise, they are read-only and updated in real-time to show the control channel frequencies or the voice channel frequencies that are in use.



When the NXDN™ Type C Trunk Test Mode is selected, the R8200 is automatically placed in Duplex Mode and begins transmitting idle messages on the control channel with no encryption. And the RF Zone offers the following measurement displays:

Input Level – Displays the average power in the specified Burst of the synchronized TDMA slot transmitted by the radio under test.

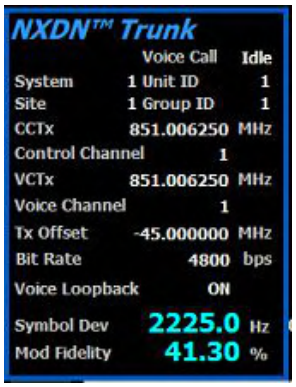
Freq Error – Displays the difference between the received NXDN™ Trunk carrier frequency and the R8200 Monitor Frequency.

Deviation – Displays the negative and positive peak frequency deviation of a modulated carrier (i.e., from the Frequency Error mean), available when Modulation Mode is FM.

While the analyzer is operating in NXDN™ Trunk Test Mode, the RF Zone soft key menus contain all of the parameter settings for the controlling the R8200 RF output. For a complete soft key reference for the RF Zone, see **"RF Zone Soft Keys for Duplex Mode" on page 441**.

The NXDN™ Trunk Zone

While operating in NXDN™ Trunk Test Mode, the AUDIO Zone and associated soft keys are replaced by the NXDN™ Trunk Zone and NXDN™ Trunk specific soft keys. The NXDN™ Trunk Zone displays the physical layer parameters that can be configured to encode and decode NXDN™ Trunk content. The NXDN™ Trunk Zone is shown in Duplex Mode, below.



The NXDN™ Trunk Zone offers the following measurement displays:

Symbol Dev – Displays the symbol deviation estimated by averaging the normalized frequency deviations at symbol times in the specified burst of the synchronized TDMA slot of the received signal and then scaling by the maximum symbol value. The normalized frequency deviation is computed as the ratio of the actual frequency measurement at a given symbol or deviation state by the corresponding symbol value. The NXDN48 (4800 bps) Mode ideal is 1050 Hz and the NXDN96 (9600 bps) Mode ideal 2400 Hz.

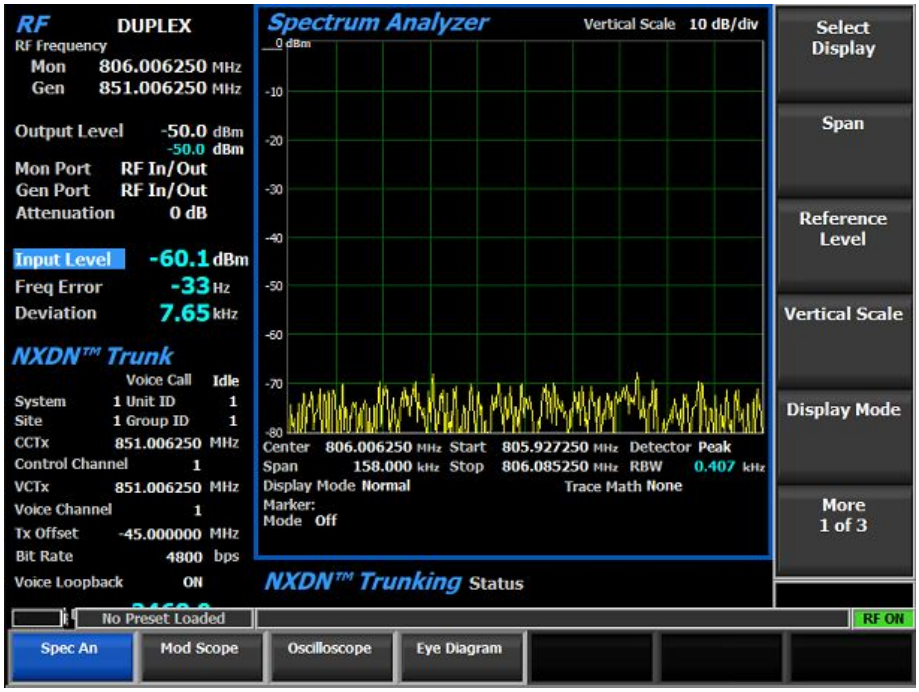
Bits	Symbol	NXDN48 (4800 bps) Mode Frequency Deviation	NXDN96 (9600 bps) Mode Frequency Deviation
01	+3	+1050 Hz	+2400 Hz
00	+1	+350 Hz	+800 Hz
10	–1	–350 Hz	–800 Hz
11	–3	–1050 Hz	–2400 Hz

Mod Fidelity – Modulation Fidelity represents how accurate a transmitter reproduces an ideal theoretical modulation waveform. The measurement is performed by first removing frequency error and symbol deviation gain error from the received signal, then computing the RMS difference between the deviation of the resulting signal at each symbol decision point and the ideal deviations of those symbols; no bit errors should exist. On the R8200, this is computed over a symbol interval and reported as an RMS error in % normalized across symbols.

While the analyzer is operating in NXDN™ Trunk Test Mode, the NXDN™ Trunk Zone soft key menus contain all of the R8200 parameter settings for the controlling the NXDN™ Trunk physical layer. For a complete soft key reference for the NXDN™ Trunk Zone, see **"NXDN™ Trunk Zone Soft Keys" on page 653**.

The DISPLAY Zone

During NXDN™ Trunk Test Mode, the DISPLAY Zone offers a Spectrum Analyzer, Modulation Scope, Oscilloscope, and an Eye Diagram, accessed by pressing **Select Display**, as shown in the horizontal soft key menu below.



Spectrum Analyzer

See **"Introducing the Spectrum Analyzer" on page 90**.

Modulation Scope

See **"Introducing the Modulation Scope" on page 91**.

Oscilloscope

See **"Introducing the Oscilloscope" on page 92**.

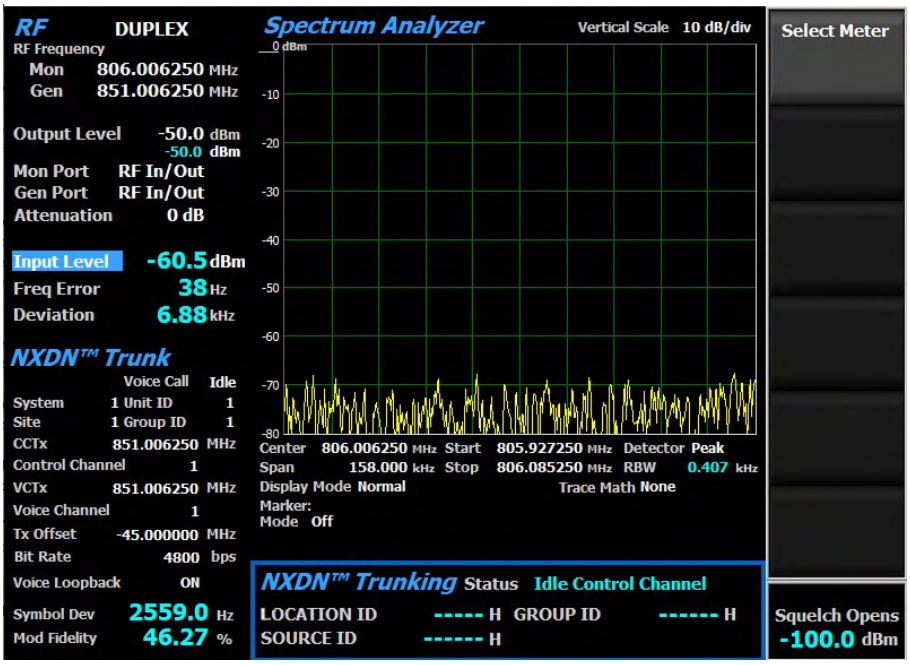
Eye Diagram

See **"Eye Diagram" on page 152**.

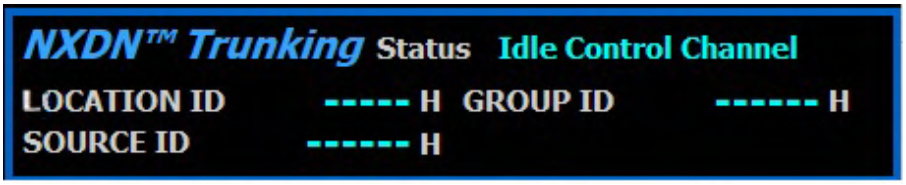
While the analyzer is operating in NXDN™ Trunk Test Mode, the DISPLAY Zone soft key menus contain all of the parameter settings for RF and baseband measurement display. For DISPLAY Zone soft keys unique to NXDN™ Trunk Test Mode, see **"DISPLAY Zone Soft Keys for DMR Transmitter Test" on page 587**. For a complete soft key reference for the DISPLAY Zone, see **"DISPLAY Zone Soft Keys for Duplex Mode" on page 474**.

The METER Zone

In NXDN™ Trunk Test Mode, the METER Zone is preloaded with a NXDN™ Trunking Meter, as shown.



NXDN™ Trunking Status Meter



A NXDN™ Type C trunked radio connected to the R8200 and activated automatically registers with the analyzer if the Bandplan settings are configured for the system under test. The radio ID parameters are displayed in the NXDN™ Trunking Status Meter above, as the registration progresses.

For a complete soft key reference for the METER Zone, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

To learn about using the R8200 to service portables, mobiles, and system infrastructure employing the NXDN™ Trunk protocol, turn to **"Using NXDN™ Trunk Test Mode" on the next page**.

Using NXDN™ Trunk Test Mode

This section provides an example measurement using the analyzer's NXDN™ Trunk Test Mode. Complete this procedure to make an initial verification of a portable radio's digital signal processing without the need for specialized power supplies, test boxes, or radio service software. It can be completed using only the radio, a single BNC cable, and two adapters.

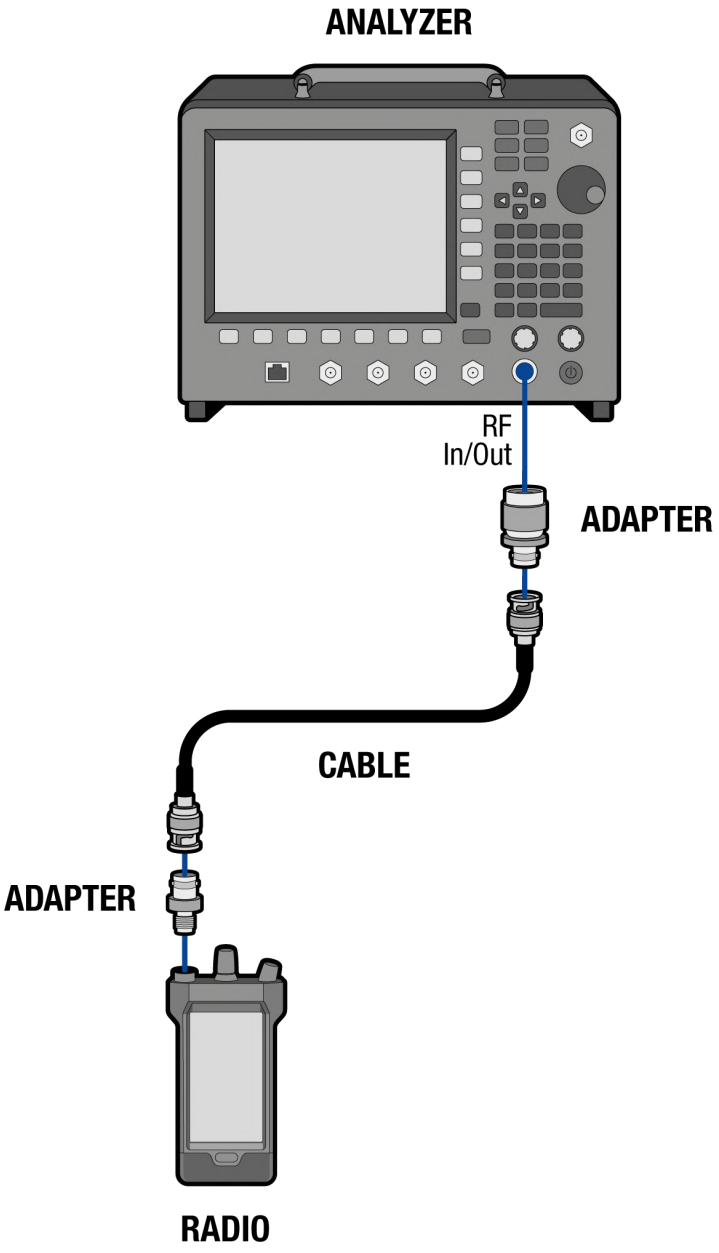
Transceiver Verification

This section describes a simple procedure for verifying the basic functionality of the radio's RF transceiver and ability to register to a Type C trunking system. Follow these steps to connect the radio to the R8200 and configure your measurement.

Required Equipment

- Freedom R8200 Communications System Analyzer
- Portable Radio, programmed for NXDN™ Type C Trunking
- Radio configuration information
- Cable, coax, BNC (m-m)
- Adapter, Type N(f)-to-BNC(f)
- Adapter, SMA(f)-to-BNC(f)

Test Setup



Procedure

Steps	Actions	Notes
1. Configure the test setup.	**a.** Connect the Type N(f)-to-BNC(f) adapter to the R8200's RF In/Out port. **b.** Remove the antenna from the radio. **c.** Connect the SMA(f)-to-BNC(f) Adapter to the Antenna port of the radio. **d.** Connect the BNC cable between the radio and the R8200.	
2. Configure the R8200.	**a.** To deactivate Auto Attenuation, press **Settings** > **System Settings** > **Automatic Attenuation** > **Off**. **b.** To set manual attenuation, press **Hot Key 1**> **Attenuation** > **36** > **Enter**. **c.** To access the NXDN™ Trunk Test Mode, press **Test** > **Test Mode** > **NXDN™ Trunk**. **d.** To configure the NXDN™ Trunk settings, press **Hot Key 4**. **e.** To set the CCTx Channel, press **CCTx Channel** > **1** > **Enter**. **f.** To set the VCTx Channel, press **VCTx Channel** > **2** > **Enter**. **g.** To set the Control Chnl TX Fre-	For a live radio Automatic attenuation often works without issue. However, for the short burst of NXDN™ signals in Trunking the delay of auto attenuation can distort the signals. The technician may find that it is better to disable auto attenuation and set a fixed value like 36 dB or more. Configuring the NXDN™ trunking will require knowledge of the radio channel setup, including System Code, Site Code, Unit ID, Group ID, Control Channel TX Frequency, Tx Control Channel number, Voice Channel TX Frequency, TX Voice Channel Number, TX Offset, and Bit Rate.

Steps	Actions	Notes
	quency, press **More** > **Control Chnl TX Frequency** > **851.05** > **Enter**.	
	h. To set the Voice Chnl TX Frequency, press **Voice Chnl TX Frequency** > **860.05** > **Enter**.	
	i. To set the Transmit Offset, press **Transmit Offset** > **–45** > **Enter**.	
	j. To set the System Code, press **System Code** > **235** > **Enter**.	
	k. To set the Site Code, press **Site Code** > **1** > **Enter**.	
	l. To set the Site Code, press **Site Code** > **1** > **Enter**.	
	m. To set the Unit ID, press **Unit ID** > **1** > **Enter**.	
	n. To set the Group ID, press **Group ID** > **1** > **Enter**.	
	o. To set the Bit Rate, press **Bit Rate** > **4800** > **Enter**.	
3. Activate and key the radio.	**a.** Activate the radio and switch to appropriate channel. Wait for radio to register with UUT.	
	b. When registration is complete then the METER Zone should show Location ID, Group ID and Source ID (Unit ID).	
4. Transmit from the radio.	**a.** Press the **PTT** button, and METER Zone Status will show **Voice Call IN Progress**.	If the Tone fails to start, press > **Voice Call** > **Stop**. Then press **PTT** again

Steps	Actions	Notes
	b. Speak into the radio while **PTT** is pressed. **c.** On release of PTT, wait about 5 seconds and the Voice Loop will transmit back to the radio with the voice information captured. **d.** Press **Voice Call** > **Start**. **e.** A 1031 Hz Tone will be heard from the radio speaker. **f.** Press **Voice Call > Stop** to end tone. **g.** Press **Send Status Inquiry**. **h.** Verify that the radio displays a message indicating receipt and replays the message.	until METER Zone Status reads **Voice Call IN Progress**. Release PTT. Try Voice call on R8200 again.

Having configured and confirmed the response of the radio, you have verified that the transceiver on this radio is working properly in NXDN™ Type C Trunk Test Mode.

Introducing TETRA Base Station Test Mode

The optional R8200 TETRA Base Station Test Package option enables testing of Base Stations compliant with the ETSI Terrestrial Trunked Radio (TETRA) radio transmission protocol per ETSI specification TS 100 392 and EN 300 392. TETRA radios use a digital transmission format employing π/4 DQPSK modulation at 36000 four-bit symbols per second with Time Division Multiple Access (TDMA) with four slots per frame as its channel access methodology.

The manufacturer's Radio Service Software is not required for Base Station Monitor operation but is required to perform tests in TETRA Base Station Mode. These performance verification measurements include RF Power, RF Frequency Error, Residual Carrier Power, and EVM (RMS and Peak). In addition, the TETRA Base Station Test Mode comes equipped with Bar Charts, Spectrum Analyzer, Power Profile, and Modulation Spectrum/Constellation Displays.

Pressing **Test** > **Test Mode** > **TETRA Base Station > TETRA Base Station** configures the R8200 for TETRA Base Station Test Mode.

Options and Functionality

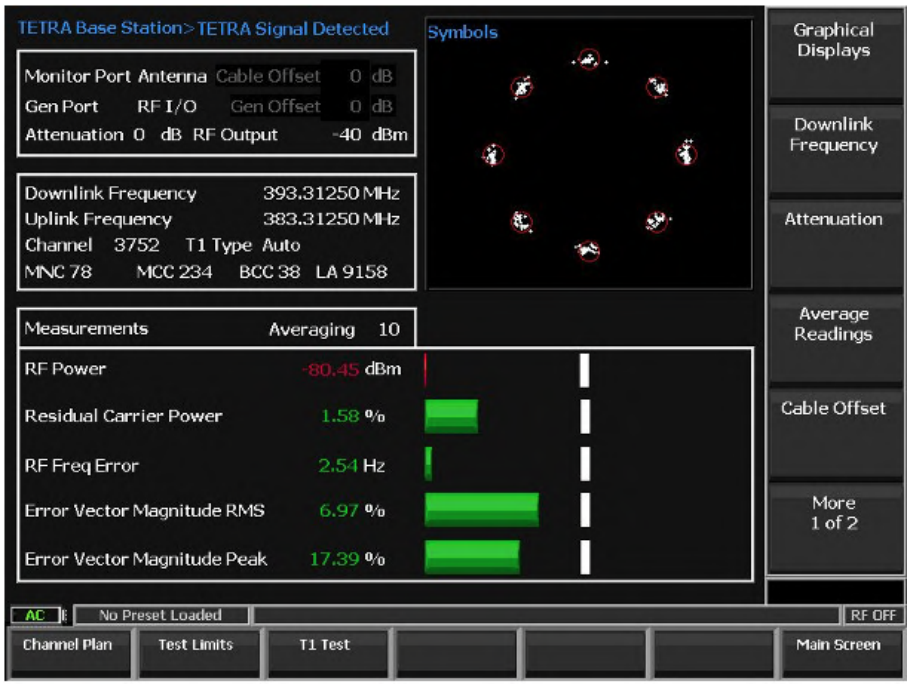
The functionality of the TETRA Base Station Test Mode depends on the installed options. The (R8-TETRA_BSM) Option enables the remote monitoring of a live traffic mode signal over the air. The (R8-TETRA_BST1) Option enables both over the air monitoring of a live traffic mode signal and TETRA T1 tests (BER testing) of the Transmitter and Receiver using a direct connection to the base station's RF network (i.e., the Antenna ports of the Duplexer).

NOTE

Only the (R8-TETRA_BST1) Option decodes the system network information, Mobile Country Code, Mobile Network Code, Base Station Color Code and Local Area Code.

Additionally, the Base Station must be under the control of the manufacturers Test Mode Software to conduct the T1 tests.

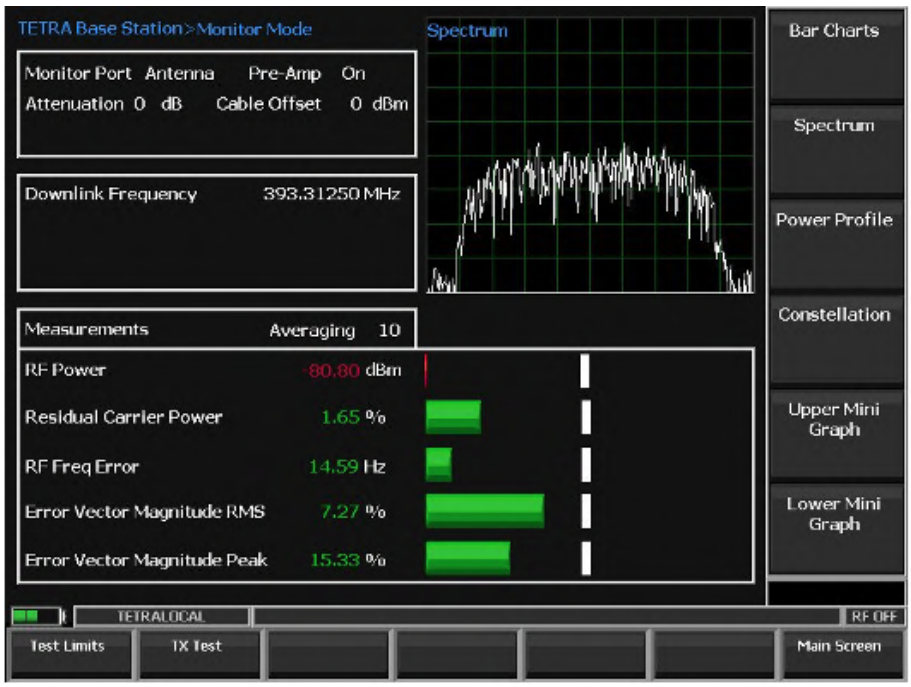
The application was designed for maximum flexibility across a variety TETRA Base Station hardware implementations. Unlike the classic Four-Zone R8000-Series display user interface, TETRA Base Station Test Mode channel assignment and baseband configuration is provided by an off-screen Channel Plan Table so that the Main Screen can be focused on displaying as many system critical measurements as possible, as shown.



TETRA Base Station Test has two operating modes: the default Monitor Mode and T1 Mode, each with their own display.

Monitor Mode (OTA Live Monitoring)

In Monitor Mode, the R8200 enables the remote monitoring of a live network's base stations. Several issues must be considered when making Over The Air (OTA) measurements. Placement of the R8200 in relation to the base station(s) to be monitored. RF Power is relative to this placement (distance) due the free space RF losses. The R8200 must receive at least -85 dBm in order to decode the transmitter parameters. This sensitivity is also dependent on the type of antenna employed and its height above ground or line-of-sight relationship with the Base Station transmitter antenna. To ensure repeatability in day to day monitoring it is important to ensure placement rules are maintained.



The Monitor Mode Display features an RF Configuration Display above a Measurements Display on the left side of the screen and Mini Graphical Displays on the right side, as shown above.

TETRA Configuration Display

This area (shown above) presents the following RF and TETRA parameter settings for the receiver:

Monitor Port – Displays the current receiver port.

Pre-Amp – Displays the operating state of the Pre-Amp.

Attenuation – Displays the amount of attenuation on the receiver port.

Cable Offset – Displays the power offset compensating for cable losses associated with the transmission line connected to the receiver port.

Downlink Frequency – Displays the Monitor Frequency for the receiver.

Measurements Display

This area (shown above, beneath the RF Configuration Display) presents the following RF parameters and measurements:

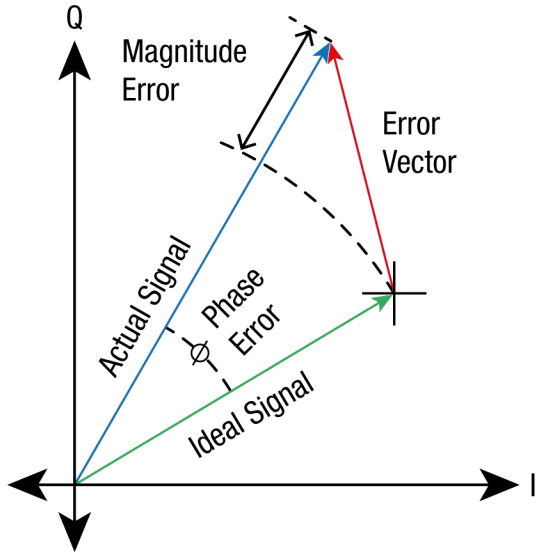
Averaging – Displays the number of bursts that are averages to produce the measurement values displayed below.

RF Power – Displays the burst power level of the synchronized TDMA slot 1 transmitted by the radio under test. The measurement is done at the optimal symbol times and positions to exclude adverse effects of frequency error and residual carrier. Averaging over multiple bursts may be performed to comply with the standard. Between 1 and 250 RF power samples are collected five to 17 times per second. The number of Averaging samples can be configured by pressing the **Averaging Readings** soft key. The current number of samples is displayed as Averaging at the top of the Measurements Display. The **Reset Averaging** soft key can be pressed to zero all TETRA DMO measurements, history, and displays, including ones in other zones.

Residual Carrier Power – Displays the percentage of carrier power from inactive timeslots.

RF Freq Error – Displays the frequency difference between the received Downlink Frequency and the R8200 current Monitor Frequency setting.

Error Vector Magnitude RMS – Displays the average deviation of the actual I/Q vectors from the ideal vectors as a percentage beyond the ideal (0% Error Vector Magnitude), as depicted by the red arrow in the image below.



The ideal TETRA Base Station signal consists of eight decision points around the origin. From these, the deviations are measured to all actual decision points closest to each. In terms of the constellation, it is the distance from the ideal to the actual symbol. The measurement is done at the optimal symbol times and positions to exclude adverse effects of frequency error and residual carrier. The RMS error vector magnitude for a burst is the square root of the sum of the squares of the error distances divided by the number of symbols in the burst.

Error Vector Magnitude Peak – Displays the maximum error distance found over the burst as a percentage beyond the ideal (0% Peak Error Vector Magnitude).

Mini Graphical Displays

This area (shown above, on the right side of the display screen) presents a dual display of the following graphical RF measurements:

Spectrum – Displays a power-versus-frequency representation of the base station transmitted carrier signal.

Power Profile – Display provides a power versus time plot of the transmitted timeslots. This specialized Oscilloscope display is useful for ensuring that near-far situations will not result in co-channel inter-slot interference on the alternate or non-transmission slot and that the power level will be adequate for acceptable BER performance. The scaling and position of the vertical power axis can be adjusted to inspect greater range or detail. The horizontal axis can be changed to view one or both slots including the additional ramp up/down time.

Symbols – Displays the measured symbol decision points as white dots and plots them on a Constellation Display of the ideal target decision points. The red targets represent the area within the 10% EVM test limit.

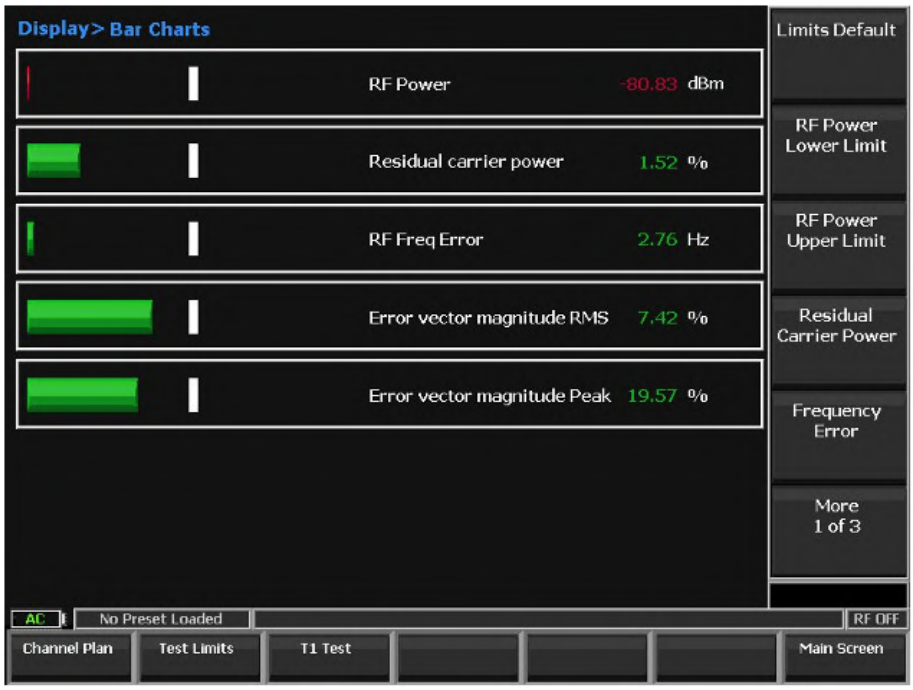
Trajectories – Displays the trajectories of the symbols between decision points as blue traces on a Constellation Display of the ideal target decision points.

Bar Graphs – Displays bar graphs of the measurements represented numerically in the Measurements Display area to the right.

Graphical Displays

Full screen versions of the following instrument displays can be accessed by pressing **Graphical Displays**:

Bar Charts



The full screen Bar Charts Display include soft keys for configuring the Test Limits of the measurements represented in the Bar Charts Display.

Spectrum Analyzer

See **"Introducing the Spectrum Analyzer" on page 90**.

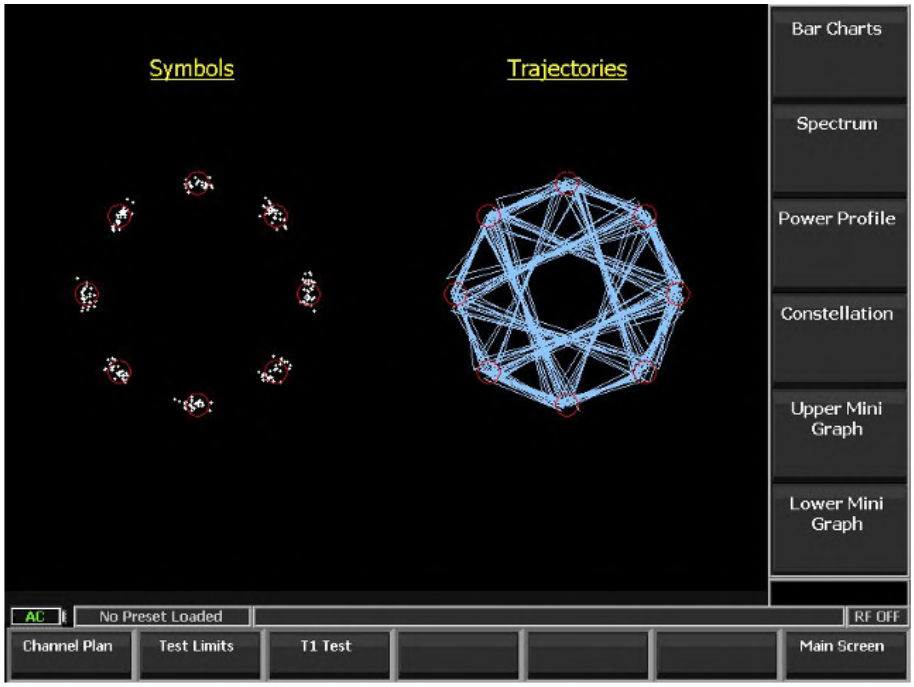
Power Profile

See **"Power Profile" on page 153** for additional details.

NOTE

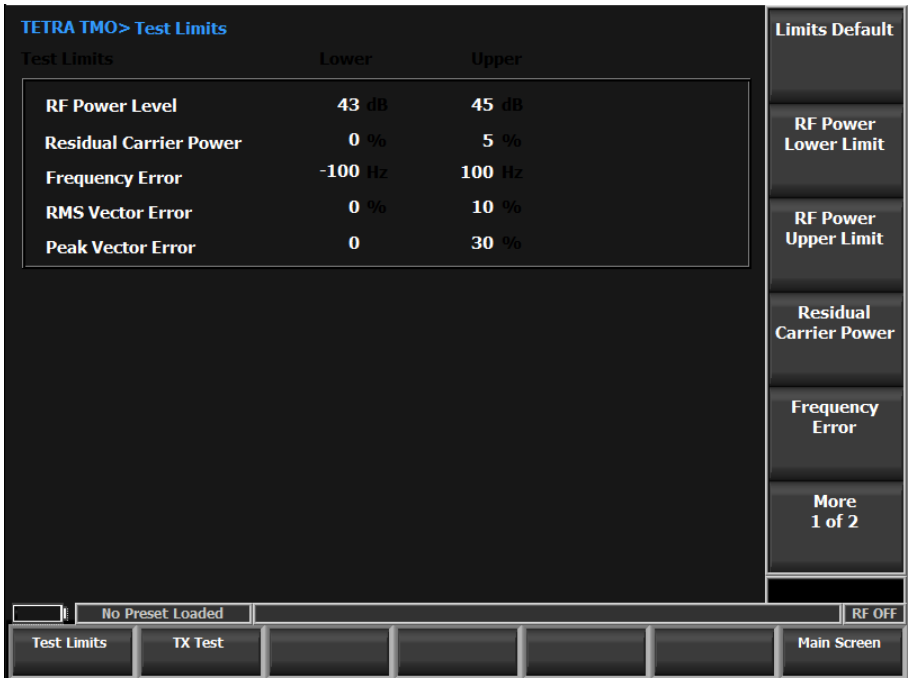
See the Technical Specification: ETSI EN 300 396-2 “Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 2: Radio aspects,” RF output power time mask.

Constellation



Symbols (above left) displays the measured symbol decision points as white dots and plots them on a Constellation Display of the ideal target decision points. The red targets represent the area within the 10% EVM test limit. Trajectories (above right) displays the signal path as a blue trace as it passes between decision points on a Constellation Display of the ideal targets.

Test Limits



Pressing **Test Limits** opens the Test Limits Table (above) where you can use the vertical soft key menu to automatically configure the PASS/FAIL boundaries for every measurement in the Measurements Display. These limits are mirrored in the Bar Charts display. Pressing **Limits Default** returns all limit settings to the ETSI standard values.

TX Test

Pressing **TX Test** opens the TX Test Table (above) where you can use the vertical soft key menu to configure your OTA performance verification of a remote Base Station. The Burst Samples setting determines the length of the test as well as the number of burst samples from which to calculate the results populating the Average column. The remaining soft keys execute the OTA transmitter test and to display the results, shown below. The transmitter test terminates when the prescribed number of samples has been gathered. See **"Measurements Display" on page 218** for an explanation of individual results.

While the analyzer is operating in TETRA Base Station Test Monitor Mode, its soft key menus contain all of the R8200 parameter settings for configuring, performing, and recording the results of OTA Base Station performance verification tests. For a complete soft key reference, see **"TETRA Base Station Test Mode Soft Keys" on page 663**.

T1 Mode

In addition to the Graphical Displays and TETRA configuration parameters for OTA Base Station OTA monitoring in Monitor Mode, TETRA Base Station T1 Mode contains additional parameter controls for the TETRA Base Station Channel Plan and the T1 Test Table for offline or OTA transceiver performance verification using the manufacturer Test Mode Software. T1 Test Mode will provide the correct Uplink response to the Downlink T1 and Network settings. Preconfigured Channel Plans are available for Cassidian TB3, Motorola Dimetra, MTS4, and MTS1, and Rohill Base Station assets.

After automatically synchronization with the Base Station via GPS standard, the TETRA Base Station T1 Mode enables the R8200 to decode and display the base station Mobile Country Code (MCC), Mobile Network Code (MNC), Base Station Color Code (BCC) and Local Area Code (Larea) as well as and provide T1 signal pattern type (typically, TCH 7.2) and BER/MER measurement results.

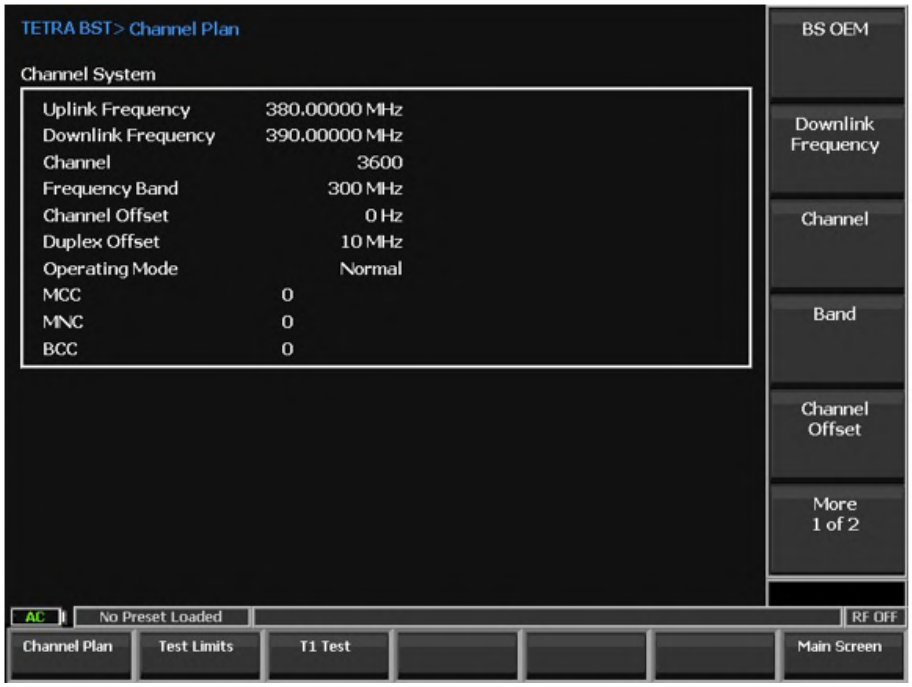
Unlike Monitor Mode, T1 Mode requires the generation of an Uplink signal to test the base station receiver in order to facilitate the measurement and display of the transmitter BER and MBR parameters. Each type of call can be made individually to and from the mobile.

- Ind Duplex Simultaneous TX and RX
- Ind Simplex PTT to TX
- Group PTT to TX
- Phone Simultaneous TX and RX
- SDS & DGNA Send and Receive short message, Assign and Unassign Dynamic Groups OTA
- Emergency
- Ambient Listening. Radio speaker is inhibited, Microphone is live.

All of these can be activated or deactivated using the Radio's Programming software. Call initiation and connections can be made by the MS Radio or the R8200 in Base Station T1 Test Mode.

Channel Plan Table

The Channel Plan Table displays the current T1 Test Mode Base Station configuration, as shown.



Use the soft keys in the T1 Test Mode vertical soft key menu to configure the RF parameters and the TETRA channeling codes.

NOTE Failure to set these parameters correctly will result in invalid test results for TX and RX BER.

Uplink Frequency – Displays the Base Station receiver frequency.

Downlink Frequency – Displays the Base Station transmitter frequency.

Channel – Displays the Downlink Main Control (MCCH) channel number.

Frequency Band – Displays the specified harmonized Frequency Band transmitted by the R8200.

Channel Offset – Displays the current Downlink Channel Offset frequency.

Duplex Offset – Displays the current Offset Frequency for both Uplink and Downlink Channels.

Operating Mode – Displays the current forward or reverse mode of operation.

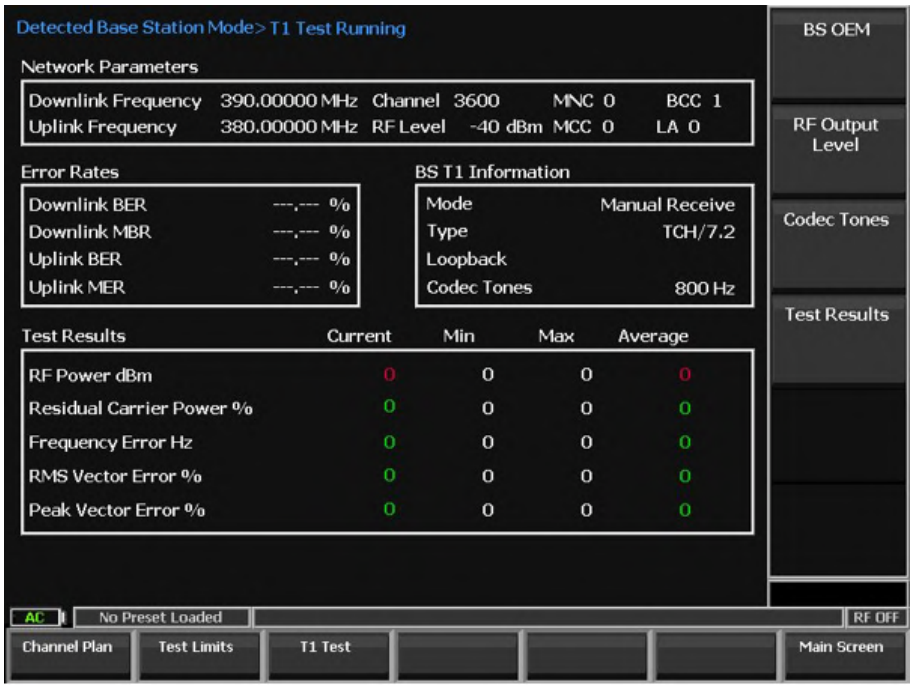
MCC – Displays the Base Station Mobile Country Code.

MNC – Displays the Base Station Mobile Network Code.

BCC– Displays the Base Station Colour Code.

T1 Test Display

The T1 Test Display presents the Base Station Test Mode Network Parameter configuration, Error Rates, Base Station T1 Information, and Test Results, as shown below for a Motorola MTS 4.



Network Parameters

This area (shown above, top) presents the following network parameter settings for the base station transceiver:

Downlink Frequency – Displays the Base Station transmitter frequency.

Uplink Frequency – Displays the Base Station receiver frequency.

Channel – Displays the Downlink Main Control (MCCH) channel number.

RF Level – Displays the RF output level of the Uplink signal transmitted by the R8200.

MNC – Displays the Base Station Mobile Network Code.

MCC – Displays the Base Station Mobile Country Code.

BCC– Displays the Base Station Colour Code.

LA – Displays the Larea Code.

Error Rates

This area (shown above, middle left) presents the following digital error rates for the base station transceiver:

Downlink BER – Displays the measured bit error rate percentage for the Downlink Channel.

Downlink MBR – Displays the Base Station receiver frequency.

Uplink BER – Displays the measured bit error rate percentage for the Uplink Channel.

Uplink MER – Displays the measured maximum bit rate percentage for the Uplink Channel.

BS T1 Information

This area (shown above, middle right) presents the following T1 parameter configurations for the base station transceiver:

Mode – Displays the Uplink Signal ETSI Specified Test Mode.

Type – Displays the operating state of the Uplink Signal ETSI Specified Test Pattern.

Loopback – Displays the operating state of the Voice Loopback function.

CODEC Tones – Displays the selected CODEC tone to transmit when Voice Loopback is activated.

Test Results

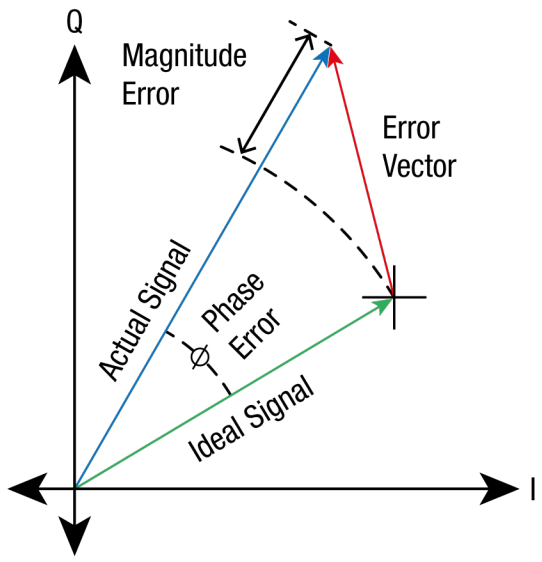
This area (shown above, middle right) presents the following T1 parameter configurations for the base station transceiver:

RF Power dBm – Displays the burst power level of the synchronized TDMA slot 1 transmitted by the base radio under test. The measurement is done at the optimal symbol times and positions to exclude adverse effects of frequency error and residual carrier. Averaging over multiple bursts may be performed to comply with the standard. Between 1 and 250 RF power samples are collected five to 17 times per second. The number of Averaging samples can be configured by pressing the **Averaging Readings** soft key. The current number of samples is displayed as Averaging at the top of the Measurements Display. The **Reset Averaging** soft key can be pressed to zero all TETRA DMO measurements, history, and displays, including ones in other zones.

Residual Carrier Power % – Displays the percentage of carrier power lost to demodulation error.

RF Freq Error – Displays the frequency difference between the received Downlink Frequency and the R8200 current Monitor Frequency setting.

Error Vector Magnitude RMS – Displays the average deviation of the actual I/Q vectors from the ideal vectors as a percentage beyond the ideal (0% Error Vector Magnitude), as depicted by the red arrow in the image below.



The ideal TETRA Base Station signal consists of eight decision points around the origin. From these, the deviations are measured to all actual decision points closest to each. In terms of the constellation, it is the distance from the ideal to the actual symbol. The measurement is done at the optimal symbol times and positions to exclude adverse effects of frequency error and residual carrier. The RMS error vector magnitude for a burst is the square root of the sum of the squares of the error distances divided by the number of symbols in the burst.

Error Vector Magnitude Peak – Displays the maximum error distance found over the burst as a percentage beyond the ideal (0% Peak Error Vector Magnitude).

While the analyzer is operating in TETRA Base Station T1 Test Mode, its soft key menus contain all of the R8200 parameter settings for the configuring the Base Station Channel Plan. For a complete soft key reference for the TETRA DMO Zone, see **"TETRA Base Station T1 Mode Soft Keys" on page 673**.

To learn about using the R8200 to service portables, mobiles, and system infrastructure employing the TETRA DMO protocol, turn to **"Using TETRA Base Station Test Mode" on the next page**.

Using TETRA Base Station Test Mode

This section provides two example measurements using the analyzer's TETRA Base Station Test Mode. Complete this procedure to make an initial verification of a Base Station's online Over-The-Air (OTA) performance using Monitor Mode, followed by an offline evaluation of its T1 performance. The T1 performance verification require the use of the manufacturer's Base Station Test Software.

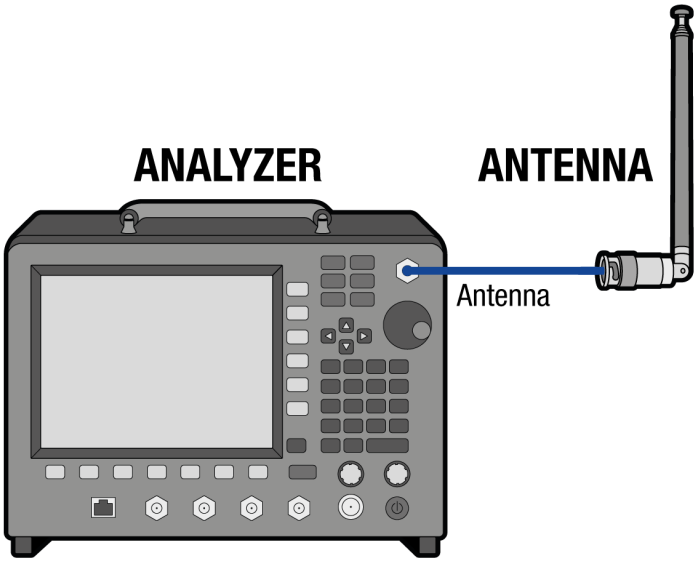
Base Station OTA and T1 Verification

This section describes a simple procedure for verifying the basic online OTA functionality of a Motorola MTS4 base station. This is followed by an offline physically connected verification of its T1 performance which requires the use of the manufacturer's Base Station Test Software. Three test setups are provided. The first is a simple OTA setup with an antenna connected to the Antenna port. The second Test Setup shows you how to connect directly to the base station, the third depicts how to connect to the base station through its combiner/duplexer. These examples test a Motorola MTS4 base station. For the physically connected T1 tests, use the test setup that best fits your particular situation. Follow these steps to connect the network hardware to the R8200 and configure your measurement.

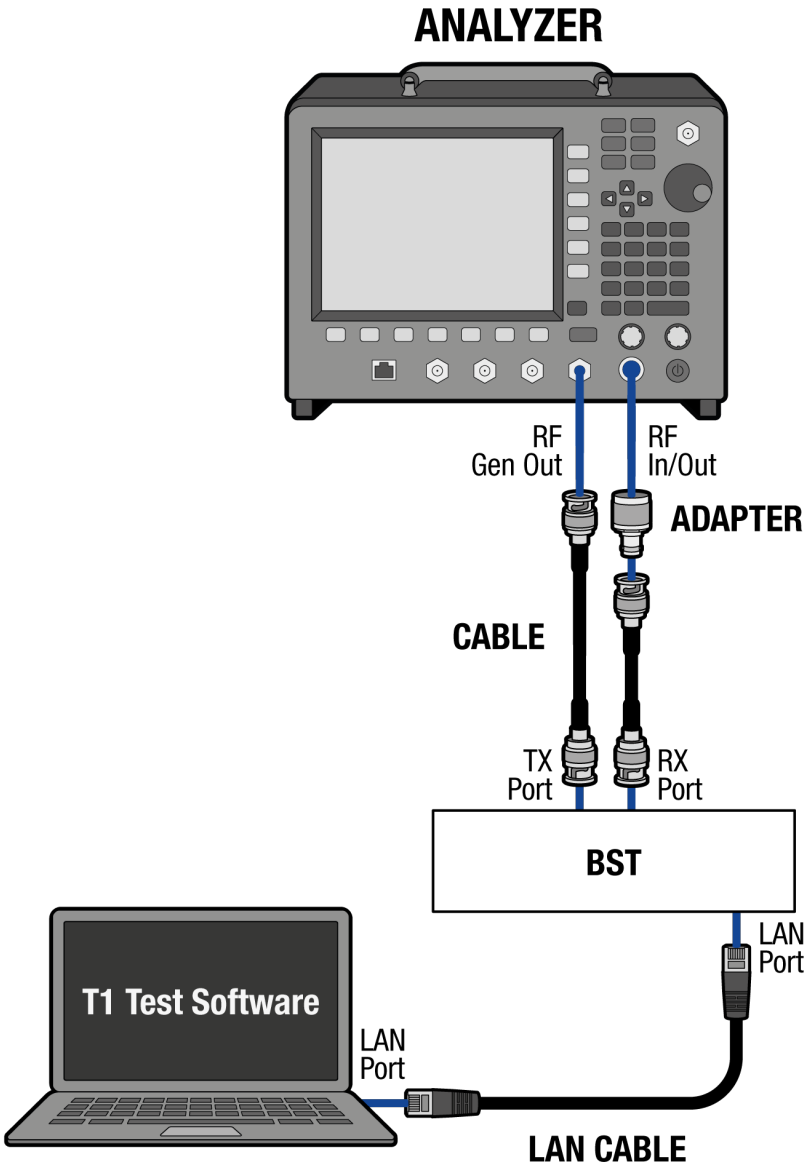
Required Equipment

- Freedom R8200 Communications System Analyzer
- TETRA Base Station (i.e., MTS4, MTS2, MTSLite)
- Antenna, VHF, BNC(m)
- (3) Cables, coax, BNC (m-m)
- Adapter, Type N(f)-to-BNC(f)
- Adapter, SMA(m)-to-BNC(f)

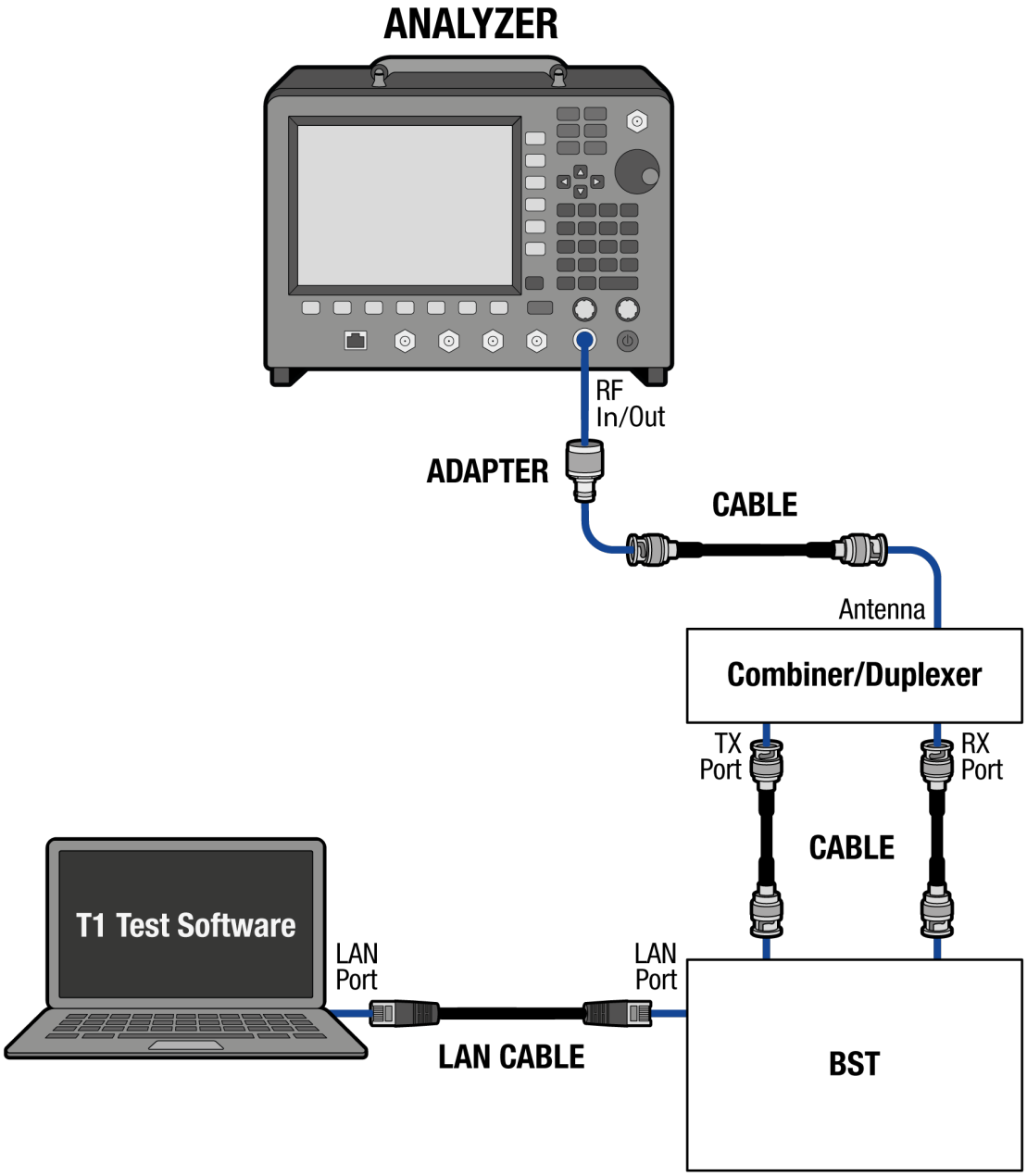
Test Setup 1



Test Setup 2


ANALYZER
RF
Gen Out
RF
In/Out
ADAPTER
CABLE
TX
Port
RX
Port
BST
LAN
Port
T1 Test Software
LAN
Port
LAN CABLE

Test Setup 3


ANALYZER
RF
In/Out
ADAPTER
CABLE
Antenna
Combiner/Duplexer
TX
Port
RX
Port
CABLE
T1 Test Software
LAN
Port
LAN
Port
LAN CABLE
BST

Procedure

Steps	Actions	Notes
1. Configure Test Setup 1 for an online OTA verification of base station performance.	**a.** Activate the R8200. **b.** Connect the antenna to the R8200 Antenna port.	
2. Configure the R8200.	**a.** Press **Test** > **Test Mode** > **TETRA Base Station > TETRA Base Station.** **b.** To select the Antenna port as the receiver input, press **More** > **Monitor Port** > **Antenna**. **c.** To reduce the attenuation, press **Attenuation** > **0 dB**. **d.** To add gain to the OTA signal, press **Pre-Amp** > **On**. **e.** To center the TETRA carrier on the Spectrum Analyzer display, press **Downlink Frequency,** enter the actual downlink frequency, and press **Enter**.	This will open the Main Screen display for TETRA Base Station Test Mode and place the R8200 in Monitor Mode.
3. Observe the Measurements Display.	**a.** Verify RF Power is within test limits. **b.** Verify Residual Carrier Power is **less than 5 %**. c. Verify RF Freq Error is **less than 100 Hz**. d. Verify Error Vector Magnitude (RMS) is Power is **less than 10 %**.	RF Power will depend on distance from base station Antenna. The R8200 sensitivity for decoding TETRA parameters is typically –85 dBm and is dependent on the type of antenna employed and the service monitor's line-of-sight relationship with the transmitting antenna. To ensure repeatability in day-to-day monitoring, it is important to maintain

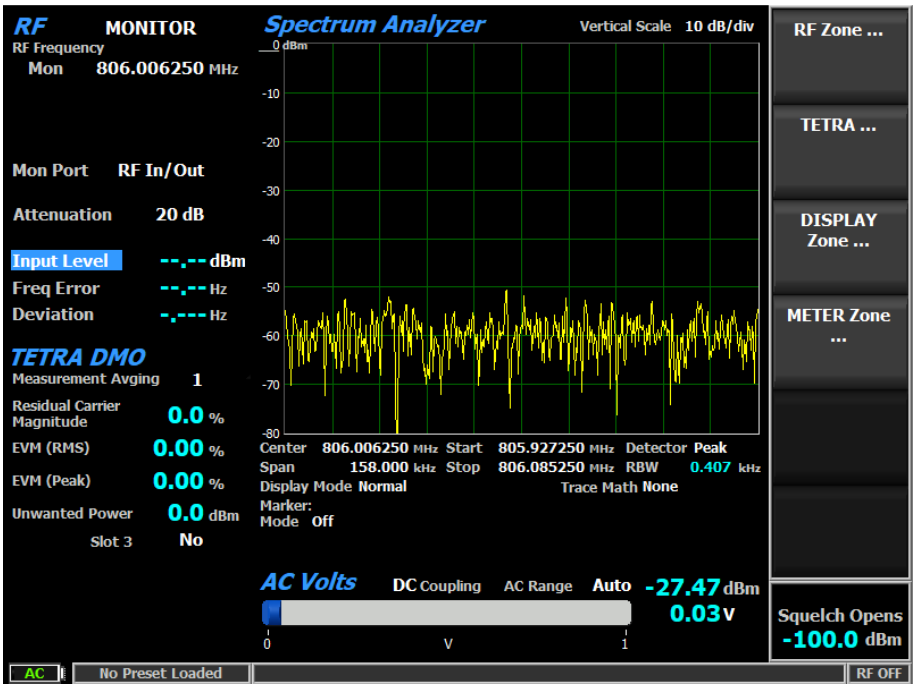
Steps	Actions	Notes
	e. Verify Error Vector Magnitude (Peak) is **less than 30 %**.	a consistent spatial relationship between the service monitor and the base station antenna. Positive test results confirm the OTA performance of the base station under test.
4. To verify offline T1 base station performance, configure Test Setup 2 or 3, according to your particular situation.	**a.** Collect the required adapters and cabling to connect the base station to the R8200. **b.** Connect the base station to the R8200.	
5. Place the base station under control of the OEM base station test software.	**a.** Make the appropriate Ethernet connection between the PC and the base station. **b.** Run the Base Station Test Software and assume control over the base station. **c.** Follow the OEM instructions to set up a T1 test and place the base station in transmit mode.	
6. Configure the R8200.	**a.** Press **Test Mode** > **T1 Mode** > **Enter**. **b.** To select the RF In/Out port as the receiver input, press **More** > **Monitor Port** > **RF In/Out**. **c.** To reduce the attenuation, press **Attenuation** > **30 dB**. **d.** To set the RF Output Level, press **More** > **RF Output Level** > **–10** > **Enter**.	This will open the Main Screen display for TETRA Base Station Test Mode and place the R8200 in Monitor Mode.

Steps	Actions	Notes
	e. To trigger the verification, press **T1 Test** > **BS OEM** > **Motorola MTS4** > **Enter**.	
7. Observe the Measurements Display.	**a.** Verify RF Power is within test limits. **b.** Verify Residual Carrier Power is **less than 5 %**. **c.** Verify RF Freq Error is **less than 100 Hz.** **d.** Verify Error Vector Magnitude (RMS) is Power is **less than 10 %.** **e.** Verify Error Vector Magnitude (Peak) is Power is **less than 30 %**.	
8. Use the OEM Test Software to test Downlink BER and MBR.	**a.** To set the R8200 RF Output Level, press **More** > **RF Output Level** > **–116.5** > **Enter**. **b.** Verify Downlink BER and MBR are within test limits. **c.** Verify Uplink BER and MER are within test limits.	
9. Observe the Error Rates display on the R8200.	**a.** Verify Downlink BER and MBR are within test limits. **b.** Verify Uplink BER and MER are within test limits.	Positive test results confirm the offline T1 performance of the base station under test.

Having confirmed these parameters, you can verify that the transceiver on this base station is working properly in TETRA Base Station Monitor and T1 modes.

Introducing TETRA DMO Test Mode

The optional R8200 TETRA DMO Test Package option / TETRA DMO Test Mode allows testing of radios compliant with the ETSI Terrestrial Trunked Radio (TETRA) Direct Mode Operation (DMO) radio transmission protocol per ETSI specification EN 300 396-2 Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 2: Radio aspects.



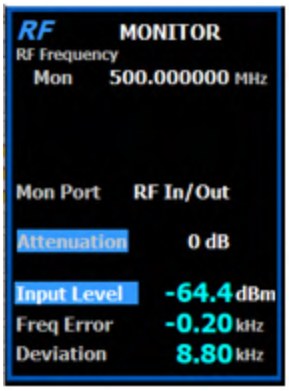
Pressing **Test** > **Test Mode** > **TETRA DMO** configures the R8200 for TETRA DMO Test Mode, as shown above. On the R8200 main display the Standard Mode's AUDIO Zone and associated soft keys are replaced by a TETRA DMO soft key and TETRA DMO-specific soft keys (accessed by pressing the **TETRA DMO** soft key).

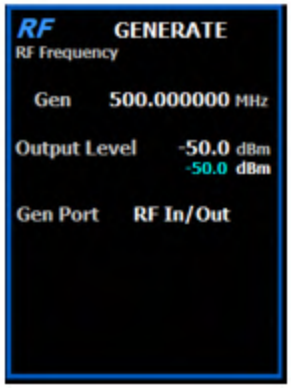
TETRA radios use a digital transmission format employing π/4 DQPSK modulation at 18000 four-bit symbols per second with a channel access method of Time Division Multiple Access (TDMA) technology with four slots per frame. The R8200 TETRA DMO Test Mode provides test functions compliant with the ETSI specification EN 300 396. The manufacturer's Radio Service Software (RSS) is not required to perform tests in TETRA Mode. These include Slot Power,

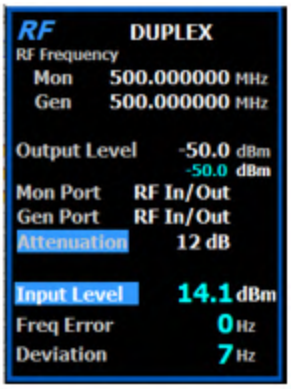
Frequency Error, Residual Carrier Magnitude, EVM (RMS), EVM (Peak), and Unwanted Power. In addition, the TETRA DMO Test Mode is equipped with a Spectrum Analyzer, Power Profile, and Modulation Spectrum/Constellation Displays.

The RF Zone

In TETRA DMO Test Mode, the RF Zone displays parameters associated with the TETRA DMO carrier stimulus generated by the R8200 as well as measurements of the RF transmissions received from the radio under test. The RF Zone during TETRA DMO transmitter testing with the R8200 in Monitor (below left) and Duplex Mode (below right), while the RF Zone during TETRA DMO receiver testing (with the R8200 in Generate Mode) is shown in the center below.







During TETRA DMO Test Mode, the RF Zone offers the following measurement displays:

Input Level – Displays the burst power level of the synchronized TDMA slot 1 transmitted by the radio under test. The measurement is done at the optimal symbol times and positions to exclude adverse effects of frequency error and residual carrier. Averaging over multiple bursts may be performed to comply with the standard. Between 1 and 250 RF power samples are collected five to 17 times per second. The number of Averaging samples can be configured by pressing the **Averaging Samples** soft key. The current number of samples is displayed as Measurement Avging at the top of the TETRA DMO Zone. The **Reset Averaging** soft key can be pressed to zero all TETRA DMO measurements, history, and displays, including ones in other zones.

NOTE Although Input Level is used for Squelch, Squelch has no effect on measurement updates.

When the RF input power on the RF In/Out port is above +20 dBm (100 mW), the R8200 utilizes a broadband power detector for the measurement. The Input Level field in the RF Zone changes to Watt Meter to indicate this measurement mode. For best accuracy, disable the Pre-amplifier in Monitor Mode and set the Gen Port in Generate Mode to RF In/Out.

Watt Meter – Displays the level of broadband power applied to the RF In/Out port when the RF input power on the RF In/Out port is above +20 dBm (100 mW).

NOTE

A TETRA TDMA transmission alternates between a used and unused time slot, so the RF Zone field will switch between them. Unused slots have no power, so the display will flash between Input Level and Watt Meter. In this condition, the Input Level reading should be used since null slots can cause the Watt Meter indication to read approximately 6 dB less than the power in the used slots.

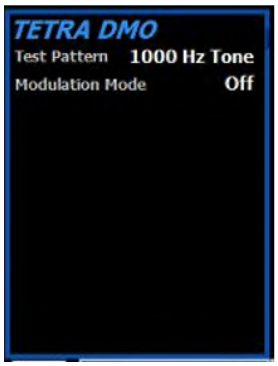
Freq Error – Displays the difference between the received TETRA DMO carrier frequency and the R8200 Monitor Frequency refined over numerous bursts for improved accuracy. The measurement is performed at optimal symbol times.

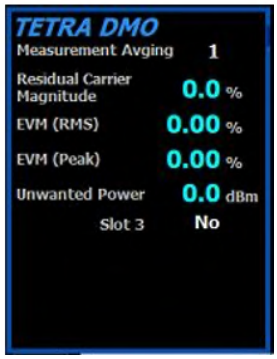
Deviation – Displays the negative and positive peak frequency deviation of a modulated carrier (i.e., from the Frequency Error mean), available when Modulation Mode is FM.

While the analyzer is operating in TETRA DMO Test Mode, the RF Zone soft key menus contain all of the parameter settings for the controlling the R8200 RF output. For a complete soft key reference for the RF Zone, see **"RF Zone Soft Keys for Duplex Mode" on page 441**.

The TETRA DMO Zone

While operating in TETRA DMO Test Mode, the AUDIO Zone and AUDIO Zone soft keys are replaced by the TETRA DMO Zone and TETRA DMO specific soft keys. The TETRA DMO Zone displays the physical layer parameters that can be configured to encode and decode TETRA DMO content. The TETRA DMO Zone is shown in Monitor Mode on the left, Generate Mode on the right, below.

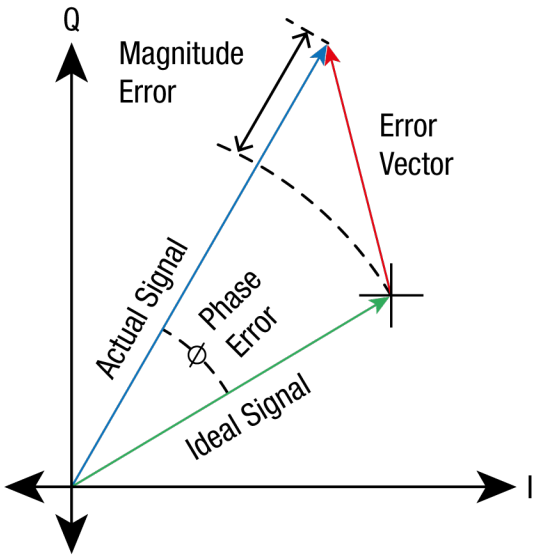




The TETRA DMO Zone offers the following measurement displays:

Residual Carrier Magnitude – Vector offset between the ideal and actual signal. In terms of its constellation, residual carrier would appear as an ideal diagram offset from the origin (0,0). The measurement is performed at optimal symbol times.

EVM (RMS) – Deviation of the actual signal (I/Q vectors) from the ideal signal, as depicted by the red arrow in the image below.



The ideal TETRA DMO signal consists of eight points around the origin. From these, the deviations are measured to all actual points closest to each. In terms of the constellation, it is the distance from the ideal to the actual symbol. The measurement is done at the optimal symbol times and positions to exclude adverse effects of frequency error and residual carrier. The RMS error vector magnitude for a burst is the square root of the sum of the squares of the error distances divided by the number of symbols in the burst.

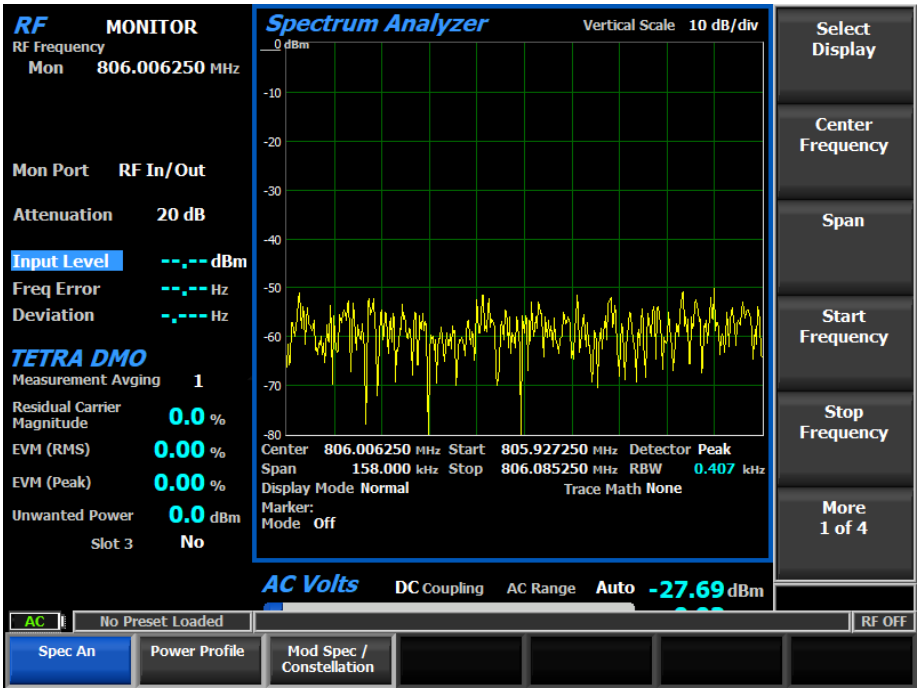
EVM (Peak) – Maximum error distance found over the burst.

Unwanted Power – Average power in non-active regions of non-active timeslots. Burst transmissions are expected to occur in every slot 1 and at times slot 3. Slots 2 and 4 of all frames are always non-active. The active region of a non-active slot is for ramping of an adjacent active slot. The measurement is done at the optimal symbol times and positions to exclude adverse effects of frequency error and residual carrier.

While the analyzer is operating in TETRA DMO Test Mode, the TETRA DMO Zone soft key menus contain all of the R8200 parameter settings for the controlling the TETRA DMO physical layer. For a complete soft key reference for the TETRA DMO Zone, see **"TETRA DMO Zone Soft Keys" on page 679**.

The DISPLAY Zone

During TETRA DMO Test Mode, the DISPLAY Zone is preconfigured with the Spectrum Analyzer display, but also offers a Power Profile, and Modulation Spectrum/Constellation Display. These are accessed by pressing **Select Display**, as shown in the horizontal soft key menu below.



Spectrum Analyzer

See **"Introducing the Spectrum Analyzer" on page 90**.

Power Profile

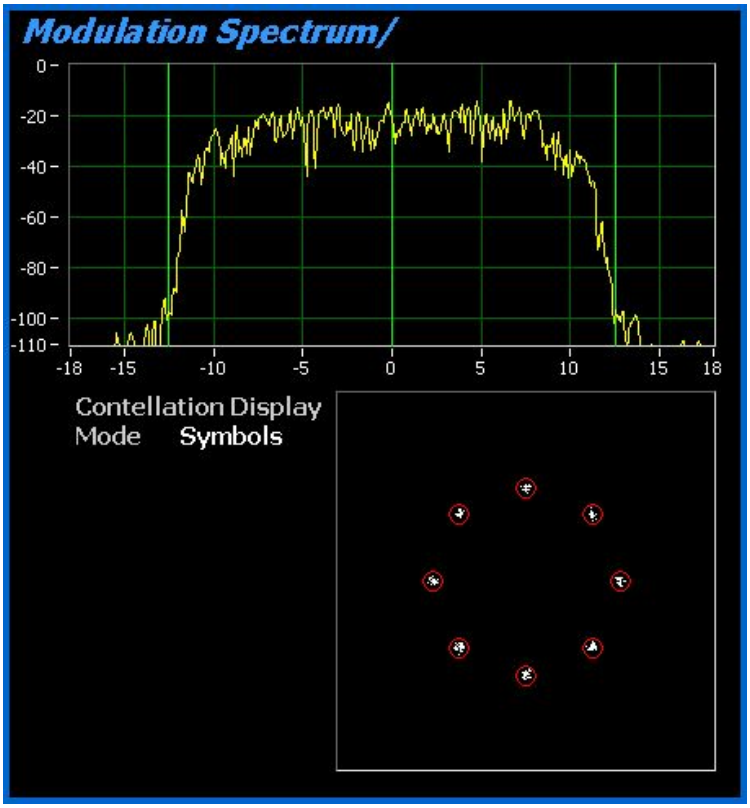
See **"Power Profile" on page 153**.

NOTE

See the Technical Specification: ETSI EN 300 396-2 “Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 2: Radio aspects,” RF output power time mask.

Modulation Spectrum / Constellation Display

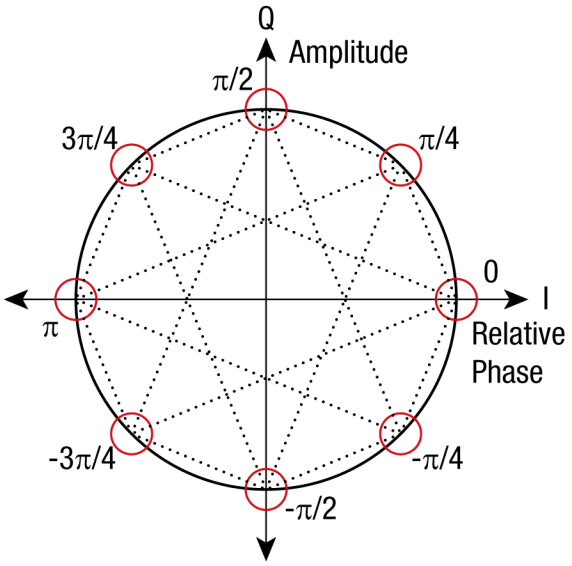
The Modulation Spectrum Display is a graph of power versus frequency (power spectral density) of the modulated symbols in the detected burst, shown below.



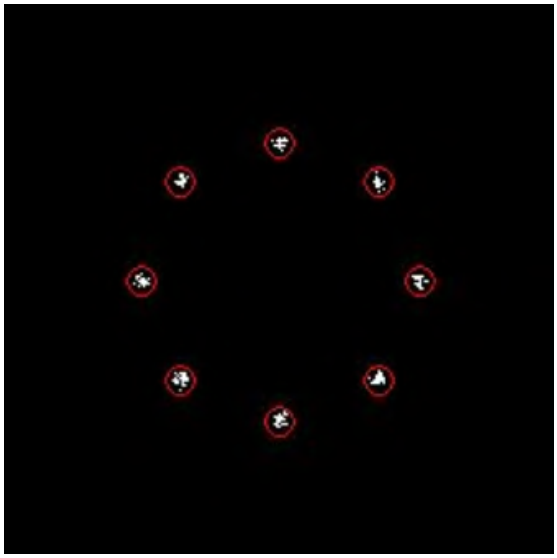
Power is shown in dB relative to Input Level (0 dB); frequency is shown in kHz relative to Center Frequency (0 Hz). The measurement is done by over-sampling at the optimal symbol times and positions to exclude adverse effects of frequency error and residual carrier.

Constellation Display

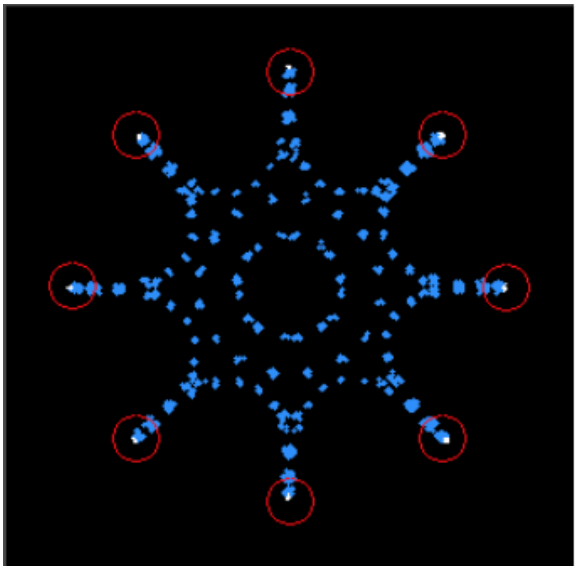
Displays the EVM measurement and a graph showing the symbol constellation on the complex I/Q plane. The display provides a visual representation of general transmitter performance when the Monitor Modulation Type is complex. TETRA radios broadcast voice and data using four differential phase shift deviations from the carrier to represent symbols containing two data bits. One of four phase shifts relative to the carrier's current phase yields eight phase points. The phase trajectory never passes through the origin, ensuring that signal amplitude never falls to zero during data transmissions. An ideal constellation is shown below.

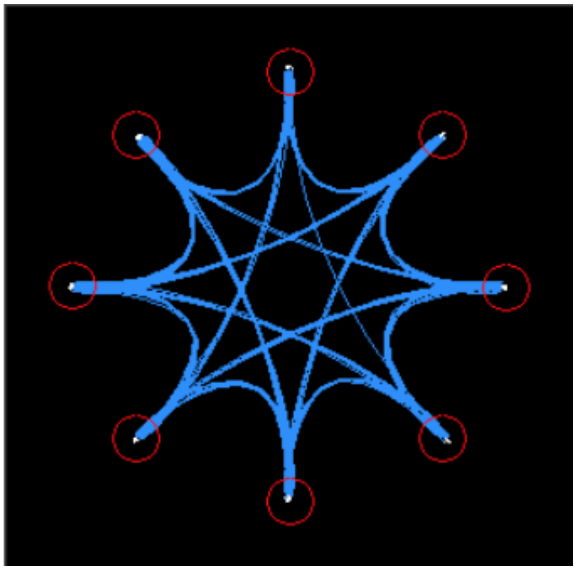


The center of the eight red circles on the display represent the expected locations for the deviation states when the radio is transmitting data bit symbols. White dots show the actual deviation measurement at symbol decision times. A tighter grouping within the red circles indicates more accurate transmitter performance. The radius of the circles is the 10% EVM (Peak) limit, as shown below.



The measurement is executed at the optimal symbol times and positions to exclude the adverse effects of frequency error and residual carrier. The Display Mode setting enables the plotting of symbols (above), samples (left, below), or trajectories (right, below).

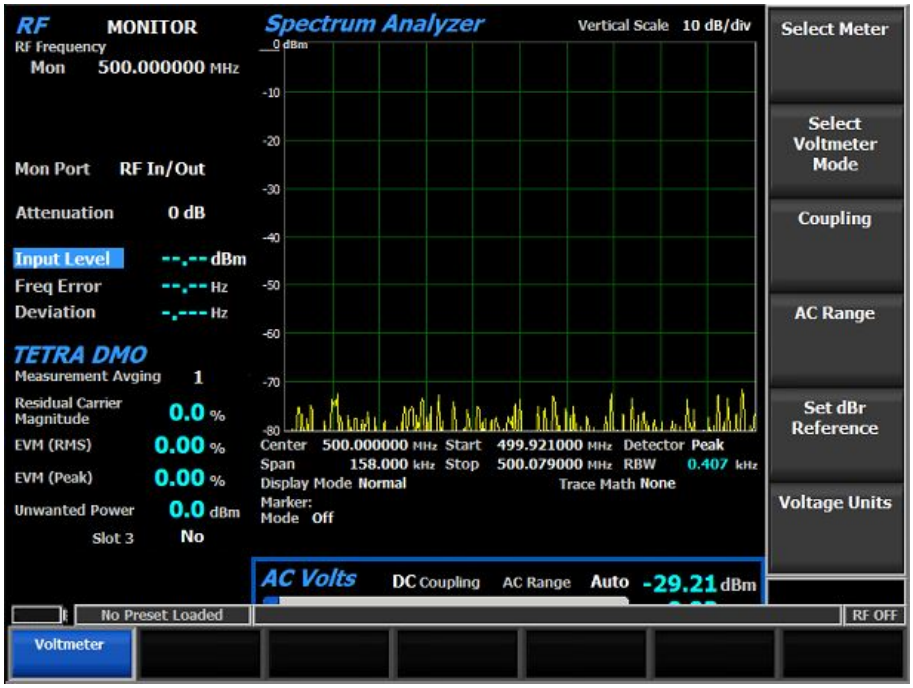




While the analyzer is operating in TETRA DMO Test Mode, the DISPLAY Zone soft key menus contain all of the parameter settings for RF and baseband measurement display. For DISPLAY Zone soft keys unique to TETRA DMO Test Mode, see **"TETRA DMO Zone Soft Keys" on page 679**. For a complete soft key reference for the DISPLAY Zone, see **"DISPLAY Zone Soft Keys for Duplex Mode" on page 474**.

The METER Zone

In TETRA DMO Test Mode, the METER Zone is preloaded with a Voltmeter, as shown.



Voltmeter

See **"Voltmeter" on page 97**.

While the analyzer is operating in TETRA DMO Test Mode, the METER Zone soft key menus contain all of the parameter settings for RF and baseband measurement metering. For METER Zone soft keys unique to TETRA DMO Test Mode, see **"TETRA DMO Zone Soft Keys for Transmitter Test" on page 680**. For a complete soft key reference for the METER Zone, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

To learn about using the R8200 to service portables, mobiles, and system infrastructure employing the TETRA DMO protocol, turn to **"Using TETRA DMO Test Mode" on the next page**.

Using TETRA DMO Test Mode

This section provides an example measurement using the TETRA DMO Test Mode. Complete this procedure to make an initial verification of a portable radio's digital signal processing without the need for specialized power supplies, test boxes, or radio service software. It can be completed using only the radio, a single BNC cable, and two adapters.

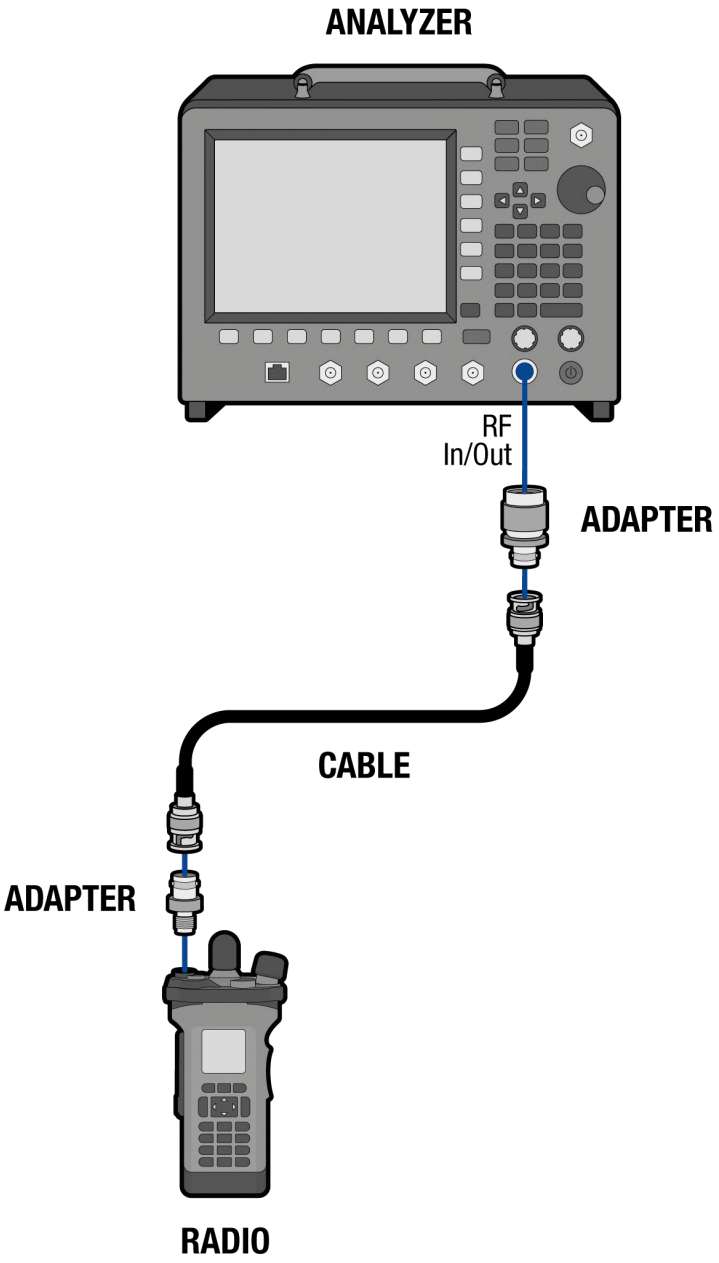
Transceiver Verification

This section describes a simple procedure for verifying the basic functionality of the radio's RF transceiver and physical layer protocol using the R8200 in TETRA DMO Test Mode. Follow these steps to connect the radio to the R8200 and configure your measurement.

Required Equipment

- Freedom R8200 Communications System Analyzer
- Portable Radio, programmed for TETRA DMO (i.e., Motorola, Sepura, Hytera or similar)
- Cable, coax, BNC (m-m)
- Adapter, Type N(f)-to-BNC(f)
- Adapter, SMA(f)-to-BNC(f)

Test Setup



Procedure

Steps	Actions	Notes
1. Configure the test setup.	**a.** Connect the Type N(f)-to-BNC(f) adapter to the R8200 RF In/Out port. **b.** Remove the antenna from the radio. **c.** Connect the SMA(f)-to-BNC(f) Adapter to the Antenna port of the radio. **d.** Connect the BNC cable between the radio and the R8200.	
2. Configure the R8200.	**a.** Press **Test** > **Test Mode** > **TETRA DMO**. **b.** To set the receiver Center Frequency to match the radio transmitter, press **Hot Key 1** > **Monitor Frequency** > **863** > **MHz**. **c.** In the RF Zone, confirm that Mon Port displays **RF In/Out** as the receiver input. **d.** To receive the appropriate TETRA RF power level, disable Auto Attenuation by pressing **Settings** > **System Settings** > **Automatic Attenuation** > **Off**. **e.** To set the receiver RF attenuation, press **Hot Key 1** > **Attenuation** > **30 dB** > **Enter**.	Alternatively, press **RF Zone** > **Monitor Frequency** > **863** > **MHz**. If not, press **Mon Port** > **RF In/Out** > **Enter**.

Steps	Actions	Notes
3. Activate and key the radio.	**a.** Turn the On/Off/Volume Knob clockwise to activate the radio. **b.** Press **PTT** on the portable radio.	This initiates a broadcast of the voice content picked up by the radio microphone.

NOTE

All TETRA Base Station radios can be configured for DMO mode. Normally this configuration is performed when the radio software is programmed. To reach DMO operation a special key press may be needed, or a specific channel selected. Contact your system administrated for details to activate DMO mode.

4. Observe the DISPLAY Zone.	**a.** To verify the radio is producing a TETRA DMO signal, press **PTT** on the radio.	
	b. Refer to the Spectrum Analyzer display.	You should observe a signal on the Spectrum Analyzer display.
	c. To view the symbol trajectories, press **Select Display** > **Mod Spec / Constellation** > **Constellation Display Mode** > **Trajectories.**	You should see active trajectories on display and tight symbols grouped withing the decision circles
5. Observe the RF Zone**.**	**a.** Confirm that the Input Level displays the radio output as approximately **1.5 W**. **b.** Confirm that the Freq Error displays the radio frequency error as **less than 100 Hz**.	This verifies the performance of the radio RF transmitter.
6. Observe the TETRA DMO Zone.	**a.** Press **Hot Key 4** > **Reset Averaging**. **b.** Press **PTT** on the radio**.** **c.** Confirm that EVM (RMS) displays **5% or less**.	This verifies that the radio is correctly broadcasting the TETRA DMO physical layer signal.

Steps	Actions	Notes
7. Configure the R8200.	**a.** To configure the TETRA DMO generator on the R8200, press **Generate**. **b.** To set the Generate Frequency to match the radio receiver, press **Hot Key 1** > **Generate Frequency** > **863** > **MHz**. **c.** To choose a test tone to broadcast to the radio, press **Hot Key 4** > **Test Pattern** > **1000 Hz Tone**. **d.** To broadcast the test tone, press, **Modulation Mode** > **Continuous**.	
8. Listen for the 1 kHz tone broadcast from the radio speaker.	**a.** Adjust the volume of the 1000 Hz tone using the radio On/Off/Volume Knob.	This verifies that the radio correctly decodes the TETRA DMO baseband content.
9. Test the sensitivity of the radio.	**a.** To adjust the Output Level of the R8200, press **Hot Key 1** > **Output Level**. **b.** Use the arrow keys and the tuning knob to decrease the Output Level until the 1000 Hz tone is no longer broadcast from the radio speaker. **c.** Confirm that the RF Output Level on the R8200 is less than –112 dBm when the tone disappears.	This confirms that the radio receiver is sensitive to transmissions as weak as –112 dBm.

Having confirmed these parameters, you can verify that the transceiver on this radio is working properly in TETRA DMO Mode.

Introducing TETRA TMO Test Mode

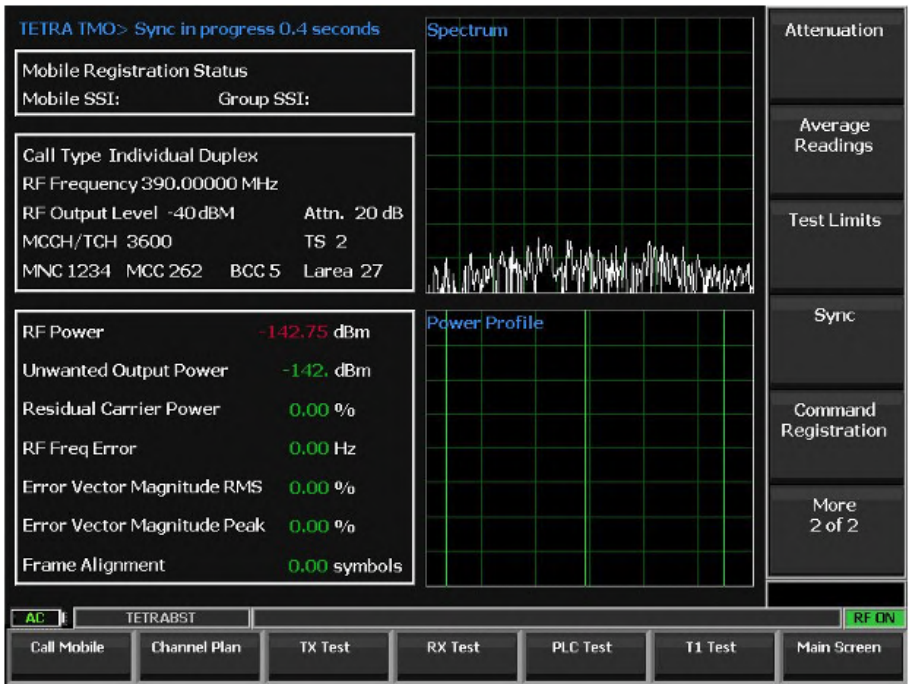
The optional R8200 TETRA TMO Test Package option enables testing of radios compliant with the ETSI Terrestrial Trunked Radio (TETRA) Direct Mode Operation (DMO) radio transmission protocol per ETSI specification EN 300 396-2 Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 2: Radio aspects. TETRA radios use a digital transmission format employing π/4 DQPSK modulation at 36000 four-bit symbols per second with Time Division Multiple Access (TDMA) with four slots per frame as its channel access methodology.

TETRA TMO Test Mode provides performance verification functionality compliant with ETSI specification EN 300 396. The manufacturer's Radio Service Software (RSS) is required to perform T1 tests in TETRA TMO Mode. These receiver and transmitter performance verification measurements include Receiver Sensitivity, Slot Power, Frequency Error, Residual Carrier Magnitude, EVM (RMS and Peak), Unwanted Power, Frame Alignment Symbols, and PLC test. In addition, the TETRA TMO Test Mode comes equipped with a Spectrum Analyzer, Power Profile, and Modulation Spectrum/Constellation Displays.

Pressing **Test** > **Test Mode** > **TETRA TMO > TETRA TMO** configures the R8200 for TETRA TMO Test Mode.

TETRA TMO Verification Tests

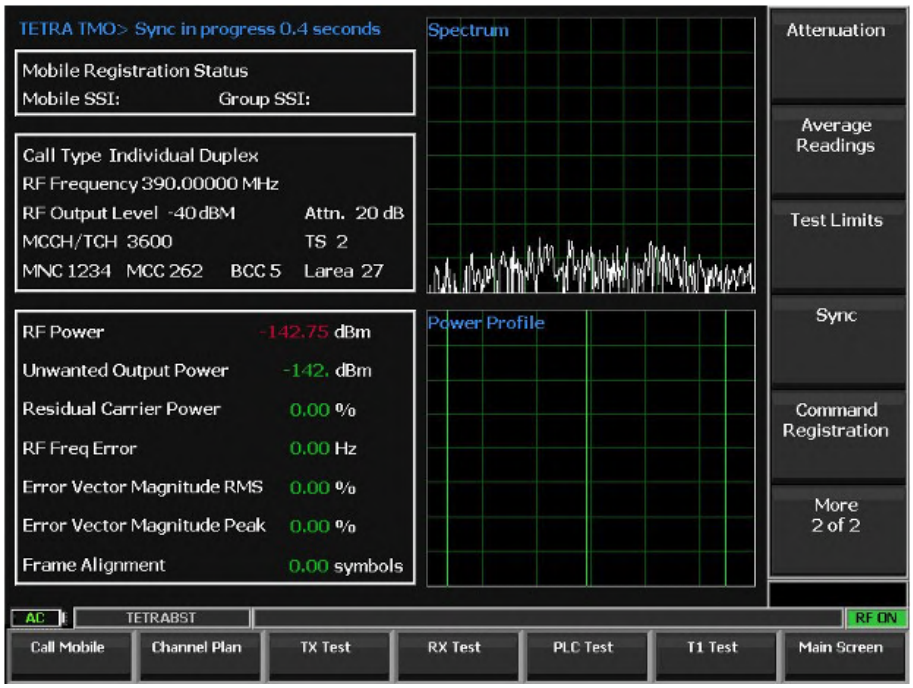
The application was designed for maximum flexibility across a variety TETRA TMO hardware implementations. Unlike the classic Four-Zone R8000-Series display user interface, TETRA TMO Test Mode channel assignment and baseband configuration is provided by an off-screen Channel Plan Table so that the Main Screen can be focused on displaying as many system critical measurements as possible, as shown.



In TETRA TMO Test Mode, the R8200 emulates a trunking Base Station. It provides a Main Screen that offers call configuration and 5 performance verification test modes: Monitor Mode, Transmitter (TX) Test, Receiver (RX) Test, Power Loop Control (PLC) Test, and T1 Test. The following sections describe the Main Display and each Test Mode display in detail.

Monitor Mode in Main Screen

In the TETRA TMO Main Screen, the R8200 emulates a trunking TMO Monitor which enables the call configuration and performance verification of subscriber radios.



The Main Screen features a TETRA Configuration Display above a Measurements Display on the left side of the screen and Mini Graphical Displays on the right side, as shown above.

TETRA Configuration Display

This area (shown above) presents the following RF and TETRA parameter settings for the receiver:

Mobile SSI – Displays the current Individual Short Subscriber Identity of the radio under test.

Group SSI – Displays the current Group Short Subscriber Identity of the radio under test.

Call Type – Displays one of the seven Call Types for the radio under test.

RF Frequency – Displays the Monitor Frequency for the receiver.

RF Output Level – Displays the RF output level of the Uplink signal transmitted by the R8200.

MCCH/TCH – Displays the Main Control (MCCH)and Traffic (TCH) channel number.

MNC – Displays the TMO Mobile Network Code.

MCC – Displays the TMO Mobile Country Code.

BCC– Displays the TMO Colour Code.

LA – Displays the Larea Code.

TS - Displays the active timeslot.

Attn – Displays the amount of attenuation on the receiver port.

Measurements Display

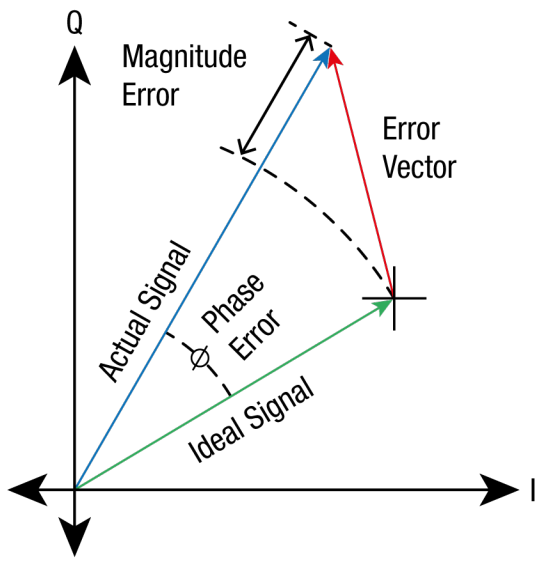
This area (shown above, beneath the TETRA Configuration Display) presents the following RF parameters and measurements:

RF Power – Displays the burst power level of the synchronized TDMA slot 1 transmitted by the radio under test. The measurement is done at the optimal symbol times and positions to exclude adverse effects of frequency error and residual carrier. Averaging over multiple bursts may be performed to comply with the standard. Between 1 and 250 RF power samples are collected five to 17 times per second. The number of Averaging samples can be configured by pressing the **Averaging Readings** soft key. The current number of samples is displayed as Averaging at the top of the Measurements Display. The **Reset Averaging** soft key can be pressed to zero all TETRA DMO measurements, history, and displays, including ones in other zones.

Residual Carrier Power – Displays the percentage of carrier power from inactive timeslots.

RF Freq Error – Displays the frequency difference between the received Downlink Frequency and the R8200 current Monitor Frequency setting.

Error Vector Magnitude RMS – Displays the average deviation of the actual I/Q vectors from the ideal vectors as a percentage beyond the ideal (0% Error Vector Magnitude), as depicted by the red arrow in the image below.



The ideal TETRA TMO signal consists of eight decision points around the origin. From these, the deviations are measured to all actual decision points closest to each. In terms of the constellation, it is the distance from the ideal to the actual symbol. The measurement is done at the optimal symbol times and positions to exclude adverse effects of frequency error and residual carrier. The RMS error vector magnitude for a burst is the square root of the sum of the squares of the error distances divided by the number of symbols in the burst.

Error Vector Magnitude Peak – Displays the maximum error distance found over the burst as a percentage beyond the ideal (0% Peak Error Vector Magnitude).

Frame Alignment – Displays the deviation from the number of expected symbols in a TETRA frame.

Mini Graphical Displays

This area (shown above, on the right side of the display screen) presents a dual display of the following graphical RF measurements:

Spectrum – Displays a power-versus-frequency representation of the base station transmitted carrier signal.

Power Profile – Display provides a power versus time plot of the transmitted timeslots. This specialized Oscilloscope display is useful for ensuring that near-far situations will not result in co-channel inter-slot interference on the alternate or non-transmission slot and that the power level will be adequate for acceptable BER performance. The scaling and position of the vertical power axis can be adjusted to inspect greater range or detail. The horizontal axis can be changed to view one or both slots including the additional ramp up/down time.

Symbols – Displays the measured symbol decision points as white dots and plots them on a Constellation Display of the ideal target decision points. The red targets represent the area within the 10% EVM test limit.

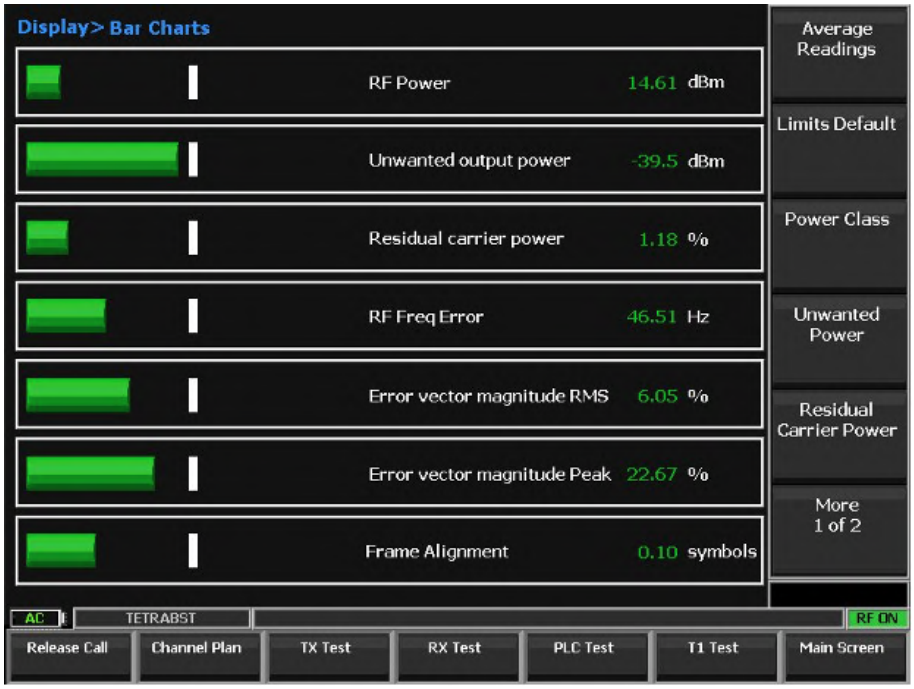
Trajectories – Displays the trajectories of the symbols between decision points as blue traces on a Constellation Display of the ideal target decision points.

Bar Graphs – Displays bar graphs of the measurements represented numerically in the Measurements Display area to the right.

Graphical Displays

Full screen versions of the following instrument displays can be accessed by pressing **Graphical Displays**:

Bar Charts



The full screen Bar Charts Display include soft keys for configuring the Test Limits of the measurements represented in the Bar Charts Display.

Spectrum Analyzer

See **"Introducing the Spectrum Analyzer" on page 90**.

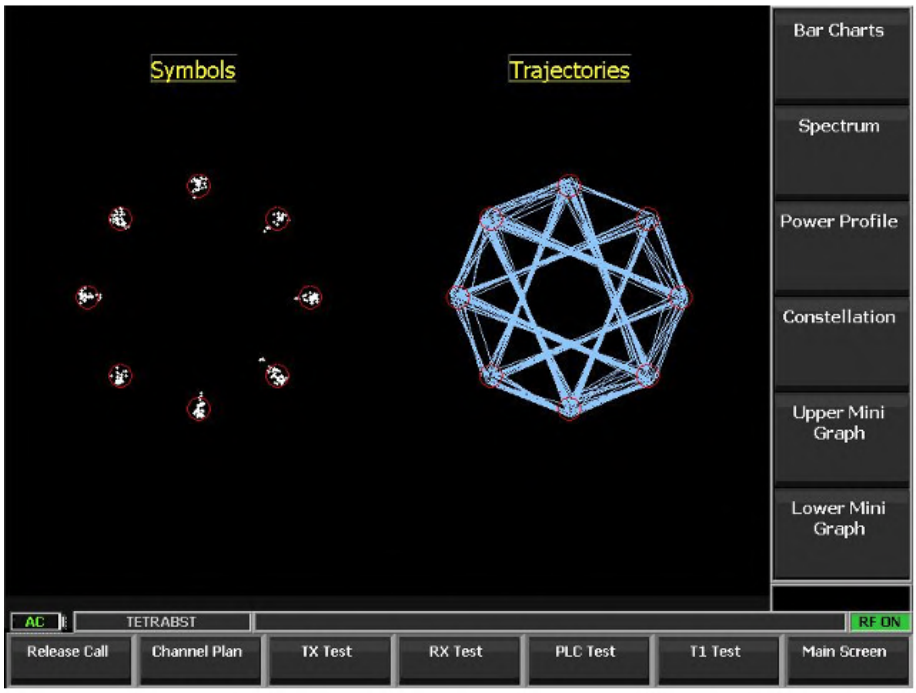
Power Profile

See **"Power Profile" on page 153** for additional details.

NOTE

See the Technical Specification: ETSI EN 300 396-2 “Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 2: Radio aspects,” RF output power time mask.

Constellation



Symbols (above left) displays the measured symbol decision points as white dots and plots them on a Constellation Display of the ideal target decision points. The red targets represent the area within the 10% EVM test limit. Trajectories (above right) displays the signal path as a blue trace as it passes between decision points on a Constellation Display of the ideal targets.

Test Limits

Pressing **Test Limits** opens the Test Limits Table (above) where you can use the vertical soft key menu to automatically configure the PASS/FAIL boundaries for every measurement in the Measurements Display. These limits are mirrored in the Bar Charts display. Pressing **Limits Default** returns all limit settings to the ETSI standard values.

Channel Plan Table

The Channel Plan Table displays the current TETRA TMO subscriber unit configuration, as shown.

Use the soft keys in the Main Menu vertical soft key menu to configure the RF parameters and the TETRA channeling codes.

NOTE Failure to set these parameters correctly will result in invalid test results for TX and RX BER.

Channel System

MCCH – Displays the Main Control Channel number and associated transmitter frequency.

TCH – Displays the Main Control Channel number and associated transmitter frequency.

TS - Displays the active timeslot.

Frequency Band – Displays the specified harmonized Frequency Band transmitted by the R8200.

Channel Offset – Displays the current Downlink Channel Offset frequency.

Duplex Offset – Displays the current Offset Frequency for both Uplink and Downlink Channels.

Operating Mode – Displays the current forward or reverse mode of operation.

Network

Connection Mode – Displays the Normal or Fallback Connection Mode.

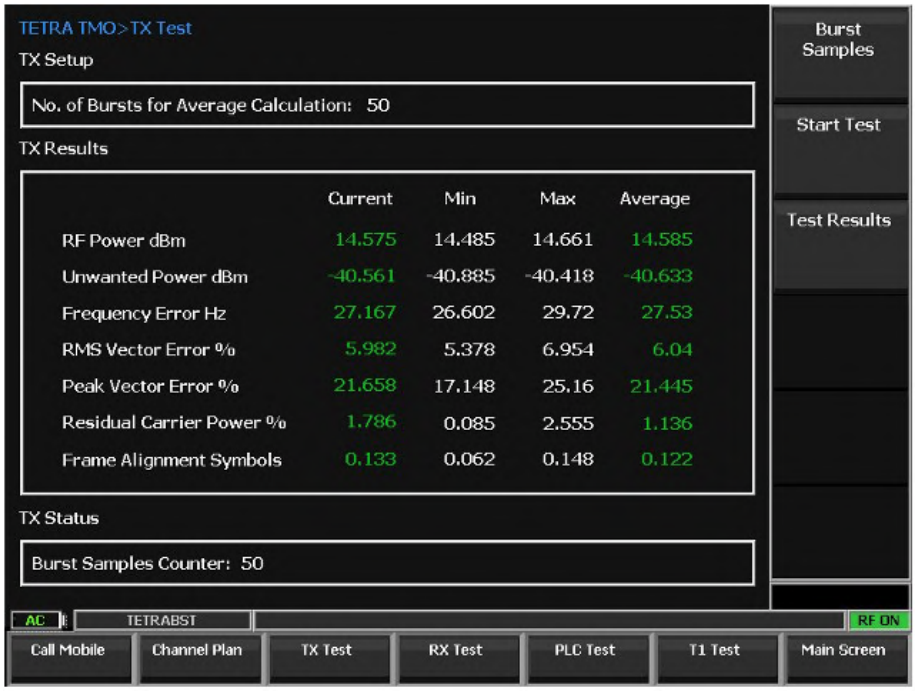
MCC – Displays the TMO Mobile Country Code.

MNC – Displays the TMO Mobile Network Code.

BCC– Displays the TMO Colour Code.

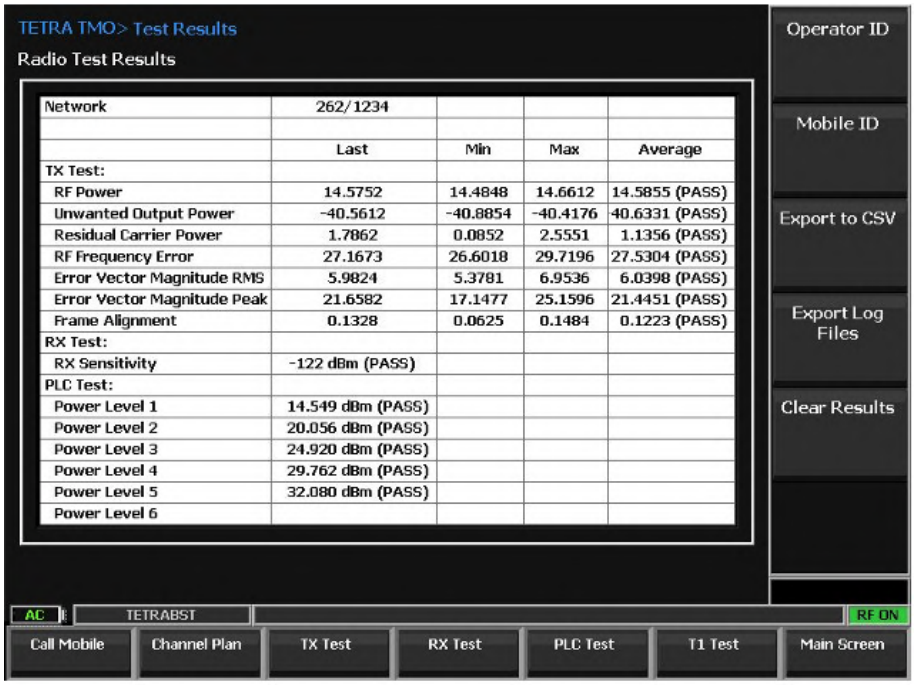
Larea – Displays the Local Area Code.

TX Test



Pressing **TX Test** opens the TX Test Table (above) where you can use the vertical soft key menu to configure your OTA performance verification of a subscriber radio. The Burst Samples setting determines the length of the test as well as the number of burst samples from which to calculate the results populating the Average column. The

remaining soft keys execute the OTA transmitter test and to display the results, shown below. The transmitter test terminates when the prescribed number of samples has been gathered. See **"Measurements Display" on page 256** for an explanation of individual results.



Network	262/1234			
	Last	Min	Max	Average
TX Test:				
RF Power	14.5752	14.4848	14.6612	14.5855 (PASS)
Unwanted Output Power	-40.5612	-40.8854	-40.4176	40.6331 (PASS)
Residual Carrier Power	1.7862	0.0852	2.5551	1.1356 (PASS)
RF Frequency Error	27.1673	26.6018	29.7196	27.5304 (PASS)
Error Vector Magnitude RMS	5.9824	5.3781	6.9536	6.0398 (PASS)
Error Vector Magnitude Peak	21.6582	17.1477	25.1596	21.4451 (PASS)
Frame Alignment	0.1328	0.0625	0.1484	0.1223 (PASS)
RX Test:				
RX Sensitivity	-122 dBm (PASS)			
PLC Test:				
Power Level 1	14.549 dBm (PASS)			
Power Level 2	20.056 dBm (PASS)			
Power Level 3	24.920 dBm (PASS)			
Power Level 4	29.762 dBm (PASS)			
Power Level 5	32.080 dBm (PASS)			
Power Level 6				

RX Test

Pressing **RX Test** opens the RX Test Table (above) where you can use the vertical soft key menu to configure your RX Sensitivity performance verification of a subscriber radio. The Start Level setting determines the power of the initial transmission for the test. The Step Level is the number of decibels that the Power Level is reduced with each step of the test. Start RX Test begins the procedure. Results can be viewed by pressing Test Results.

PLC Test

Pressing **PLC Test** opens the PLC Test Table (above) where you can use the vertical soft key menu to perform a Power Loop Control Test on a subscriber radio. Start PLC Test begins the procedure. Results can be viewed by pressing Test Results.

T1 Test

TETRA TMO T1 Test contains additional parameter controls for the TETRA TMO T1 Test Table for transceiver performance verification of the subscriber unit under test using the manufacturer Test Mode Software. T1 Test Mode will provide the correct Uplink response to the Downlink T1 and Network settings. T1 Test Mode provides 3 different Burst Types, 3 different mobile subscriber modes, and user-defined RF output power in order to complete T1 Bit Error Rate and Modulation Error Rate performance verification for the subscriber unit under test.

While the analyzer is operating in TETRA TMO Test Monitor Mode, its soft key menus contain all of the R8200 parameter settings for configuring, performing, and recording the results of OTA TMO performance verification tests. For a complete soft key reference, see **"TETRA TMO Test Mode Soft Keys" on page 691**.

Using TETRA TMO Test Mode

This section provides an example measurement using the TETRA TMO Test Mode. Complete this procedure to make an initial verification of a portable radio's digital signal processing without the need for specialized power supplies, test boxes, or radio service software. It can be completed using only the radio, a single BNC cable, and two adapters.

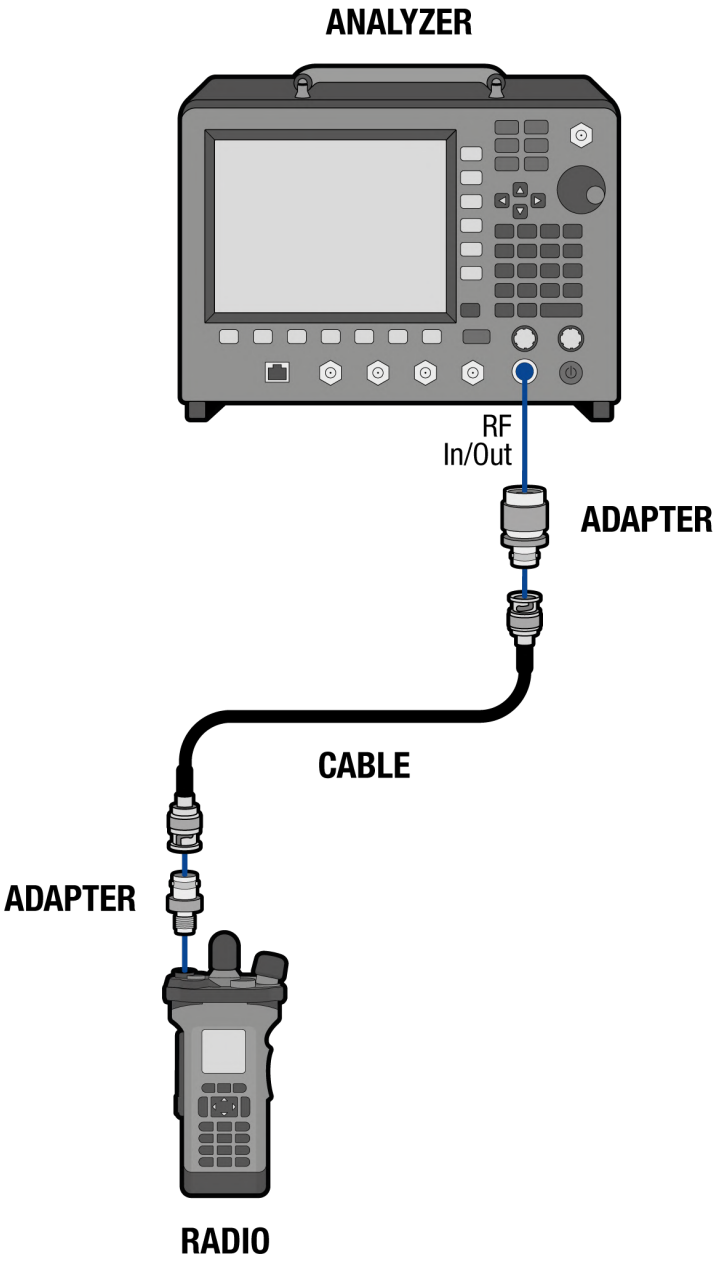
Transceiver Verification

This section describes a simple procedure for verifying the basic functionality of the radio's RF transceiver and physical layer protocol using the R8200 in TETRA TMO Test Mode. Follow these steps to connect the radio to the R8200 and configure your measurement.

Required Equipment

- Freedom R8200 Communications System Analyzer
- Portable Radio, programmed for TETRA TMO (i.e., Motorola, Sepura, Hytera or similar)
- Cable, coax, BNC (m-m)
- Adapter, Type N(f)-to-BNC(f)
- Adapter, SMA(f)-to-BNC(f)

Test Setup



Procedure

Steps	Actions	Notes
1. Configure the test setup.	**a.** Connect the Type N(f)-to-BNC(f) adapter to the R8200 RF In/Out port. **b.** Remove the antenna from the radio. **c.** Connect the SMA(f)-to-BNC(f) Adapter to the Antenna port of the radio. **d.** Connect the BNC cable between the radio and the R8200.	
2. Gather the TETRA TMO network programming information for the radio under test (it may be necessary to refer to the manufacturer Radio Support Software).	**a.** Record the MCCH/TCH. **b.** Record the MNC. **c.** Record the MCC. **d.** Record the BCC. **e.** Record the TS. **f.** Record the Larea.	This example uses the following network programming parameters: MCCH/TCH = 3600 MNC = 1234 MCC = 262 BCC = 5 TS = 2 Larea = 27
3. Configure the R8200.	**a.** Press **Test** > **Test Mode** > **TETRA TMO > TETRA TMO.** **b.** To configure the network programming for the subscriber unit, press **Channel Plan.** **c.** Press the following soft keys to enter your radio's network configuration parameters: **MCCH**, **TS**, **Channel Offset**, **Duplex Offset**, **Operating Mode**, **Con-**	This will open the Main Screen display for TETRA TMO Test Mode.

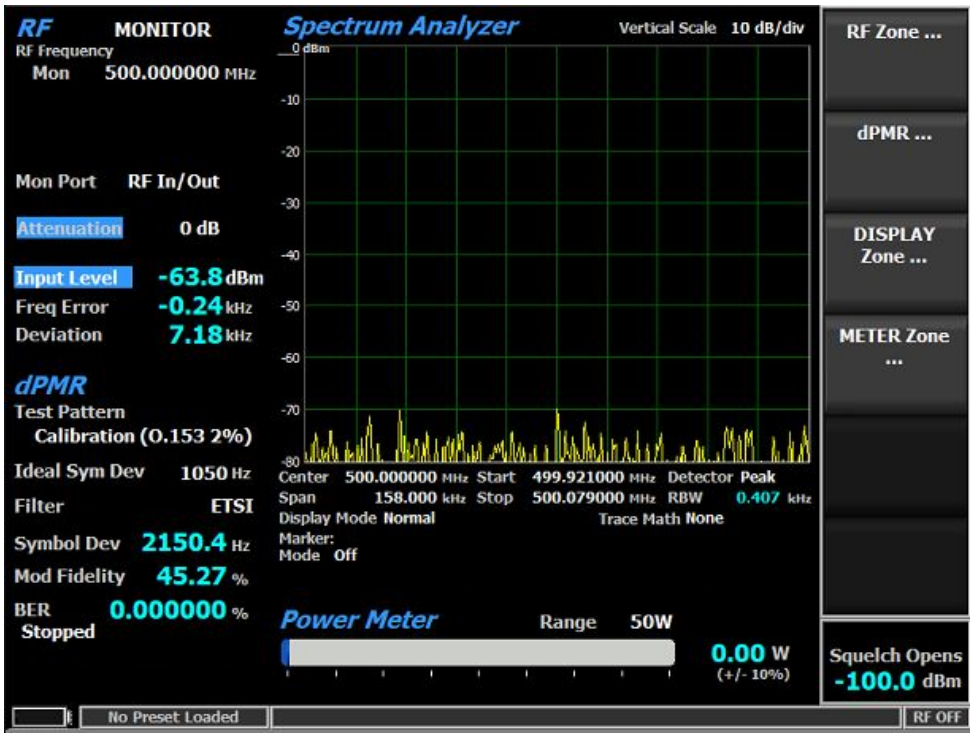
Steps	Actions	Notes
	nection Mode, **MCC**, **MNC**, **BCC**, and **Larea**.	
4. Activate the radio.	**a.** Turn the On/Off/Volume Knob clockwise to activate the radio.	The radio will scan for a valid network and then perform a registration with the R8200, then beep and display its connected status.
5. Configure the R8200.	**a.** To show the Bar Graphs in the Mini Display, press **Graphical Displays** > **Lower Mini Graph** > **Bar Graphs**. **b.** To address the radio, in the horizontal soft key menu, press **Call Mobile**. **c.** When the radio rings, answer the call.	
6. Observe the DISPLAY Zone.	**a.** To verify the radio is producing a valid TETRA TMO signal, refer to the Bar Graph display. **b.** Refer to the Spectrum Analyzer display. **c.** To view symbols and trajectories, press **Select Display** > **Constellation.**	You should observe green bars in the Bar Graphs if the radio is working properly. You should observe a TMO signal in the Spectrum Analyzer display if the radio is working properly. You should observe active trajectories on display and tight symbols grouped withing the decision circles.
7. Release the call**.**	**a.** To release the call, in the horizontal soft key menu, press **Release Call**.	This verifies the performance of the radio's RF transceiver.
8. Perform a Transmitter Verification test**.**	**a.** To perform a receiver sensitivity test, press **TX Test > Start TX Test**. **b.** To view results, press **Test Res-**	This verifies the performance of the radio's RF transmitter.

Steps	Actions	Notes
	ults.	
9. Perform a Receiver Sensitivity test**.**	**a.** To perform a receiver sensitivity test, press **RX Test > Start RX Test**. **b.** To view results, press **Test Results.**	This verifies the performance of the radio's RF receiver.
10. Perform a Power Loop Control test**.**	**a.** To perform a receiver sensitivity test, press **PLC Test > Start PLCTest**. **b.** To view results, press **Test Results.**	This verifies the performance of the radio's RF receiver.

Having confirmed these parameters, you can verify that the transceiver on this radio is working properly in TETRA TMO Mode.

Introducing dPMR Test Mode

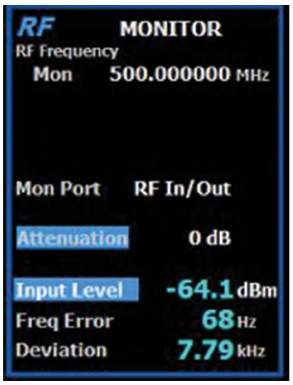
The R8200 dPMR Test Package option dPMR Test Mode allows testing of radios compliant with the Digital Private Mobile Radio (dPMR) protocol. dPMR radios use a digital transmission format employing Four-Level Frequency Shift Keying (4FSK) modulation in an RF spectrum managed by Frequency Division Multiple Access (FDMA) technology. The R8200 dPMR Test Mode provides performance verification functions compliant with the Conformance Test section of the dPMR Common Air Interface (CAI) standard. These include RF Power, Frequency Error and Deviation, Symbol Deviation, Modulation Fidelity (FSK Error), and Bit Error Rate (BER). BER tests require the manufacturer's Radio Service Software (RSS) to place the radio in a special test mode. The dPMR format also provides Test Patterns for BER verification. In addition, a Spectrum Analyzer, Modulation Scope, Oscilloscope, Bar Graphs, and an Eye Diagram with graphical representation of the dPMR signal are provided. A Voice Loopback function enables the Voice Loop feature (U.S. patent 5703479) for audio verification of the radio's end-to-end operation. Both provide qualitative indication of the radio's performance. Averaging can be applied to some measurements via the System Settings.

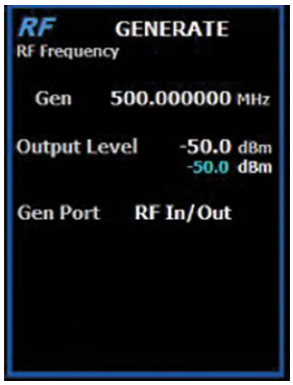


Pressing **Test** > **Test Mode** > **dPMR** configures the R8200 for dPMR protocol testing, as shown above. On the R8200 main display, the Standard mode's AUDIO Zone and associated soft keys are replaced by the dPMR Zone and dPMR-specific soft keys (accessed by pressing the **dPMR** soft key).

The RF Zone

In dPMR Test Mode, the RF Zone displays parameters associated with the dPMR carrier stimulus generated by the R8200 as well as measurements of the RF transmissions received from the radio under test. The RF Zone during dPMR transmitter testing (with the R8200 in Monitor Mode) is shown on the left while the RF Zone during dPMR receiver testing (with the R8200 in Generate Mode) is shown below.





During dPMR Test Mode, the RF Zone offers the following measurement displays:

Input Level – Displays the average power in the dPMR channel under test.

Freq Error – Displays the frequency difference of the received dPMR transmission carrier minus the R8200 Monitor Frequency.

Deviation – Displays the positive peak FM frequency deviation of the received modulated carrier (i.e. from the Frequency Error mean). See negative peak frequency deviation with DISPLAY Zone Bar Graphs.

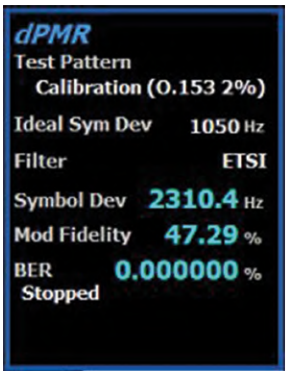
NOTE

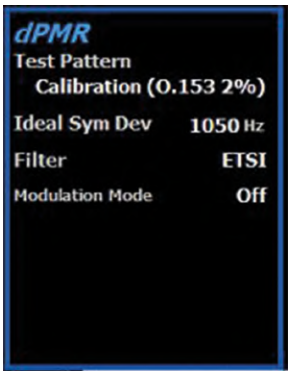
When the RF input power on the RF In/Out port is above +20 dBm (100 mW), the R8200 utilizes a broadband power detector for the measurement. The Input Level field in the RF Zone changes to Watt Meter to indicate this measurement mode. For best accuracy, disable the Pre-amplifier in Monitor Mode and set the Gen Port in Generate Mode to RF In/Out.

While the analyzer is operating in dPMR Test Mode, the RF Zone soft key menus contain all of the parameter settings for the controlling the R8200 RF output. For a complete soft key reference for the RF Zone, see **"RF Zone Soft Keys for Duplex Mode" on page 441**.

The dPMR Zone

While operating in dPMR Test Mode, the AUDIO Zone and AUDIO Zone soft keys are replaced by the dPMR Zone and dPMR specific soft keys. The dPMR Zone displays the physical layer parameters that can be configured to encode and decode dPMR content. The dPMR Zone is shown in Monitor Mode on the left, Generate Mode on the right, below.





The dPMR Zone offers the following measurement displays:

Symbol Dev – Displays the symbol deviation estimated by averaging the normalized frequency deviations at symbol times in the specified burst of the synchronized FDMA slot of the received signal and then scaling by the maximum symbol value. The normalized frequency deviation is computed as the ratio of the actual frequency measurement at a given symbol or deviation state by the corresponding symbol value. dPMR radios broadcast voice and data using a four level frequency deviation of the carrier to represent symbols containing data bits as shown in the table below. The nominal symbol deviation value for a dPMR radio using 4FSK modulation is 1050 Hz in a 6.25 kHz channel. Since the deviation of a dPMR 4FSK signal is data dependent, that aspect is factored when measuring overall carrier deviation. The Symbol Deviation field provides the deviation measurement at symbol decision times.

Bits	Symbol	Frequency Deviation
01	+3	+1050 Hz
00	+1	+350 Hz
10	–1	–350 Hz
11	–3	–1050 Hz

Mod Fidelity – Modulation Fidelity (FSK error) represents how accurate a transmitter reproduces an ideal theoretical modulation waveform. The measurement is performed by first removing frequency error and symbol deviation gain error from the received signal, then computing the RMS difference between the deviation of the resulting signal at each symbol decision point and the ideal deviations of those symbols; no bit errors should exist. On the R8200, this is reported as an RMS error in % relative to the mean deviation across symbols.

BER – Displays the percentage of bit differences between the bits of the selected Test Pattern and the bits from the received synchronized FDMA signal. This bit error rate test checks the modulation, encoding, and timing of the transmit signal during the data transmission period. When performing the BER Test, the radio transmitter under test must be placed into a test diagnostic mode with the correct TX test pattern selected using the manufacturer's Radio Service Software (RSS). The test is done at nominal power with the radio transmitting the test pattern into the service monitor. (It is acceptable to have an attenuator between the radio under test and the service monitor.)

While the analyzer is operating in dPMR Test Mode, the dPMR Zone soft key menus contain all of the R8200 parameter settings for the controlling the dPMR physical layer. For a complete soft key reference for the dPMR Zone, see **"dPMR Zone Soft Keys" on page 713**.

The DISPLAY Zone

During dPMR Test Mode, the DISPLAY Zone offers a Spectrum Analyzer, Modulation Scope, Oscilloscope, Bar Graphs, and an Eye Diagram, accessed by pressing **Select Display**, as shown in the horizontal soft key menu below.

Spectrum Analyzer

See **"Introducing the Spectrum Analyzer" on page 90**.

Modulation Scope

See **"Introducing the Modulation Scope" on page 91**.

Oscilloscope

See **"Introducing the Oscilloscope" on page 92**.

Bar Graphs

See **"Bar Graphs" on page 77**.

Eye Diagram

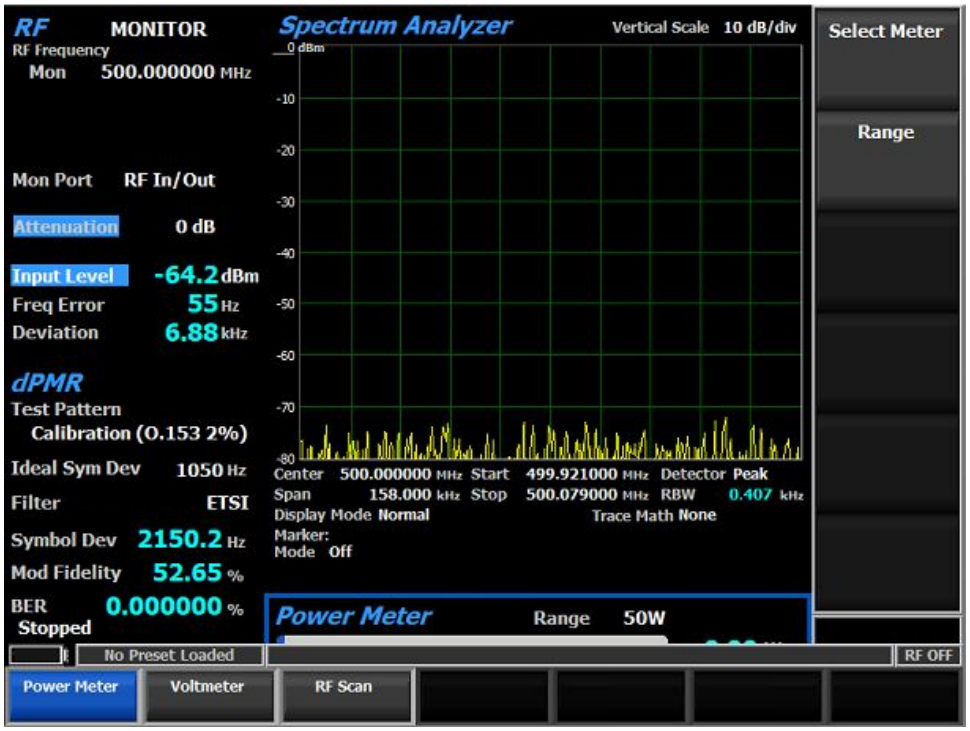
See **"Eye Diagram" on page 152**.

While the analyzer is operating in dPMR Test Mode, the DISPLAY Zone soft key menus contain all of the parameter settings for RF and baseband measurement display. For DISPLAY Zone soft keys unique to dPMR Test Mode, see **"DISPLAY Zone Soft Keys for dPMR Transmitter Test" on page 717**. For a complete soft key reference for the DISPLAY Zone, see **"DISPLAY Zone Soft Keys for Duplex Mode" on page 474**.

The METER Zone

In dPMR Test Mode, the METER Zone is preloaded with a Power Meter.

A Voltmeter and RF Scan are also available by pressing **Hot Key 5** > **Select Meter** and choosing the desired meter, as shown below.



Power Meter

See **"Power Meter" on page 97**.

Voltmeter

See **"Voltmeter" on page 97**.

RF Scan

"RF Scan" on page 102.

While the analyzer is operating in dPMR Test Mode, the METER Zone soft key menus contain all of the parameter settings for RF and baseband measurement metering. For METER Zone soft keys unique to dPMR Test Mode, see **"METER Zone Soft Keys for dPMR Transmitter Test" on page 719**. For a complete soft key reference for the METER Zone, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

To learn about using the R8200 to service portables, mobiles, and system infrastructure employing the dPMR protocol, turn to **"Using dPMR Test Mode" on the next page**.

Using dPMR Test Mode

This section provides an example measurement using the analyzer's dPMR Mode. Complete this procedure to make an initial verification measurement of a portable radio's digital signal processing without the need for specialized power supplies, test boxes, or radio service software. It can be completed using only the radio, a single BNC cable, and two adapters.

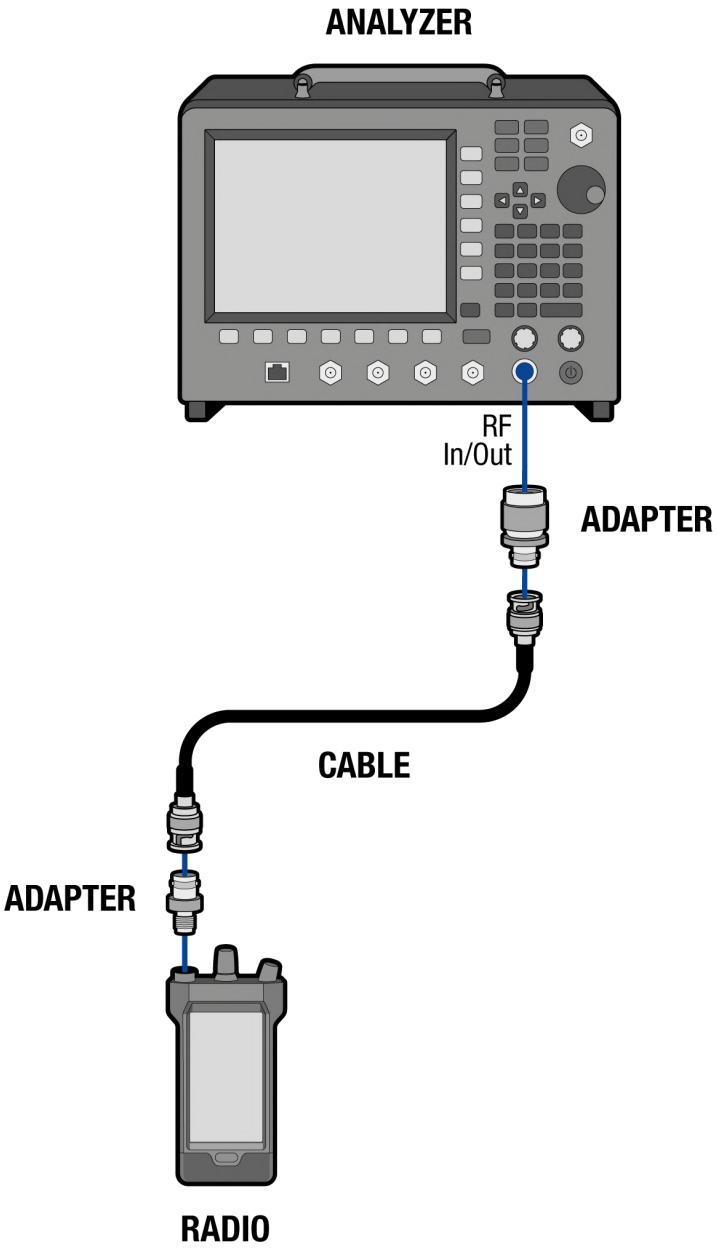
Transceiver Verification

This section describes a simple procedure for verifying the basic functionality of the radio's RF transceiver and physical layer protocol using the R8200 in dPMR Mode. Follow these steps to connect the radio to the R8200 and configure your measurement.

Required Equipment

- Freedom R8200 Communications System Analyzer
- Portable Radio, programmed for dPMR direct mode
- Cable, coax, BNC (m-m)
- Adapter, Type N(f)-to-BNC(f)
- Adapter, SMA(f)-to-BNC(f)

Test Setup



Procedure

Steps	Actions	Notes
1. Configure the test setup.	**a.** Connect the Type N(f)-to-BNC(f) adapter to the R8200's RF In/Out port. **b.** Remove the antenna from the radio. **c.** Connect the SMA(f)-to-BNC(f) Adapter to the Antenna port of the radio. **d.** Connect the BNC cable between the radio and the R8200.	
2. Configure the R8200.	**a.** To access the dPMR Test Mode, press **Test** > **Test Mode** > **DPMR**. **b.** Press **Monitor**. **c.** To set the receiver Center Frequency to match the radio transmitter, press **Hot Key 1** > **Monitor Frequency** > **413** > **MHz**. **d.** In the RF Zone, confirm that Mon Port displays **RF In/Out** as the receiver's input.	This opens the dPMR Test Mode. Alternatively, press **RF Zone** > > **Monitor Frequency** > **413** > **MHz**. If not, press **Mon Port** > **RF In/Out** > **Enter.**
3. Activate and key the radio.	**a.** Turn the On/Off/Volume Knob clockwise to activate the radio. **b.** Press **PTT** on the portable.	This initiates a broadcast of the voice content picked up by the radio microphone.
4. Observe the DISPLAY Zone.	**a.** Press **Hot Key 2** > **Select Display** > **Eye Diagram**.	You should observe change in the deviation of the carrier at the symbol

Steps	Actions	Notes
	b. Confirm that the analyzer is decoding.	decision times as measured in the post detection filter. The tighter the transitions are to the target crossing points the better the modulator performance
5. Observe the RF Zone**.**	**a.** Confirm that the Input Level displays the radio's output as approximately **3 W**. **b.** Confirm that the Freq Error displays the radio's frequency error as **less than 100 Hz**.	This verifies the performance of the radio's RF transmitter.
6. Observe the dPMR Zone.	**a.** Confirm that Mod Fidelity displays **less than 1%**. **b.** Confirm that Symbol Dev displays **less than 2 kHz**.	Having confirmed these transmission parameters, you can verify that the transmitter on this radio is working properly in dPMR Test Mode.
7. Configure the R8200 for Voice loopback.	**a.** Disable **PPT** on radio. **b.** To set the transmitter Generate Frequency to match the radio receiver, press **Hot Key 1** > **Copy Frequency to Generator.** **c.** To setup Voice loop transmitting RF from the R8200, press **Hot Key 4** > **Voice Loopback** > **On**. **d.** To enable voice loop, press the **PTT** on the radio and speak into the radio. **e.** Release **PTT** after about 5 seconds of transmission.	A status bar in the Voice loop setup screen with will highlight as transmission continues. When the bar reach 100% the voice loop recording is complete.
8. Listen for the returned voice broadcast from the radio's speaker.	**a.** Adjust the volume of the voice loop using the radio's On/Off/Volume Knob.	This verifies that the radio correctly decodes the dPMR broadcast content.

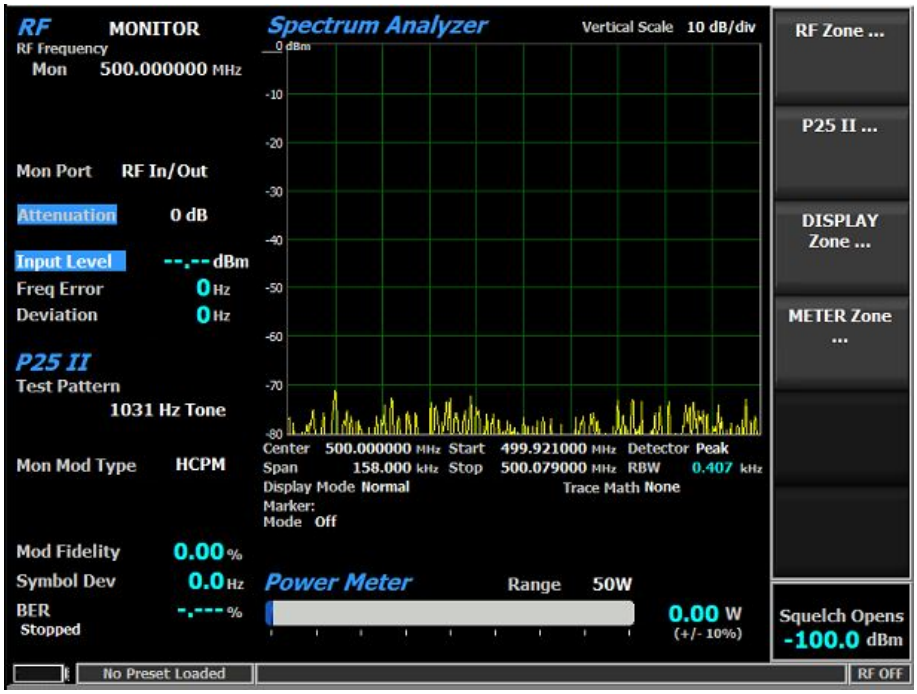
Having confirmed these parameters, you can verify that the transceiver on this radio is working properly in dPMR Test Mode.

Introducing P25 Phase 2 Mode

The optional R8200 P25 II Test Mode allows testing of APCO Project 25 phase 2 compliant mobile stations (radios) and base stations (repeaters) in simplex test mode. P25 phase 2 stations use a two-slot TDMA digital transmission format and modulation schemes compliant with the TIA-102.BBAB specification. The quaternary baud rate is 6000 symbols per second. Phase 2 radios employ Harmonized Continuous Phase Modulation (HCPM) with practically constant amplitude envelope and insignificant Inter-Symbol Interference (ISI) for inbound traffic channels. Phase 2 repeaters employ Harmonized Differential Quadrature Phase Shift Keyed modulation (HDQPSK) with varying amplitude envelope and insignificant ISI for outbound traffic channels. The R8200 provides a grouping of test functions for the asymmetrical superframe structure that are compliant with the TIA-102.CCAA measurement standard. These include RF Slot Power, Power Envelope/Timing, Symbol Rate, Symbol Deviation, Modulation Fidelity, Frequency Error and Deviation, Bit Error Rate (BER), and test pattern generator. In addition, Eye Diagram, Distribution Plot, Frequency Constellation, and Power Profile displays are provided.

The 180-symbol TDMA slots (0 and 1) form a 60 ms frame, six frames form a 360 ms superframe, and four superframes form a 1.44 second ultraframe. Two logical channels (LCH0 and LCH1) are allocated in the physical slots (1st l 2nd) in an asymmetrical superframe for use in all over-the-air communications as illustrated in the table below. An inbound slot is used only if its logical channel is active; the unused slot may be called a null slot because it does not contain transmitter power. However, both outbound slots are transmitted even if neither logical channel is active. Testing of both logical channels is supported by the R8200. The logical channels are listed below.

Frame	**1**		**2**		**3**		**4**		**5**		**6**	
Outbound LCHn	0	1	0	1	0	1	0	1	0	1	1	0
Inbound LCHn	1	0	1	0	1	0	1	0	1	0	0	1



Pressing **Test** > **Test Mode** > **P25 II** configures the R8200 for P25 Phase 2 protocol testing, as shown above. On the R8200 main display, the Standard mode's AUDIO Zone and associated soft keys are replaced by the P25 II Zone and P25 II-specific soft keys (accessed by pressing the **P25 II** soft key).

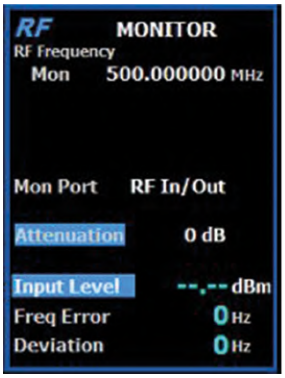
NOTE

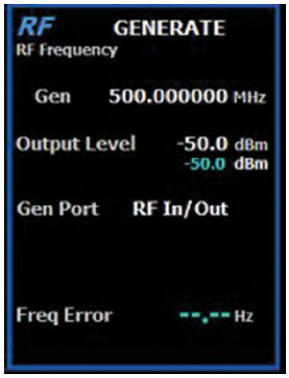
The manufacturer's Radio Service Software (RSS) is required to perform some tests because certain measurements (e.g., BER, Symbol Rate) require placing the radio in a special test mode. Although TIA measurement methods assume that the transceiver is in Test Mode, most R8200 test functions will work with a live signal. Averaging can be applied to some measurements by the System Settings.

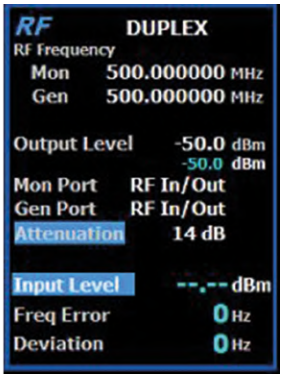
The RF Zone

In P25 II Test Mode, the RF Zone displays parameters associated with the P25 Phase 2 carrier stimulus generated by the R8200 as well as measurements of the RF transmissions received from the radio under test. The RF Zone during

P25 Phase 2 transmitter testing (with the R8200 in Monitor Mode is shown on the left while the RF Zone during P25 Phase 2 receiver testing (with the R8200 in Monitor Mode on the left, Generate Mode in the center, and Duplex Mode is shown on the right, below.







During P25 II Test Mode, the RF Zone offers the following measurement displays:

Input Level – Displays the average power in the logical channel under test.

NOTE

Although Input Level is used for Squelch, Squelch has no effect on measurement updates.

When the RF input power on the RF In/Out port is above +20 dBm (100 mW), the R8200 utilizes a broadband power detector for the measurement. The Input Level field in the RF Zone changes to Watt Meter to indicate this measurement mode. For best accuracy, disable the Pre-amplifier in Monitor Mode and set the Gen Port in Generate Mode to RF In/Out. The Input Source parameter can be used to force narrow or broadband power. That is useful for TDMA protocols whose on and off slots can cause the indicator to toggle between them.

Watt Meter – Displays the level of broadband power applied to the RF In/Out port when the RF input power on the RF In/Out port is above +20 dBm (100 mW).

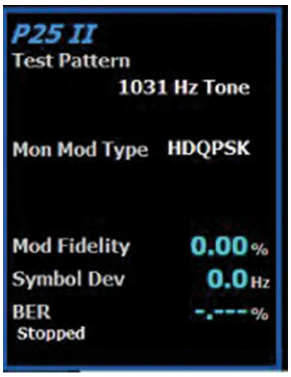
Freq Error – Displays the frequency difference of the received transmission carrier minus the R8200 Monitor Frequency.

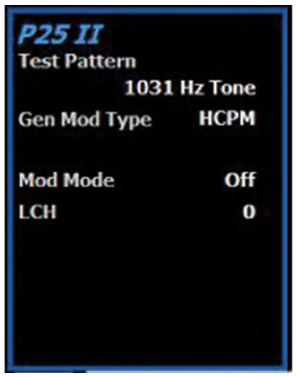
Deviation – Displays the positive peak frequency deviation of the received modulated carrier (i.e., from the Frequency Error mean). See negative peak frequency deviation with DISPLAY Zone Bar Graphs.

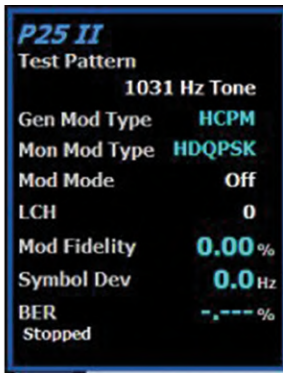
While the analyzer is operating in P25 II Test Mode, the RF Zone soft key menus contain all of the parameter settings for the controlling the R8200 RF output. For a complete soft key reference for the RF Zone, see **"RF Zone Soft Keys for Duplex Mode" on page 441**.

The P25 II Zone

While operating in P25 II Test Mode, the AUDIO Zone and associated soft keys are replaced by the P25 II Zone and P25 II specific soft keys. The P25 II Zone displays the physical layer parameters that can be configured to encode and decode P25 Phase 2 content. The P25 II Zone is shown in Monitor Mode on the left, Generate Mode in the middle, and Duplex Mode on the right, below.







The P25 II Zone offers the following measurement displays:

Mod Fidelity – Modulation Fidelity represents how accurate a P25 transmitter reproduces an ideal theoretical modulation waveform. The measurement is performed by first removing frequency error and symbol deviation gain error from the received signal, then computing the RMS difference between the deviation of the resulting signal at each symbol decision point and the ideal deviations of those symbols; no bit errors should exist. On the R8200, this is computed over a symbol interval (180 for HDQPSK; 164 for HCPM) and reported as an RMS error in % normalized across symbols.

Symbol Dev – This selection displays the symbol deviation estimated by averaging the normalized frequency deviations (of the FM representation of the phase-based modulation) at symbol times in the received signal and then scaling by the maximum symbol value. The normalized frequency deviation is computed as the ratio of the actual frequency measurement at a given symbol or deviation state by the corresponding symbol value. The HCPM ideal is 2992 Hz; since symbol decisions are based on 60° phase changes, they do not correspond to four frequency deviations. The HDQPSK ideal is 2250 Hz.

Bits	Symbol	HCPM Carrier Frequency Deviation	HDQPSK Carrier Frequency Deviation	Phase Deviation
01	+3	+2992 Hz	+2250 Hz	+135º
00	+1	+997 Hz	+750 Hz	+45º
10	–1	–997 Hz	–750 Hz	–45º
11	–3	–2992 Hz	–2250 Hz	–135º

BER – Displays the percentage of bit differences between the bits of the Test Pattern and the bits from the received synchronized TDMA signal. This bit error rate test checks the modulation, encoding, and timing of the transmit signal during the data transmission period. When performing the BER Test, the radio transmitter under test must be placed into a test diagnostic mode with the correct TX test pattern selected using the manufacturer's Radio Service Software (RSS). The test is done at nominal power with the radio transmitting the test pattern into the service monitor. It is acceptable to have an attenuator between the radio under test and the service monitor.

While the analyzer is operating in P25 II Test Mode, the P25 II Zone soft key menus contain all of the R8200 parameter settings for the controlling the P25 Phase 2 physical layer. For a complete soft key reference for the P25 II Zone, see **"P25 II Zone Soft Keys" on page 726**.

The DISPLAY Zone

During P25 II Test Mode, the DISPLAY Zone offers a Spectrum Analyzer, Oscilloscope, Bar Graphs, Eye Diagram, and a Distribution Plot, accessed by pressing **Select Display**, as shown in the horizontal soft key menu below.

Spectrum Analyzer

See **"Introducing the Spectrum Analyzer" on page 90**.

Oscilloscope

See **"Introducing the Oscilloscope" on page 92**.

Bar Graphs

See **"Bar Graphs" on page 77**.

Eye Diagram

See **"Eye Diagram" on page 152**.

Distribution Plot

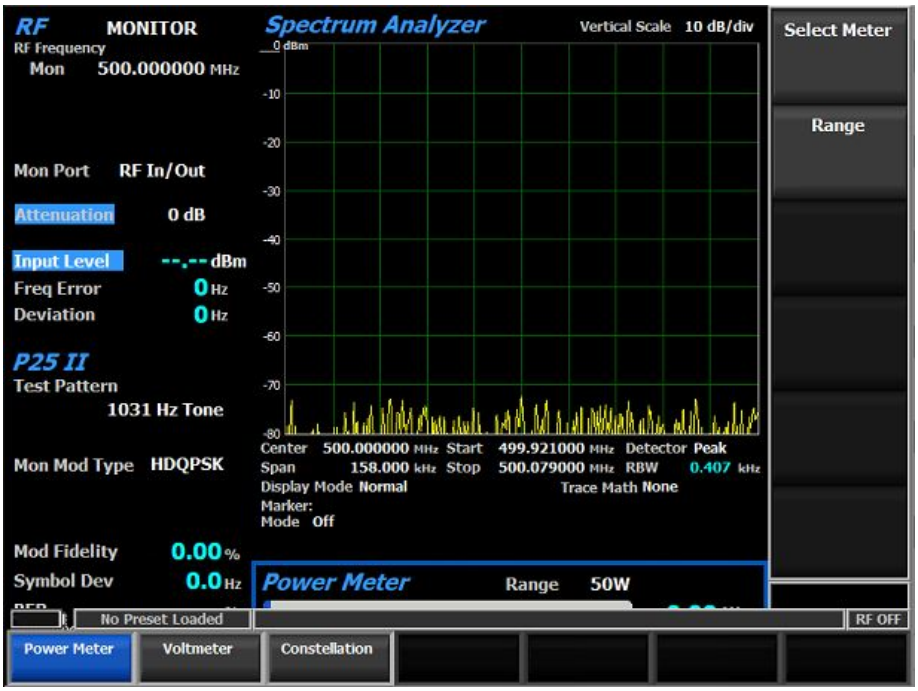
See **"Introducing PROJECT 25 Test Mode" on page 163**.

While the analyzer is operating in P25 II Test Mode, the DISPLAY Zone soft key menus contain all of the parameter settings for RF and baseband measurement display. For DISPLAY Zone soft keys unique to P25 II Test Mode, see **"DISPLAY Zone Soft Keys for P25 Phase 2 Transmitter Test" on page 728**. For a complete soft key reference for the DISPLAY Zone, see **"DISPLAY Zone Soft Keys for Duplex Mode" on page 474**.

The METER Zone

In P25 II Test Mode, the METER Zone is preloaded with a Power Meter.

A Voltmeter and Constellation Meter are also available by pressing **Hot Key 5** > **Select Meter** and choosing the desired meter, as shown below.



Power Meter

See **"Power Meter" on page 97**.

Voltmeter

See **"Voltmeter" on page 97**.

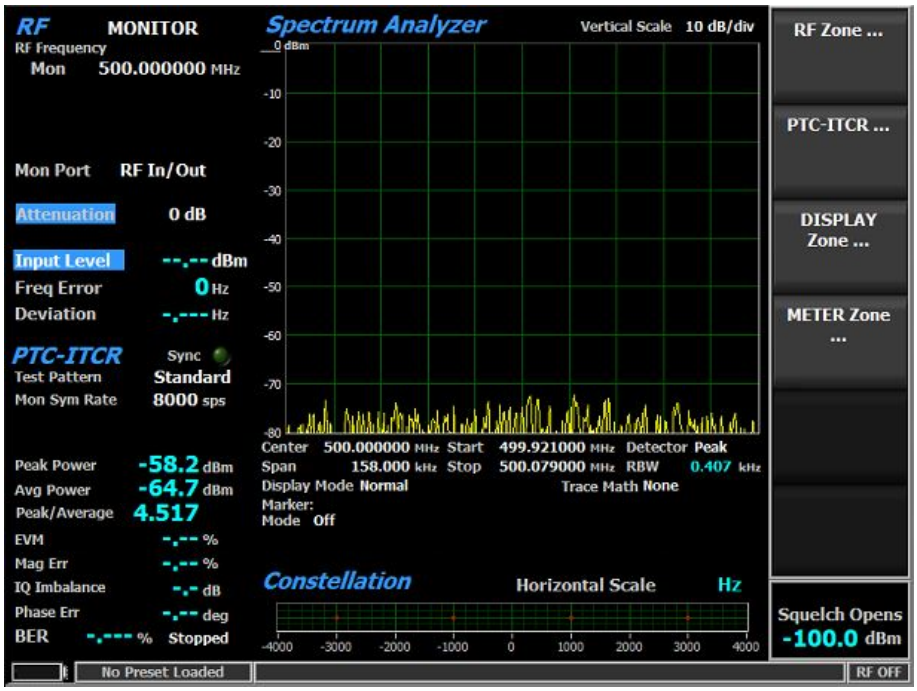
Constellation Meter

See **"Constellation Meter" on page 156**.

While the analyzer is operating in P25 II Test Mode, the METER Zone soft key menus contain all of the parameter settings for RF and baseband measurement metering. For METER Zone soft keys unique to P25 II Test Mode, see **"P25 II Zone Soft Keys" on page 726**. For a complete soft key reference for the METER Zone, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

Introducing PTC-ITCR Mode

The optional R8200 PTC-ITCR Test Mode allows testing of cab, wayside, and base radios compliant with the Positive Train Control-Interoperable Train Control Radio standard. PTC-ITCR uses a radio network known as Interoperable Train Control Radio (ITCR) that operates from 217.6 MHz to 222 MHz using 25 kHz channels. The physical layer consists of a π/4 DQPSK waveform providing bit rates of 16 kilobits per second (kbps) at the full rate and 8 kbps at the half rate in a 25 kHz channel managed by Time Division Multiple Access (TDMA) technology. The network consists of three types of radios: locomotive radios positioned in the cab of each locomotive, wayside radios positioned along the edge of the railroad tracks and 75-watt base radios. The R8200 PTC-ITCR Test Mode provides signals and measurements compliant with the PTC-ITCR protocol. These include RF Input Power, Frequency Error and Deviation, Peak Envelope Power, Average Power, Peak-to-Average Ratio, Error Vector Magnitude, Magnitude Error, IQ Imbalance, Phase Error, and Bit Error Rate (BER) with test pattern. In addition, a Spectrum Analyzer, Eye Diagram, Power Profile, Constellation Plot, and a Distribution Plot are provided.



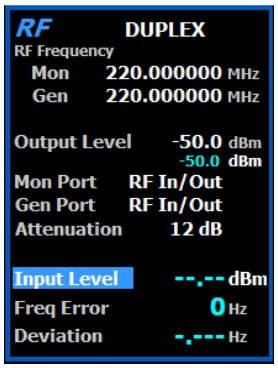
Pressing **Test** > **Test Mode** > **PTC-ITCR** configures the R8200 for PTC-ITCR protocol testing, as shown above. On the R8200 main display, the Standard mode's AUDIO Zone and associated soft keys are replaced by the PTC-ITCR Zone and PTC-ITCR-specific soft keys (accessed by pressing the **PTC-ITCR** soft key).

NOTE

The manufacturer's Radio Service Software (RSS) is required to perform some tests in PTC-ITCR because certain measurements (BER) require placing the radio in a special test mode. Tests that do not require RSS include RF Input Power, Frequency Error and Deviation, Peak Envelope Power, Average Power, Peak-to-Average Ratio, Error Vector Magnitude, Magnitude Error, IQ Imbalance, and Phase Error. Averaging can be applied to some measurements by the System Settings. The Spectrum Analyzer, Eye Diagram, Power Profile, Constellation Plot, and Distribution Plot also provide qualitative indication of the radio's performance.

The RF Zone

In PTC-ITCR Test Mode, the RF Zone displays parameters associated with the PTC-ITCR carrier stimulus generated by the R8200 as well as measurements of the RF transmissions received from the radio under test. The RF Zone during PTC-ITCR transmitter testing and receiver testing with the R8200 in Duplex Mode is shown below.



During PTC-ITCR Test Mode, the RF Zone offers the following measurement displays:

Input Level – Displays the average power in the specified Burst of the synchronized TDMA slot of the received signal.

NOTE

Although Input Level is used for Squelch, Squelch has no effect on measurement updates.

When the RF input power on the RF In/Out port is above +20 dBm (100 mW), the R8200 utilizes a broadband power detector for the measurement. The Input Level field in the RF Zone changes to Watt Meter to indicate this measurement mode. For best accuracy, disable the Pre-amplifier in Monitor Mode and set the Gen Port in Generate Mode to RF In/Out.

Watt Meter – Displays the level of broadband power applied to the RF In/Out port when the RF input power on the RF In/Out port is above +20 dBm (100 mW).

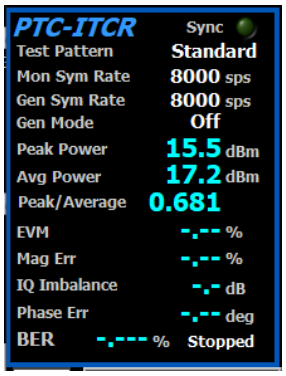
Freq Error – Displays the difference between the received PROJECT 25 Trunk carrier frequency and the R8200 Monitor Frequency.

Deviation – Displays the negative and positive peak frequency deviation of a modulated carrier (i.e., from the Frequency Error mean), available when Modulation Mode is FM.

While the analyzer is operating in PTC-ITCR Test Mode, the RF Zone soft key menus contain the parameter settings for the controlling the R8200 RF output. For a complete soft key reference for the RF Zone, see **"RF Zone Soft Keys for Duplex Mode" on page 441**.

The PTC-ITCR Zone

While operating in PTC-ITCR Test Mode, the AUDIO Zone and associated soft keys are replaced by the PTC-ITCR Zone and PTC-ITCR-specific soft keys. The PTC-ITCR Zone displays the physical layer parameters that can be configured to encode and decode PTC-ITCR content. The PTC-ITCR Zone is shown in Duplex Mode below.

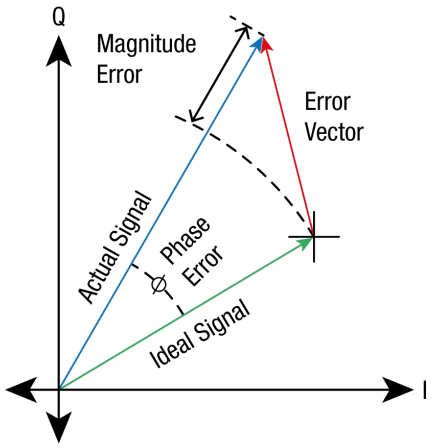


The PTC-ITCR Zone offers the following measurement displays:

Peak Power – Peak envelope power of the modulation envelope.

Avg Power – The RMS power of the modulation envelope.

EVM (RMS) – Deviation of the actual signal (I/Q vectors) from the ideal signal, as depicted by the red arrow in the image below.



The ideal PTC-ITCR signal consists of eight points around the origin. From these, the deviations are measured to all actual points closest to each. In terms of the constellation, it is the distance from the ideal to the actual symbol. The measurement is done at the optimal symbol times and positions to exclude adverse effects of frequency error and residual carrier. The RMS error vector magnitude for a burst is the square root of the sum of the squares of the error distances divided by the number of symbols in the burst.

Mag Err – The difference between the magnitude of the measured signal versus the magnitude of the ideal signal, see above.

IQ Imbalance – Difference between quadrature and in-phase components of the transmitted signal from the radio under test.

Phase Err – Difference in phase between the transmitted and received carrier.

BER – Displays the percentage of bit differences between the bits of the Test Pattern and the bits from the received synchronized TDMA signal. This bit error rate test checks the modulation, encoding, and timing of the transmit signal during the data transmission period. When performing the BER Test, the radio transmitter under test must be placed into a test diagnostic mode with the correct TX test pattern selected using the manufacturer's Radio Service Software (RSS). The test is done at nominal power with the radio transmitting the test pattern into the service monitor. It is acceptable to have an attenuator between the radio under test and the service monitor.

While the analyzer is operating in PTC-ITCR Test Mode, the PTC-ITCR Zone soft key menus contain all of the R8200 parameter settings for the controlling the PTC-ITCR physical layer. For a complete soft key reference for the PTC-ITCR Zone, see **"PTC-ITCR Zone Soft Keys" on page 742**.

The DISPLAY Zone

During PTC-ITCR Test Mode, the DISPLAY Zone provides a Spectrum Analyzer, Eye Diagram, Power Profile, Constellation Plot, and a Distribution Plot, accessed by pressing **Select Display**, as shown in the horizontal soft key menu below.

Spectrum Analyzer

See **"Introducing the Spectrum Analyzer" on page 90**.

Eye Diagram

See **"Eye Diagram" on page 152**.

Power Profile

See **"Power Profile" on page 153**.

Constellation Plot

See **"Introducing PROJECT 25 Test Mode" on page 163**.

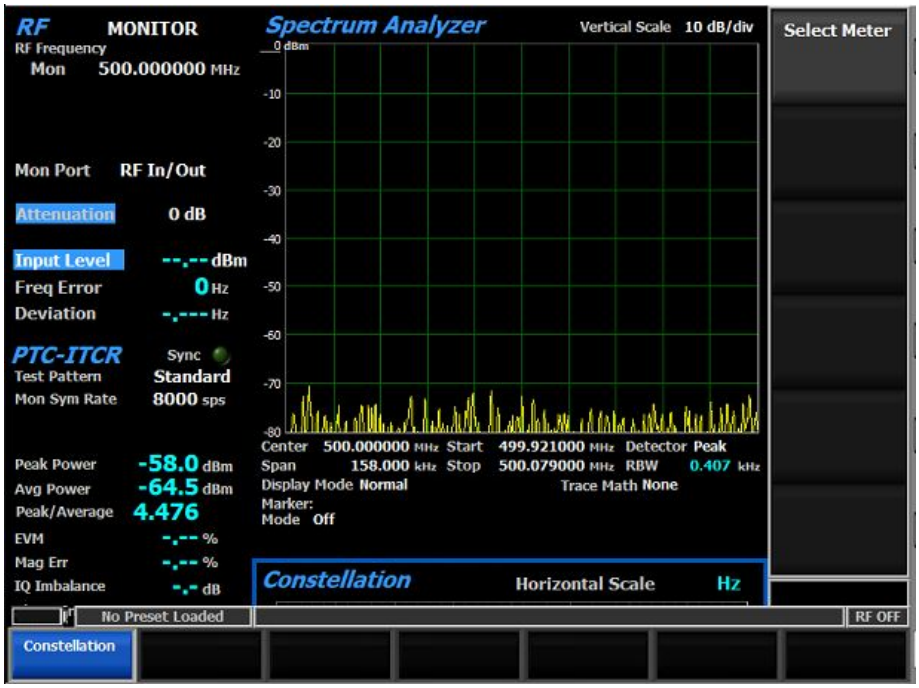
Distribution Plot

See **"Introducing PROJECT 25 Test Mode" on page 163**.

While the analyzer is operating in PTC-ITCR Test Mode, the DISPLAY Zone soft key menus contain all of the parameter settings for RF and baseband measurement display. For DISPLAY Zone soft keys unique to PTC-ITCR Test Mode, see **"PTC-ITCR Zone Soft Keys" on page 742**. For a complete soft key reference for the DISPLAY Zone, see **"DISPLAY Zone Soft Keys for Duplex Mode" on page 474**.

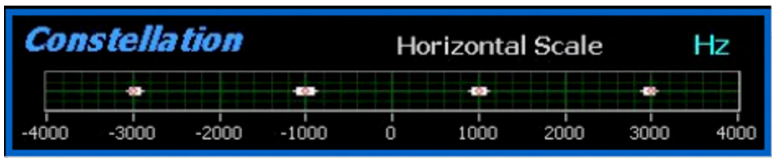
The METER Zone

In PTC-ITCR Test Mode, the METER Zone is preloaded with a Constellation Meter.



Constellation Meter

The Constellation Meter provides a visual representation of overall transmitter performance, as shown below.



PTC-ITCR radios broadcast voice and data using four frequency shift deviations of the carrier to represent symbols containing two data bits. Four red tick marks on the display represent the expected locations for the deviation states when the radio is transmitting data bit symbols using the modulation. White tick marks show the actual deviation measurement at symbol decision times. A tighter grouping around the red tick marks indicates more accurate transmitter performance.

The nominal deviation points for each data symbol are as follows:

Bits	Symbol	Deviation
01	+3	+3000 Hz
00	+1	+1000 Hz
10	–1	–1000 Hz
11	–3	–3000 Hz

While the analyzer is operating in PTC-ITCR Test Mode, the METER Zone soft key menus contain all of the parameter settings for RF and baseband measurement metering. For METER Zone soft keys unique to PTC-ITCR Test Mode, see **"PTC-ITCR Zone Soft Keys" on page 742**. For a complete soft key reference for the METER Zone, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

To become familiar with using the R8200 to observe PTC-ITCR signals, turn to **"Using PROJECT 25 Test Mode" on page 178**.

Using PTC-ITCR Test Mode

This section provides an example measurement using the analyzer's PTC-ITCR Test Mode. Complete this procedure to gain an understanding of the test setup and available measurements without the use of an ITCR radio. This procedure will utilize the R8200 transmitting ITCR signals to itself as a demonstration of measurement functionality. For testing an actual ITCR radio, see Freedom Application Note FCT-1012 at FreedomCTE.com.

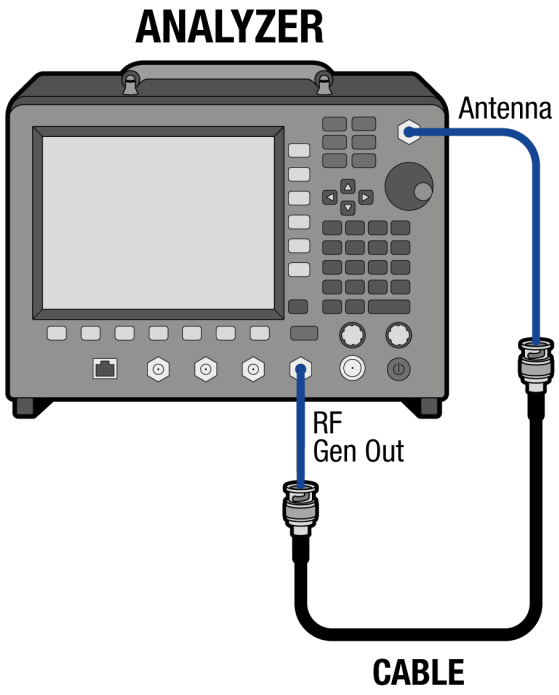
PTC-ITCR Demonstration

This section describes a simple procedure to demonstrate the basic functionality of the PTC-ITCR Test Mode and its available measurements

Required Equipment

- Freedom R8200 Communications System Analyzer
- Cable, coax, BNC (m-m)

Test Setup



Procedure

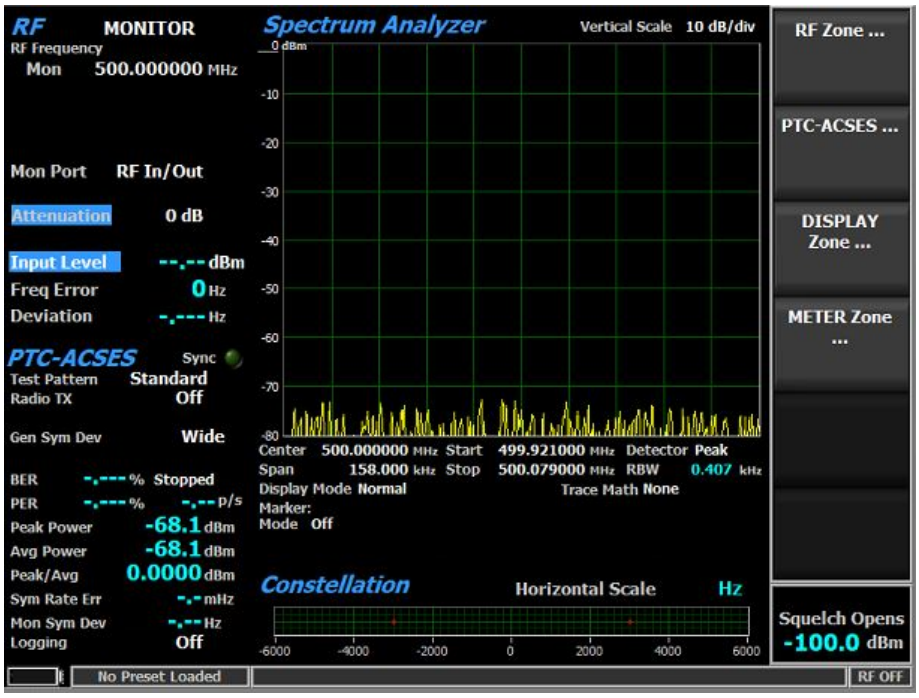
Steps	Actions	Notes
1. Configure the test setup.	**a.** Connect the BNC cable from Gen Out port to Antenna port on the R8200.	This will be a loopback test for demonstration purposes only.
2. Configure the R8200.	**a.** Press **Duplex**.	
	b. To set the receiver Center Frequency press **Hot Key 1** > **Monitor Frequency** > **219** > **MHz**.	Alternatively, press **RF Zone** > **Monitor Frequency** > **219** > **MHz**.
	c. In the RF Zone, confirm that Mon Port displays **Antenna** as the receiver's input.	If not, press **Mon Port** > **Antenna** > **Enter.**
	d. To set the Generate Frequency press **Hot Key 1** > **Generate Frequency** > **219** > **MHz**.	
	e. In the RF Zone, to change the Gen Port, press **Gen Port** > **Gen Out** > **Enter**.	
	f. For this demonstration, use Automatic Attenuation.	For actual live radio testing, automatic attenuation often works without issue. However, for TDMA signals (as in PTC-ITCR) set a fixed attenuation value of 30 dB or more.
	g. To access the PTC-ITCR Test Mode, press **Test** > **Test Mode** > **PTC-ITCR**.	
3. Activate the transmitted modulation.	**a.** To select the PTC-ITCR Zone, press **Hot Key 4**.	This broadcasts the PTC-ITCR signal back into the R8200.
	b. To broadcast the PTC-ITCR signal, press **Modulation Mode** > **Continuous**.	
	c. Observe the Signal Analyzer and	The PTC-ITCR baseband content is inaudible data, so there is no tone to hear.

Steps	Actions	Notes
	confirm the PTC-ITCR signal at 219 MHz.	
4. Observe the PTC-ITCR Zone.	**a.** In the PTC-ITCR Zone, confirm that the green Sync indicator is illuminated.	The analyzer is decoding the radio's transmitted data.
5. Observe the PTC-ITCR signal.	**a.** To view the PTC-ITCR signal in the Eye Diagram, press **Hot Key 2** > **Select Display** > **Eye Diagram**. **b.** Confirm the PTC-ITCR signal in the Eye Diagram.	The Eye Diagram should display 4 groupings of symbol decision points.
6. Observe the Power Profile.	**a.** Press **Select Display** > **Power Profile**. **b.** To adjust the Vertical Maximum to bring the power ramps into view, press **Vertical Maximum** and adjust the Tuning Knob to bring the signal into view. **c.** Press **Horizontal Start** to adjust forward or backward (–100 ms) the displayed start relative to slot 0. **d.** Press **Horizontal Maximum** to adjust the displayed time to 1000 ms.	The slot time of the test signal is 50 ms, so the power profile display will show 20 slots in 1000 ms. This test signal is even slots only. Overshoot will be seen more clearly on an actual radio and the not test signals provided here. Horizontal Maximum can be adjusted out to 4000 ms (1 Superframe of the ITCR transmission). Vertical Scale and Vertical Maximum can be adjusted to enable viewing of the transmitter's ramp up and overshoot .

For a detailed verification test procedure using an actual ITCR radio, contact the Freedom sales team and request a copy of Freedom Application Note FCT-1012.

Introducing PTC-ACSES Test Mode

The optional R8200 PTC-ACSES Test Mode allows testing of conventional (non-trunked) Advanced Civil Speed Enforcement System (ACSES). PTC-ACSES uses a radio network that operates from 217.0 MHz to 221.9875 MHz. The physical layer consists of a GMSK waveform providing a raw bit rate of 9.6 kilobits per second (kbps) 12.5 kHz channel managed by Time Division Multiple Access (TDMA) technology. The network consists of two types of radios: on-board (locomotive radios positioned in the cab of each locomotive) and wayside radios (interlocking and right of way infrastructure). The R8200 PTC-ACSES Test Mode provides signals and measurements compliant with the PTC-ACSESprotocol. These include RF Input Power, Frequency Error and Deviation, test patterns for Bit Error Rate, Packet Error Rate, and Packets-Per-Second, as well as Peak Envelope Power, Average Power, Peak-to-Average Ratio, Symbol Rate Error, and Symbol Deviation measurements. In addition, a Spectrum Analyzer, Eye Diagram, Power Profile, Slot Map are provided.



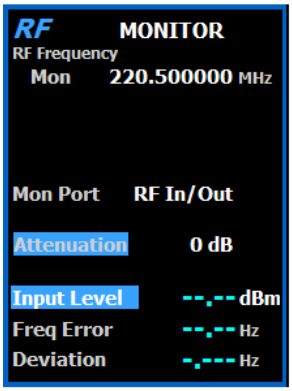
Pressing **Test** > **Test Mode** > **PTC-ACSES** configures the R8200 for PTC-ACSES protocol testing, as shown above. On the R8200 main display, the Standard mode's AUDIO Zone and associated soft keys are replaced by the PTC-ACSES Zone and PTC-ACSES-specific soft keys (accessed by pressing the PTC-ACSES soft key).

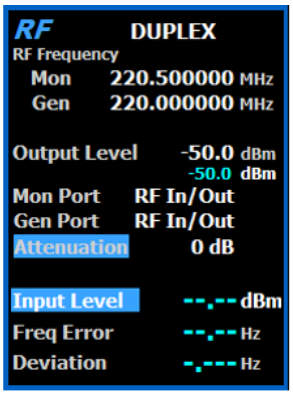
NOTE

The manufacturer's Radio Service Software (RSS) is required to perform some tests in PTC-ACSES Mode because certain measurements (BER) require placing the radio in a special test mode. Tests that do not require RSS include power include Frequency Error and Deviation, Peak Envelope Power, Average Power, Peak-to-Average Ratio, Symbol Rate Error, and Symbol Deviation. Averaging can be applied to some measurements by the System Settings. The Eye Diagram, Power Profile, and Slot Map also provide qualitative indication of the radio's performance.

The RF Zone

In PTC-ACSES Test Mode, the RF Zone displays parameters associated with the PTC-ACSES carrier stimulus generated by the R8200 as well as measurements of the RF transmissions received from the radio under test. The RF Zone during PTC-ACSES transmitter testing (with the R8200 in Monitor Mode) is shown on the left while the RF Zone during PTC-ACSES receiver testing (with the R8200 in Duplex Mode) is shown on the right, below.





During PTC-ACSES Test Mode, the RF Zone offers the following measurement displays:

Input Level – Displays the average power in the specified burst of the synchronized TDMA slot for the transmitted signal.

NOTE

Although Input Level is used for Squelch, Squelch has no effect on measurement updates.

When the RF input power on the RF In/Out port is above +20 dBm (100 mW), the R8200 utilizes a broadband power detector for the measurement. The Input Level field in the RF Zone

changes to Watt Meter to indicate this measurement mode. For best accuracy, disable the Pre-amplifier in Monitor Mode and set the Gen Port in Generate Mode to RF In/Out.

The TDMA transmission alternates between a used and unused time slot, so the RF Zone field will switch between the two. An unused slot has no power, so the display will flash between Input Level and Watt Meter. In this condition the Input Level reading should be used since null slots can cause the Watt Meter indication to read approximately 3 dB less than the power in the used slots.

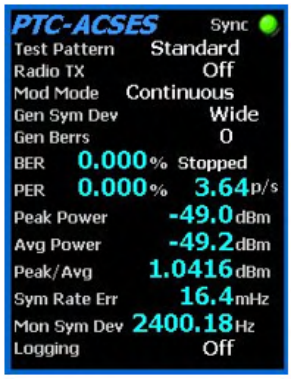
Freq Error – Displays the difference between the received PTC-ACSES carrier frequency and the R8200 Monitor Frequency.

Deviation – Displays the negative and positive peak frequency deviation of a modulated carrier (i.e., from the Frequency Error mean), available when Modulation Mode is FM.

While the analyzer is operating in PTC-ACSES Test Mode, the RF Zone soft key menus contain all of the parameter settings for the controlling the R8200 RF output. For a complete soft key reference for the RF Zone, see **"RF Zone Soft Keys for Duplex Mode" on page 441**.

The PTC-ACSES Zone

While operating in PTC-ACSES Test Mode, the AUDIO Zone and associated soft keys are replaced by the PTC-ACSES Zone and PTC-ACSES-specific soft keys. The PTC-ACSES Zone displays the physical layer parameters that can be configured to encode and decode PTC-ACSES content. The PTC-ACSES Zone is shown in Duplex Mode below.



The PTC-ACSES Zone offers the following measurement displays:

BER – Bit Error Rate in %, calculated from O.153 test pattern in the incoming RF packets.

PER – Packet Error Rate in % calculated from O.153 test pattern in the incoming RF packets. Any bit error in a packet labels the packet as failed.

p/s – Reports the number of packets received each second (packets-per-second).

Peak Power – Peak envelope power of the modulation envelope.

Avg Power – RMS power of the modulation envelope.

Peak/Avg – Peak to Average power ratio.

Sym Rate Err – Symbol Rate Error (mHz) reports the average error of symbols relative to the expected symbol rate.

Mon Sym Dev – Monitor (RF) Symbol Deviation reports the average deviation of the GMSK symbols.

NOTE

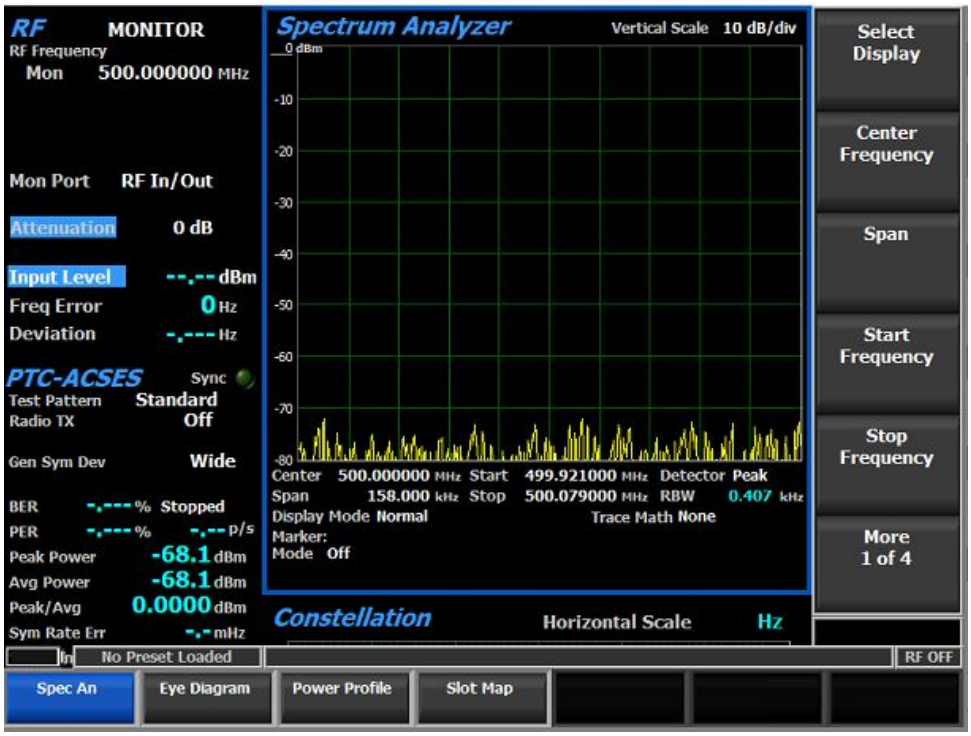
The Monitor Symbol Deviation reported in the PTC-ACSES Zone is the correct measurement when made using the OTA transmitted test pattern generated by the R8200. This measurement can only be made properly with the Ethernet test payload sent to the radio from the R8200. The test payload contains information about the slot and sequence used for PER calculation, an O.153 pattern for BER calculation, and a deviation test pattern to correctly measure Symbol Deviation.

Placing an attenuator between the radio under test and the service monitor is acceptable but should not be needed.

While the R8200 is operating in PTC-ACSES Test Mode, the PTC-ACSES Zone soft key menus contain all of the parameter settings for the controlling both the PTC-ACSES RF physical layer and the configuration setup to transmit and receive data with the ACSES radio across the Ethernet port. For a complete soft key reference for the PTC-ACSES Zone, see **"PTC-ACSES Zone Soft Keys for Transceiver Test" on page 748**.

The DISPLAY Zone

During PTC-ACSES Test Mode, the DISPLAY Zone offers a Spectrum Analyzer, Eye Diagram, Power Profile, and a Slot Map, accessed by pressing **Select Display**, as shown in the horizontal soft key menu below.



Spectrum Analyzer

See **"Introducing the Spectrum Analyzer" on page 90**.

Eye Diagram

See **"Eye Diagram" on page 152**.

Power Profile

See **"Power Profile" on page 153**.

Slot Map

The RF transmitted from the R8200 to the PTC-ACSES radio is processed across the Ethernet interface and reported on the Slot Map display. The Slot Map displays timeslot error status by slot. For example, timeslot error by slot for a 6 second epoch, below.

NOTE

The map updates based on incoming data. If no data is arriving at the Ethernet port, the Slot Map will stop updating and no values will change.

Information available on the Slot Map per slot:

Gray – no data received for that slot.

Green – Good data received in that slot, no errors.

Red – at least 1 error received in that slot since the last reset.

NOTE

Detailed Slot Map information is available in the full Application Note available by request at www.freedomcte.com/PTC.

The values within each slot are a cumulative error for that slot in terms of PER or BER, based on the current Data Type selection.

The Slot Map offers the following measurement displays:

Epochs – Number of Epochs received since last reset.

Error Packets – Number of slots with errors since the last reset. A slot error can come from several sources. Typical errors reported include:

- Payload had CRC failure
- Payload had BER failure
- Payload sequence value out of order
- Payload sequence value unknown (no majority)
- Payload slot number not equal to header slot number
- Payload type not as expected
- Payload size not as expected
- Message type not as expected

Lost Packets – The number of missing (unreceived) packets since last reset.

NOTE

Lost packets is a standalone measurement and is not included in PER/Epoch. Due to a built in CRC check in radio, most OTA losses of any type will result in lost packets being reported.

Valid Packets – Number of slots valid (without errors) since last reset.

PER/Epoch – Packet Error Rate for last received Epoch only.

BER/Epoch – Bit Error Rate for last received Epoch only.

NOTE

The Packet Error Rate (PER), and Bit Error Rate (BER) reported in the slot map is based on a test packet sent by an R8200. The values are calculated from the information found in the test packet. The R8200 may be capable of capturing live traffic from a TD220MAX radio but it will *not* be able to perform error analyses of the incoming data from live traffic.

Data Logging

The R8200 supports data logging from both the RF Receive and Ethernet Receive. Data logging is enabled with the PTC-ACSES Zone soft key of the same name. Pressing **Export Logs** sends a snapshot of the current logs to a thumb drive inserted in the R8200 USB port.

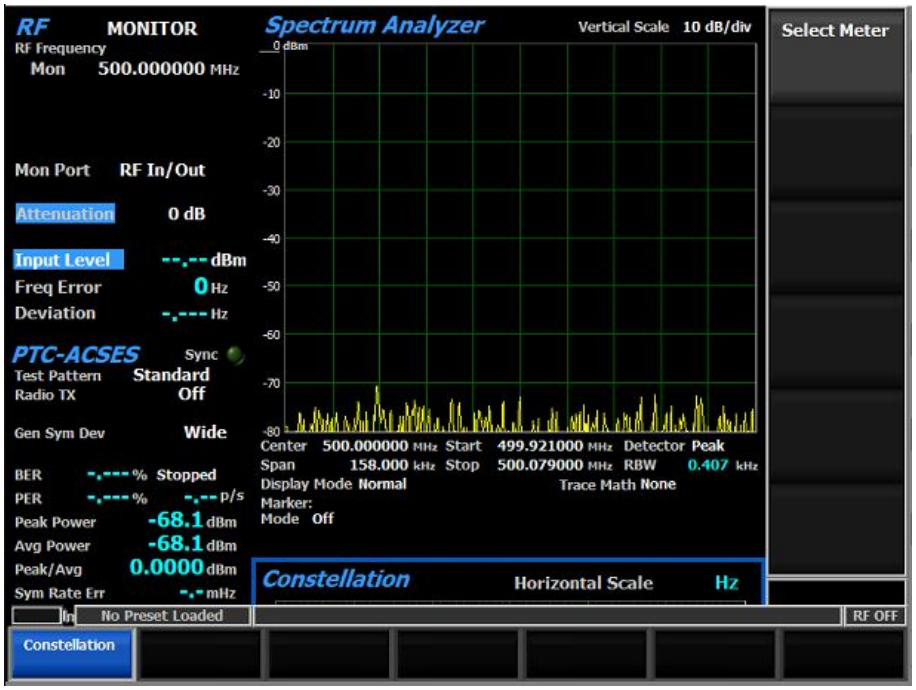
Example of Ethernet log:

Date Time	dTime	Lost	H-Slot	P-Slot	P-Type	SEQ#	BER%	CRC?	ERR	RSSI
12/3/2018 8:56	0	0	10	10	2	5	0	1	x0	-60
12/3/2018 8:56	253	0	12	12	2	6	0	1	x0	-60
12/3/2018 8:56	248	0	14	14	2	7	0	1	x0	-60
12/3/2018 8:56	251	0	16	16	2	8	0	1	x0	-60
12/3/2018 8:56	249	0	18	18	2	9	0	1	x0	-60
12/3/2018 8:56	249	0	20	20	2	10	0	1	x0	-60

While the analyzer is operating in PTC-ACSES Test Mode, the DISPLAY Zone soft key menus contain all of the parameter settings for RF and baseband measurement display. For DISPLAY Zone soft keys unique to PTC-ACSES Test Mode, see **"DISPLAY Zone Soft Keys for PTC-ACSES Transceiver Test" on page 754**. For a complete soft key reference for the DISPLAY Zone, see **"DISPLAY Zone Soft Keys for Duplex Mode" on page 474**.

The METER Zone

In PTC-ACSES Test Mode, the METER Zone is preloaded with a Constellation Meter.



While the analyzer is operating in PTC-ACSES Test Mode, the METER Zone soft key menus contain all of the parameter settings for baseband measurement metering. For METER Zone soft keys unique to PTC-ACSES Test Mode, see **"METER Zone Soft Keys for PTC-ACSES Transceiver Test" on page 755** For a complete soft key reference for the METER Zone, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

To become familiar with using the R8200 to observe PTC-ACSES signals, turn to **"Using PTC-ACSES Test Mode" on the next page**.

Using PTC-ACSES Test Mode

This section provides an example measurement using the PTC-ACSES Test Mode. Complete this procedure to gain understand the test setup and available measurements without the use of a TD220 radio. This procedure will utilize the R8200 transmitting ACSES signals to itself as a demonstration of measurement functionality. For testing an actual ACSES radio, see Freedom Application Note FCT 1013 “Testing PTC-ACSES (TD220MAX) Radios Using the Freedom Communications System Analyzers” at FreedomCTE.com.

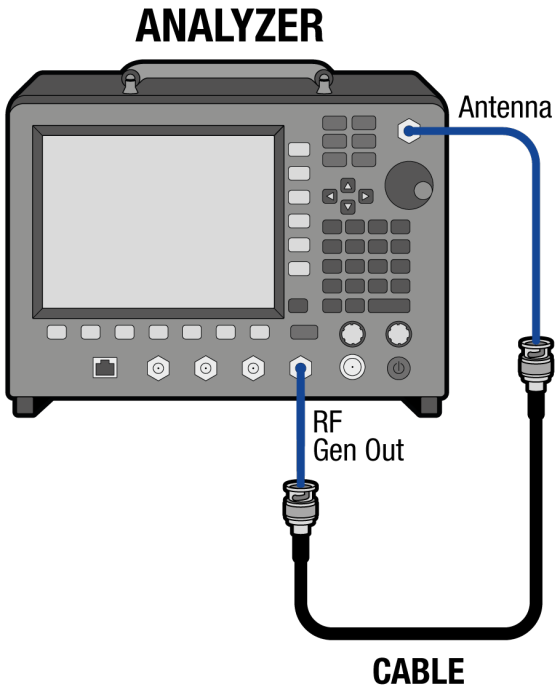
PTC-ACSES Demonstration

This section describes a simple procedure to demonstrate the basic functionality of the PTC-ACSES Test Mode and its available measurements.

Required Equipment

- Freedom R8200 Communications System Analyzer
- Cable, coax, BNC (m-m)

Test Setup



Procedure

Steps	Actions	Notes
1. Configure the test setup.	**a.** Connect the BNC cable from Gen Out port to Antenna port on the R8200.	This will be a loopback test for demonstration purposes only.
2. Configure the R8200.	**a.** Press **Duplex**.	
	b. To set the receiver Center Frequency press **Hot Key 1** > **Monitor Frequency** > **219** > **MHz**.	Alternatively, press **RF Zone** > **Monitor Frequency** > **219** > **MHz**.
	c. In the RF Zone, confirm that Mon Port displays **Antenna** as the receiver input.	If not, press **Mon Port** > **Antenna** > **Enter.**

Steps	Actions	Notes
	d. To set the Generate Frequency press **Hot Key 1** > **Generate Frequency** > **219** > **MHz**.	
	e. In the RF Zone, to change the Gen Port, press **Gen Port** > **Gen Out** > **Enter**.	
	f. For this test it is acceptable to use the default Automatic Attenuation.	For actual live radio testing, automatic attenuation often works without issue. However, for TDMA signals (as in PTC-ACSES) set a fixed attenuation value of 30 dB or more.
	g. To access the PTC-ACSES Test Mode, press **Test** > **Test Mode** > **PTC-ACSES**.	
3. Activate the transmitted modulation.	**a.** To select the PTC-ACSES Zone, press **Hot Key 4**.	This broadcasts the PTC-ACSES signal back into the R8200.
	b. To broadcast the PTC-ACSES signal, press **Modulation Mode** > **Continuous**.	The PTC-ACSES baseband content is inaudible data, so there is no tone to hear.
	c. Observe the Signal Analyzer and confirm the PTC-ACSES signal at 219 MHz.	
	d. Press **Hot Key 2** > **More** > **Reference Level** and adjust to –40 dBm to bring signal into view.	
4. Observe the PTC-ACSES Zone.	**a.** In the PTC-ACSES Zone, confirm that the green Sync indicator is illuminated.	The analyzer is decoding the radio transmitted data.
5. Observe the PTC-ACSES signal.	**a.** To view the PTC-ACSES signal in the Eye Diagram, press **Hot Key 2** > **Select Display** > **Eye Diagram**.	The Eye Diagram should display 2

Steps	Actions	Notes
	b. Confirm the PTC-ACSES signal in the Eye Diagram.	groupings of symbol decision points.
6. Observe the Power Profile.	**a.** Press **Select Display** > **Power Profile**. **b.** To adjust the Vertical Maximum to bring the power ramps into view, press **Vertical Maximum** and adjust the Tuning Knob to bring the signal into view. **c.** Press **Horizontal Start** to adjust forward or backward (–100 ms) the displayed start relative to slot 0. **d.** Press **Horizontal Maximum** to adjust the displayed time to 1000 ms.	The slot time of the test signal is 125 ms, so the power profile display will show 8 slots in 1000 ms. This test signal is even slots only. Overshoot will be seen more clearly on an actual radio and the not test signals provided here. Horizontal Maximum can be adjusted out to 6000 ms (1 Superframe of the ACSES transmission). Vertical Scale and Vertical Maximum can be adjusted to enable viewing the transmitter ramp up and overshoot.

For a detailed verification test procedure using an actual PTC-ACSES radio, contact the Freedom sales team and request a copy of Freedom Application Note FCT 1013.

Introducing AutoTune

AutoTune is an optional automated test and alignment software application for manufacturer-specific radios embedded in the R8200. The AutoTune display is shown below.

AutoTune eliminates the need for an external computer, simplifying setup and equipment costs for repeated verification test procedures. A connection between an R8200 USB port and the radio under test controls the radio. The software automatically configures the analyzer and the radio to alleviate most operator intervention during alignment and test activities.

AutoTune performs recommended factory alignment procedures in addition to critical transmitter and receiver performance tests. AutoTune maintains detailed test logs and reports in CSV (comma-separated values) file format. These can be conveniently viewed within the application or exported for further analysis by spreadsheet software and other data manipulation programs. A demonstration version of AutoTune is installed on R8200 analyzers that are not equipped with a functional version.

AutoTune currently supports the following land mobile radio makes and models:

Harris XG-75, XT-100M, P7300, XL-200P

Kenwood NX-706, NX-806 portables and mobiles (using USB programming cables)

Motorola APX 1000 (minus Tx Power Out Alignment), APX 2000, APX 2500, APX 4000, APX 4000 Li, APX 4500, APX 4500 Li, APX 5000, APX 5500, APX 6000, APX 6000B, APX 6000 Li, APX 6500, APX 6500 Li, APX 7000, APX 7000XE, APX 7500, MOTOTRBO, SRX 2200, SRX 2200B, XTL 1500, XTL 2500 , XTL 5000, XTS 1500, XTS 2500, XTS 5000.

Motorola MOTOTRBO series portables and mobiles

Relm BK KNG-PXXX

To learn how to use AutoTune to decrease your LMR servicing costs, see **"Using AutoTune" on page 318**.

For AutoTune soft key definitions, ranges, discrete and default values, and detailed notes, see **"AutoTune Soft Keys" on page 773**.

Using AutoTune

The AutoTune menu enables virtually hands-free verification and adjustment of critical LMR performance characteristics. This example uses a Harris XL 200 portable radio. To use AutoTune follow these steps.

Steps	Actions	Notes
1. Open AutoTune and choose your radio.	**a.** Press **Test** > **AutoTune**. **b.** To identify the operator, press **Operator ID**. **c.** Use the arrow keys, tuning knob or the alphanumeric keypad to enter an identifier (up to 16 characters), then press **Enter**. **d.** To configure your specific radio, press **Radio Make & Model.** **e.** Using the Make and Model dialog, chose **Harris XL Portable** and press **Enter**.	
2. Configure the test activity and setup, the start the test.	**a.** Configure the test setup per the displayed Harris XL Radio Test Setup diagram, then press **Return**. **b.** Press **Activity** > **Test Only** > **Select All** > **Start.**	
3. Review the test results and log out as operator.	**a.** Press **Tools** > **Test Report**. **b.** Review the Test Report, the press **Return**. **c.** To log out, press **Log Out Operator**.	

See **"AutoTune Soft Keys" on page 773** for detailed descriptions of the soft keys in this menu. Each soft key is defined, along with its range, discrete, default, and saved state values.

7 Using Remote Front Panel

An R8200 with Remote Front Panel (Option R8-Remote) enabled can be operated over a network via Ethernet connection using the Remote Front Panel client installed on a personal computer. This chapter contains step-by-step instructions for licensing, downloading and installing the software along with an overview of the user interface.

NOTE For the command and response interface, see the R8000 Monitor & Control Programmer's Guide (FCT-1110).

"Introducing Remote Front Panel" on page 321 contains an overview of the application as well as the system requirements.

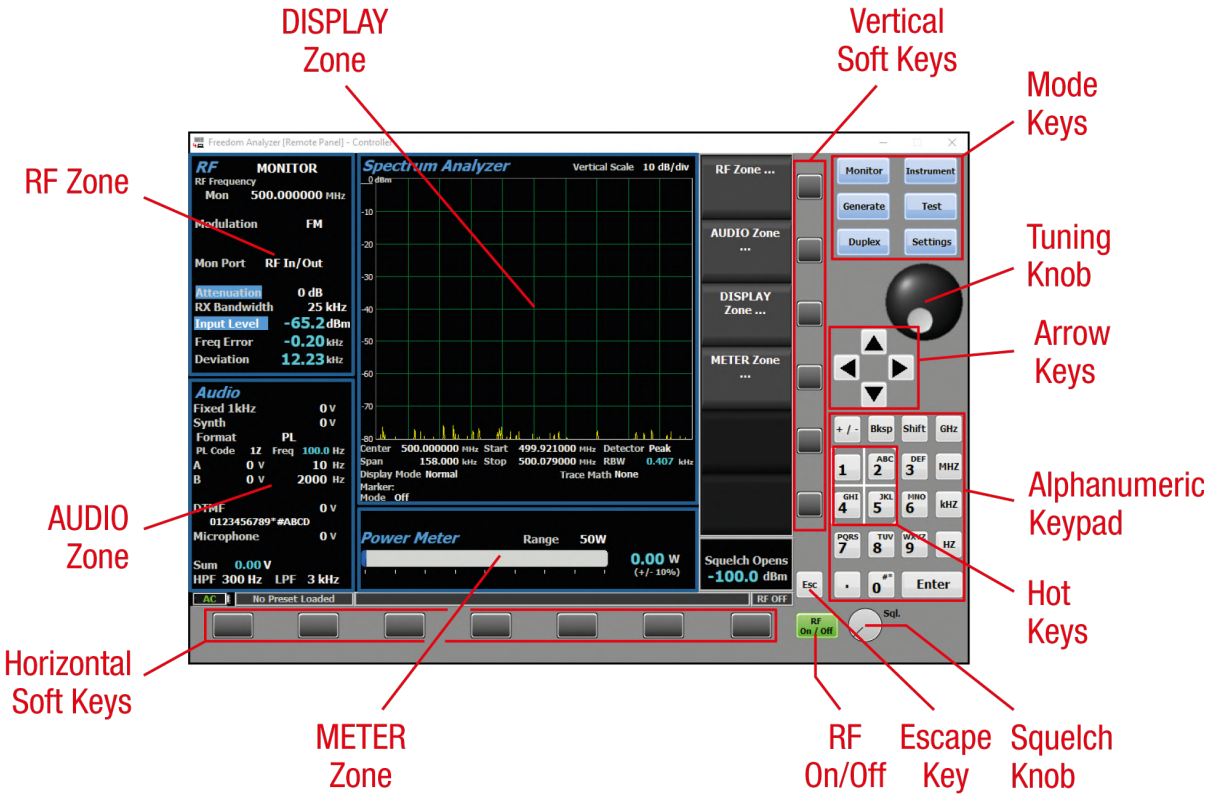
"Configuring the DHCP Server" on page 326 contains instructions on configuring the server so that it automatically address the R8200.

"Configuring the Analyzer Network Port" on page 327 explains how to configure the analyzer for remote operation.

Introducing Remote Front Panel

An R8200 with Remote Front Panel (option R8-Remote) enabled can be operated at distance via TCP/IP network using the Remote Front Panel application installed on a personal computer.

The Remote Front Panel application is a software emulation of the Freedom R8200 front panel user interface. The remote front panel includes all of the user interface features of the hardware with the exceptions of the microphone, speaker, volume knob, squelch LED, and line power switch, as shown.



Ensure that your R8200 is running the latest firmware before enabling Option R8-Remote and installing the Remote Front Panel software on the Windows PC. For information on updating the instrument firmware, see http://-freedomcte.com/upgrades/.

Remote Operation Requirements

The following equipment and personnel are required to install and configure the Remote Front Panel software:

- R8200 with AC power adapter and latest firmware.
- Windows 10 computer with network connectivity and Administrator privileges
- Ethernet 10/100Base-T network
- DHCP server (for operation over routed networks)
- Ethernet 10/100Base-T patch cable
- Network technician and/or administrator
- Browser with Java scripts and ActiveX controls enabled
- Network bandwidth ≥ 1.5MB/s
- Display resolution ≥ 1024 × 768 pixels

Control

CAUTION It is recommended that only one browser tab or window be used to access the R8200 in order to reduce the potential of losing control of the access license for the single point of control.

A single PC may view the R8200 display and control the interface with a computer mouse. Controlling the unit remotely does not prevent control locally and vice versa.

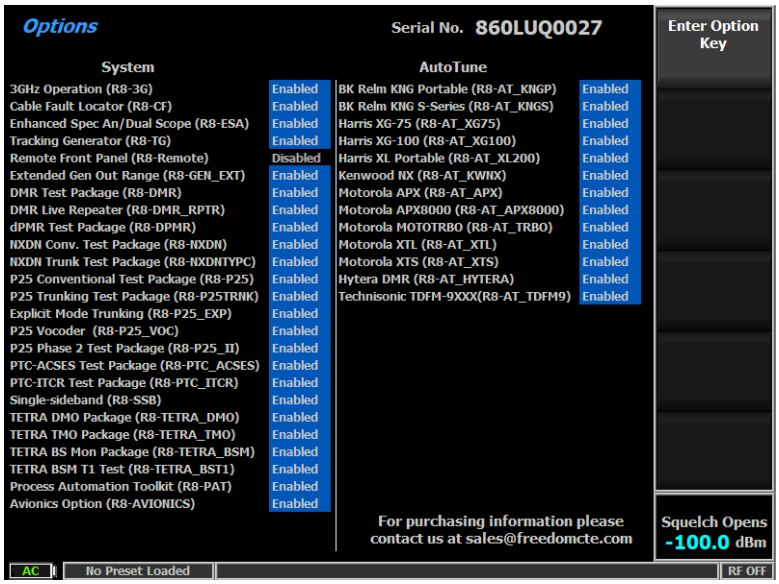
Remote Interface Limitations

- The graphical update rate is slower and depends on network latency.
- Calibration, which requires that RF connections be removed, is not supported.
- Updates, which require that a USB drive be inserted, are not supported.
- The following user-interface items are not supported: microphone, speaker, volume knob, squelch LED, and power button.

Enabling the Remote Front Panel

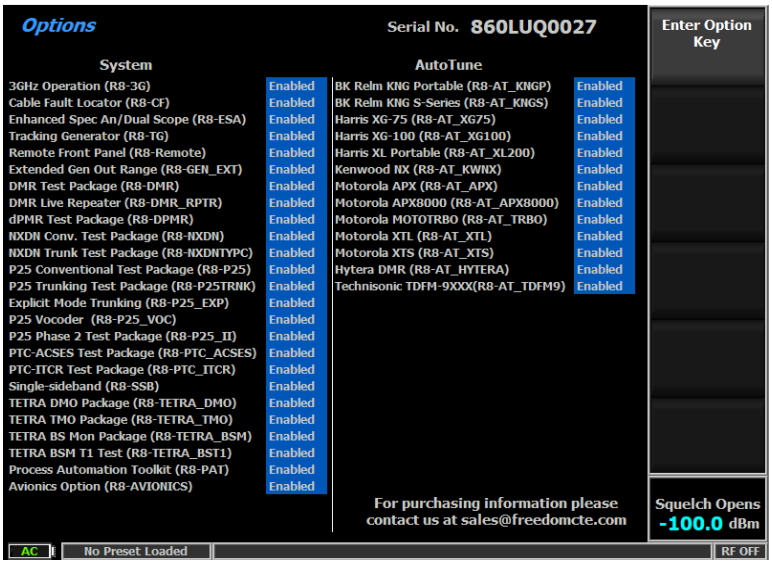
Option R8-Remote along with the Remote Front Panel installation package enable the use of the Remote Front Panel. If you ordered Option R8-Remote after receiving your R8200, you will receive a licensing document listing the 16-digit hexadecimal license code for Option R8-Remote. You will need this code to complete the following licensing procedure. To enable Option R8-Remote, complete the following steps.

Steps	Actions	Notes
1. Access the Options menu on the R8200.	**a.** Press **Test** > **Presets** > **Load Factory Configuration**.	This returns the analyzer to its factory default settings.
	b. Press **Settings** > **Options**.	This opens the Options table containing a complete list of all available System and AutoTune options for your R8200. A blue Enabled field highlights the active options. Inactive options are listed as Disabled.



2. Enable the R8-Remote option.	**a.** Press **Enter Option Key**.	This opens the 16-digit Enter Option Key dialog.
	b. Refer to the 16-digit hexadecimal	

Steps	Actions	Notes
	key for Option R8-Remote in the license document.	
	c. Enter the 16-digit hexadecimal key using the Enter Option Key dialog.	The R8200 displays a dialog confirming the option you are about to enable. To keep the option disabled, press **Cancel**. After pressing **Continue**, the option is enabled as shown.
	d. Verify your entry before pressing **Enter**.	
	e. To enable the option, press **Continue**.	



Installing the Remote Front Panel Software

To locate and install the Remote Front Panel installation package, complete the following steps.

Steps	Actions	Notes
1. Locate the RFP installation package.	**a.** On the PC that will use the Remote Front Panel to access the R8200, open your browser. **b.** Browse to **http://-freedomcte.com/upgrades/**. **c.** Click Remote Front Panel **DOWNLOAD**. **d.** Using Explorer, locate the ZIP file in your */Downloads* folder and extract the compressed folder. **e.** Double-click the folder **RemoteFPClient.Installer.1.1.0.0.**	
2. Install the software.	**a.** Double-click the file ***setup.exe***. **b.** Follow the prompts to complete the software installation.	

Configuring the DHCP Server

There are three approaches to configuring a DHCP server for connecting the R8200 to the network. Obtain assistance from network technician or administrator. Common scenarios are:

- Fixed: The DHCP server assigns a fixed IP address for the specific physical address (MAC address) of the R8200. That IP address is always valid (e.g., 10.20.30.40). This is the recommended DHCP configuration.
- Leased: The DHCP server assigns the next available IP address to the R8200 for some duration (lease). The address is displayed by the R8200 on the Network Settings screen. The address may not be valid if the lease expires, or it may change if the unit reboots. Obtaining a new address from a remote location may be difficult, e.g., connecting to the DHCP server to obtain it.
- DNS: The DHCP server assigns an IP address to the R8200. The address is given a fixed name by DNS. That name is always valid even if the IP address changes. Instead of entering the IP address into the browser, the name may be entered (e.g., unit1.company.com).
- APIPA: No DHCP server is present. The R8200 supports Automatic Private IP Addressing (APIPA), appropriate for simple networks that have only one subnet. With APIPA, if no DHCP server is available, the R8200 automatically assigns itself a private IP address. If a DHCP server later becomes available, the R8200 changes its IP address to one obtained from the DHCP server. Using APIPA, the R8200 assigns itself an IP address from a range reserved for authorized private class B network addresses (169.254.0.1 through 169.254.255.254), with a subnet mask of 255.255.0.0; it does not assign a default gateway. See http://-technet.microsoft.com/enus/library/bb457118.aspx.

Configuring the Analyzer Network Port

To configure the R8200 network port, complete the following steps.

Steps	Actions	Notes
1. Connect an Ethernet cable between your router and the R8200.	**a.** Plug the Ethernet cable into an empty Ethernet connector on your router. **b.** Plug the opposite end of the Ethernet cable into the Ethernet port on the R8200.	
2. Enable Network Connections on the R8200.	**a.** Activate the analyzer. **b.** Wait for the boot sequence to complete. **c.** Press **Settings** > **Network Setup** > **Enable**.	
3. Acknowledge the security alert.	**a.** Review the security alert. **b.** Press **Enter**.	Observe the green indicator below the configuration data fields that reads **Configuration In Progress**. Wait several seconds for the configuration to complete. The analyzer remembers the previously set network settings.

CAUTION When the network connection is enabled, the R8200 may be controlled by other computers on the network without restriction. It is strongly recommended that the R8200 be protected from unauthorized access through the use of external security measures.

NOTE DHCP must be On. It is On by default when the Network Connection is enabled for the first time.

4. Ensure DHCP is active and enable if necessary.	**a.** Press **DHCP**.	

Steps	Actions	Notes
	b. Observe the DHCP operating state. **c.** If DHCP is On, continue to Step 5. **d.** If DHCP is Off, press **On** > **Apply Network Changes**.	

CAUTION When DHCP is used to configure the network interface, the R8200 may be controlled by computers on local or external networks.

5. Save the R8200 IP address.	**a.** Record the analyzer IP address. **b.** Store the information in a safe place.	To disable the network connection, press **Settings** > **Network Setup** > **Disable**.

Enabling Power-Loss Recovery

Following the loss of line service power, the R8200 is configured to remain off when power is restored. This is factory set functionality. If automatic reactivation of the R8200 is required after the loss of line power, the unit must be returned to the factory to be reconfigured for this operation.

Disabling Remote Access

Follow these steps to disable remote access to the analyzer.

Steps	Actions	Notes
1. Enable Network Connections on the R8200.	**a.** Activate the analyzer. **b.** Wait for the boot sequence to complete. **c.** Press **Settings** > **Network Setup** > **Enable**.	
2. Acknowledge the security alert.	**a.** Acknowledge the alert. **b.** Press **Enter**.	Observe the green indicator below the configuration data fields that reads **Configuration In Progress.** Wait several seconds for the configuration to complete. The analyzer remembers the previously set network settings.

Verification / Troubleshooting Information

The R8200 responds to ICMP ping. Default gateway connectivity questions are best resolved by confirming that both local and remote pings to the R8200 succeed.

The Remote Front Panel application communicates with the R8200 via TCP port 8000. If the network is protected by one or more firewalls, ensure that the network configuration does not block access to the R8200.

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

Network Setup, APIPA IP Address is blank or zeros when the network connection is enabled. First, wait a minute. If the condition persists, then connect a live network cable to the Ethernet port, disable the network connection, restart the unit, and try again.

8 Monitor Mode Soft Keys

The Monitor Mode screen is divided into four functional Zones: RF, AUDIO, DISPLAY, and METER. This chapter contains detailed descriptions of the soft keys accessible in each Zone. Each soft key is defined, along with its range, discrete, default, and saved state values.

"RF Zone Soft Keys for Monitor Mode" on the next page includes the RF parameters associated with configuring the receiver.

"AUDIO Zone Soft Keys for Monitor Mode" on page 335 includes the parameters associated with demodulating the RF carrier.

"DISPLAY Zone Soft Keys for Monitor Mode" on page 362 includes the parameters associated with configuring your desired display.

"METER Zone Soft Keys for Monitor Mode" on page 380 includes the parameters associated with configuring general purpose and specialized instruments providing detailed analysis of the recovered baseband content from RF signals.

RF Zone Soft Keys for Monitor Mode

In Monitor Mode, the RF Zone contains the parameters for the receiver RF inputs. Use these soft keys to configure the R8200 receiver's center frequency, frequency span, start and stop frequency and which input you would like to analyze (RF In/Out or Antenna).

Monitor Frequency

Displays the Monitor Frequency dialog where you can enter the desired center frequency for the receiver.

Range	250 kHz to 3.0 GHz
Default	500 MHz
Saved State	Saved with instrument state

Copy Frequency to Generator

Sets the Generator output to the same frequency as the Monitor.

Range	250 kHz to 3.0 GHz
Default	500 MHz
Saved State	Saved with instrument state

Modulation Type

Activates a horizontal soft key menu where you can select the receiver's demodulation mode.

Discrete	FM, AM, USB, LSB

Values	
Default	FM
Saved State	Saved with instrument state
Notes	You can choose between Frequency Modulation , Amplitude Modulation, Lower Side-Band Modulation, and Upper Side-Band Modulation. Output Level upper limits are reduced in AM to accommodate peak power levels.

Bandwidth

Activates a horizontal soft key menu where you can select the receiver's resolution (IF detection) bandwidth.

Discrete Values	6.25 kHz, 8.33 kHz, 10 kHz, 12.5 kHz, 25 kHz, 50 kHz, 100 kHz, 200 kHz
Default	25 kHz
Saved State	Saved with instrument state
Notes	For best measurement quality, always set an IF bandwidth no wider than necessary for the signal carrier of interest. For example, typical channel spacing for modern narrowband two-way radio is 12.5 kHz. Monitor IF bandwidths that are wider than needed for the channel spacing, allow more noise in the measurement, and degrade the quality of readings for deviation, frequency error, SINAD, etc.

Attenuation

Displays the Attenuation dialog where you can select the desired input port attenuation for the receiver.

Discrete	0 to 62 dB in 2 dB steps

Values	
Default	0 dB
Saved State	Saved with instrument state

Pre-Amplifier

Displays the Pre-Amplifier dialog where you can enable a supplementary input amplifier that extends the sensitivity of the R8200 receiver by improving the S/N ratio for low signal levels.

Discrete Values	On, Off
Default	Off
Saved State	Saved with instrument state
Notes	**AMP** appears next to the Attenuation setting in the RF Zone whenever the Pre-Amplifier is active. By default, the pre-amplifier Auto-Off feature disables the pre-amplifier for best accuracy during broadband power (Watt Meter) measurements. When enabled, avoid input overload and erroneous signal strength readings by using the pre-amplifier only under the following conditions: **Monitor Port** — **Maximum input level for using pre-amplifier** Antenna — (Input signal in dBm – Attenuator setting) is equal or less than –40 dBm RF In/Out — (Input signal in dBm – Attenuator setting) is equal or less than –10 dBm

Mon Port

Displays the Mon Port dialog where you can select the desired input port for the receiver.

Discrete Values	RF In/Out, Antenna
Default	RF In/Out
Saved State	Saved with instrument state
Notes	If RF Level Offset is enabled, the Mon Port label is cyan-colored, indicating that receiver measurements are adjusted by the Mon Port-specific offset. Select an option using the arrow keys or tuning knob. **CAUTION** Do not apply input power to the Antenna input port.

Input Source

Activates a horizontal soft key menu where you can select the receiver's input source.

Discrete Values	Auto, Input Level, Power Meter
Default	Auto
Saved State	Saved with instrument state
Notes	When the RF input power on the RF In/Out port is above +20 dBm (100 mW), the analyzer utilizes a broadband power detector for the measurement. The Input Level field in the RF Zone changes to Power Meter to indicate this measurement mode. This disables TDMA from auto-switching between input sources during unused slots.

Input Units

Activates a horizontal soft key menu where you can select the units of measure for the receiver's input source.

Discrete Values	Volts, Watts, dBm
Default	dBm
Saved State	Saved with instrument state

AUDIO Zone Soft Keys for Monitor Mode

In Monitor Mode, the audio synthesizers operate like a stand-alone audio generator since they are not modulating a carrier generated by the R8200. Use these soft keys to generate message content available at the Mod In/Out connector as a modulating stimulus for your device under test.

Fixed 1 kHz Level

Displays the Fixed 1 kHz Level dialog where you can enter the desired value for tone generator amplitude.

Range	0 to 8 V_p
Default	0 V
Saved State	Saved with instrument state

Fixed 1 kHz Mode

Activates a horizontal soft key menu where you can select the tone generator operating state.

Discrete Value	Off, Continuous
Default	Off
Saved State	Saved with instrument state
Notes	When the tone is activated, the Fixed 1 kHz field is highlighted in green.

Synth Level

Displays the Synth Level dialog where you can enter the amplitude for the synthesized audio generator.

Range	0 to 8 V_p
Default	0 V
Saved State	Saved with instrument state

Format

Activates a horizontal soft key menu where you can select the encoding format for the synthesized audio generator.

NOTE

This section describes the Monitor Mode AUDIO Zone soft keys in their factory default configuration order. Thus, the PL format soft key is listed below as the default encoding format for the synthesized audio generator in Monitor Mode. Soft keys for the other synthesized audio generator formats such as DPL, DPL Invert, A/B Sequence, 5/6 Tone, POCSAG, and General Sequence, as well as their unique submenu soft keys, begin with **"DPL and DPL Invert Synthesizer Formats Soft Keys" on page 345**.

Discrete Values	PL, DPL, DPL Invert, A/B Sequence, 5/6 Tone, POCSAG, General Sequence
Default	PL
Saved State	Saved with instrument state
Notes	In Monitor Mode, the audio synthesizers operate like a stand-alone audio generator since they are not modulating a carrier. Selecting a format instantiates the active encoding type for the audio synthesizer. This is an independent synthesizer for encoding audio stimulus such as PL, DPL, or A/B Sequence. The output of this encoded signal is available at the Mod In/Out port. See below for specific soft keys associated with each format.

Synth Mode

Activates a horizontal soft key menu where you can select the select the synthesized audio generator operating state.

Discrete Values	Off, Continuous
Default	Off
Saved State	Saved with instrument state

PL Code

When the audio synthesizer format is set to PL, pressing this soft key displays the PL Code dialog where you can enter codes for the Motorola Private-Line coded squelch signaling format. The following table lists valid codes and their frequencies.

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

PL Code Table

When the audio synthesizer format is set to PL, pressing this soft key displays the PL Code Table where you can enter codes for the Motorola Private-Line coded squelch signaling format.

Tone A Level

Pressing this soft key displays the Tone A Level dialog where you can enter the amplitude for the A Variable tone generator.

Range	0 to 8 V_p
Default	0 V
Saved State	Saved with instrument state
Notes	This is an independent generator used for encoded audio such as PL, DPL, A/B Sequence, etc.

Tone A Frequency

Pressing this soft key displays the Tone A Frequency dialog where you can enter the frequency for the A Variable tone generator.

Range	0 to 19999 Hz
Default	10 Hz
Saved State	Saved with instrument state

Tone A Mode

Pressing this soft key activates a horizontal soft key menu where you can select the operating mode for the A Variable tone generator.

Discrete Values	Off, Continuous, Burst
Default	Off
Saved State	Saved with instrument state

Tone B Level

Pressing this soft key displays the Tone B Level dialog where you can enter the amplitude for the B Variable tone generator.

Range	0 to 8 V_p
Default	0 V
Saved State	Saved with instrument state

Tone B Frequency

Pressing this soft key displays the Tone B Frequency dialog where you can enter the frequency for the B Variable tone generator.

Range	0 to 19999 Hz
Default	10 Hz
Saved State	Saved with instrument state

Tone B Mode

Pressing this soft key activates a horizontal soft key menu where you can select the operating mode for the B Variable tone generator.

Discrete Values	Off, Continuous, Burst
Default	Off
Saved State	Saved with instrument state

DTMF Level

Pressing this soft key displays the DTMF Level dialog where you can enter the amplitude for the Dual Tone Multi-Frequency tone generator.

Range	0 to 8 V_p
Default	0 V
Saved State	Saved with instrument state
Notes	DTMF is used for testing telephone-interfaced systems.

DTMF Mode

Pressing this soft key activates a horizontal soft key menu where you can select the operating mode for the Dual Tone Multi-Frequency tone generator.

Discrete	Off, Continuous, Burst

Values	
Default	Off
Saved State	Saved with instrument state
Notes	DTMF is used for testing telephone-interfaced systems.

DTMF Code

Pressing this soft key opens the DTMF Code dialog where you can enter a code sequence for the Dual Tone Multi-Frequency tone generator. Pressing this key also activates a horizontal soft key menu where you can insert a space in the code sequence or clear the present values from the cursor to the end.

Discrete Values	1, 2, 3, 4, 5, 6, 7, 8, 9, 0, *, #, A, B, C, D
Default	1234567890*#ABCD
Saved State	Saved with instrument state
Notes	DTMF is used for testing telephone-interfaced systems. The code may be entered by using the vertical arrow keys or tuning knob to highlight the desired field in the DTMF Code table. The alpha-numeric keypad enables direct numeric entry. Alpha characters are entered by cycling through repeated presses of the appropriate numeric key.

DTMF Code Table

Pressing this soft key activates the DTMF Code Table providing additional control when generating a DTMF Code sequence. In addition to the DTMF Code data entry window, other selections permit 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.

Tone Duration

Pressing this soft key opens the Tone Duration dialog where you can enter the code sequence duration for the Dual Tone Multi-Frequency tone generator.

Range	1 to 9999 ms
Default	100 ms
Saved State	Saved with instrument state
Notes	DTMF is used for testing telephone-interfaced systems.

Inter-Digit Delay

Pressing this soft key opens the Inter-Digit Delay dialog where you can enter the delay between individual digits broadcast by the code sequence from the Dual Tone Multi-Frequency tone generator.

Range	1 to 9999 ms
Default	100 ms
Saved State	Saved with instrument state
Notes	DTMF is used for testing telephone-interfaced systems.

Single Digit

Pressing this soft key activates a horizontal soft key menu where you can choose a single digit to broadcast as the code sequence from the Dual Tone Multi-Frequency tone generator.

Discrete Values	*, #, A, B, C, D
Default	*
Saved State	Saved with instrument state
Notes	DTMF is used for testing telephone-interfaced systems.

Microphone Level

Pressing this soft key activates a Microphone Level dialog where you can set the modulation level for the external microphone attached to the R8200.

Range	0 to 8 V
Default	0 V
Saved State	Saved with instrument state
Notes	The displayed units reflect the modulation mode chosen in the RF Zone, either *Deviation* in kHz for FM or *%AM* (percent modulation) for AM.

Microphone Mode

Pressing this soft key activates a horizontal soft key menu where you can enable or disable modulation from an external microphone attached to the Mic In port of the analyzer.

Discrete Values	Off, Continuous
Default	Off

Saved State	Saved with instrument state
Notes	Pressing the PTT button on the external microphone switches the analyzer into Generate Mode. Modulation from the microphone is applied to the carrier when the Microphone mode is set to Continuous.

High Pass Filter

Pressing this soft key activates a horizontal soft key menu where you can select the 3 dB high pass frequency for filtering the R8200 baseband response to recovered audio.

Discrete Values	1 Hz, 300 Hz, 3 kHz
Default	300 Hz
Saved State	Saved with instrument state
Notes	This setting is used in conjunction with the Low Pass Filter to determine the audio pass band for the R8200 baseband circuitry. For best audio and measurement quality, always set an audio pass band no wider than necessary for the signal of interest. For example, a typical two-way radio audio pass band is 300 Hz to 3 kHz. Pass bands wider than necessary allow more noise in the measurement and degrade the audio quality and the readings for deviation, frequency error, SINAD, etc. The default settings for the High and Low Pass filters are 300 Hz and 3 kHz respectively.

Low Pass Filter

Pressing this soft key activates a horizontal soft key menu where you can select an audio filter low pass frequency.

Discrete	300 Hz, 3 kHz, 20 kHz

Values	
Default	300 Hz
Saved State	Saved with instrument state
Notes	This setting is used in conjunction with the High Pass Filter to determine the audio pass band for the R8200 baseband circuitry. For best audio and measurement quality, always set an audio pass band no wider than necessary for the signal of interest. For example, a typical two-way radio pass band is 300 Hz to 3 kHz. Pass bands wider than necessary allow more noise in the measurement and degrade the audio quality and the readings for deviation, frequency error, SINAD, etc.

Voltage Units

Pressing this soft key activates a horizontal soft key menu where you can select the type of voltage units to be used in the AUDIO Zone **Sum** display.

Discrete Values	Volts (V), Millivolts (mV), Decibel Volts (dBV)
Default	Volts (V)
Saved State	Saved with instrument state

DPL and DPL Invert Synthesizer Formats Soft Keys

NOTE

The following sections describe the soft keys for the supplementary audio synthesizer formats: DPL, DPL Invert, A/B Sequence, 5/6 Tone, POCSAG, and General Sequence. For the default audio synthesizer format, see **"PL Code" on page 337**.

The following soft key is unique to the DPL and DPL Invert synthesizer formats.

DPL Code

When the audio synthesizer format is set to DPL or DPL Invert, pressing this soft key displays the DPL Code dialog where you can enter codes for the Motorola Digital-Private-Line coded squelch signaling format using the vertical arrow keys or the tuning knob.

Discrete Values	000, 001, 002, 003, 004, 005, 006, 007, 010, 011, 012, 013, 014, 015, 016, 017, 020, 021, 022, 023, 024, 025, 026, 027, 030, 031, 032, 033, 034, 035, 036, 037, 040, 041, 042, 043, 044, 045, 046, 047, 050, 051, 052, 053, 054, 055, 056, 057, 060, 061, 062, 063, 064, 065, 066, 067, 070, 071, 072, 073, 074, 075, 076, 077, 100, 101, 102, 103, 104, 105, 106, 107, 110, 111, 112, 113, 114, 115, 116, 117, 120, 121, 122, 123, 124, 125, 126, 127, 130, 131, 132, 133, 134, 135, 136, 137, 140, 141, 142, 143, 144, 145, 146, 147, 150, 151, 152, 153, 154, 155, 156, 157, 160, 161, 162, 163, 164, 165, 166, 167, 170, 171, 172, 173, 174, 175, 176, 177, 200, 201, 202, 203, 204, 205, 206, 207, 210, 211, 212, 213, 214, 215, 216, 217, 220, 221, 222, 223, 224, 225, 226, 227, 230, 231, 232, 233, 234, 235, 236, 237, 240, 241, 242, 243, 244, 245, 246, 247, 250, 251, 252, 253, 254, 255, 256, 257, 260, 261, 262, 263, 264, 265, 266, 267, 270, 271, 272, 273, 274, 275, 276, 277, 300, 301, 302, 303, 304, 305, 306, 307, 310, 311, 312, 313, 314, 315, 316, 317, 320, 321, 322, 323, 324, 325, 326, 327, 330, 331, 332, 333, 334, 335, 336, 337, 340, 341, 342, 343, 344, 345, 346, 347, 350, 351, 352, 353, 354, 355, 356, 357, 360, 361, 362, 363, 364, 365, 366, 367, 370, 371, 372, 373, 374, 375, 376, 377, 400, 401, 402, 403, 404, 405, 406, 407, 410, 411, 412, 413, 414, 415, 416, 417, 420, 421, 422, 423, 424, 425, 426, 427, 430, 431, 432, 433, 434, 435, 436, 437, 440, 441, 442, 443, 444, 445, 446, 447, 450, 451, 452, 453, 454, 455, 456, 457, 460, 461, 462, 463, 464, 465, 466, 467, 470, 471, 472, 473, 474, 475, 476, 477, 500, 501, 502, 503, 504, 505, 506, 507, 510, 511, 512, 513, 514, 515, 516, 517, 520, 521, 522, 523, 524, 525, 526, 527, 530, 531, 532, 533, 534, 535, 536, 537, 540, 541, 542, 543, 544, 545, 546, 547, 550, 551, 552, 553, 554, 555, 556, 557, 560, 561, 562, 563, 564, 565, 566, 567, 570, 571, 572, 573, 574, 575, 576, 577, 600, 601, 602, 603, 604, 605, 606, 607, 610, 611, 612, 613, 614, 615, 616, 617, 620, 621, 622, 623, 624, 625, 626, 627, 630, 631, 632, 633, 634, 635, 636, 637, 640, 641, 642, 643, 644, 645, 646, 647, 650, 651, 652, 653, 654, 655, 656, 657, 660, 661, 662, 663, 664, 665, 666, 667, 670, 671, 672, 673, 674, 675, 676, 677, 700, 701, 702, 703, 704, 705, 706, 707, 710, 711, 712, 713, 714, 715, 716, 717, 720, 721, 722, 723, 724, 725, 726, 727, 730, 731, 732, 733, 734, 735, 736, 737, 740, 741, 742, 743, 744, 745, 746, 747, 750, 751, 752, 753, 754, 755,

	756, 757, 760, 761, 762, 763, 764, 765, 766, 767, 770, 771, 772, 773, 774, 775, 776, 777
Default	000
Saved State	Saved with instrument state

A/B Sequence Synthesizer Format Soft Keys

The following soft keys are unique to the A/B Sequence synthesizer format.

A/B Sequence

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates a horizontal soft key menu where you can select one of four timing sequences for the two-tone sequential paging format.

Discrete Values	1, 2, 3, 4
Default	1
Saved State	Saved with instrument state
Notes	Sequences 1 and 2 utilize fixed timing for standard Tone and Tone/Voice pagers, while Sequences 3 and 4 afford user-defined tone frequencies, durations, and delays.

A/B Sequence Table

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates a programming table for the two-tone sequential paging format. The A/B Sequence encoding mode uses the Tone A and Tone B generators and one of four selectable timing sequences determined by the Sequence soft key. Sequences 1 and 2 utilize fixed timing for standard tone and tone/voice pagers, while sequences 3 and 4 may be customized. When the vertical arrow keys highlight the programmable sequences 3 and 4, an additional submenu appears for defining tone frequencies, durations, and delays.

Sequence

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates a horizontal soft key menu where you can select one of four timing sequences for the two-tone sequential paging format.

Discrete Values	1, 2, 3, 4
Default	1
Saved State	Saved with instrument state
Notes	Sequences 1 and 2 utilize fixed timing for standard tone and tone/voice pagers, while Sequences 3 and 4 afford user-defined tone frequencies, durations, and delays.

Sequence (3 or 4) Tone A Duration

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates the Tone A Duration dialog where you can adjust the length of Tone A.

Range	0 to 9.99 s
Default	0 s
Saved State	Saved with instrument state
Notes	This function only applies to Sequence 3 and 4.

Sequence (3 or 4) Tone A Delay

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates the Tone A Delay dialog where you can adjust the delay for Tone A.

Range	0 to 9.99 s
Default	0 s
Saved State	Saved with instrument state
Notes	This function only applies to sequence 3 and 4

Sequence (3 or 4) Tone B Duration

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates the Tone B Duration dialog where you can adjust the length of Tone B.

Range	0 to 9.99 s
Default	0 s
Saved State	Saved with instrument state
Notes	This function only applies to sequence 3 and 4.

Sequence (3 or 4) Tone B Delay

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates the Tone B Delay dialog where you can adjust the delay for Tone B.

Range	0 to 9.99 s
Default	0 s
Saved State	Saved with instrument state
Notes	This function only applies to sequence 3 and 4.

5/6 Tone Synthesizer Format Soft Keys

The following soft keys are unique to the 5/6 Tone synthesizer format.

5/6 Tone

When the audio synthesizer format is set to 5/6 Tone, pressing this soft key activates a 5/6 Tone dialog, where you can enter a 5/6 tone sequence.

Discrete Values	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, R, X
Default	R-12345X
Saved State	Saved with instrument state
Notes	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. After hearing the tone, the operator may assume that 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 that a different beep pattern is used in place of that used for the standard 5 tone response. Pressing the 6-Tone soft key adds the “X” tone to the transmission.

POCSAG Synthesizer Format Soft Keys

The following soft keys are unique to the POCSAG synthesizer format.

POCSAG Message

When the audio synthesizer format is set to POCSAG, pressing this soft key activates a POCSAG Message dialog.

Discrete Values	Tone Only, NumericNum, NumericSet, AlphaNumUC, AlphaNumLC, AlphaNumSP, NumericCust, AlphaNumCust

Default	Tone Only
Saved State	Saved with instrument state
Notes	Highlighting the NumericCust or AlphaNumCust selections allows editing of the respective custom Numeric or Alpha-numeric strings. Up to 16 characters may be entered. Entered NumericCust and AlphaNumCust strings are truncated or expanded to match Message Length. See **"POCSAG Message Encoding Tables" below**. Tone Only: <empty string> NumericNum: 0123456789 NumericSet: The used characters in the Numeric set. AlphaNumUC: ABCDEFGHIJKLMNOPQRSTUVWXYZ AlphaNumLC: abcdefghijklmnopqrstuvwxyz AlphaNumSP: space!”#$%’()*+, -./:;<=>?@[\]^_`{|}~ NumericCust: Anything in the Numeric set. AlphaNumCust: Anything in the Alpha-numeric set.

POCSAG Message Encoding Tables

POCSAG Numeric Character Set	
Binary	**Character**
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6

POCSAG Numeric Character Set	
Binary	**Character**
0111	7
1000	8
1001	9
1010	Spare (not available)
1011	U
1100	-
1110	[
1111	]

POCSAG Alphanumeric Character Set (7-bit ASCII)								
Decimal	Binary	Character	Decimal	Binary	Character	Decimal	Binary	Character
20	0100000	SPACE	52	1000000	@	84	1100000	`
21	0100001	!	53	1000001	A	85	1100001	a
22	0100010	“	54	1000010	B	86	1100010	b
23	0100011	#	55	1000011	C	87	1100011	c
24	0100100	$	56	1000100	D	88	1100100	d
25	0100101	%	57	1000101	E	89	1100101	e
26	0100110	&	58	1000110	F	90	1100110	f
27	0100111	‘	59	1000111	G	91	1100111	g
28	0101000	(	60	1001000	H	92	1101000	h
29	0101001	)	61	1001001	I	93	1101001	i
30	0101010	*	62	1001010	J	94	1101010	j
31	0101011	+	63	1001011	K	95	1101011	k
32	0101100	,	64	1001100	L	96	1101100	l
33	0101101	-	65	1001101	M	97	1101101	m
34	0101110	.	66	1001110	N	98	1101110	n
35	0101111	/	67	1001111	O	99	1101111	o
36	0110000	0	68	1010000	P	100	1110000	p
37	0110001	1	69	1010001	Q	101	1110001	q
38	0110010	2	70	1010010	R	102	1110010	r
39	0110011	3	71	1010011	S	103	1110011	s
40	0110100	4	72	1010100	T	104	1110100	t
41	0110101	5	73	1010101	U	105	1110101	u
42	0110110	6	74	1010110	V	106	1110110	v
43	0110111	7	75	1010111	W	107	1110111	w
44	0111000	8	76	1011000	X	108	1111000	x
45	0111001	9	77	1011001	Y	109	1111001	y
46	0111010	:	78	1011010	Z	110	1111010	z
47	0111011	;	79	1011011	[	111	1111011	{
48	0111100	<	80	1011100	\	112	1111100	|
49	0111101	=	81	1011101	]	113	1111101	}
50	0111110	>	82	1011110	^	114	1111110	~
51	0111111	?	83	1011111	_	115	1111111	N/A

POCSAG Table

When the audio synthesizer format is set to POCSAG, pressing this soft key displays the POCSAG Table where you can enter codes for the Motorola Private-Line coded squelch signaling format.

Discrete Values	Tone Only, NumericNum, NumericSet, AlphaNumUC, AlphaNumLC, AlphaNumSP, NumericCust, AlphaNumCust
Default	Tone Only
Saved State	Saved with instrument state

Synth Mode

When the audio synthesizer format is set to POCSAG, pressing this soft key activates a horizontal soft key menu where you can select the synthesized audio generator operating state.

Discrete Values	Off, Continuous, Burst
Default	Off
Saved State	Saved with instrument state
Notes	This is an independent generator used for encoded audio such as PL, DPL, A/B Sequence, etc.

Capcode

When the audio synthesizer format is set to POCSAG, pressing this key activates the Capcode input dialog.

Range	0 to 2097151

Default	0
Saved State	Saved with instrument state

Function Bits

When the audio synthesizer format is set to POCSAG, pressing this soft key activates a horizontal soft key menu where you can select the function bits.

Discrete Values	00, 01 ,10, 11
Default	00
Saved State	Saved with instrument state

Message Length

When the audio synthesizer format is set to POCSAG, pressing this key activates the Message Length input dialog.

Range	0 to 60
Default	16
Saved State	Saved with instrument state

Data Rate

When the audio synthesizer format is set to POCSAG, pressing this key activates the Data Rate input dialog.

Range	400 to 4800
Default	1200
Saved State	Saved with instrument state

Polarity

When the audio synthesizer format is set to POCSAG, pressing this soft key activates a horizontal soft key menu where you can select the POCSAG datastream polarity.

Discrete Values	Normal, Inverted
Default	Normal
Saved State	Saved with instrument state
Notes	When set to Normal, a logic high (1) results in a more positive frequency deviation in FM mode. A logic low (0) results in a more negative frequency deviation in FM mode. When set to Inverted, a logic high (1) results in more negative frequency deviation in FM mode. A logic low (0) results in a more positive frequency deviation in FM mode.

Error Bit

When the audio synthesizer format is set to POCSAG, pressing this key activates the Error Bit input dialog.

Range	0 to 2200
Default	1200
Saved State	Saved with instrument state

Notes	The error bit allows targeted insertion of an error into the page to test a POCSAG decoder's error correction capability. The setting toggles the Error Bit in the POCSAG page bit stream, where the bit stream uses a 1-based index. If Error Bit is set to 0 (default), no bits are toggled. If Error Bit is set ≥ 1, then bit stream (Error Bit) is toggled.

General Sequence Synthesizer Format Soft Keys

The following soft keys are unique to the General Sequence synthesizer format.

Code Sequence

When the audio synthesizer format is set to General Sequence, pressing this key activates the Code Sequence input dialog where you can define a custom code sequence.

Discrete Values	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, G, H, I, J
Default	0123456789ABCDEFGHIJ
Saved State	Saved with instrument state

General Sequence Table

When the audio synthesizer format is set to General Sequence, pressing this soft key displays the General Sequence Table where you can enter custom codes for use in sequences.

Notes	The table is populated with 20 Tone Codes (0 to 9 and A to J) with preset data for frequency, duration, and post-tone delay. The selected Tone Standard determines the preset data for each tone code. Regardless of the standard selected, each Tone Code can be edited for the current operating session or saved as a customized sequence.

Select Tone Standard

When the audio synthesizer format is set to General Sequence, pressing this key activates the Tone Standard input dialog where you can select from a list of Tone Standards to use in sequencing.

Discrete Values	None, CCIR1, CCIR2, PCCIR, CCITT, EEA, EIA, Euro, NATEL, MODAT, ZVEI1, ZVEI2, ZVEI3, DZVEI, PDZVEI
Default	None
Saved State	Saved with instrument state

Synth Mode

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a horizontal soft key menu where you can select the synthesized audio generator operating state.

Discrete Values	Off, Continuous, Burst
Default	Off
Saved State	Saved with instrument state
Notes	The status of the Synth Mode is shown in the Mode field.

Tone Frequency

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a Tone Frequency input dialog where you can enter a frequency value for the highlighted code.

Range	0 to 20000 Hz
Default	0 Hz
Saved State	Saved with instrument state

Tone Duration

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a Tone duration dialog where you can enter a duration for a highlighted code.

Range	0 to 0.5 s
Default	0 s
Saved State	Saved with instrument state

Post-Tone Delay

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a Post-Tone Delay dialog, where you can enter the duration of the delay following the transmitted tone.

Range	0 to 1 s
Default	0.5 s
Saved State	Saved with instrument state

Save Sequence Definition

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a Save Sequence Definition dialog, where you can enter an alphanumeric sequence name.

Range	A to Z and 0 to 9
Default	MY
Saved State	Saved with instrument state

Load Sequence Definition

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a Load Sequence Definition dialog, where you can load a sequence.

Export Sequence Definition

When the audio synthesizer format is set to General Sequence, pressing this soft key activates an Export Sequence Definition dialog, where you can select a sequence definition to save on an external USB device.

Delete Sequence Definition

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a Delete Sequence Definition dialog, where you can delete a sequence.

Sync to Code Entry

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a Sync to Code Entry dialog, where you can select General Sequence sync setting.

Discrete Values	No, Yes
Default	Yes
Saved State	Saved with instrument state
Notes	Yes – Any Tone Code alphanumeric value entered into the Code Sequence field is initially pop-

	ulated into the associated position in the Duration and Delay Sequence fields. This matches the frequency, duration, and delay values for each tone in the Code Sequence to that shown on the Tone Code line entry in the table. If desired, these initially synchronized Duration and Delay sequence entries can be changed to other values from the table. No – The entries for the Duration and Delay Sequences are set independently of the Code Sequence, with duration and delay values from any Tone Code on the table.

Duration Sequence

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a Duration Sequence dialog, where you can enter a custom duration sequence. Pressing this soft key also activates a horizontal soft key menu where you can clear a Duration Sequence entry.

Discrete Values	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, G, H, I, J
Default	0123456789ABCDEFGHIJ
Saved State	Saved with instrument state
Notes	Clear to End – clears the highlighted entry and all others to the right. Each entry in the Duration Sequence is paired in positional order with the associated entry in the Code Sequence, which provides the tone frequency, and the Delay Sequence, which provides the post tone delay. A duration of zero is used for Code Sequence entries that do not have an associated Duration Sequence entry. Duration Sequence entries that do not have an associated Code Sequence entry are ignored.

Delay Sequence

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a Delay Sequence dialog, where you can enter a custom delay sequence. Pressing this soft key also activates a horizontal soft key menu where you can clear a Delay Sequence entry.

Discrete Values	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, G, H, I, J
Default	0123456789ABCDEFGHIJ
Saved State	Saved with instrument state
Notes	Clear to End – clears the highlighted entry and all others to the right. Each entry in the Delay Sequence is paired in positional order with the associated entry in the Code Sequence, which provides the tone frequency, and the Duration Sequence, which provides the tone duration. A delay of zero is used for Code Sequence entries that do not have an associated Delay Sequence entry. Delay Sequence entries that do not have an associated Code Sequence entry are ignored.

DISPLAY Zone Soft Keys for Monitor Mode

In Monitor Mode, the DISPLAY Zone represents the controls for the primary graticule measurement display or bar graphs. Use these soft keys to configure your desired display.

Select Display (DISPLAY Zone Menu)

Pressing this soft key activates a horizontal soft key menu where you can select the display mode.

Discrete Values	Spec An, Mod Scope, Oscilloscope, Bar Graphs
Default	Spec An
Saved State	Saved with instrument state

Center Frequency (Spectrum Analyzer submenu)

When display is set to Spec An, pressing this soft key displays the Center Frequency dialog where you can enter the desired value to set the center frequency on the receiver display.

Range	250 kHz to 3.0 GHz
Default	500 MHz
Saved State	Saved with instrument state

Span (Spectrum Analyzer submenu)

When display is set to Spec An, pressing this soft key displays the Span dialog where you can input the desired frequency span for the receiver.

Range	10 kHz to 20 MHz
Default	10 MHz
Saved State	Saved with instrument state
Notes	Frequency span allows you to zoom in or out (change the span of the X-axis) on a signal of interest, while maintaining the relative power (Y-axis). To zoom in on a signal, decrease the frequency span while maintaining the signal at center frequency. To zoom out, increase the frequency span. The value entered for Span is automatically split between each side of the current center frequency. Receiver modulated audio is inhibited at spans above 158 kHz. Switch display to Mod Scope or use Demod at Marker function to hear audio at wider spans.

Start Frequency (Spectrum Analyzer submenu)

When display is set to Spec An, pressing this soft key displays the Start Frequency dialog where you can input the lowest frequency currently measured and shown on the receiver display.

Range	250 kHz to 1.5 GHz
Default	495 MHz
Saved State	Saved with instrument state
Notes	The analyzer automatically centers the frequency display midway between Start and Stop frequencies.
Couplings	When adjusting the start frequency the stop frequency is held constant, meaning that both the center frequency and span will change.

Stop Frequency (Spectrum Analyzer submenu)

When display is set to Spec An, pressing this soft key displays the Stop Frequency dialog where you can input the highest frequency currently measured and shown on the receiver display.

Range	260 kHz to 3 GHz
Default	1 MHz
Saved State	Saved with instrument state
Notes	The analyzer automatically centers the frequency display midway between Start and Stop frequencies.
Couplings	When adjusting the stop frequency the start frequency is held constant, meaning that both the center frequency and span will change.

Reference Level (Spectrum Analyzer submenu)

When display is set to Spec An, pressing this soft key displays the Reference Level dialog where you can input the value of the top graticule line.

Range	0 to 90 dBm
Default	0 dBm
Saved State	Saved with instrument state

Vertical Scale (Spectrum Analyzer submenu)

When the display is set to Spec An, pressing this soft key activates a horizontal soft key menu where you can select the Y-axis scale.

Discrete Values	10 dB/div, 5 dB/div, 2 dB/div, 1 dB/div
Default	10 dB/div
Saved State	Saved with instrument state

Display Mode (Spectrum Analyzer submenu)

When the display is set to Spec An, pressing this soft key activates a horizontal soft key menu where you can select the trace graphing mode.

Discrete Values	Normal, Freeze, Max Hold, Average

Default	Normal
Saved State	Saved with instrument state
Notes	Normal – The display updates continuously. Freeze – The display provides a snapshot of the current display indication and stops additional updates. In Freeze Mode, the R8200 reacquires data and updates the display whenever **Center Marker** or **Center Peak** is pressed. Max Hold – The display retains the highest peak signal amplitudes measured during successive sweeps. Average – The displayed signal amplitudes are a rolling average of the peak amplitudes measured on each successive sweep. The average consists of one to five sweeps, shown beside the mode indication.

Trace Math (Spectrum Analyzer submenu)

When the display is set to Spec An, pressing this soft key activates a horizontal soft key menu where you can select the trace math to be applied.

Discrete Values	None, Spec-Ref (log), |Spec-Ref| (lin), Spec+Ref (lin)
Default	None
Saved State	Saved with instrument state
Notes	The underlying units of the result are no longer dBm but dB for the displayed spectrum and thus marker power. None – This selection hides the reference trace and displays the spectrum resulting from the Display Mode unmodified.

	Spec-Ref (log) – This selection displays the difference of the Display Mode spectrum in dBm minus the reference trace in dBm, which normalizes the spectrum to 0 on the Y-axis. Subsequently, spectrum power is shown on the display and measured by absolute markers relative to the reference trace, i.e., correctly interpreted as dBm above the reference. |Spec-Ref| (lin) – This choice displays the logarithm of the absolute value of the difference of the Display Mode spectrum in volts^2 minus the reference trace in volts^2. Although the absolute value of the difference avoids logarithm of negatives, it has the side effect of increasing the apparent noise power. Spec+Ref (lin) – This choice displays the logarithm of the sum of the Display Mode spectrum in volts^2 plus the reference trace in volts^2.

Set Reference Trace (Spectrum Analyzer submenu)

When the display is set to Spec An, pressing this soft key saves the current trace as a separate blue reference trace.

Notes	The trace is copied from what is currently shown, which is after any Display Mode processing as well as Trace Math computations. Therefore, ensure that both of those settings are appropriately set (i.e., Trace Math is None); setting the reference when Trace Math is active may yield incoherent results. Setting Display Mode to Average minimizes effects of a low level / high variance signal such as the noise floor. This static trace is used for computations when a Trace Math equation is specified and may simply be viewed even when one is not. It can be hidden by selecting Trace Math None. System changes that may invalidate the reference trace include port, amplification, attenuation, frequency, span, temperature, and calibration.

Detector (Spectrum Analyzer submenu)

When the display is set to Spec An, pressing this soft key activates a horizontal soft key menu where you can select the Detector mode.

Discrete Values	Power, Peak, Sample, Mean, Valley
Default	Peak
Saved State	Saved with instrument state

3 dB Marker (Spectrum Analyzer submenu)

When the display is set to Spec An, pressing this soft key activates a horizontal soft key menu where you can select the 3 dB Marker mode.

Discrete Values	Off, Frequency, Delta
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. Frequency – This selection places a marker above and below center frequency where the signal is –3 dB below the peak amplitude measured at center frequency. The upper and lower frequencies are shown on the display. Delta – This selection places a marker above and below center frequency where the signal is –3 dB below the peak amplitude measured at center frequency. The difference between these two frequencies is shown on the display.

Marker Mode (Spectrum Analyzer submenu)

When the display is set to Spec An, pressing this soft key activates a horizontal soft key menu where you can select the Marker type and operating state.

Discrete Values	Off, Absolute, Delta
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. Absolute – This selection displays the frequency and absolute signal amplitude for each marker selected. Delta – This selection displays the frequency and amplitude difference between each pair of markers selected. Depending on the installed options, up to four markers can be enabled and selected for positioning while in Instrument Mode.

Toggle Marker (Spectrum Analyzer submenu)

When the display is set to Spec An, pressing this soft key cycles through the available markers to activate one for repositioning. Active markers are yellow.

Center Marker (Spectrum Analyzer submenu)

When the display is set to Spec An, pressing this soft key moves the active marker to the middle of the spectrum.

Find Peak (Spectrum Analyzer submenu)

When the display is set to Spec An, pressing this soft key moves the active marker to highest trace peak.

Center Peak (Spectrum Analyzer submenu)

When the display is set to Spec An, pressing this soft key centers the display around the highest peak.

Demod at Marker (Spectrum Analyzer submenu)

When the display is set to Spec An and Marker Mode is set to absolute, pressing this soft key activates a horizontal soft key menu where you can select the demodulation mode at the active marker.

Discrete Values	Off, Single, Continuous
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. Single – Provides a one-time demodulation of the carrier signal located at the marker position for a quick listen at the marker frequency. Moving the marker or changing the monitor frequency, mode, or DISPLAY Zone selection switches the Demod At Marker function Off. Continuous – Continuous Mode allows users to move the selected marker to demodulate carriers across the entire displayed spectrum. On full-screen instruments, the user can setup several markers on various peaks and use the marker selection to quickly demodulate and listen to those peaks. Additionally, on the Dual Display, the user can simultaneously view the Modulation Scope while tuning the marker positions. To ensure audio is demodulated, the marker must be close enough to overlap the analyzer Monitor Bandwidth around the carrier frequency. Large Span settings increase marker frequency step size, limiting how close the marker can get to the actual frequency. To minimize step size, use the narrowest span practical when displaying multiple carriers.

Vertical Scale (Modulation Scope submenu)

When display is set to Mod Scope, pressing this soft key activates a horizontal soft key menu where you can select the vertical scale.

Discrete Values	100, 200, 500 Hz and 1, 2, 5, 10, 20, 50 kHz/Div
Default	1 kHz/Div
Saved State	Saved with instrument state

Horizontal Scale (Modulation Scope submenu)

When display is set to Mod Scope, pressing this softkey displays the Horizontal Scale input dialog where you can select the horizontal scale.

Discrete Values	20, 50, 100, 200, 500 µs and 1, 2, 5, 10, 20, 50, 100, 200, 500 ms and 1 s
Default	20 ms
Saved State	Saved with instrument state

Marker Mode (Modulation Scope submenu)

When display is set to Mod Scope, pressing this soft key activates a horizontal soft key menu where you can select the Marker type and operating state.

Discrete Values	Off, Delta V, Delta T, 1/Delta T
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers.

	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/Delta T – The numeric reading shows the inverse of the time difference between markers, which can be used to determine the frequency of a repetitive waveform. Depending on the installed options, up to four markers can be enabled and selected for positioning while in Instrument Mode.

Toggle Marker (Modulation Scope submenu)

When the display is set to Mod Scope, pressing this soft key cycles through the available markers to activate one for repositioning. Active markers are yellow.

Trigger Mode (Modulation Scope submenu)

When display is set to Mod Scope, pressing this soft key activates a horizontal soft key menu where you can select the Modulation Scope Trigger type.

Discrete Values	Auto, Normal, Single
Default	Auto
Saved State	Saved with instrument state
Notes	Auto – If a signal satisfying the Trigger Edge and Trigger Level settings is present, the display will sweep as in Normal Mode. If no signal satisfying the Trigger Edge and Trigger Level settings is present, then the display sweeps continuously until a signal satisfying the settings is acquired. Normal – The display sweeps only when the input signal satisfies the Trigger Edge and Trigger Level settings. Single – The display sweeps once after a key press is performed on the Single soft key if the signal satisfies the Trigger Edge and Trigger level settings.

Trigger Level (Modulation Scope submenu)

When display is set to Mod Scope, pressing this soft key activates a Trigger Level dialog where you can enter the trigger threshold level in kHz.

Range	–200 to 200 kHz
Default	0 kHz
Saved State	Saved with instrument state

Trigger Edge (Modulation Scope submenu)

When display is set to Mod Scope, pressing this soft key activates a horizontal soft key menu where you can select the Modulation Scope trigger type.

Discrete Values	Rising, Falling, Either
Default	Rising
Saved State	Saved with instrument state

Vertical Position (Modulation Scope submenu)

When display is set to Mod Scope, pressing this soft key activates a horizontal soft key menu where you can adjust the Modulation Scope vertical position up or down.

Discrete Values	Move Down, Move Up
Saved State	Saved with instrument state

Coupling (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a Coupling dialog menu where you can select the input voltage coupling.

Discrete Values	DC, AC
Default	DC
Saved State	Saved with instrument state

Horizontal Scale (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this softkey displays the Horizontal Scale input dialog where you can select the horizontal scale.

Discrete Values	20, 50, 100, 200, 500 µs and 1, 2, 5, 10, 20, 50, 100, 200, 500 ms and 1 s
Default	1 ms
Saved State	Saved with instrument state
Notes	Digital Oscilloscopes are susceptible to aliasing, which can cause inaccurate signal reconstruction. The Maximum recommended input frequency for each horizontal scale setting is shown in the display area. For best results, follow the guidelines shown in the table below.

Horizontal Scale	Max Signal Frequency	Max Recommended Signal Frequency
20 µs	50000 Hz	50000 Hz

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

Vertical Scale (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this softkey displays the Vertical Scale input dialog where you can select the vertical scale.

Discrete Values	50, 100, 200, 500 mV and 1, 2, 5, 10, 15, 20, 25 V
Default	1 V
Saved State	Saved with instrument state

Marker Mode (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a horizontal soft key menu where you can select the select the Marker type and operating state.

Discrete Values	Off, Delta V, Delta T, 1/Delta T
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. 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/Delta T – The numeric reading shows the inverse of the time difference between markers, which can be used to determine the frequency of a repetitive waveform. Depending on the installed options, up to four markers can be enabled and selected for positioning while in Instrument Mode.

Toggle Marker (Oscilloscope submenu)

When the display is set to Oscilloscope, pressing this soft key switches between Marker 1 and 2.

Trigger Mode (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a horizontal soft key menu where you can select the Oscilloscope Trigger Mode.

Discrete	Auto, Normal, Single

Values	
Default	Auto
Saved State	Saved with instrument state
Notes	Auto – If a signal satisfying the Trigger Edge and Trigger Level settings is present, the display will sweep as in Normal Mode. If no signal satisfying the Trigger Edge and Trigger Level settings is present, then the display sweeps continuously until a signal satisfying the settings is acquired. Normal – The display sweeps only when the input signal satisfies the Trigger Edge and Trigger Level settings. Single – The display sweeps once after a key press is performed on the Single soft key if the signal satisfies the Trigger Edge and Trigger level settings.

Trigger Level (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a Trigger Level dialog where you can enter the trigger threshold level.

Range	–100 to 100
Default	0
Saved State	Saved with instrument state

Trigger Position (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a Trigger Level dialog where you can enter the trigger threshold level.

Discrete Values	10%, 50%, 90%
Default	50%
Saved State	Saved with instrument state

Trigger Edge (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a horizontal soft key menu where you can select the Oscilloscope trigger type.

Discrete Values	Rising, Falling, Either
Default	Rising
Saved State	Saved with instrument state

Vertical Position (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a horizontal soft key menu where you can adjust the Oscilloscope up or down.

Discrete Values	Move Down, Move Up
Default	Move Down
Saved State	Saved with instrument state

Set DC Offset (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key zeroes out the Oscilloscope to account for a DC offset.

Notes	With the Meter In port disconnected, press the soft key to eliminate the offset. The compensation is stored permanently in the analyzer until the next time this soft key is pressed.

Deviation Average (Bar Graphs submenu)

When display is set to Bar Graphs, pressing this soft key activates a horizontal soft key menu where select Deviation Average settings to process the response settings.

Discrete Values	Normal, Peak Average, Pwr-Weight Average, RMS Average, +/-Peak/2
Default	Normal
Saved State	Saved with instrument state
Notes	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. Pwr-Weight Average – The deviation measurement is processed with an RMS converter, but the display calibration remains in peak units (i.e., a deviation of 3 kHz pk will read 3 kHz on the numeric readout and bar graph). This type of processing significantly reduces the effect of narrow deviation spikes and noise while providing a speed of response similar to the normal mode. Scale calibration and the peak readings are only valid for single tone repetitive sine wave modulation. For the RMS value of any modulation waveform, divide the displayed peak reading by 1.414.

	RMS Average – The deviation measurement is the square root of the mean of the squares of the deviation values. This type of processing significantly reduces the effect of narrow deviation spikes and noise while providing a speed of response similar to the normal mode. Scale calibration and the RMS readings are valid for any wave modulation (e.g., sawtooth).

METER Zone Soft Keys for Monitor Mode

In Monitor Mode, the METER Zone displays the controls for configuring supplementary metering devices. Use these soft keys to apply general purpose and specialized instruments providing detailed analysis of the recovered baseband content from RF signals.

Select Meter (METER Zone menu)

Activates a horizontal soft key menu where you can select the metering device.

Discrete Values	Power Meter, Voltmeter, SINAD/Distortion, Decoder, Frequency Counter, RF Scan, SNRMeter
Default	Power Meter
Saved State	Saved with instrument state
Notes	RF Scan is not available in Generate Mode.

Power Meter (METER Zone menu)

Opens the Power Meter display and submenu.

Range (Power Meter submenu)

When the meter is set to Power Meter, pressing this soft key activates a horizontal soft key menu where you can select the power meter range.

Discrete Values	5, 10, 50, 150 W
Default	50 W
Saved State	Saved with instrument state
Notes	For best accuracy, disable the Pre-amplifier in Monitor Mode and set the Gen Port in Generate Mode to RF In/Out.

Voltmeter (METER Zone menu)

Opens the Voltmeter display and submenu.

Select Voltmeter Mode (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the voltage mode for the Voltmeter.

Discrete Values	AC Volts, DC Volts
Default	AC Volts
Saved State	Saved with instrument state
Notes	AC Volts measures AC voltage applied to the Meter In port. The dBm computation assumes an impedance of 600Ω.

Coupling (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a Coupling dialog menu where you can select the input voltage coupling.

Discrete Values	DC, AC
Default	DC
Saved State	Saved with instrument state

AC Range (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter AC voltage range.

Discrete Values	Auto, 1, 10, 70 V
Default	Auto
Saved State	Saved with instrument state
Notes	The range on AC and DC must be 1 or 10 Volts to use 600 Ohm Input Impedance.

Set dBr Reference (Voltmeter submenu)

When the meter is set to Voltmeter and Voltmeter mode is set to AC, pressing this soft key sets a reference input voltage.

Notes	When selected, dBm measurements are frozen, and a dBr indicator appears. The dBr indicates the normalized measurement between the reference input voltage and the current input voltage.

Clear dBr Reference (Voltmeter submenu)

When the meter is set to Voltmeter and Voltmeter mode is set to AC, pressing this soft key clears the dBr reference input voltage.

Voltage Units (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter range.

Discrete Values	Volts (V), Millivolts (mV), Decibel Volts (dBV)
Default	Volts (V)
Saved State	Saved with instrument state

DC Range (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter DC voltage range.

Discrete Values	Auto, 1, 10, 70 V
Default	Auto
Saved State	Saved with instrument state
Notes	The range on AC and DC must be 1 or 10 Volts to use 600 Ohm Input Impedance.

SINAD/Distortion (METER Zone menu)

Opens the SINAD/Distortion display and submenu.

Select Audio Measurement (SINAD/Distortion submenu)

When the meter is set to SINAD/Ext Distortion, pressing this soft key activates a horizontal soft key menu where you can select the distortion source.

Discrete Values	SINAD/Ext Distortion, Internal Distortion
Default	SINAD/Ext Distortion
Saved State	Saved with instrument state

Decoder (METER Zone menu)

Opens the Decoder display and submenu.

Select Decoder Type (Decoder submenu)

When the meter is set to Decoder, pressing this soft key activates a horizontal soft key menu where you can select the decoder type.

Discrete Values	PL/Period Counter, DPL Decode, DTMF Decode, 2-Tone Decode, 5/6 Tone Decode, General Sequence
Default	PL/Period Counter
Saved State	Saved with instrument state

Reset (Decoder submenu)

When the meter is set to Decoder and Decoder Type is set to DTMF Decode, pressing this soft key resets the decoder.

Decode (Decoder submenu)

When the meter is set to Decoder, pressing this soft key activates a horizontal soft key menu where you can select start and stop the decoding.

Discrete Values	Stop, Start
Default	Stop
Saved State	Saved with instrument state
Notes	This function is available one for the 2-Tone Decode, 5/6 Tone Decode, General Sequence decoder types.

Decode to Standard (Decoder submenu)

When the meter is set to Decoder, pressing this soft key activates a horizontal soft key menu where you can select the decoding standard to be used.

Discrete Values	None, CCIR1, CCIR2, PCCIR, CCITT, EEA, EIA, Euro, NATEL, MODAT, ZVEI1, ZVEI2, ZVEI3, PZVEI, DZVEI, PDZVEI
Default	None
Saved State	Saved with instrument state
Notes	This function is available one for the General Sequence decoder type.

Low Pass Filter (Decoder submenu)

When the meter is set to Decoder, pressing this soft key activates a horizontal soft key menu where you can select the high pass frequency.

Discrete Values	300 Hz, 3 kHz, 20 kHz
Default	300 Hz
Saved State	Saved with instrument state

High Pass Filter (Decoder submenu)

When the meter is set to Decoder, pressing this soft key activates a horizontal soft key menu where you can select the high pass frequency.

Discrete Values	1 Hz, 300 Hz, 3 kHz
Default	1 Hz
Saved State	Saved with instrument state

Input Decoding (Decoder submenu)

When the meter is set to Decoder, pressing this soft key displays a Input Decoding dialog menu where you can select which decoding source to use.

Discrete Values	Internal, External
Default	Internal
Saved State	Saved with instrument state

Frequency Counter (METER Zone menu)

Opens the Frequency Counter display and submenu.

Reset (Frequency Counter submenu)

When the meter is set to Frequency Counter, pressing this soft key resets the frequency counter.

Input Decoding (Frequency Counter submenu)

When the meter is set to Frequency Counter, pressing this soft key displays a Input Decoding dialog menu where you can select which decoding source to use.

Discrete Values	Internal, External
Default	Internal
Saved State	Saved with instrument state

Resolution (Frequency Counter submenu)

When the meter is set to Frequency Counter, pressing this soft key activates a horizontal soft key menu where you can select the frequency counter resolution.

Discrete Values	0.001 Hz, 0.01 Hz, 0.1 Hz, 1.0 Hz, 10 Hz
Default	1.0 Hz
Saved State	Saved with instrument state

RF Scan (METER Zone menu)

Opens the RF Scan display and submenu.

Start Frequency (RF Scan submenu)

When the meter is set to RF Scan, pressing this key displays the Start Frequency dialog where you can input the start frequency to be used in the RF scan.

Range	1 to 2991 MHz
Default	400 MHz
Saved State	Saved with instrument state

Stop Frequency (RF Scan submenu)

When the meter is set to RF Scan, pressing this key displays the Stop Frequency dialog where you can input the start frequency to be used in the RF scan.

Range	1 to 2991 MHz
Default	600 MHz
Saved State	Saved with instrument state

Scan (RF Scan submenu)

When the meter is set to RF Scan, pressing this soft key activates a horizontal soft key menu where you can select the scanning mode.

Discrete Values	Off, Single, Auto
Default	Off
Saved State	Saved with instrument state

SNR (METER Zone menu)

Opens the Signal-to-Noise Ratio display.

9 Generate Mode Soft Keys

The Generate Mode screen is divided into four functional Zones: RF, AUDIO, DISPLAY, and METER. This chapter contains detailed descriptions of the soft keys accessible in each Zone. Each soft key is defined, along with its range, discrete, default, and saved state values.

"RF Zone Soft Keys for Generate Mode" on the next page includes the RF parameters associated with configuring the transmitter.

"AUDIO Zone Soft Keys for Generate Mode" on page 393 includes the parameters associated with modulating the RF carrier.

"DISPLAY Zone Soft Keys for Generate Mode" on page 421 includes the parameters associated with configuring your desired display.

"METER Zone Soft Keys for Generate Mode" on page 430 includes the parameters associated with configuring general purpose and specialized instruments providing detailed analysis of the recovered baseband content from RF signals.

RF Zone Soft Keys for Generate Mode

In Generate Mode, the RF Zone contains the controls for the transmitter RF outputs. Use these soft keys to configure your transmitter including generate frequency, modulation type, output level and the output you wish to broadcast on (RF In/Out or RF Gen Out).

Generate Frequency

Displays the Generate Frequency dialog where you can enter the desired value to set the center frequency on the transmitter display.

Range	250 kHz to 3.0 GHz
Default	500 MHz
Saved State	Saved with instrument state

Copy Frequency to Monitor

Sets the analyzer Monitor to the same frequency as the Generator.

Modulation Type

Activates a horizontal soft key menu where you can select the transmitter modulation mode.

Discrete Values	FM, AM, USB, LSB
Default	FM
Saved State	Saved with instrument state
Notes	Output Level upper limits are reduced in AM to accommodate peak power levels.

Output Level

Displays the Output Level dialog, where you can enter the desired output power level.

Range	RF Gen Out port: –95 dBm to 5 dBm RF In/Out port: –130 dBm to –30 dBm
Default	–50 dBm
Saved State	Saved with instrument state
Notes	When Modulation Type is AM, the upper limits are –1 dBm and –36 dBm respectively.

Gen Port

Displays the Gen Port dialog where you can select the desired output port for the transmitter.

Discrete Values	RF In/Out, Gen Out
Default	RF In/Out
Saved State	Saved with instrument state
Notes	If RF Level Offset is enabled, the Gen Port label is cyan-colored, indicating that Output Level amplitudes are adjusted by the Gen Port-specific offset.

Output Units

Activates a horizontal soft key menu where you can select the units for the transmitter output source.

Discrete	Volts, Watts, dBm

Values	
Default	dBm
Saved State	Saved with instrument state
Notes	The level is displayed in the Output Level field in the RF Zone display window.

AUDIO Zone Soft Keys for Generate Mode

In Generate Mode, the AUDIO Zone displays the controls for modulating the RF carrier. Use these soft keys to configure the transmitted message.

Mod Port Mode

Displays the Mod Port Mode dialog menu where you can set the directionality of the Mod Port.

Discrete Value	In, Out
Default	Out
Saved State	Saved with instrument state
Notes	Remove voltage sources before selecting Out. If input voltage is detected at the port, the Out selection is ignored, and an alert is displayed at the bottom of the display.

Fixed 1 kHz Level

Displays the Fixed 1 kHz Level dialog where you can enter the desired value for the tone generator amplitude.

Range	0 to 12.5 kHz
Default	0 kHz
Saved State	Saved with instrument state

Fixed 1 kHz Mode

Activates a horizontal soft key menu where you can select the tone generator operating state.

Discrete Value	Off, Continuous
Default	Off
Saved State	Saved with instrument state
Notes	When the tone is activated, the Fixed 1kHz field is highlighted in green.

Synth Level

Displays the Synth Level dialog where you can enter the amplitude for the synthesized audio generator.

Range	0 to 12.5 kHz
Default	0 V
Saved State	Saved with instrument state
Notes	This is an independent generator used for encoded audio such as PL, DPL, A/B Sequence, etc.

Format

Activates a horizontal soft key menu where you can select the encoding format for the synthesized audio generator.

NOTE

This section describes the Generate Mode AUDIO Zone soft keys in their factory default configuration order. Thus, the PL format soft key is listed below as the default encoding format for the synthesized audio generator in Generate Mode. Soft keys for the other synthesized audio generator formats such as DPL, DPL Invert, A/B Sequence, 5/6 Tone, POCSAG, and General Sequence, as well as their unique submenu soft keys, begin with **"DPL and DPL Invert Synthesizer Formats Soft Key" on page 405**.

Discrete Values	PL, DPL, DPL Invert, A/B Sequence, 5/6 Tone, POCSAG, General Sequence
Default	PL
Saved State	Saved with instrument state
Notes	Selecting a format instantiates the active encoding type for the audio synthesizer. This is an independent synthesizer for encoding audio stimulus such as PL, DPL, or A/B Sequence. This encoded signal is available at the Mod In/Out port.

Synth Mode

Activates a horizontal soft key menu where you can select the select the synthesized audio generator operating state.

Discrete Values	Off, Continuous
Default	Off
Saved State	Saved with instrument state

PL Code

When the audio synthesizer format is set to PL, pressing this soft key displays the PL Code dialog where you can enter codes for the Motorola Private-Line coded squelch signaling format. The following table lists valid codes and their frequencies.

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

PL Code Table

When the audio synthesizer format is set to PL, pressing this soft key displays the PL Code Table where you can enter codes for the Motorola Private-Line coded squelch signaling format. The following table lists valid codes and their frequencies.

Code	Frequency (Hz)	Code	Frequency (Hz)	Code	Frequency (Hz)	Code	Frequency (Hz)
XZ	67.0	ZB	97.0	4Z	136.5	7A	192.8

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

Tone A Level

Displays the Tone A Level dialog where you can enter the amplitude for the A Variable tone generator.

Range	0 to 12.5 kHz
Default	0 kHz
Saved State	Saved with instrument state
Notes	When modulation type is set to AM, Tone A Level utilizes units of %.

Tone A Frequency

Displays the Tone A Frequency dialog where you can enter the frequency for the A Variable tone generator.

Range	0 to 20000 Hz
Default	10 Hz
Saved State	Saved with instrument state

Tone A Mode

Displays a horizontal soft key menu where you can select the operating mode for the A Variable tone generator.

Discrete Values	Off, Continuous, Burst
Default	Off
Saved State	Saved with instrument state

Tone B Level

Displays the Tone B Level dialog where you can enter the amplitude for the B Variable tone generator.

Range	0 to 12.5 kHz
Default	0 kHz
Saved State	Saved with instrument state
Notes	When modulation type is set to AM, Tone B Level utilizes units of %.

Tone B Frequency

Displays the Tone B Frequency dialog where you can enter the frequency for the B Variable tone generator.

Range	0 to 20000 Hz
Default	2000 Hz
Saved State	Saved with instrument state

Tone B Mode

Displays a horizontal soft key menu where you can select the operating mode for the B Variable tone generator.

Discrete Values	Off, Continuous, Burst
Default	Off
Saved State	Saved with instrument state

Tone C Level

Displays the Tone B Level dialog where you can enter the amplitude for the C Variable tone generator.

Range	0 to 12.5 kHz
Default	0 kHz
Saved State	Saved with instrument state
Notes	When modulation type is set to AM, Tone C Level utilizes units of %.

Tone C Frequency

Displays the Tone B Frequency dialog where you can enter the frequency for the C Variable tone generator.

Range	0 to 100000 Hz
Default	30000 Hz
Saved State	Saved with instrument state

Tone C Mode

Displays a horizontal soft key menu where you can select the operating mode for the C Variable tone generator.

Discrete Values	Off, Continuous, Burst
Default	Off
Saved State	Saved with instrument state

DTMF Level

Activates the DTMF Level dialog where you can enter the amplitude for the Dual Tone Multi-Frequency tone generator.

Range	0 to 12.5 kHz
Default	0 kHz
Saved State	Saved with instrument state
Notes	When modulation type is set to AM, DTMF Level utilizes units of %.

DTMF Mode

Activates a horizontal soft key menu where you can select the operating mode for the Dual Tone Multi-Frequency tone generator.

Discrete Values	Off, Continuous, Burst

Default	Off
Saved State	Saved with instrument state

DTMF Code

Displays the DTMF Code dialog where you can enter a code sequence for the Dual Tone Multi-Frequency tone generator. Pressing this key also activates a horizontal soft key menu where you can insert a space in the code sequence or clear the present values from the cursor to the end.

Discrete Values	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, *, #, A , B, C, D
Default	01234567890*#ABCD
Saved State	Saved with instrument state
Notes	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

Displays soft keys and the DTMF Table that provides more control when generating a DTMF Code sequence.

Tone Duration

Displays the Tone Duration dialog where you can enter the code sequence duration for the Dual Tone Multi-Frequency tone generator.

Range	40 to 9999 ms
Default	100 ms
Saved State	Saved with instrument state

Inter-Digit Delay

Displays the Inter-Digit Delay dialog where you can enter the delay between individual digits broadcast by the code sequence for the Dual Tone Multi-Frequency tone generator.

Range	20 to 9999 ms
Default	70 ms
Saved State	Saved with instrument state

Single Digit

Displays a horizontal soft key menu where you can choose a single digit to broadcast as the code sequence for the Dual Tone Multi-Frequency tone generator.

Discrete Values	*, #, A, B, C, D, 0 to 9
Default	*
Saved State	Saved with instrument state
Notes	Pressing the alphanumeric keypad allows direct numeric entry.

Microphone Level

Displays a Microphone Level dialog where you can enter the level in kHz.

Range	0 to 12.5 kHz

Default	0 kHz
Saved State	Saved with instrument state
Notes	When modulation type is set to AM, Microphone Level utilizes units of %.

Microphone Mode

Displays a horizontal soft key menu where you can enable or disable modulation from an external microphone attached to the Mic In port of the analyzer.

Discrete Values	Off, Continuous
Default	Off
Saved State	Saved with instrument state
Notes	Pressing the PTT button on the external microphone switches the analyzer into Generate Mode. Modulation from the microphone is applied to the carrier when the mode is set to Continuous.

Mod In Port Level

Displays the Mod In Port Level dialog where you can enter the level in kHz.

Range	0 to 12.5 kHz
Default	0 kHz
Saved State	Saved with instrument state
Notes	The audio signals must equal ± 1 V_{pk} to provide a reference for accurate display of the applied modulation level. When modulation type is set to AM, Mod In Port Level utilizes units of %.

Mod In Port Mode

Displays a horizontal soft key menu where you can select the Mod In Port operating state.

Discrete Values	Off, Continuous
Default	Off
Saved State	Saved with instrument state
Notes	Remove voltage sources before selecting Out. If input voltage is detected at the port, the Out selection is ignored, and an alert is displayed at the bottom of the display.

High Pass Filter

Displays a horizontal soft key menu where you can select an audio filter high pass frequency.

Discrete Values	1 Hz, 300 Hz, 3 kHz
Default	300 Hz
Saved State	Saved with instrument state
Notes	For best audio and measurement quality, always set an audio pass band no wider than necessary for the signal of interest. Example: A typical two-way radio pass band is 300 Hz to 3 kHz. Pass bands wider than necessary allow more noise in the measurement and degrade the audio quality and the readings for deviation, frequency error, SINAD, etc.

Low Pass Filter

Displays a horizontal soft key menu where you can select an audio filter low pass frequency.

Discrete Values	300 Hz, 3 kHz, 20 kHz
Default	300 Hz
Saved State	Saved with instrument state
Notes	For best audio and measurement quality, always set an audio pass band no wider than necessary for the signal of interest. Example: A typical two-way radio pass band is 300 Hz to 3 kHz. Pass bands wider than necessary allow more noise in the measurement and degrade the audio quality and the readings for deviation, frequency error, SINAD, etc.

DPL and DPL Invert Synthesizer Formats Soft Key

NOTE

The following sections describe the soft keys for the supplementary audio synthesizer formats: DPL, DPL Invert, A/B Sequence, 5/6 Tone, POCSAG, and General Sequence. For the default audio synthesizer format, see **"PL Code" on page 396**.

The following soft key is unique to the DPL and DPL Invert audio synthesizer format.

DPL Code

When the audio synthesizer format is set to DPL or DPL Invert, pressing this soft key displays the DPL Code dialog where you can enter codes for the Motorola Digital-Private-Line coded squelch signaling format.

Range	000 to 777
Default	000
Saved State	Saved with instrument state

A/B Sequence Synthesizer Format Soft Keys

The following soft keys are unique to the A/B Sequence audio synthesizer format.

A/B Sequence Code

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates a horizontal soft key menu where you can select one of four timing sequences for the two-tone sequential paging format.

Discrete Values	1, 2, 3, 4
Default	1
Saved State	Saved with instrument state
Notes	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.

A/B Sequence Table

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates soft keys and the A/B Sequence Table that provides more control when generating an A/B Code sequence.

Sequence

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates a horizontal soft key menu where you can select one of four timing sequences for the two-tone sequential paging format.

Discrete Values	1, 2, 3, 4
Default	1
Saved State	Saved with instrument state
Notes	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.

Sequence 3/4 Tone A Duration

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates a Tone A duration dialog.

Range	0 to 9.99 s
Default	0 s
Saved State	Saved with instrument state
Notes	This function only applies to sequence 3 and 4, with 3/4 being 3 or 4 depending on the selected channel.

Sequence 3/4 Tone A Delay

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates a Tone A delay dialog.

Range	0 to 9.99 s
Default	0 s
Saved State	Saved with instrument state
Notes	This function only applies to sequence 3 and 4, with 3/4 being 3 or 4 depending on the selected channel.

Sequence 3/4 Tone B Duration

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates the Tone B duration dialog.

Range	0 to 9.99 s

Default	0 s
Saved State	Saved with instrument state
Notes	This function only applies to sequence 3 and 4, with 3/4 being 3 or 4 depending on the selected channel.

Sequence 3/4 Tone B Delay

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates the Tone B delay dialog.

Range	0 to 9.99 s
Default	0 s
Saved State	Saved with instrument state
Notes	This function only applies to sequence 3 and 4, with 3/4 being 3 or 4 depending on the selected channel.

5/6 Tone Synthesizer Format Soft Keys

The following soft keys are unique to the 5/6 Tone audio synthesizer format.

5/6 Tone

When the audio synthesizer format is set to 5/6 Tone, pressing this soft key activates a horizontal submenu and 5/6 Tone dialog, where you can enter a 5/6 tone sequence.

Discrete Values	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, R, X

Default	R-12345X
Saved State	Saved with instrument state
Notes	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. After hearing the tone, the operator may assume that 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 that a different beep pattern is used in place of that used for the standard 5 tone response. Pressing the 6-Tone soft key adds the “X” tone to the transmission.

POCSAG Synthesizer Format Soft Keys

The following soft keys are unique to the POCSAG audio synthesizer format.

POCSAG Table

When the audio synthesizer format is set to POCSAG, pressing this soft key displays the POCSAG Table where you can enter codes for the Motorola Private-Line coded squelch signaling format.

Discrete Values	Tone Only, NumericNum, NumericSet, AlphaNumUC, AlphaNumLC, AlphaNumSP, NumericCust, AlphaNumCust
Default	Tone Only
Saved State	Saved with instrument state

Capcode

When the audio synthesizer format is set to POCSAG, pressing this key activates the Capcode input dialog.

Range	0 to 2097151
Default	0
Saved State	Saved with instrument state

Function Bits

When the audio synthesizer format is set to POCSAG, pressing this soft key activates a horizontal soft key menu where you can select the function bits.

Discrete Values	00, 01 ,10, 11
Default	00
Saved State	Saved with instrument state

POCSAG Message

When the audio synthesizer format is set to POCSAG, pressing this soft key activates a POCSAG Message dialog where you can choose the message content.

Discrete Values	Tone Only, NumericNum, NumericSet, AlphaNumUC, AlphaNumLC, AlphaNumSP, NumericCust, AlphaNumCust
Default	Tone Only
Saved State	Saved with instrument state
Notes	Highlighting the NumericCust or AlphaNumCust selections allows editing of the respective custom Numeric or Alpha-numeric strings. Up to 16 characters may be entered. Entered Numer-

	icCust and AlphaNumCust strings are truncated or expanded to match Message Length. See **"POCSAG Message Encoding Tables" below**. Tone Only: <empty string> NumericNum: 0123456789 NumericSet: The used characters in the Numeric set. AlphaNumUC: ABCDEFGHIJKLMNOPQRSTUVWXYZ AlphaNumLC: abcdefghijklmnopqrstuvwxyz AlphaNumSP: space!”#$%’()*+, -./:;<=>?@[\]^_`{|}~ NumericCust: Anything in the Numeric set. AlphaNumCust: Anything in the Alpha-numeric set.

POCSAG Message Encoding Tables

POCSAG Numeric Character Set	
Binary	**Character**
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	Spare (not available)
1011	U

POCSAG Numeric Character Set	
Binary	**Character**
1100	-
1110	[
1111	]

POCSAG Alphanumeric Character Set (7-bit ASCII)									
Decimal	Binary	Character	Decimal	Binary	Character		Decimal	Binary	Character
20	0100000	SPACE	52	1000000	@		84	1100000	`
21	0100001	!	53	1000001	A		85	1100001	a
22	0100010	“	54	1000010	B		86	1100010	b
23	0100011	#	55	1000011	C		87	1100011	c
24	0100100	$	56	1000100	D		88	1100100	d
25	0100101	%	57	1000101	E		89	1100101	e
26	0100110	&	58	1000110	F		90	1100110	f
27	0100111	‘	59	1000111	G		91	1100111	g
28	0101000	(	60	1001000	H		92	1101000	h
29	0101001	)	61	1001001	I		93	1101001	i
30	0101010	*	62	1001010	J		94	1101010	j
31	0101011	+	63	1001011	K		95	1101011	k
32	0101100	,	64	1001100	L		96	1101100	l
33	0101101	-	65	1001101	M		97	1101101	m
34	0101110	.	66	1001110	N		98	1101110	n
35	0101111	/	67	1001111	O		99	1101111	o
36	0110000	0	68	1010000	P		100	1110000	p
37	0110001	1	69	1010001	Q		101	1110001	q
38	0110010	2	70	1010010	R		102	1110010	r
39	0110011	3	71	1010011	S		103	1110011	s
40	0110100	4	72	1010100	T		104	1110100	t
41	0110101	5	73	1010101	U		105	1110101	u
42	0110110	6	74	1010110	V		106	1110110	v
43	0110111	7	75	1010111	W		107	1110111	w
44	0111000	8	76	1011000	X		108	1111000	x
45	0111001	9	77	1011001	Y		109	1111001	y
46	0111010	:	78	1011010	Z		110	1111010	z
47	0111011	;	79	1011011	[		111	1111011	{
48	0111100	<	80	1011100	\		112	1111100	|
49	0111101	=	81	1011101	]		113	1111101	}
50	0111110	>	82	1011110	^		114	1111110	~
51	0111111	?	83	1011111	_		115	1111111	N/A

Message Length

When the audio synthesizer format is set to POCSAG, pressing this key activates the Message Length input dialog where you can set the message length from 0 to 60 characters.

Range	0 to 60
Default	16
Saved State	Saved with instrument state

Data Rate

When the audio synthesizer format is set to POCSAG, pressing this key activates the Data Rate input dialog where you can set the communication data rate.

Range	400 to 4800 bps
Default	1200 bps
Saved State	Saved with instrument state

Polarity

When the audio synthesizer format is set to POCSAG, pressing this soft key activates a horizontal soft key menu where you can select the POCSAG datastream polarity.

Discrete Values	Normal, Inverted
Default	Normal

Saved State	Saved with instrument state
Notes	When set to Normal, a logic high (1) results in a more positive frequency deviation in FM mode. A logic low (0) results in a more negative frequency deviation in FM mode. When set to Inverted, a logic high (1) results in more negative frequency deviation in FM mode. A logic low (0) results in a more positive frequency deviation in FM mode.

Error Bit

When the audio synthesizer format is set to POCSAG, pressing this key activates the Error Bit input dialog to set the error bit at the specified location in the POCSAG page bit stream.

Range	0 to 2200
Default	1200
Saved State	Saved with instrument state
Notes	The error bit allows targeted insertion of an error into the page to test a POCSAG decoder's error correction capability. The setting toggles the Error Bit in the POCSAG page bit stream, where the bit stream uses a 1-based index. If Error Bit is set to 0 (default), no bits are toggled. If Error Bit is set ≥ 1, then the bit stream (Error Bit) is toggled.

General Sequence Synthesizer Format Soft Keys

The following soft keys are unique to the General Sequence audio synthesizer format.

Code Sequence

When the audio synthesizer format is set to General Sequence, pressing this key activates the Code Sequence dialog and a horizontal menu for entering an audio tone sequence for encoding on either the RF carrier or Mod Out port. Pressing **Clear to End** in the horizontal menu clears the highlighted entry and all others to the right.

Discrete Values	0 , 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, G, H, I, J
Default	None
Saved State	Saved with instrument state
Notes	Each entry can be one of 20 Tone Codes (0 to 9 and A to J) with the frequency, duration, and post tone delay specified in the General Sequence Table.

General Sequence Table

When the audio synthesizer format is set to General Sequence, pressing this soft key displays the General Sequence Table where you can enter create custom codes for use in sequences.

Notes	The table is populated with 20 Tone Codes (0 to 9 and A to J) with preset data for frequency, duration, and post-tone delay. The selected Tone Standard determines the preset data for each tone code. Regardless of the standard selected, each Tone Code can be edited for the current operating session or saved as a customized Sequence.

Select Tone Standard

When the audio synthesizer format is set to General Sequence, pressing this key activates the Select Tone Standard dialog where you can select which standard is used for the preset Tone Code entries on the General Sequence table.

Discrete Values	None, CCIR1, CCIR2, PCCIR, CCITT, EEA, EIA, Euro, NATEL, MODAT, ZVEI1, ZVEI2, ZVEI3, DZVEI, PDZVEI
Default	None
Saved State	Saved with instrument state
Notes	Edited tables can be saved as a user-defined Sequence Definition. Reselecting and entering any Tone Standard restores the original table entries.

Synth Mode

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a horizontal soft key menu where you can select the synthesized audio generator operating state.

Discrete Values	Off, Continuous, Burst
Default	Off
Saved State	Saved with instrument state
Notes	The status of the Synth Mode is shown in the Mode field.

Tone Frequency

When the audio synthesizer format is set to General Sequence, use the arrow keys to highlight a Tone Code to edit with the blue selection arrow, then press this soft key to activate a data entry window for customizing the Tone Frequency of the highlighted Tone Code.

Range	0 to 20000 Hz
Default	0 Hz
Saved State	Saved with instrument state

Tone Duration

When the audio synthesizer format is set to General Sequence, use the arrow keys to highlight a Tone Code to edit with the blue selection arrow, then press this soft key to activate a Tone duration dialog where you can enter a duration for a highlighted code duration.

Range	0 to 10 s
Default	0 s
Saved State	Saved with instrument state

Post-Tone Delay

When the audio synthesizer format is set to General Sequence, use the arrow keys to highlight a Tone Code to edit with the blue selection arrow, then press this soft key to activate a Post-Tone Delay dialog, where you can enter a duration of the delay following the transmitted tone.

Range	0 to 10 s
Default	0 s
Saved State	Saved with instrument state

Save Sequence Definition

When the audio synthesizer format is set to General Sequence, pressing this soft key activates the Save Sequence Definition dialog, where you can enter an alphanumeric filename for saving the sequence definition.

Range	A to Z and 0 to 9
Default	MY
Saved State	Saved with instrument state

Load Sequence Definition

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a Load Sequence Definition dialog, where you can load a sequence definition.

Notes	Must have a saved sequence definition to activate this soft key.

Export Sequence Definition

When the audio synthesizer format is set to General Sequence, pressing this soft key activates an Export Sequence Definition dialog, where you can select a sequence definition to save on an external USB.

Notes	Must have a saved sequence definition to activate this soft key.

Delete Sequence Definition

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a Delete Sequence Definition dialog, where you can delete a sequence definition.

Notes	Must have a saved sequence definition to activate this soft key.

Sync to Code Entry

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a Sync to Code Entry dialog, where you can select the status of code synchronization.

Discrete	No, Yes

Values	
Default	Yes
Saved State	Saved with instrument state
Notes	Yes – Any Tone Code alphanumeric value entered into the Code Sequence field is initially populated into the associated position in the Duration and Delay Sequence fields. This matches the frequency, duration, and delay values for each tone in the Code Sequence to that shown on the Tone Code line entry in the table. If desired, these initially synchronized Duration and Delay sequence entries can be changed to other values from the table. No – The entries for the Duration and Delay Sequences are set independently of the Code Sequence, with duration and delay values from any Tone Code on the table.

Duration Sequence

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a Duration Sequence dialog, where you can enter a custom duration sequence as well as a horizontal soft key menu where you can clear the current Duration Sequence entry.

Discrete Values	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, G, H, I, J
Default	0123456789ABCDEFGHIJ
Saved State	Saved with instrument state
Notes	Clear to End – clears the highlighted entry and all others to the right. Each entry in the Duration Sequence is paired in positional order with the associated entry in the Code Sequence, which provides the tone frequency, and the Delay Sequence, which provides the post tone delay. A duration of zero is used for Code Sequence entries that do not have an associated Duration Sequence entry. Duration Sequence entries that do not have an associated Code Sequence entry are ignored

Delay Sequence

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a Delay Sequence dialog, where you can enter a custom duration sequence, as well as activates a horizontal soft key menu where you can clear the current Delay Sequence entry.

Discrete Values	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, G, H, I, J
Default	0123456789ABCDEFGHIJ
Saved State	Saved with instrument state
Notes	Clear to End – clears the highlighted entry and all others to the right. Each entry in the Delay Sequence is paired in positional order with the associated entry in the Code Sequence, which provides the tone frequency, and the Duration Sequence, which provides the tone duration. A delay of zero is used for Code Sequence entries that do not have an associated Delay Sequence entry. Delay Sequence entries that do not have an associated Code Sequence entry are ignored.

DISPLAY Zone Soft Keys for Generate Mode

In Generate Mode, the DISPLAY Zone represents the controls for the time-based graticule measurements. Use these soft keys to configure your desired display.

Select Display (DISPLAY Zone Menu)

Pressing this soft key activates a horizontal soft key menu where you can select the display mode.

Discrete Values	Spec An, Mod Scope, Oscilloscope, Bar Graphs

Default	Spec An (disabled)
Saved State	Saved with instrument state
Notes	Frequency based analysis (spectrum analysis/bar graphs) is disabled during Generate Mode.

Vertical Scale (Modulation Scope submenu)

When display is set to Mod Scope, pressing this soft key activates a horizontal soft key menu where you can select the vertical scale.

Discrete Values	100, 200, 500 Hz and 1, 2, 5, 10, 20, 50 kHz/Div
Default	1 kHz/Div
Saved State	Saved with instrument state

Horizontal Scale (Modulation Scope submenu)

When display is set to Mod Scope, pressing this soft key displays the Horizontal Scale input dialog where you can select the horizontal scale.

Discrete Values	20, 50, 100, 200, 500 µs and 1, 2, 5, 10, 20, 50, 100, 200, 500 ms and 1 s
Default	20 ms
Saved State	Saved with instrument state

Marker Mode (Modulation Scope submenu)

When display is set to Mod Scope, pressing this soft key activates a horizontal soft key menu where you can select the Marker type and operating state.

Discrete Values	Off, Delta V, Delta T, 1/Delta T
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. 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. Depending on the installed options, up to four markers can be enabled and selected for positioning while in Instrument Mode.

Toggle Marker (Modulation Scope submenu)

When the display is set to Mod Scope, pressing this soft key cycles through the available markers to activate one for repositioning. Active markers are yellow.

Trigger Mode (Modulation Scope submenu)

When display is set to Mod Scope, pressing this soft key activates a horizontal soft key menu where you can select the Modulation Scope Trigger type.

Discrete Values	Auto, Normal, Single
Default	Auto
Saved State	Saved with instrument state
Notes	Auto – If a signal satisfying the Trigger Edge and Trigger Level settings is present, the display will sweep as in Normal Mode. If no signal satisfying the Trigger Edge and Trigger Level settings is present, then the display sweeps continuously until a signal satisfying the settings is acquired. Normal – The display sweeps only when the input signal satisfies the Trigger Edge and Trigger Level settings. Single – The display sweeps once after a key press is performed on the Single soft key if the signal satisfies the Trigger Edge and Trigger level settings.

Trigger Level (Modulation Scope submenu)

When display is set to Mod Scope, pressing this soft key activates the Trigger Level dialog where you can enter the trigger threshold level in kHz.

Range	–200 to 200 kHz
Default	0 kHz
Saved State	Saved with instrument state

Trigger Edge (Modulation Scope submenu)

When display is set to Mod Scope, pressing this soft key activates a horizontal soft key menu where you can select the Modulation Scope trigger type.

Discrete Values	Rising, Falling, Either
Default	Rising
Saved State	Saved with instrument state

Vertical Position (Modulation Scope submenu)

When display is set to Mod Scope, activates a horizontal soft key menu where you can adjust the Modulation Scope vertical position up or down.

Discrete Values	Move Down, Move Up
Saved State	Saved with instrument state

Coupling (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a Coupling dialog menu where you can select the input voltage coupling.

Discrete Values	DC, AC
Default	DC
Saved State	Saved with instrument state

Horizontal Scale (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this softkey displays the Horizontal Scale input dialog where you can select the horizontal scale.

Discrete Values	20, 50, 100, 200, 500 µs and 1, 2, 5, 10, 20, 50, 100, 200, 500 ms and 1 s
Default	1 ms
Saved State	Saved with instrument state
Notes	Digital Oscilloscopes are susceptible to aliasing, which can cause inaccurate signal reconstruction. The Maximum recommended input frequency for each horizontal scale setting is shown in the display area. For best results, follow the guidelines shown in the table below.

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

Vertical Scale (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this softkey displays the Vertical Scale input dialog where you can select the vertical scale.

Discrete Values	50, 100, 200, 500 mV and 1, 2, 5, 10, 15, 20, 25 V
Default	1 V
Saved State	Saved with instrument state

Marker Mode (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a horizontal soft key menu where you can select the select the Marker type and operating state.

Discrete Values	Off, Delta V, Delta T, 1/Delta T
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. 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/Delta T – The numeric reading shows the inverse of the time difference between markers, which can be used to determine the frequency of a repetitive waveform. Depending on the installed options, up to four markers can be enabled and selected for positioning while in Instrument Mode.

Toggle Marker (Oscilloscope submenu)

When the display is set to Oscilloscope, pressing this soft key switches between Marker 1 and 2.

Trigger Mode (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a horizontal soft key menu where you can select the Oscilloscope Trigger Mode.

Discrete Values	Auto, Normal, Single
Default	Auto
Saved State	Saved with instrument state
Notes	Auto – If a signal satisfying the Trigger Edge and Trigger Level settings is present, the display will sweep as in Normal Mode. If no signal satisfying the Trigger Edge and Trigger Level settings is present, then the display sweeps continuously until a signal satisfying the settings is acquired. Normal – The display sweeps only when the input signal satisfies the Trigger Edge and Trigger Level settings. Single – The display sweeps once after a key press is performed on the Single soft key if the signal satisfies the Trigger Edge and Trigger level settings.

Trigger Level (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a Trigger Level dialog where you can enter the sweep trigger threshold level.

Range	–100 to 100
Default	0
Saved State	Saved with instrument state

Trigger Position (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a Trigger Position dialog where you can select the amount of pre-threshold waveform displayed on the screen allocated to the waveform preceding the trigger threshold.

Discrete Values	10%, 50%, 90%
Default	50%
Saved State	Saved with instrument state

Trigger Edge (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a horizontal soft key menu where you can select the Oscilloscope trigger type.

Discrete Values	Rising, Falling, Either
Default	Rising
Saved State	Saved with instrument state

Vertical Position (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a horizontal soft key menu where you can adjust the Oscilloscope up or down.

Discrete	Move Down, Move Up

Values	
Default	Move Down
Saved State	Saved with instrument state

Set DC Offset (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key zeroes out the Oscilloscope to account for a DC offset.

Notes	With the Meter In port disconnected, press the soft key to eliminate the offset. The compensation is stored permanently in the analyzer until the next time this soft key is pressed.

METER Zone Soft Keys for Generate Mode

In Generate Mode, the METER Zone displays the controls for configuring supplementary metering devices. Use these soft keys to apply general purpose and specialized instruments providing detailed analysis of the recovered baseband content from RF signals.

Select Meter (METER Zone menu)

Activates a horizontal soft key menu where you can select the metering device.

Discrete Values	Power Meter, Voltmeter, SINAD/Distortion, Decoder, Frequency Counter, RF Scan, SNRMeter
Default	Power Meter
Saved State	Saved with instrument state
Notes	RF Scan is not available in Generate Mode.

Power Meter (METER Zone menu)

Opens the Power Meter display and submenu.

Range (Power Meter submenu)

When the meter is set to Power Meter, pressing this soft key activates a horizontal soft key menu where you can select the power meter range.

Discrete Values	5, 10, 50, 150 W
Default	50 W
Saved State	Saved with instrument state
Notes	For best accuracy, disable the Pre-amplifier in Monitor Mode and set the Gen Port in Generate Mode to RF In/Out.

Voltmeter (METER Zone menu)

Opens the Voltmeter display and submenu.

Select Voltmeter Mode (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the voltage mode for the Voltmeter.

Discrete Values	AC Volts, DC Volts
Default	AC Volts
Saved State	Saved with instrument state
Notes	AC Volts measures AC voltage applied to the Meter In port. The dBm computation assumes an impedance of 600Ω.

Coupling (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a Coupling dialog menu where you can select the input voltage coupling.

Discrete Values	DC, AC
Default	DC
Saved State	Saved with instrument state

AC Range (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter AC voltage range.

Discrete Values	Auto, 1 V, 10 V, 70 V
Default	Auto
Saved State	Saved with instrument state
Notes	The range on AC and DC must be 1 or 10 Volts to use 600 Ohm Input Impedance.

Set dBr Reference (Voltmeter submenu)

When the meter is set to Voltmeter and Voltmeter mode is set to AC, pressing this soft key sets a reference input voltage.

Notes	When selected, dBm measurements are frozen, and a dBr indicator appears. The dBr indicates the normalized measurement between the reference input voltage and the current input voltage.

Clear dBr Reference (Voltmeter submenu)

When the meter is set to Voltmeter and Voltmeter mode is set to AC, pressing this soft key clears the dBr reference input voltage.

Voltage Units (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter range.

Discrete Values	Volts (V), Millivolts (mV), Decibel Volts (dBV)
Default	Volts (V)
Saved State	Saved with instrument state

DC Range (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter DC voltage range.

Discrete Values	Auto, 1 V, 10 V, 70 V
Default	Auto
Saved State	Saved with instrument state
Notes	The range on AC and DC must be 1 or 10 Volts to use 600 Ohm Input Impedance.

SINAD/Distortion (METER Zone menu)

Opens the SINAD/Distortion display and submenu.

Select Audio Measurement (SINAD/Distortion submenu)

When the meter is set to SINAD/Ext Distortion, pressing this soft key activates a horizontal soft key menu where you can select the distortion source.

Discrete Values	SINAD/Ext Distortion, Internal Distortion
Default	SINAD/Ext Distortion
Saved State	Saved with instrument state

Decoder (METER Zone menu)

Opens the Decoder display and submenu.

Select Decoder Type (Decoder submenu)

When the meter is set to Decoder, pressing this soft key activates a horizontal soft key menu where you can select the decoder type.

Discrete Values	PL/Period Counter, DPL Decode, DTMF Decode, 2-Tone Decode, 5/6 Tone Decode, General Sequence
Default	PL/Period Counter
Saved State	Saved with instrument state

Reset (Decoder submenu)

When the meter is set to Decoder and Decoder Type is set to DTMF Decode, pressing this soft key resets the decoder.

Decode (Decoder submenu)

When the meter is set to Decoder, pressing this soft key activates a horizontal soft key menu where you can select start and stop the decoding.

Discrete Values	Stop, Start
Default	Stop
Saved State	Saved with instrument state
Notes	This function is available one for the 2-Tone Decode, 5/6 Tone Decode, General Sequence decoder types.

Decode to Standard (Decoder submenu)

When the meter is set to Decoder, pressing this soft key activates a horizontal soft key menu where you can select the decoding standard to be used.

Discrete Values	None, CCIR1, CCIR2, PCCIR, CCITT, EEA, EIA, Euro, NATEL, MODAT, ZVEI1, ZVEI2, ZVEI3, PZVEI, DZVEI, PDZVEI
Default	None
Saved State	Saved with instrument state
Notes	This function is available one for the General Sequence decoder type.

Low Pass Filter (Decoder submenu)

When the meter is set to Decoder, pressing this soft key activates a horizontal soft key menu where you can select the high pass frequency.

Discrete Values	300 Hz, 3 kHz, 20 kHz
Default	300 Hz
Saved State	Saved with instrument state

High Pass Filter (Decoder submenu)

When the meter is set to Decoder, pressing this soft key activates a horizontal soft key menu where you can select the high pass frequency.

Discrete Values	1 Hz, 300 Hz, 3 kHz
Default	1 Hz
Saved State	Saved with instrument state

Input Decoding (Decoder submenu)

When the meter is set to Decoder, pressing this soft key displays a Input Decoding dialog menu where you can select which decoding source to use.

Discrete Values	Internal, External
Default	Internal
Saved State	Saved with instrument state

Frequency Counter (METER Zone menu)

Opens the Frequency Counter display and submenu.

Reset (Frequency Counter submenu)

When the meter is set to Frequency Counter, pressing this soft key resets the frequency counter.

Input Decoding (Frequency Counter submenu)

When the meter is set to Frequency Counter, pressing this soft key displays a Input Decoding dialog menu where you can select which decoding source to use.

Discrete Values	Internal, External
Default	Internal
Saved State	Saved with instrument state

Resolution (Frequency Counter submenu)

When the meter is set to Frequency Counter, pressing this soft key activates a horizontal soft key menu where you can select the frequency counter resolution.

Discrete Values	0.001 Hz, 0.01 Hz, 0.1 Hz, 1.0 Hz, 10 Hz
Default	1.0 Hz
Saved State	Saved with instrument state

RF Scan (METER Zone menu)

Opens the RF Scan display and submenu.

Start Frequency (RF Scan submenu)

When the meter is set to RF Scan, pressing this key displays the Start Frequency dialog where you can input the start frequency to be used in the RF scan.

Range	1 to 2991 MHz
Default	400 MHz
Saved State	Saved with instrument state

Stop Frequency (RF Scan submenu)

When the meter is set to RF Scan, pressing this key displays the Stop Frequency dialog where you can input the start frequency to be used in the RF scan.

Range	1 to 2991 MHz
Default	600 MHz
Saved State	Saved with instrument state

Scan (RF Scan submenu)

When the meter is set to RF Scan, pressing this soft key activates a horizontal soft key menu where you can select the scanning mode.

Discrete Values	Off, Single, Auto
Default	Off
Saved State	Saved with instrument state

SNR (METER Zone menu)

Opens the Signal-to-Noise Ratio display.

10 Duplex Mode Soft Keys

The Duplex Mode screen is divided into four functional Zones: RF, AUDIO, DISPLAY, and METER. This chapter contains detailed descriptions of the soft keys accessible in each Zone. Each soft key is defined, along with its range, discrete, default, and saved state values.

"RF Zone Soft Keys for Duplex Mode" on the next page includes the RF parameters associated with configuring the transceiver.

"AUDIO Zone Soft Keys for Duplex Mode" on page 446 includes the parameters associated with RF carrier modulation.

"DISPLAY Zone Soft Keys for Duplex Mode" on page 474 includes the parameters associated with configuring your desired display.

"METER Zone Soft Keys for Duplex Mode" on page 492 includes the parameters associated with configuring general purpose and specialized instruments providing detailed analysis of the recovered baseband content from RF signals.

RF Zone Soft Keys for Duplex Mode

In Duplex Mode, the RF Zone contains the controls for the transceiver RF inputs and RF outputs. Use these soft keys to configure your transceiver including the frequency and power of your RF stimulus and measurement as well as which port you would like to transmit on (RF In/Out or RF Gen Port) or analyze (RF In/Out or Antenna).

Monitor Frequency

Displays the Monitor Frequency dialog where you can enter the desired value to set the center frequency on the transceiver display.

Range	250 kHz to 3.0 GHz
Default	500 MHz
Saved State	Saved with instrument state

Generate Frequency

Displays the Generate Frequency dialog where you can set the desired transmission frequency for the RF generator.

Range	250 kHz to 3.0 GHz
Default	500 MHz
Saved State	Saved with instrument state

Modulation Type

Activates a horizontal soft key menu where you can select the transceiver modulation and demodulation mode.

Discrete Values	FM, AM, USB, LSB
Default	FM
Saved State	Saved with instrument state
Notes	Output Level upper limits are reduced in AM to accommodate peak power levels.

Output Level

Displays the Output Level dialog, where you can enter the desired output power level.

Range	RF Gen Out port: –95 dBm to 5 dBm RF In/Out port: –130 dBm to –30 dBm
Default	–50 dBm
Saved State	Saved with instrument state
Notes	When Modulation Type is AM, the upper limits are –1 dBm and –36 dBm respectively.

Gen Port

Displays the Gen Port dialog where you can select the desired output port for the transceiver.

Discrete Values	RF In/Out, Gen Out
Default	RF In/Out
Saved State	Saved with instrument state
Notes	If RF Level Offset is enabled, the Gen Port label is cyan-colored, indicating that Output Level amplitudes are adjusted by the Gen Port-specific offset.

Bandwidth

Activates a horizontal soft key menu where you can select transceiver resolution (IF detection) bandwidth.

Discrete Values	6.25 kHz, 8.33 kHz, 10 kHz, 12.5 kHz, 25 kHz, 50 kHz, 100 kHz, 200 kHz
Default	25 kHz
Saved State	Saved with instrument state
Notes	For best measurement quality, always set an IF bandwidth no wider than necessary for the signal carrier of interest. Example: Typical channel spacing for modern narrowband two-way radio is 12.5 kHz. Monitor IF bandwidths that are wider than needed for the channel spacing, allow more noise in the measurement, and degrade the quality of readings for deviation, frequency error, SINAD, etc.

Attenuation

Displays the Attenuation dialog where you can select the desired input port attenuation for the transceiver.

Discrete Values	0 to 62 dB in 2 dB steps
Default	0 dB
Saved State	Saved with instrument state

Pre-Amplifier

Displays the Pre-Amplifier dialog where you can activate and deactivate the amplification.

Discrete Values	On, Off
Default	Off
Saved State	Saved with instrument state
Notes	**AMP** appears next to the Attenuation setting in the RF Zone whenever the Pre-Amplifier is active. By default, the pre-amplifier Auto-Off feature disables the pre-amplifier for best accuracy during broadband power (Watt Meter) measurements. When enabled, avoid input overload and erroneous signal strength readings by using the pre-amplifier only under the following conditions: **Monitor Port** — **Maximum input level for using pre-amplifier** Antenna — (Input signal in dBm – Attenuator setting) is equal or less than –40 dBm RF In/Out — (Input signal in dBm – Attenuator setting) is equal or less than –10 dBm

Mon Port

Displays the Mon Port dialog where you can select the desired input port for the transceiver.

Discrete Values	RF In/Out, Antenna
Default	RF In/Out
Saved State	Saved with instrument state
Notes	If RF Level Offset is enabled, the Mon Port label is cyan-colored, indicating that RX measurements are adjusted by the Mon Port-specific offset. CAUTION Do not apply input power to the Antenna input port.

Input Source

Activates a horizontal soft key menu where you can select transceiver input source.

Discrete Values	Auto, Input Level, Power Meter
Default	Auto
Saved State	Saved with instrument state
Notes	When the RF input power on the RF In/Out port is above +20 dBm (100 mW), the analyzer utilizes a broadband power detector for the measurement. The Input Level field in the RF Zone changes to Power Meter to indicate this measurement mode. This disables TDMA signals from auto-switching between input sources during unused slots.

Input Units

Activates a horizontal soft key menu where you can select the units for the transceiver input source.

Discrete Values	Volts, Watts, dBm
Default	dBm
Saved State	Saved with instrument state

Output Units

Activates a horizontal soft key menu where you can select the measurement units for the output level display.

Discrete	Volts, Watts, dBm

Values	
Default	dBm
Saved State	Saved with instrument state

AUDIO Zone Soft Keys for Duplex Mode

In Duplex Mode, the AUDIO Zone displays the controls for modulating/demodulating the RF carrier. Use these soft keys to recover the transmitted/received message.

Mod Port Mode

Displays a dialog menu where you can select a Mod Port Mode option.

Discrete Value	In, Out
Default	Out
Saved State	Saved with instrument state
Notes	Remove voltage sources before selecting Out. If input voltage is detected at the port, the Out selection is ignored, and an alert is displayed at the bottom of the display.

Fixed 1 kHz Level

Displays the Fixed 1 kHz Level dialog where you can enter the desired value for the tone generator amplitude.

Range	0 to 12.5 kHz
Default	0 kHz
Saved State	Saved with instrument state

Fixed 1 kHz Mode

Activates a horizontal soft key menu where you can select the tone generator operating state.

Discrete Value	Off, Continuous
Default	Off
Saved State	Saved with instrument state
Notes	When the tone is activated, the Fixed 1kHz field is highlighted in green.

Synth Level

Displays the Synth Level dialog where you can enter the amplitude for the synthesized audio generator.

Range	0 to 12.5 kHz
Default	0 V
Saved State	Saved with instrument state
Notes	This is an independent generator used for encoded audio such as PL, DPL, A/B Sequence, etc.

Format

NOTE

This section describes the Duplex Mode AUDIO Zone soft keys in their factory default configuration order. Thus, the PL format soft key is listed below as the default encoding format for the synthesized audio generator in Duplex Mode. Soft keys for the other synthesized audio generator formats such as DPL, DPL Invert, A/B Sequence, 5/6 Tone, POCSAG, and General Sequence, as well as their unique submenu soft keys, begin with **"DPL and DPL Invert Synthesizer Formats Soft Key" on page 458**.

Activates a horizontal soft key menu where you can select the encoding format for the synthesized audio generator.

Discrete Values	PL, DPL, DPL Invert, A/B Sequence, 5/6 Tone, POCSAG, General Sequence
Default	PL
Saved State	Saved with instrument state
Notes	Selecting a format instantiates the active encoding type for the audio synthesizer. This is an independent synthesizer for encoding audio stimulus such as PL, DPL, or A/B Sequence. This encoded signal is available at the Mod In/Out port.

Synth Mode

Activates a horizontal soft key menu where you can select the select the synthesized audio generator operating state.

Discrete Values	Off, Continuous
Default	Off
Saved State	Saved with instrument state

PL Code

When the audio synthesizer format is set to PL, pressing this soft key displays the PL Code dialog where you can enter codes for the Motorola Private-Line coded squelch signaling format. The following table lists valid codes and their frequencies.

Code	Frequency (Hz)	Code	Frequency (Hz)	Code	Frequency (Hz)	Code	Frequency (Hz)

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

PL Code Table

When the audio synthesizer format is set to PL, pressing this soft key displays the PL Code Table where you can enter codes for the Motorola Private-Line coded squelch signaling format. The following table lists valid codes and their frequencies.

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

Tone A Level

When the audio synthesizer format is set to PL, pressing this soft key displays the Tone A Level dialog where you can enter the amplitude for the A Variable tone generator.

Range	0 to 12.5 kHz
Default	0 kHz
Saved State	Saved with instrument state
Notes	When modulation type is set to AM, Tone A Level utilizes units of %.

Tone A Frequency

When the audio synthesizer format is set to PL, pressing this soft key displays the Tone A Frequency dialog where you can enter the frequency for the A Variable tone generator.

Range	0 to 20000 Hz
Default	10 Hz
Saved State	Saved with instrument state

Tone A Mode

When the audio synthesizer format is set to PL, pressing this soft key activates a horizontal soft key menu where you can select the operating mode for the A Variable tone generator.

Discrete Values	Off, Continuous, Burst

Default	Off
Saved State	Saved with instrument state

Tone B Level

When the audio synthesizer format is set to PL, pressing this soft key displays the Tone B Level dialog where you can enter the amplitude for the B Variable tone generator.

Range	0 to 12.5 kHz
Default	0 kHz
Saved State	Saved with instrument state
Notes	When modulation type is set to AM, Tone B Level utilizes units of %.

Tone B Frequency

When the audio synthesizer format is set to PL, pressing this soft key displays the Tone B Frequency dialog where you can enter the frequency for the B Variable tone generator.

Range	0 to 20000 Hz
Default	2000 Hz
Saved State	Saved with instrument state

Tone B Mode

When the audio synthesizer format is set to PL, pressing this soft key activates a horizontal soft key menu where you can select the operating mode for the B Variable tone generator.

Discrete Values	Off, Continuous, Burst
Default	Off
Saved State	Saved with instrument state

Tone C Level

When the audio synthesizer format is set to PL, pressing this soft key displays the Tone B Level dialog where you can enter the amplitude for the C Variable tone generator.

Range	0 to 12.5 kHz
Default	0 kHz
Saved State	Saved with instrument state
Notes	When modulation type is set to AM, Tone C Level utilizes units of %.

Tone C Frequency

When the audio synthesizer format is set to PL, pressing this soft key displays the Tone B Frequency dialog where you can enter the frequency for the C Variable tone generator.

Range	0 to 100000 Hz
Default	30000 Hz
Saved State	Saved with instrument state

Tone C Mode

When the audio synthesizer format is set to PL, pressing this soft key activates a horizontal soft key menu where you can select the operating mode for the C Variable tone generator.

Discrete Values	Off, Continuous, Burst
Default	Off
Saved State	Saved with instrument state

DTMF Level

When the audio synthesizer format is set to PL, pressing this soft key displays the DTMF Level dialog where you can enter the amplitude for the Dual Tone Multi-Frequency tone generator.

Range	0 to 12.5 kHz
Default	0 kHz
Saved State	Saved with instrument state
Notes	When modulation type is set to AM, DTMF Level utilizes units of %.

DTMF Mode

When the audio synthesizer format is set to PL, pressing this soft key activates a horizontal soft key menu where you can select the operating mode for the Dual Tone Multi-Frequency tone generator.

Discrete	Off, Continuous, Burst

Values	
Default	Off
Saved State	Saved with instrument state

DTMF Code

When the audio synthesizer format is set to PL, pressing this soft key opens the DTMF Code dialog where you can enter a code sequence for the Dual Tone Multi-Frequency tone generator. Pressing this key also activates a horizontal soft key menu where you can insert a space in the code sequence or clear the present values from the cursor to the end.

Discrete Values	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, *, #, A , B, C, D
Default	01234567890*#ABCD
Saved State	Saved with instrument state
Notes	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

When the audio synthesizer format is set to PL, pressing this soft key activates soft keys and the DTMF Table that provides more control when generating a DTMF Code sequence.

Tone Duration

When the audio synthesizer format is set to PL, pressing this soft key opens the Tone Duration dialog where you can enter the code sequence duration for the Dual Tone Multi-Frequency tone generator.

Range	40 to 9999 ms
Default	100 ms
Saved State	Saved with instrument state

Inter-Digit Delay

When the audio synthesizer format is set to PL, pressing this soft key opens the Inter-Digit Delay dialog where you can enter the delay between individual digits broadcast by the code sequence for the Dual Tone Multi-Frequency tone generator.

Range	20 to 9999 ms
Default	70 ms
Saved State	Saved with instrument state

Single Digit

When the audio synthesizer format is set to PL, pressing this soft key activates a horizontal soft key menu where you can choose a single digit to broadcast as the code sequence for the Dual Tone Multi-Frequency tone generator.

Discrete Values	*, #, A, B, C, D, 0 to 9
Default	*
Saved State	Saved with instrument state
Notes	Pressing the alphanumeric keypad allows direct numeric entry.

Microphone Level

When the audio synthesizer format is set to PL, pressing this soft key activates a Microphone level dialog where you can enter the level in kHz.

Range	0 to 12.5 kHz
Default	0 kHz
Saved State	Saved with instrument state
Notes	When modulation type is set to AM, Microphone Level utilizes units of %.

Microphone Mode

When the audio synthesizer format is set to PL, pressing this soft key activates a horizontal soft key menu where you can enable or disable modulation from an external microphone attached to the Mic In port of the analyzer.

Discrete Values	Off, Continuous
Default	Off
Saved State	Saved with instrument state
Notes	Pressing the PTT button on the external microphone switches the analyzer into Generate Mode. Modulation from the microphone is applied to the carrier when the mode is set to Continuous.

Mod In Port Level

When the audio synthesizer format is set to PL, pressing this soft key activates a dialog where you can enter the level in kHz.

Range	0 to 12.5 kHz
Default	0 kHz
Saved State	Saved with instrument state
Notes	The audio signals must equal ± 1 V_{pk} to provide a reference for accurate display of the applied modulation level. When modulation type is set to AM, Mod In Port Level utilizes units of %.

Mod In Port Mode

When the audio synthesizer format is set to PL, pressing this soft key activates a horizontal soft key menu where you can select the Mod In Port Mode.

Discrete Values	Off, Continuous
Default	Off
Saved State	Saved with instrument state
Notes	Remove voltage sources before selecting “Out.” If input voltage is detected at the port, the “Out” selection is ignored, and an alert is displayed at the bottom of the display.

High Pass Filter

When the audio synthesizer format is set to PL, pressing this soft key activates a horizontal soft key menu where you can select an audio filter high pass frequency.

Discrete Values	1 Hz, 300 Hz, 3 kHz

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

Low Pass Filter

When the audio synthesizer format is set to PL, pressing this soft key activates a horizontal soft key menu where you can select an audio filter low pass frequency.

Discrete Values	300 Hz, 3 kHz, 20 kHz
Default	300 Hz
Saved State	Saved with instrument state
Notes	For best audio and measurement quality, always set an audio pass band no wider than necessary for the signal of interest. Example: A typical two-way radio pass band is 300 Hz to 3 kHz. Pass bands wider than necessary allow more noise in the measurement and degrade the audio quality and the readings for deviation, frequency error, SINAD, etc.

DPL and DPL Invert Synthesizer Formats Soft Key

NOTE

The following sections describe the soft keys for the supplementary audio synthesizer formats: DPL, DPL Invert, A/B Sequence, 5/6 Tone, POCSAG, and General Sequence. For the default audio synthesizer format, see **"PL Code" on page 448**.

The following soft key is unique to the DPL and DPL Invert audio synthesizer formats.

DPL Code

When the audio synthesizer format is set to DPL, pressing this soft key displays the DPL Code dialog where you can enter codes for the Motorola Digital-Private-Line coded squelch signaling format.

Range	000 to 777
Default	000
Saved State	Saved with instrument state

A/B Sequence Synthesizer Format Soft Keys

The following soft keys are unique to the A/B Sequence audio synthesizer format.

A/B Sequence Code

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates a horizontal soft key menu where you can select one of four timing sequences for the two-tone sequential paging format.

Discrete Values	1, 2, 3, 4
Default	1
Saved State	Saved with instrument state
Notes	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.

A/B Sequence Table

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates soft keys and the A/B Sequence Table that provides more control when generating an A/B Code sequence.

Sequence

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates a horizontal soft key menu where you can select one of four timing sequences for the two-tone sequential paging format.

Discrete Values	1, 2, 3, 4
Default	1
Saved State	Saved with instrument state
Notes	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.

Sequence 3/4 Tone A Duration

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates a Tone A duration dialog.

Range	0 to 9.99 s
Default	0 s
Saved State	Saved with instrument state
Notes	This function only applies to sequence 3 and 4, with 3/4 being 3 or 4 depending on the selected channel.

Sequence 3/4 Tone A Delay

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates a Tone A delay dialog.

Range	0 to 9.99 s
Default	0 s
Saved State	Saved with instrument state
Notes	This function only applies to sequence 3 and 4, with 3/4 being 3 or 4 depending on the selected channel.

Sequence 3/4 Tone B Duration

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates the Tone B duration dialog.

Range	0 to 9.99 s
Default	0 s
Saved State	Saved with instrument state
Notes	This function only applies to sequence 3 and 4, with 3/4 being 3 or 4 depending on the selected channel.

Sequence 3/4 Tone B Delay

When the audio synthesizer format is set to A/B Sequence, pressing this soft key activates the Tone B delay dialog.

Range	0 to 9.99 s

Default	0 s
Saved State	Saved with instrument state
Notes	This function only applies to sequence 3 and 4, with 3/4 being 3 or 4 depending on the selected channel.

5/6 Tone Synthesizer Format Soft Keys

The following soft keys are unique to the 5/6 Tone audio synthesizer format.

5/6 Tone

When the audio synthesizer format is set to 5/6 Tone, pressing this soft key activates a horizontal submenu and 5/6 Tone dialog, where you can enter a 5/6 tone sequence.

Discrete Values	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, R, X
Default	R-12345X
Saved State	Saved with instrument state
Notes	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. After hearing the tone, the operator may assume that 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 that a different beep pattern is used in place of that used for the standard 5 tone response. Pressing the 6-Tone soft key adds the “X” tone to the transmission.

POCSAG Synthesizer Format Soft Keys

The following soft keys are unique to the POCSAG audio synthesizer format.

POCSAG Table

When the audio synthesizer format is set to POCSAG, pressing this soft key displays the POCSAG Table where you can enter codes for the Motorola Private-Line coded squelch signaling format.

Discrete Values	Tone Only, NumericNum, NumericSet, AlphaNumUC, AlphaNumLC, AlphaNumSP, NumericCust, AlphaNumCust
Default	Tone Only
Saved State	Saved with instrument state

Capcode

When the audio synthesizer format is set to POCSAG, pressing this key activates the Capcode input dialog.

Range	0 to 2097151
Default	0
Saved State	Saved with instrument state

Function Bits

When the audio synthesizer format is set to POCSAG, pressing this soft key activates a horizontal soft key menu where you can select the function bits.

Discrete Values	00, 01 ,10, 11
Default	00
Saved State	Saved with instrument state

POCSAG Message

When the audio synthesizer format is set to POCSAG, pressing this soft key activates a POCSAG Message dialog where you can choose the message content.

Discrete Values	Tone Only, NumericNum, NumericSet, AlphaNumUC, AlphaNumLC, AlphaNumSP, NumericCust, AlphaNumCust
Default	Tone Only
Saved State	Saved with instrument state
Notes	Highlighting the NumericCust or AlphaNumCust selections allows editing of the respective custom Numeric or Alpha-numeric strings. Up to 16 characters may be entered. Entered NumericCust and AlphaNumCust strings are truncated or expanded to match Message Length. Tone Only: <empty string> NumericNum: 0123456789 NumericSet: The used characters in the Numeric set. See table below. AlphaNumUC: ABCDEFGHIJKLMNOPQRSTUVWXYZ AlphaNumLC: abcdefghijklmnopqrstuvwxyz AlphaNumSP: space!”#$%’()*+, -./:;<=>?@[\]^_`{|}~ NumericCust: Anything in the Numeric set. See table below. AlphaNumCust: Anything in the Alpha-numeric set. See table below.

POCSAG Message Encoding Tables

POCSAG Numeric Character Set	
Binary	**Character**
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	Spare (not available)
1011	U
1100	-
1110	[
1111	]

POCSAG Alphanumeric Character Set (7-bit ASCII)								
Decimal	**Binary**	**Character**	**Decimal**	**Binary**	**Character**	**Decimal**	**Binary**	**Character**
20	0100000	SPACE	52	1000000	@	84	1100000	`
21	0100001	!	53	1000001	A	85	1100001	a
22	0100010	“	54	1000010	B	86	1100010	b
23	0100011	#	55	1000011	C	87	1100011	c
24	0100100	$	56	1000100	D	88	1100100	d
25	0100101	%	57	1000101	E	89	1100101	e
26	0100110	&	58	1000110	F	90	1100110	f
27	0100111	‘	59	1000111	G	91	1100111	g
28	0101000	(	60	1001000	H	92	1101000	h
29	0101001	)	61	1001001	I	93	1101001	i
30	0101010	*	62	1001010	J	94	1101010	j

POCSAG Alphanumeric Character Set (7-bit ASCII)								
Decimal	Binary	Character	Decimal	Binary	Character	Decimal	Binary	Character
31	0101011	+	63	1001011	K	95	1101011	k
32	0101100	,	64	1001100	L	96	1101100	l
33	0101101	-	65	1001101	M	97	1101101	m
34	0101110	.	66	1001110	N	98	1101110	n
35	0101111	/	67	1001111	O	99	1101111	o
36	0110000	0	68	1010000	P	100	1110000	p
37	0110001	1	69	1010001	Q	101	1110001	q
38	0110010	2	70	1010010	R	102	1110010	r
39	0110011	3	71	1010011	S	103	1110011	s
40	0110100	4	72	1010100	T	104	1110100	t
41	0110101	5	73	1010101	U	105	1110101	u
42	0110110	6	74	1010110	V	106	1110110	v
43	0110111	7	75	1010111	W	107	1110111	w
44	0111000	8	76	1011000	X	108	1111000	x
45	0111001	9	77	1011001	Y	109	1111001	y
46	0111010	:	78	1011010	Z	110	1111010	z
47	0111011	;	79	1011011	[	111	1111011	{
48	0111100	<	80	1011100	\	112	1111100	|
49	0111101	=	81	1011101	]	113	1111101	}
50	0111110	>	82	1011110	^	114	1111110	~
51	0111111	?	83	1011111	_	115	1111111	N/A

Message Length

When the audio synthesizer format is set to POCSAG, pressing this key activates the Message Length input dialog where you can set the message length from 0 to 60 characters.

Range	0 to 60
Default	16
Saved State	Saved with instrument state

Data Rate

When the audio synthesizer format is set to POCSAG, pressing this key activates the Data Rate input dialog where you can set the communication data rate.

Range	400 to 4800 bps
Default	1200 bps
Saved State	Saved with instrument state

Polarity

When the audio synthesizer format is set to POCSAG, pressing this soft key activates a horizontal soft key menu where you can select the POCSAG datastream polarity.

Discrete Values	Normal, Inverted
Default	Normal
Saved State	Saved with instrument state
Notes	When set to Normal, a logic high (1) results in a more positive frequency deviation in FM mode. A logic low (0) results in a more negative frequency deviation in FM mode. When set to Inverted, a logic high (1) results in more negative frequency deviation in FM mode. A logic low (0) results in a more positive frequency deviation in FM mode.

Error Bit

When the audio synthesizer format is set to POCSAG, pressing this key activates the Error Bit input dialog to set the error bit at the specified location in the POCSAG page bit stream.

Range	0 to 2200
Default	1200
Saved State	Saved with instrument state
Notes	The error bit allows targeted insertion of an error into the page to test a POCSAG decoder's error correction capability. The setting toggles the Error Bit in the POCSAG page bit stream, where the bit stream uses a 1-based index. If Error Bit is set to 0 (default), no bits are toggled. If Error Bit is set ≥ 1, then the bit stream (Error Bit) is toggled.

General Sequence Synthesizer Format Soft Keys

The following soft keys are unique to the General Sequence audio synthesizer format.

Code Sequence

When the audio synthesizer format is set to General Sequence, pressing this key activates the Code Sequence dialog and a horizontal menu for entering an audio tone sequence for encoding on either the RF carrier or Mod Out port. Pressing **Clear to End** in the horizontal menu clears the highlighted entry and all others to the right.

Discrete Values	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, G, H, I, J
Default	0123456789ABCDEFGHIJ
Saved State	Saved with instrument state
Notes	Each entry can be one of 20 Tone Codes (0 to 9 and A to J) with the frequency, duration, and post tone delay specified in the General Sequence Table.

General Sequence Table

When the audio synthesizer format is set to General Sequence, pressing this soft key displays the General Sequence Table where you can enter create custom codes for use in sequences.

Notes	The table is populated with 20 Tone Codes (0 to 9 and A to J) with preset data for frequency, duration, and post-tone delay. The selected Tone Standard determines the preset data for each tone code. Regardless of the standard selected, each Tone Code can be edited for the current operating session or saved as a customized sequence.

Select Tone Standard

When the audio synthesizer format is set to General Sequence, pressing this key activates the Select Tone Standard dialog where you can select which standard is used for the preset Tone Code entries on the General Sequence table.

Discrete Values	None, CCIR1, CCIR2, PCCIR, CCITT, EEA, EIA, Euro, NATEL, MODAT, ZVEI1, ZVEI2, ZVEI3, DZVEI, PDZVEI
Default	None
Saved State	Saved with instrument state
Notes	Edited tables can be saved as a user-defined Sequence Definition. Reselecting and entering any Tone Standard restores the original table entries.

Synth Mode

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a horizontal soft key menu where you can select the synthesized audio generator operating state.

Discrete Values	Off, Continuous, Burst
Default	Off
Saved State	Saved with instrument state
Notes	The status of the Synth Mode is shown in the Mode field.

Tone Frequency

When the audio synthesizer format is set to General Sequence, use the arrow keys to highlight a Tone Code to edit with the blue selection arrow, then press this soft key to activate a data entry window for customizing the Tone Frequency of the highlighted Tone Code.

Range	0 to 20000 Hz
Default	0 Hz
Saved State	Saved with instrument state

Tone Duration

When the audio synthesizer format is set to General Sequence, use the arrow keys to highlight a Tone Code to edit with the blue selection arrow, then press this soft key to activate a Tone duration dialog where you can enter a duration for a highlighted code duration.

Range	0 to 10 s
Default	0 s
Saved State	Saved with instrument state

Post-Tone Delay

When the audio synthesizer format is set to General Sequence, use the arrow keys to highlight a Tone Code to edit with the blue selection arrow, then press this soft key to activate a Post-Tone Delay dialog, where you can enter a duration of the delay following the transmitted tone.

Range	0 to 10 s
Default	0 s
Saved State	Saved with instrument state

Save Sequence Definition

When the audio synthesizer format is set to General Sequence, pressing this soft key activates the Save Sequence Definition dialog, where you can enter an alphanumeric filename for saving the sequence definition.

Range	A to Z and 0 to 9
Default	MY
Saved State	Saved with instrument state

Load Sequence Definition

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a Load Sequence Definition dialog, where you can load a sequence definition.

Notes	Must have a saved sequence definition to activate this soft key.

Export Sequence Definition

When the audio synthesizer format is set to General Sequence, pressing this soft key activates an Export Sequence Definition dialog, where you can select a sequence definition to save on an external USB.

Notes	Must have a saved sequence definition to activate this soft key.

Delete Sequence Definition

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a Delete Sequence Definition dialog, where you can delete a sequence definition.

Notes	Must have a saved sequence definition to activate this soft key.

Sync to Code Entry

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a Sync to Code Entry dialog, where you can select the status of code synchronization.

Discrete Values	No, Yes
Default	Yes
Saved State	Saved with instrument state
Notes	Yes – Any Tone Code alphanumeric value entered into the Code Sequence field is initially populated into the associated position in the Duration and Delay Sequence fields. This matches the frequency, duration, and delay values for each tone in the Code Sequence to that shown on the Tone Code line entry in the table. If desired, these initially synchronized Duration and Delay

	sequence entries can be changed to other values from the table. No – The entries for the Duration and Delay Sequences are set independently of the Code Sequence, with duration and delay values from any Tone Code on the table.

Duration Sequence

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a Duration Sequence dialog, where you can enter a custom duration sequence as well as a horizontal soft key menu where you can clear the current Duration Sequence entry.

Discrete Values	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, G, H, I, J
Default	0123456789ABCDEFGHIJ
Saved State	Saved with instrument state
Notes	Clear to End – clears the highlighted entry and all others to the right. Each entry in the Duration Sequence is paired in positional order with the associated entry in the Code Sequence, which provides the tone frequency, and the Delay Sequence, which provides the post tone delay. A duration of zero is used for Code Sequence entries that do not have an associated Duration Sequence entry. Duration Sequence entries that do not have an associated Code Sequence entry are ignored

Delay Sequence

When the audio synthesizer format is set to General Sequence, pressing this soft key activates a Delay Sequence dialog, where you can enter a custom duration sequence, as well as activates a horizontal soft key menu where you can clear the current Delay Sequence entry.

Discrete Values	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, G, H, I, J
Default	0123456789ABCDEFGHIJ
Saved State	Saved with instrument state
Notes	Clear to End – clears the highlighted entry and all others to the right. Each entry in the Delay Sequence is paired in positional order with the associated entry in the Code Sequence, which provides the tone frequency, and the Duration Sequence, which provides the tone duration. A delay of zero is used for Code Sequence entries that do not have an associated Delay Sequence entry. Delay Sequence entries that do not have an associated Code Sequence entry are ignored.

DISPLAY Zone Soft Keys for Duplex Mode

In Monitor Mode, the DISPLAY Zone represents the controls for the primary graticule measurement display or bar graphs. Use these soft keys to configure your desired display.

Select Display (DISPLAY Zone menu)

Pressing this soft key activates a horizontal soft key menu where you can select the display mode.

Discrete Values	Spec An, Mod Scope, Oscilloscope, Bar Graphs
Default	Spec An
Saved State	Saved with instrument state

Center Frequency (Spectrum Analyzer submenu)

When display is set to Spec An, pressing this soft key displays the Center Frequency dialog where you can enter the desired value to set the center frequency on the receiver display.

Range	250 kHz to 3.0 GHz
Default	500 MHz
Saved State	Saved with instrument state

Span (Spectrum Analyzer submenu)

When display is set to Spec An, pressing this soft key displays the Span dialog where you can input the desired frequency span for the receiver.

Range	10 kHz to 20 MHz
Default	10 MHz
Saved State	Saved with instrument state
Notes	Frequency span allows you to zoom in or out (change the span of the X-axis) on a signal of interest, while maintaining the relative power (Y-axis). To zoom in on a signal, decrease the frequency span while maintaining the signal at center frequency. To zoom out, increase the frequency span. The value entered for Span is automatically split between each side of the current center frequency. Receiver modulated audio is inhibited at spans above 158 kHz. Switch display to Mod Scope or use Demod at Marker function to hear audio at wider spans.

Start Frequency (Spectrum Analyzer submenu)

When display is set to Spec An, pressing this soft key displays the Start Frequency dialog where you can input the lowest frequency currently measured and shown on the receiver display.

Range	250 kHz to 1.5 GHz
Default	495 MHz
Saved State	Saved with instrument state
Notes	The analyzer automatically centers the frequency display midway between Start and Stop frequencies.
Couplings	When adjusting the start frequency the stop frequency is held constant, meaning that both the center frequency and span will change.

Stop Frequency (Spectrum Analyzer submenu)

When display is set to Spec An, pressing this soft key displays the Stop Frequency dialog where you can input the highest frequency currently measured and shown on the receiver display.

Range	260 kHz to 3 GHz
Default	1 MHz
Saved State	Saved with instrument state
Notes	The analyzer automatically centers the frequency display midway between Start and Stop frequencies.
Couplings	When adjusting the stop frequency the start frequency is held constant, meaning that both the center frequency and span will change.

Reference Level (Spectrum Analyzer submenu)

When display is set to Spec An, pressing this soft key displays the Reference Level dialog where you can input the value of the top graticule line.

Range	0 to 90 dBm
Default	0 dBm
Saved State	Saved with instrument state

Vertical Scale (Spectrum Analyzer submenu)

When the display is set to Spec An, pressing this soft key activates a horizontal soft key menu where you can select the Y-axis scale.

Discrete Values	10 dB/div, 5 dB/div, 2 dB/div, 1 dB/div
Default	10 dB/div
Saved State	Saved with instrument state

Display Mode (Spectrum Analyzer submenu)

When the display is set to Spec An, pressing this soft key activates a horizontal soft key menu where you can select the trace graphing mode.

Discrete Values	Normal, Freeze, Max Hold, Average

Default	Normal
Saved State	Saved with instrument state
Notes	Normal – The display updates continuously. Freeze – The display provides a snapshot of the current display indication and stops additional updates. In Freeze Mode, the R8200 reacquires data and updates the display whenever Center Marker or Center Peak is pressed. Max Hold – The display retains the highest peak signal amplitudes measured during successive sweeps. Average – The displayed signal amplitudes are a rolling average of the peak amplitudes measured on each successive sweep. The average consists of one to five sweeps, shown beside the mode indication.

Trace Math (Spectrum Analyzer submenu)

When the display is set to Spec An, pressing this soft key activates a horizontal soft key menu where you can select the trace math to be applied.

Discrete Values	None, Spec-Ref (log), |Spec-Ref| (lin), Spec+Ref (lin)
Default	None
Saved State	Saved with instrument state
Notes	The underlying units of the result are no longer dBm but dB for the displayed spectrum and thus marker power. None – This selection hides the reference trace and displays the spectrum resulting from the Display Mode unmodified.

	Spec-Ref (log) – This selection displays the difference of the Display Mode spectrum in dBm minus the reference trace in dBm, which normalizes the spectrum to 0 on the Y-axis. Subsequently, spectrum power is shown on the display and measured by absolute markers relative to the reference trace, i.e., correctly interpreted as dBm above the reference. |Spec-Ref| (lin) – This choice displays the logarithm of the absolute value of the difference of the Display Mode spectrum in volts^2 minus the reference trace in volts^2. Although the absolute value of the difference avoids logarithm of negatives, it has the side effect of increasing the apparent noise power. Spec+Ref (lin) – This choice displays the logarithm of the sum of the Display Mode spectrum in volts^2 plus the reference trace in volts^2.

Set Reference Trace (Spectrum Analyzer submenu)

When the display is set to Spec An, pressing this soft key saves the current trace as a separate blue reference trace.

Notes	The trace is copied from what is currently shown, which is after any Display Mode processing as well as Trace Math computations. Therefore, ensure that both of those settings are appropriately set (i.e., Trace Math is None); setting the reference when Trace Math is active may yield incoherent results. Setting Display Mode to Average minimizes effects of a low level / high variance signal such as the noise floor. This static trace is used for computations when a Trace Math equation is specified and may simply be viewed even when one is not. It can be hidden by selecting Trace Math None. System changes that may invalidate the reference trace include port, amplification, attenuation, frequency, span, temperature, and calibration.

Detector (Spectrum Analyzer submenu)

When the display is set to Spec An, pressing this soft key activates a horizontal soft key menu where you can select the Detector mode.

Discrete Values	Power, Peak, Sample, Mean, Valley
Default	Peak
Saved State	Saved with instrument state

3 dB Marker (Spectrum Analyzer submenu)

When the display is set to Spectrum Analyzer, pressing this soft key activates a horizontal soft key menu where you can select the 3 dB Marker mode.

Discrete Values	Off, Frequency, Delta
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. Frequency – This selection places a marker above and below center frequency where the signal is –3 dB below the peak amplitude measured at center frequency. The upper and lower frequencies are shown on the display. Delta – This selection places a marker above and below center frequency where the signal is –3 dB below the peak amplitude measured at center frequency. The difference between these two frequencies is shown on the display.

Marker Mode (Spectrum Analyzer submenu)

When the display is set to Spec An, pressing this soft key activates a horizontal soft key menu where you can select the Marker Mode.

Discrete Values	Off, Absolute, Delta
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. Absolute – This selection displays the frequency and absolute signal amplitude for each marker selected. Delta – This selection displays the frequency and amplitude difference between each pair of markers selected. Depending on the installed options, up to four markers can be enabled and selected for positioning while in Instrument Mode.

Toggle Marker (Spectrum Analyzer submenu)

When the display is set to Spec An, cycles through the available markers to select a marker for repositioning along the trace.

Center Marker (Spectrum Analyzer submenu)

When the display is set to Spec An, pressing this soft key moves the active marker to the middle of the spectrum.

Find Peak (Spectrum Analyzer submenu)

When the display is set to Spec An, pressing this soft key moves the active marker to highest trace peak.

Center Peak (Spectrum Analyzer submenu)

When the display is set to Spec An, pressing this soft key centers the display around the highest peak.

Demod at Marker (Spectrum Analyzer submenu)

When the display is set to Spec An and Marker Mode is set to absolute, pressing this soft key activates a horizontal soft key menu where you can select the demodulation mode at the active marker.

Discrete Values	Off, Single, Continuous
Default	Off
Saved State	Saved with instrument state
Notes	Off – Demod is deactivated. Single – This selection provides a one-time demodulation of the carrier signal located at the marker position for a quick listen at the marker frequency. Moving the marker or changing the monitor frequency, mode, or DISPLAY Zone selection switches the Demod At Marker function Off. Continuous – Continuous Mode allows users to move the selected marker to demodulate carriers across the entire displayed spectrum. On full-screen instruments, the user can setup several markers on various peaks and use the marker selection to quickly demodulate and listen to those peaks. Additionally, on the Dual Display, the user can simultaneously view the Modulation Scope while tuning the marker positions. To ensure audio is demodulated, the marker must be close enough to overlap the analyzer Monitor Bandwidth around the carrier frequency. Large Span settings increase marker frequency step size, limiting how close the marker can get to the actual frequency. To minimize step size, use the narrowest span practical when displaying multiple carriers.

Vertical Scale (Modulation Scope submenu)

When display is set to Mod Scope, pressing this soft key activates a horizontal soft key menu where you can select the vertical scale.

Discrete Values	100, 200, 500 Hz and 1, 2, 5, 10, 20, 50 kHz/Div
Default	1 kHz/Div
Saved State	Saved with instrument state

Horizontal Scale (Modulation Scope submenu)

When display is set to Mod Scope, pressing this softkey displays the Horizontal Scale input dialog where you can select the horizontal scale.

Discrete Values	20, 50, 100, 200, 500 µs and 1, 2, 5, 10, 20, 50, 100, 200, 500 ms and 1 s
Default	20 ms
Saved State	Saved with instrument state

Marker Mode (Modulation Scope submenu)

When display is set to Mod Scope, pressing this soft key activates a horizontal soft key menu where you can select the Marker Mode.

Discrete Values	Off, Delta V, Delta T, 1/Delta T
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers.

	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. Depending on the installed options, up to four markers can be enabled and selected for positioning while in Instrument Mode.

Toggle Marker (Modulation Scope submenu)

When the display is set to Mod Scope, pressing this soft key cycles through the available markers to activate one for repositioning (active markers are yellow).

Trigger Mode (Modulation Scope submenu)

When display is set to Mod Scope, pressing this soft key activates a horizontal soft key menu where you can select the Modulation Scope Trigger type.

Discrete Values	Auto, Normal, Single
Default	Auto
Saved State	Saved with instrument state
Notes	Auto – If a signal satisfying the Trigger Edge and Trigger Level settings is present, the display will sweep as in Normal Mode. If no signal satisfying the Trigger Edge and Trigger Level settings is present, then the display sweeps continuously until a signal satisfying the settings is acquired. Normal – The display sweeps only when the input signal satisfies the Trigger Edge and Trigger Level settings. Single – The display sweeps once after a key press is performed on the Single soft key if the signal satisfies the Trigger Edge and Trigger level settings.

Trigger Level (Modulation Scope submenu)

When display is set to Mod Scope, pressing this soft key activates a Trigger Level dialog where you can enter the trigger threshold level in kHz.

Range	–200 to 200 kHz
Default	0 kHz
Saved State	Saved with instrument state

Trigger Edge (Modulation Scope submenu)

When display is set to Mod Scope, pressing this soft key activates a horizontal soft key menu where you can select the Modulation Scope trigger type.

Discrete Values	Rising, Falling, Either
Default	Rising
Saved State	Saved with instrument state

Vertical Position (Modulation Scope submenu)

When display is set to Mod Scope, pressing this soft key activates a horizontal soft key menu where you can adjust the Modulation Scope vertical position up or down.

Discrete Values	Move Down, Move Up
Saved State	Saved with instrument state

Coupling (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a Coupling dialog menu where you can select the input voltage coupling.

Discrete Values	DC, AC
Default	DC
Saved State	Saved with instrument state

Horizontal Scale (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this softkey displays the Horizontal Scale input dialog where you can select the horizontal scale.

Discrete Values	20, 50, 100, 200, 500 µs and 1, 2, 5, 10, 20, 50, 100, 200, 500 ms and 1 s
Default	1 ms
Saved State	Saved with instrument state
Notes	Digital Oscilloscopes are susceptible to aliasing, which can cause inaccurate signal reconstruction. The Maximum recommended input frequency for each horizontal scale setting is shown in the display area. For best results, follow the guidelines shown in the table below.

Horizontal Scale	Max Signal Frequency	Max Recommended Signal Frequency
20 µs	50000 Hz	50000 Hz

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

Vertical Scale (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this softkey displays the Vertical Scale input dialog where you can select the vertical scale.

Discrete Values	50, 100, 200, 500 mV and 1, 2, 5, 10, 15, 20, 25 V
Default	1 V
Saved State	Saved with instrument state

Marker Mode (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a horizontal soft key menu where you can select the select the Marker Mode.

Discrete Values	Off, Delta V, Delta T, 1/Delta T
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. 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/Delta T – The numeric reading shows the inverse of the time difference between markers, which can be used to determine the frequency of a repetitive waveform. Depending on the installed options, up to four markers can be enabled and selected for positioning while in Instrument Mode.

Toggle Marker (Oscilloscope submenu)

When the display is set to Oscilloscope, pressing this soft key switches between Marker 1 and 2.

Trigger Mode (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a horizontal soft key menu where you can select the Oscilloscope Trigger Mode.

Discrete	Auto, Normal, Single

Values	
Default	Auto
Saved State	Saved with instrument state
Notes	Auto – If a signal satisfying the Trigger Edge and Trigger Level settings is present, the display will sweep as in Normal Mode. If no signal satisfying the Trigger Edge and Trigger Level settings is present, then the display sweeps continuously until a signal satisfying the settings is acquired. Normal – The display sweeps only when the input signal satisfies the Trigger Edge and Trigger Level settings. Single – The display sweeps once after a key press is performed on the Single soft key if the signal satisfies the Trigger Edge and Trigger level settings.

Trigger Level (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a Trigger Level dialog where you can enter the trigger threshold level.

Range	–100 to 100
Default	0
Saved State	Saved with instrument state

Trigger Position (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a Trigger Level dialog where you can enter the trigger threshold level.

Discrete Values	10%, 50%, 90%
Default	50%
Saved State	Saved with instrument state

Trigger Edge (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a horizontal soft key menu where you can select the Oscilloscope trigger type.

Discrete Values	Rising, Falling, Either
Default	Rising
Saved State	Saved with instrument state

Vertical Position (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key activates a horizontal soft key menu where you can adjust the Oscilloscope up or down.

Discrete Values	Move Down, Move Up
Default	Move Down
Saved State	Saved with instrument state

Set DC Offset (Oscilloscope submenu)

When display is set to Oscilloscope, pressing this soft key zeroes out the Oscilloscope to account for a DC offset.

Notes	With the Meter In port disconnected, press the soft key to eliminate the offset. The compensation is stored permanently in the analyzer until the next time this soft key is pressed.

Deviation Average (Bar Graphs submenu)

When display is set to Bar Graphs, pressing this soft key activates a horizontal soft key menu where select Deviation Average settings to process the response settings.

Discrete Values	Normal, Peak Average, Pwr-Weight Average, RMS Average, ±Peak/2
Default	Normal
Saved State	Saved with instrument state
Notes	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. Pwr-Weight Average – The deviation measurement is processed with an RMS converter, but the display calibration remains in peak units (i.e., a deviation of 3 kHz pk will read 3 kHz on the numeric readout and bar graph). This type of processing significantly reduces the effect of narrow deviation spikes and noise while providing a speed of response similar to the normal mode. Scale calibration and the peak readings are only valid for single tone repetitive sine wave modulation. For the RMS value of any modulation waveform, divide the displayed peak reading by 1.414.

	RMS Average – The deviation measurement is the square root of the mean of the squares of the deviation values. This type of processing significantly reduces the effect of narrow deviation spikes and noise while providing a speed of response similar to the normal mode. Scale calibration and the RMS readings are valid for any wave modulation (e.g., sawtooth).

METER Zone Soft Keys for Duplex Mode

In Duplex Mode, the METER Zone displays the controls for configuring supplementary metering devices. Use these soft keys to apply general purpose and specialized instruments providing detailed analysis of both the RF carrier and its recovered baseband content.

Select Meter (METER Zone menu)

Activates a horizontal soft key menu where you can select the metering device.

Discrete Values	Power Meter, Voltmeter, SINAD/Distortion, Decoder, Frequency Counter, RF Scan, SNRMeter
Default	Power Meter
Saved State	Saved with instrument state
Notes	RF Scan is not available in Generate Mode.

Power Meter (METER Zone menu)

Opens the Power Meter display and submenu.

Range (Power Meter submenu)

When the meter is set to Power Meter, pressing this soft key activates a horizontal soft key menu where you can select the power meter range.

Discrete Values	5, 10, 50, 150 W
Default	50 W
Saved State	Saved with instrument state
Notes	For best accuracy, disable the Pre-amplifier in Monitor Mode and set the Gen Port in Generate Mode to RF In/Out.

Voltmeter (METER Zone menu)

Opens the Voltmeter display and submenu.

Select Voltmeter Mode (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the voltage mode for the Voltmeter.

Discrete Values	AC Volts, DC Volts
Default	AC Volts
Saved State	Saved with instrument state
Notes	AC Volts measures AC voltage applied to the Meter In port. The dBm computation assumes an impedance of 600Ω.

Coupling (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a Coupling dialog menu where you can select the input voltage coupling.

Discrete Values	DC, AC
Default	DC
Saved State	Saved with instrument state

AC Range (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter AC voltage range.

Discrete Values	Auto, 1 V, 10 V, 70 V
Default	Auto
Saved State	Saved with instrument state
Notes	The range on AC and DC must be 1 or 10 Volts to use 600 Ohm Input Impedance.

Set dBr Reference (Voltmeter submenu)

When the meter is set to Voltmeter and Voltmeter mode is set to AC, pressing this soft key sets a reference input voltage.

Notes	When selected, dBm measurements are frozen, and a dBr indicator appears. The dBr indicates the normalized measurement between the reference input voltage and the current input voltage.

Clear dBr Reference (Voltmeter submenu)

When the meter is set to Voltmeter and Voltmeter mode is set to AC, pressing this soft key clears the dBr reference input voltage.

Voltage Units (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter range.

Discrete Values	Volts (V), Millivolts (mV), Decibel Volts (dBV)
Default	Volts (V)
Saved State	Saved with instrument state

DC Range (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter DC voltage range.

Discrete Values	Auto, 1 V, 10 V, 70 V
Default	Auto
Saved State	Saved with instrument state
Notes	The range on AC and DC must be 1 or 10 Volts to use 600 Ohm Input Impedance.

SINAD/Distortion (METER Zone menu)

Opens the SINAD/Distortion display and submenu.

Select Audio Measurement (SINAD/Distortion submenu)

When the meter is set to SINAD/Ext Distortion, pressing this soft key activates a horizontal soft key menu where you can select the distortion source.

Discrete Values	SINAD/Ext Distortion, Internal Distortion
Default	SINAD/Ext Distortion
Saved State	Saved with instrument state

Decoder (METER Zone menu)

Opens the Decoder display and submenu.

Select Decoder Type (Decoder submenu)

When the meter is set to Decoder, pressing this soft key activates a horizontal soft key menu where you can select the decoder type.

Discrete Values	PL/Period Counter, DPL Decode, DTMF Decode, 2-Tone Decode, 5/6 Tone Decode, General Sequence
Default	PL/Period Counter
Saved State	Saved with instrument state

Reset (Decoder submenu)

When the meter is set to Decoder and Decoder Type is set to DTMF Decode, pressing this soft key resets the decoder.

Decode (Decoder submenu)

When the meter is set to Decoder, pressing this soft key activates a horizontal soft key menu where you can select start and stop the decoding.

Discrete Values	Stop, Start
Default	Stop
Saved State	Saved with instrument state
Notes	This function is available one for the 2-Tone Decode, 5/6 Tone Decode, General Sequence decoder types.

Decode to Standard (Decoder submenu)

When the meter is set to Decoder, pressing this soft key activates a horizontal soft key menu where you can select the decoding standard to be used.

Discrete Values	None, CCIR1, CCIR2, PCCIR, CCITT, EEA, EIA, Euro, NATEL, MODAT, ZVEI1, ZVEI2, ZVEI3, PZVEI, DZVEI, PDZVEI
Default	None
Saved State	Saved with instrument state
Notes	This function is available one for the General Sequence decoder type.

Low Pass Filter (Decoder submenu)

When the meter is set to Decoder, pressing this soft key activates a horizontal soft key menu where you can select the high pass frequency.

Discrete Values	300 Hz, 3 kHz, 20 kHz
Default	300 Hz
Saved State	Saved with instrument state

High Pass Filter (Decoder submenu)

When the meter is set to Decoder, pressing this soft key activates a horizontal soft key menu where you can select the high pass frequency.

Discrete Values	1 Hz, 300 Hz, 3 kHz
Default	1 Hz
Saved State	Saved with instrument state

Input Decoding (Decoder submenu)

When the meter is set to Decoder, pressing this soft key displays a Input Decoding dialog menu where you can select which decoding source to use.

Discrete Values	Internal, External
Default	Internal
Saved State	Saved with instrument state

Frequency Counter (METER Zone menu)

Opens the Frequency Counter display and submenu.

Reset (Frequency Counter submenu)

When the meter is set to Frequency Counter, pressing this soft key resets the frequency counter.

Input Decoding (Frequency Counter submenu)

When the meter is set to Frequency Counter, pressing this soft key displays a Input Decoding dialog menu where you can select which decoding source to use.

Discrete Values	Internal, External
Default	Internal
Saved State	Saved with instrument state

Resolution (Frequency Counter submenu)

When the meter is set to Frequency Counter, pressing this soft key activates a horizontal soft key menu where you can select the frequency counter resolution.

Discrete Values	0.001 Hz, 0.01 Hz, 0.1 Hz, 1.0 Hz, 10 Hz
Default	1.0 Hz
Saved State	Saved with instrument state

RF Scan (METER Zone menu)

Opens the RF Scan display and submenu.

Start Frequency (RF Scan submenu)

When the meter is set to RF Scan, pressing this key displays the Start Frequency dialog where you can input the start frequency to be used in the RF scan.

Range	1 to 2991 MHz
Default	400 MHz
Saved State	Saved with instrument state

Stop Frequency (RF Scan submenu)

When the meter is set to RF Scan, pressing this key displays the Stop Frequency dialog where you can input the start frequency to be used in the RF scan.

Range	1 to 2991 MHz
Default	600 MHz
Saved State	Saved with instrument state

Scan (RF Scan submenu)

When the meter is set to RF Scan, pressing this soft key activates a horizontal soft key menu where you can select the scanning mode.

Discrete Values	Off, Single, Auto
Default	Off

Saved State	Saved with instrument state
Notes	Off – Deactivates scanning. Single – Sweep the span defined by the Start and Stop Frequency parameters once. Auto – Continuously sweeps the span defined by the Start and Stop Frequency parameters .

SNR (METER Zone menu)

Opens the Signal-to-Noise Ratio display.

11 Instrument Mode Soft Keys

The Instrument Mode menu enables access to standard and optional full-screen analyzers, scopes, and meters. This chapter contains detailed descriptions of the soft keys accessible in each instrument. Each soft key is defined, along with its range, discrete, default, and saved state values.

The sections are organized as the instruments appear in the display user interface:

"Spectrum Analyzer Soft Keys" on the next page describes the adjustable parameters for spectrum analysis.

"Modulation Scope Soft Keys" on page 512 describes the adjustable parameters for time-based modulation analysis.

"Oscilloscope Soft Keys" on page 516 describes the adjustable parameters for time-based analysis.

"Dual Display Soft Keys" on page 521 describes the adjustable parameters for spectrum and time-based modulation analysis.

"Tracking Generator Soft Keys" on page 534 describes the adjustable parameters for scalar network analysis.

"Cable Fault Locator Soft Keys" on page 569 describes the adjustable parameters for scalar network analysis of cables.

"Single-Port VNA Soft Keys" on page 544 describes the adjustable parameters for single-port vector network analysis.

"METER Zone Soft Keys for Monitor Mode" on page 380 describes the adjustable parameters for metering.

Spectrum Analyzer Soft Keys

In the Spectrum Analyzer Instrument Mode, the R8200 operates as a stand-alone full-screen instrument capable of signal analysis between 250 kHz to 3 GHz. Use the following soft keys to configure your measurement.

Center Frequency (Spectrum Analyzer submenu)

Enables the Center Frequency dialog where you can set the center frequency for the receiver display.

Range	250 kHz to 3.0 GHz
Default	500 MHz
Saved State	Saved with instrument state

Span (Spectrum Analyzer submenu)

Displays the Span dialog where you can input the desired frequency span for the receiver.

Range	10 kHz to 20 MHz
Default	10 MHz
Saved State	Saved with instrument state
Notes	Frequency span allows you to zoom in or out (change the span of the X-axis) on a signal of interest, while maintaining the relative power (Y-axis). To zoom in on a signal, decrease the frequency span while maintaining the signal at center frequency. To zoom out, increase the frequency span. The value entered for Span is automatically split between each side of the current center fre-

	quency. Receiver modulated audio is inhibited at spans above 158 kHz. Switch display to Mod Scope or use Demod at Marker function to hear audio at wider spans.

Start Frequency (Spectrum Analyzer submenu)

Displays the Start Frequency dialog where you can input the lowest frequency currently measured and shown on the receiver display.

Range	250 kHz to 1.5 GHz
Default	495 MHz
Saved State	Saved with instrument state
Notes	When adjusting the start frequency the stop frequency is held constant, meaning that both the center frequency and span will change. The analyzer automatically centers the frequency display midway between Start and Stop frequencies.

Stop Frequency (Spectrum Analyzer submenu)

Displays the Stop Frequency dialog where you can input the highest frequency currently measured and shown on the receiver display.

Range	260 kHz to 3 GHz
Default	1 MHz

Saved State	Saved with instrument state
Notes	When adjusting the stop frequency the start frequency is held constant, meaning that both the center frequency and span will change. The analyzer automatically centers the frequency display midway between Start and Stop frequencies.

Reference Level (Spectrum Analyzer submenu)

Displays the Reference Level dialog where you can input the value of the top graticule line.

Range	0 to 90 dBm
Default	0 dBm
Saved State	Saved with instrument state

Vertical Scale (Spectrum Analyzer submenu)

Activates a horizontal soft key menu where you can select the Y-axis scale.

Discrete Values	10 dB/div, 5 dB/div, 2 dB/div, 1 dB/div
Default	10 dB/div
Saved State	Saved with instrument state

Display Mode (Spectrum Analyzer submenu)

Activates a horizontal soft key menu where you can select the trace graphing mode.

Discrete Values	Normal, Freeze, Max Hold, Average
Default	Normal
Saved State	Saved with instrument state
Notes	Normal – The display updates continuously. Freeze – The display provides a snapshot of the current display indication and stops additional updates. In Freeze Mode, the R8200 reacquires data and updates the display whenever **Center Marker** or **Center Peak** is pressed. Max Hold – The display retains the highest peak signal amplitudes measured during successive sweeps. Average – The displayed signal amplitudes are a rolling average of the peak amplitudes measured on each successive sweep. The average consists of one to five sweeps, shown beside the mode indication.

Trace Math (Spectrum Analyzer submenu)

Activates a horizontal soft key menu where you can select the trace math to be applied.

Discrete Values	None, Spec-Ref (log), |Spec-Ref| (lin), Spec+Ref (lin)
Default	None
Saved State	Saved with instrument state
Notes	Setting Display Mode to Average minimizes effects of a low level / high variance signal such as the noise floor.

	The underlying units of the result are no longer dBm but dB for the displayed spectrum and thus marker power. The following are horizontal menu choices. None – This selection hides the reference trace and displays the spectrum resulting from the Display Mode unmodified. Spec-Ref (log) – This selection displays the difference of the Display Mode spectrum in dBm minus the reference trace in dBm, which normalizes the spectrum to 0 on the Y-axis. Subsequently, spectrum power interpreted as dBm above the reference. |Spec-Ref| (lin) – This choice displays the logarithm of the absolute value of the difference of the Display Mode spectrum in volts^2 minus the reference trace in volts^2. Although the absolute value of the difference avoids logarithm of negatives, it has the side effect of increasing the apparent noise power. Spec+Ref (lin) – This choice displays the logarithm of the sum of the Display Mode spectrum in volts^2 plus the reference trace in volts^2.

Set Reference Trace (Spectrum Analyzer submenu)

Saves the current trace as a separate blue reference trace.

Notes	The trace is copied from what is currently shown, which is after any Display Mode processing as well as Trace Math computations. Therefore, ensure that both of those settings are appropriately set (i.e., Trace Math is None); setting the reference when Trace Math is active may yield incoherent results. Setting Display Mode to Average minimizes effects of a low level / high variance signal such as the noise floor. This static trace is used for computations when a Trace Math equation is specified and may simply be viewed even when one is not. It can be hidden by selecting Trace Math None. System changes that may invalidate the reference trace include port, amplification, attenuation, frequency, span, temperature, and calibration.

Detector (Spectrum Analyzer submenu)

Activates a horizontal soft key menu where you can select the Detector mode.

Discrete Values	Power, Peak, Sample, Mean, Valley
Default	Peak
Saved State	Saved with instrument state

3 dB Marker (Spectrum Analyzer submenu)

Activates a horizontal soft key menu where you can select the 3 dB Marker mode.

Discrete Values	Off, Frequency, Delta
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. Frequency – This selection places a marker above and below center frequency where the signal is –3 dB below the peak amplitude measured at center frequency. The upper and lower frequencies are shown on the display. Delta – This selection places a marker above and below center frequency where the signal is –3 dB below the peak amplitude measured at center frequency. The difference between these two frequencies is shown on the display.

Marker Mode (Spectrum Analyzer submenu)

Activates a horizontal soft key menu where you can select the Marker type and operating state.

Discrete Values	Off, Absolute, Delta
Default	Off
Saved State	Saved with instrument state
Notes	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 of both power and frequency between the markers. Depending on the installed options, up to four markers can be enabled and selected for positioning while in Instrument Mode.

Select Marker (Spectrum Analyzer submenu)

Activates a horizontal soft key menu where you can select the marker to activate.

Discrete Values	1, 2, 3, 4
Default	1
Saved State	Saved with instrument state

Center Marker (Spectrum Analyzer submenu)

Moves the active marker to the middle of the spectrum.

Find Peak (Spectrum Analyzer submenu)

Moves the marker to the highest signal peak and displays the amplitude and frequency.

Center Peak (Spectrum Analyzer submenu)

Centers the operating frequency and display around the highest peak signal within the display range.

Demod At Marker (Spectrum Analyzer submenu)

When the Marker Mode is Absolute, this function demodulates the carrier and provides audio for the signal at the marker location.

Discrete Values	Off, Single, Continuous
Default	Off
Saved State	Saved with instrument state
Notes	Off – Function is off. Single – Provides a one-time demodulation of the carrier signal located at the marker position for a quick listen at the marker frequency. Moving the marker or changing the monitor frequency, mode, or DISPLAY Zone selection switches the Demod At Marker function Off. Continuous – Enables moving the selected marker to demodulate carriers across the entire displayed spectrum. On full-screen instruments, the user can setup several markers on various peaks and use the marker selection to quickly demodulate and listen to those peaks. Additionally, on the Dual Display, the user can simultaneously view the Modulation Scope while tuning the marker positions. To ensure audio is demodulated, the marker must be close enough to overlap the R8200 Monitor Bandwidth around the carrier frequency. Large Span settings increase marker frequency step size, limiting how close the marker can get to the actual frequency. To minimize step size, use the narrowest span practical when displaying multiple carriers.

OBW (Spectrum Analyzer submenu)

Activates the OBW (occupied bandwidth) dialog where you can set the operating state of the occupied bandwidth parameter.

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state

OBW % (Spectrum Analyzer submenu)

Activates the OBW % dialog where you can input ratio of power contained in a bandwidth.

Range	70 % to 99 %
Default	99 %
Saved State	Saved with instrument state
Notes	The Spectrum Analyzer provides a numerical readout of the bandwidth and contained power.

Modulation Scope Soft Keys

In the Modulation Scope Instrument Mode, the R8200 emulates a stand-alone instrument that displays the internally-processed RF modulation waveforms. It automatically switches between Generator and Monitor modulation depending on which mode is selected. In Duplex Mode an additional soft key allows manual selection of the Monitor or Generator modulation waveform.

Vertical Scale (Modulation Scope submenu)

Activates a horizontal soft key menu where you can select the vertical scale.

Discrete Values	FM –100, 200, 500 Hz/Div and 1, 2, 5, 10, 20, 50 kHz/Div AM – 1%/Div to 50%/Div
Default	1 kHz/Div
Saved State	Saved with instrument state
Dependencies	The display units presented are dependent on the modulation setting in the RF Zone. For FM the units are in Hz and kHz deviation, ranging from 100 Hz/Div to 50 kHz/Div. For AM the units are in % modulation depth and range from 1%/Div to 50%/Div

Horizontal Scale (Modulation Scope submenu)

Displays the Horizontal Scale dialog where you can select the horizontal time scale resolution for the display's major grid lines.

Discrete Values	20, 50, 100, 200, 500 µs and 1, 2, 5, 10, 20, 50, 100, 200, 500 ms and 1 s
Default	20 ms
Saved State	Saved with instrument state

Marker Mode (Modulation Scope submenu)

Activates a horizontal soft key menu where you can select the Marker type and operating state.

Discrete Values	Off, Delta V, Delta T, 1/Delta T
Default	Off
Saved State	Saved with instrument state
Notes	Depending on the installed options, up to four markers can be enabled and selected for positioning while in Instrument Mode. Off – Deactivates markers. 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 (Modulation Scope submenu)

Cycles through the available markers to select a marker for repositioning along the trace.

Trigger Mode (Modulation Scope submenu)

Activates a horizontal soft key menu where you can select the Modulation Scope Trigger Mode.

Discrete Values	Auto, Normal, Single

Default	Auto
Saved State	Saved with instrument state
Notes	Auto – If a signal satisfying the Trigger Edge and Trigger Level settings is present, the display will sweep as in Normal Mode. If no signal satisfying the Trigger Edge and Trigger Level settings is present, then the display sweeps continuously until a signal satisfying the settings is acquired. Normal – The display sweeps only when the input signal satisfies the Trigger Edge and Trigger Level settings. Single – The display sweeps once after a key press is performed on the Single soft key if the signal satisfies the Trigger Edge and Trigger level settings.

Trigger Level (Modulation Scope submenu)

Activates a Trigger Level dialog where you can adjust the signal threshold at which a horizontal sweep is initiated.

Range	FM – 0 to 200 kHz AM – 0 to 99 %
Default	0
Saved State	Saved with instrument state

Trigger Edge (Modulation Scope submenu)

Activates a horizontal soft key menu where you can select the mod scope trigger type.

Discrete Values	Rising, Falling, Either

Default	Rising
Saved State	Saved with instrument state

Vertical Position (Modulation Scope submenu)

Activates a horizontal soft key menu where you can adjust the waveform position up or down in fixed increments.

Discrete Values	Move Down, Move Up
Saved State	Saved with instrument state

Scope Mode (Modulation Scope submenu)

When operating in Duplex Mode, pressing this soft key activates a Scope Mode dialog where you can select the modulation waveform from the Monitor or the Generator.

Discrete Values	Monitor, Generate
Default	Monitor
Saved State	Saved with instrument state

Oscilloscope Soft Keys

In the Oscilloscope Instrument Mode the R8200 emulates a stand-alone 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.

Coupling (Oscilloscope submenu)

Displays the Coupling dialog where you can select the input coupling for the external signal applied to the Meter In port.

Discrete Values	DC, AC
Default	DC
Saved State	Saved with instrument state

Horizontal Scale (Oscilloscope submenu)

Displays the Horizontal Scale input dialog where you can select the horizontal scale.

Discrete Values	20, 50, 100, 200, 500 µs and 1, 2, 5, 10, 20, 50, 100, 200, 500 ms and 1 s
Default	1 ms
Saved State	Saved with instrument state
Notes	Digital Oscilloscopes are susceptible to aliasing, which can cause inaccurate signal reconstruction. The Maximum recommended input frequency for each horizontal scale setting is shown in the display area. For best results, follow the guidelines shown in the table below.

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

Vertical Scale (Oscilloscope submenu)

Displays the Vertical Scale dialog where you can select the vertical scale resolution for the display's major grid lines.

Discrete Values	50, 100, 200, 500 mV and 1, 2, 5, 10, 15, 20, 25 V
Default	1 V
Saved State	Saved with instrument state

Marker Mode (Oscilloscope submenu)

Activates a horizontal soft key menu where you can select the select the Marker type and operating state.

Discrete Values	Off, Delta V, Delta T, 1/Delta T
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. Depending on the installed options, up to four markers can be enabled and positioned. Markers can provide several different numerical displays: Delta V – shows the difference in amplitude between marker positions. Delta T – shows the difference in time between marker positions. 1/Delta T – shows the inverse of the time difference between markers, which can be used to determine the frequency of a repetitive waveform.

Toggle Marker (Oscilloscope submenu)

Cycles through the available markers to select a marker for repositioning along the trace.

Notes	The highlighted marker is yellow.

Trigger Mode (Oscilloscope submenu)

Activates a horizontal soft key menu where you can select the horizontal sweep trigger mode.

Discrete Values	Auto, Normal, Single

Default	Auto
Saved State	Saved with instrument state
Notes	Auto – If a signal satisfying the Trigger Edge and Trigger Level settings is present, the display will sweep as in Normal Mode. If no signal satisfying the Trigger Edge and Trigger Level settings is present, then the display sweeps continuously until a signal satisfying the settings is acquired. Normal – The display sweeps only when the input signal satisfies the Trigger Edge and Trigger Level settings. Single – The display sweeps once after a key press is performed on the Single soft key.

Trigger Level (Oscilloscope submenu)

Adjusts the signal threshold at which a horizontal sweep is initiated.

Range	–100 to 100 V
Default	0 V
Saved State	Saved with instrument state

Trigger Position (Oscilloscope submenu)

Activates a horizontal soft key menu where you can select the amount of pre-trigger waveform preceding the trigger threshold.

Discrete Values	10%, 50%, 90%
Default	50%
Saved State	Saved with instrument state

Trigger Edge (Oscilloscope submenu)

Activates a horizontal soft key menu where you can select which waveform edge triggers the Modulation Scope sweep.

Discrete Values	Rising, Falling, Either
Default	Rising
Saved State	Saved with instrument state

Vertical Position (Oscilloscope submenu)

Activates a horizontal soft key menu where you can adjust the waveform up or down on the display.

Discrete Values	Move Down, Move Up
Default	Move Down
Saved State	Saved with instrument state

Set DC Offset (Oscilloscope submenu)

Zeros or compensates for any accumulated DC offset caused by drift in the input amplifier of the R8200 over long periods of time.

Notes	This may show up as a DC level indicated on the Oscilloscope and DC Voltmeter when no input is connected to the Meter In port. With the Meter In port disconnected, press the soft key to eliminate the offset. The compensation is stored permanently in the R8200 until the next time this soft key is pressed.

Dual Display Soft Keys

In the Dual Display Instrument Mode, the R8200 provides a convenient single-screen presentation of two instruments often used together, the Spectrum Analyzer and Modulation Scope, enabling the independent configuration and display of both measurements. The submenus, control, and parameter entry are unchanged from the full screen versions of the Spectrum Analyzer and Modulation Scope.

Select Instrument (Dual Display submenu)

Activates a horizontal soft key menu where you can select the active Dual Display instrument.

Discrete Values	Spectrum Analyzer, Modulation Scope
Default	Spectrum Analyzer
Saved State	Saved with instrument state

Center Frequency (Spectrum Analyzer submenu)

When Select Instrument is set to Spectrum Analyzer, pressing this soft key displays the Center Frequency dialog where you can enter the center frequency for the receiver display.

Range	250 kHz to 3.0 GHz
Default	500 MHz
Saved State	Saved with instrument state

Span (Spectrum Analyzer submenu)

When Select Instrument is set to Spectrum Analyzer, pressing this soft key displays the Span dialog where you can input the desired frequency span for the receiver.

Range	10 kHz to 20 MHz
Default	10 MHz
Saved State	Saved with instrument state
Notes	Receiver modulated audio is inhibited at spans above 158 kHz. Switch display to Mod Scope or use Demod at Marker function to hear audio at wider spans. Frequency span allows you to zoom in or out (change the span of the X-axis) on a signal of interest, while maintaining the relative power (Y-axis). To zoom in on a signal, decrease the frequency span while maintaining the signal at center frequency. To zoom out, increase the frequency span. The value entered for Span is automatically split between each side of the current center frequency.

Start Frequency (Spectrum Analyzer submenu)

When Select Instrument is set to Spectrum Analyzer, pressing this soft key displays the Start Frequency dialog where you can input the lowest frequency currently measured and shown on the receiver display.

Range	250 kHz to 1.5 GHz
Default	495 MHz
Saved State	Saved with instrument state
Notes	When adjusting the start frequency the stop frequency is held constant, meaning that both the center frequency and span will change. The analyzer automatically centers the frequency display midway between Start and Stop frequencies.

Stop Frequency (Spectrum Analyzer submenu)

When Select Instrument is set to Spectrum Analyzer, pressing this soft key displays the Stop Frequency dialog where you can input the highest frequency currently measured and shown on the receiver display.

Range	260 kHz to 3 GHz
Default	1 MHz
Saved State	Saved with instrument state
Notes	When adjusting the stop frequency the start frequency is held constant, meaning that both the center frequency and span will change. The analyzer automatically centers the frequency display midway between Start and Stop frequencies.

Reference Level (Spectrum Analyzer submenu)

When Select Instrument is set to Spectrum Analyzer, pressing this soft key displays the Reference Level dialog where you can input the value of the top graticule line.

Range	0 to 90 dBm
Default	0 dBm
Saved State	Saved with instrument state

Vertical Scale (Spectrum Analyzer submenu)

When Select Instrument is set to Spectrum Analyzer, pressing this soft key activates a horizontal soft key menu where you can select the Y-axis scale.

Discrete Values	10 dB/div, 5 dB/div, 2 dB/div, 1 dB/div
Default	10 dB/div
Saved State	Saved with instrument state

Display Mode (Spectrum Analyzer submenu)

When Select Instrument is set to Spectrum Analyzer, pressing this soft key activates a horizontal soft key menu where you can select the trace graphing mode.

Discrete Values	Normal, Freeze, Max Hold, Average
Default	Normal
Saved State	Saved with instrument state
Notes	Normal – The display updates continuously. Freeze – The display provides a snapshot of the current display indication and stops additional updates. In Freeze Mode, the R8200 reacquires data and updates the display whenever **Center Marker** or **Center Peak** is pressed. Max Hold – The display retains the highest peak signal amplitudes measured during successive sweeps. Average – The displayed signal amplitudes are a rolling average of the peak amplitudes measured on each successive sweep. The average consists of one to five sweeps, shown beside the mode indication.

Trace Math (Spectrum Analyzer submenu)

When Select Instrument is set to Spectrum Analyzer, pressing this soft key activates a horizontal soft key menu where you can select the trace math to be applied.

Discrete Values	None, Spec-Ref (log), |Spec-Ref| (lin), Spec+Ref (lin)
Default	None
Saved State	Saved with instrument state
Notes	The underlying units of the result are no longer dBm but dB for the displayed spectrum and thus marker power. None – This selection hides the reference trace and displays the spectrum resulting from the Display Mode unmodified. Spec-Ref (log) – This selection displays the difference of the Display Mode spectrum in dBm minus the reference trace in dBm, which normalizes the spectrum to 0 on the Y-axis. Subsequently, spectrum power is shown on the display and measured by absolute markers relative to the reference trace, i.e., correctly interpreted as dBm above the reference. |Spec-Ref| (lin) – This choice displays the logarithm of the absolute value of the difference of the Display Mode spectrum in volts^2 minus the reference trace in volts^2. Although the absolute value of the difference avoids logarithm of negatives, it has the side effect of increasing the apparent noise power. Spec+Ref (lin) – This choice displays the logarithm of the sum of the Display Mode spectrum in volts^2 plus the reference trace in volts^2.

Set Reference Trace (Spectrum Analyzer submenu)

When Select Instrument is set to Spectrum Analyzer, pressing this soft key saves the current trace as a separate blue reference trace.

Notes	The trace is copied from what is currently shown, which is after any Display Mode processing as well as Trace Math computations. Therefore, ensure that both of those settings are appropriately set (i.e., Trace Math is None); setting the reference when Trace Math is active may yield incoherent results. Setting Display Mode to Average minimizes effects of a low level / high variance signal such as the noise floor. This static trace is used for computations when a Trace Math equation is specified and may simply be viewed even when one is not. It can be hidden by selecting Trace Math None. System changes that may invalidate the reference trace include port, amplification, attenuation, frequency, span, temperature, and calibration.

Detector (Spectrum Analyzer submenu)

When Select Instrument is set to Spectrum Analyzer, pressing this soft key activates a horizontal soft key menu where you can select the Detector mode.

Discrete Values	Power, Peak, Sample, Mean, Valley
Default	Peak
Saved State	Saved with instrument state

3 dB Marker (Spectrum Analyzer submenu)

When Select Instrument is set to Spectrum Analyzer, pressing this soft key activates a horizontal soft key menu where you can select the 3 dB Marker mode.

Discrete Values	Off, Frequency, Delta

Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. Frequency – This selection places a marker above and below center frequency where the signal is –3 dB below the peak amplitude measured at center frequency. The upper and lower frequencies are shown on the display. Delta – This selection places a marker above and below center frequency where the signal is –3 dB below the peak amplitude measured at center frequency. The difference between these two frequencies is shown on the display.

Marker Mode (Spectrum Analyzer submenu)

When Select Instrument is set to Spectrum Analyzer, pressing this soft key activates a horizontal soft key menu where you can select the Marker type and operating state.

Discrete Values	Off, Absolute, Delta
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. Absolute – This selection displays the frequency and absolute signal amplitude for each marker selected. Delta – This selection displays the frequency and amplitude difference between each pair of markers selected. Depending on the installed options, up to four markers can be enabled and selected for positioning while in Instrument Mode.

Toggle Marker (Spectrum Analyzer submenu)

When Select Instrument is set to Spectrum Analyzer, pressing this soft key activates a horizontal soft key menu where you can select the Marker type and operating state.

Discrete Values	Off, Absolute, Delta
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. Absolute – This selection displays the frequency and absolute signal amplitude for each marker selected. Delta – This selection displays the frequency and amplitude difference between each pair of markers selected. Depending on the installed options, up to four markers can be enabled and selected for positioning while in Instrument Mode.

Center Marker (Spectrum Analyzer submenu)

When Select Instrument is set to Spectrum Analyzer, pressing this soft key moves the active marker to the middle of the spectrum.

Find Peak (Spectrum Analyzer submenu)

When Select Instrument is set to Spectrum Analyzer, pressing this soft key moves the active marker to highest trace peak.

Center Peak (Spectrum Analyzer submenu)

When Select Instrument is set to Spectrum Analyzer, pressing this soft key centers the display around the highest trace peak.

Demod at Marker (Spectrum Analyzer submenu)

When Select Instrument is set to Spectrum Analyzer and Marker Mode is set to absolute, pressing this soft key activates a horizontal soft key menu where you can select the demodulation mode at the active marker.

Discrete Values	Off, Single, Continuous
Default	Off
Saved State	Saved with instrument state
Notes	Off – Function is off. Single – This selection provides a one-time demodulation of the carrier signal located at the marker position for a quick listen at the marker frequency. Moving the marker or changing the monitor frequency, mode, or DISPLAY Zone selection switches the Demod At Marker function Off. Continuous – Continuous Mode allows users to move the selected marker to demodulate carriers across the entire displayed spectrum. On full-screen instruments, the user can setup several markers on various peaks and use the marker selection to quickly demodulate and listen to those peaks. Additionally, on the Dual Display, the user can simultaneously view the deModulation Scope while tuning the marker positions. To ensure audio is demodulated, the marker must be close enough to overlap the analyzer Monitor Bandwidth around the carrier frequency. Large Span settings increase marker frequency step size, limiting how close the marker can get to the actual frequency. To minimize step size, use the narrowest span practical when displaying multiple carriers.

Vertical Scale (Modulation Scope submenu)

When Select Instrument is set to Mod Scope, pressing this soft key activates a horizontal soft key menu where you can select the vertical scale.

Discrete Values	FM – 100, 200, 500 Hz/Div and 1, 2, 5, 10, 20, 50 kHz/Div AM – 1%/Div to 50%/Div
Default	1 kHz/Div
Saved State	Saved with instrument state
Dependencies	The display units presented are dependent on the modulation setting in the RF Zone. For FM the units are in Hz and kHz deviation, ranging from 100 Hz/Div to 50 kHz/Div. For AM the units are in % modulation depth and range from 1%/Div to 50%/Div

Horizontal Scale (Modulation Scope submenu)

When Select Instrument is set to Mod Scope, pressing this softkey displays the Horizontal Scale dialog where you can select the horizontal scale.

Discrete Values	20, 50, 100, 200, 500 µs and 1, 2, 5, 10, 20, 50, 100, 200, 500 ms and 1 s
Default	20 ms
Saved State	Saved with instrument state

Marker Mode (Modulation Scope submenu)

When Select Instrument is set to Mod Scope, pressing this soft key activates a horizontal soft key menu where you can select the Marker type and operating state.

Discrete Values	Off, Delta V, Delta T, 1/Delta T
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. 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. Depending on the installed options, up to four markers can be enabled and selected for positioning while in Instrument Mode.

Toggle Marker (Modulation Scope submenu)

When Select Instrument is set to Mod Scope pressing this soft key switches between Marker 1 and 2.

Trigger Mode (Modulation Scope submenu)

When Select Instrument is set to Mod Scope, pressing this soft key activates a horizontal soft key menu where you can select the Modulation Scope Trigger Mode.

Discrete Values	Auto, Normal, Single
Default	Auto
Saved State	Saved with instrument state

Notes	Auto – If a signal satisfying the Trigger Edge and Trigger Level settings is present, the display will sweep as in Normal Mode. If no signal satisfying the Trigger Edge and Trigger Level settings is present, then the display sweeps continuously until a signal satisfying the settings is acquired. Normal – The display sweeps only when the input signal satisfies the Trigger Edge and Trigger Level settings. Single – The display sweeps once after a key press is performed on the Single soft key if the signal satisfies the Trigger Edge and Trigger level settings. Spec An and Bar Graphs are not available in Generate Mode.

Trigger Level (Modulation Scope submenu)

When Select Instrument is set to Mod Scope, pressing this soft key activates a Trigger Level dialog where you can enter the trigger threshold level in kHz.

Range	FM – 0 to 200 kHz AM – 0 to 99 %
Default	0
Saved State	Saved with instrument state

Trigger Edge (Modulation Scope submenu)

When Select Instrument is set to Mod Scope, pressing this soft key activates a horizontal soft key menu where you can select the mod scope trigger type.

Discrete	Rising, Falling, Either

Values	
Default	Rising
Saved State	Saved with instrument state

Vertical Position (Modulation Scope submenu)

When Select Instrument is set to Mod Scope, pressing this soft key activates a horizontal soft key menu where you can adjust the waveform position up or down in fixed increments.

Discrete Values	Move Down, Move Up
Saved State	Saved with instrument state

Tracking Generator Soft Keys

In the optional Tracking Generator Instrument Mode, the Communications System Analyzer behaves like a stand-alone instrument, configuring the RF generator in a swept mode for simultaneous use with the Spectrum Analyzer display. This delivers a valuable capability for measuring and servicing a wide variety of RF filtering and combining networks.

Center Frequency (Tracking Generator submenu)

Displays a Center Frequency generator where you can set the Tracking Generator Center Frequency in MHz

Range	250 kHz to 3 GHz
Default	500 MHz
Saved State	Saved with instrument state

Span (Tracking Generator submenu)

Displays a Span dialog where you can set the Tracking Generator Span in MHz.

Range	0.000001 to 50 MHz
Default	50 MHz
Saved State	Saved with instrument state
Notes	The Span entry total is automatically split on each side of the current center frequency.

Start Frequency (Tracking Generator submenu)

Displays a Start Frequency dialog, where you can set the Tracking Generator start frequency in MHz.

Range	250 kHz to 3 GHz
Default	475 MHz
Saved State	Saved with instrument state
Notes	Spec An and Bar Graphs are not available in Generate Mode.
Couplings	The analyzer automatically centers the frequency display midway between Start and Stop frequencies.

Stop Frequency (Tracking Generator submenu)

Displays a Stop Frequency dialog, where you can set the Tracking Generator stop frequency in MHz.

Range	260 kHz to 3 GHz
Default	525 MHz
Saved State	Saved with instrument state
Notes	The analyzer automatically centers the frequency display midway between Start and Stop frequencies.

Reference Level (Tracking Generator submenu)

Displays a Reference Level dialog where you can set the Y offset of the display.

Range	–120 to 60 dB
Default	0 dB
Saved State	Saved with instrument state

Vertical Scale (Tracking Generator submenu)

Activates a horizontal soft key menu where you can select the vertical scale.

Discrete Values	15, 10, 5, 2, 1 dB/div
Default	10 dB/div
Saved State	Saved with instrument state

of Points (Tracking Generator submenu)

Displays a # of Points dialog where you can set the number of points per sample.

Range	100 to 600
Default	200
Saved State	Saved with instrument state
Notes	Higher settings increase the trace resolution for viewing signal detail but also slow the update rate.

RBW (Tracking Generator submenu)

Activates a horizontal menu where you can set the Tracking Generator Resolution Bandwidth.

Discrete Values	Wide, Medium, Narrow

Default	Medium
Saved State	Saved with instrument state
Notes	RBW controls the amount of averaging done. Wide RBW provides minimal sampling and a faster response time. Medium RBW provides a moderate amount of sampling with a reduced response time. Narrow RBW provides the most sampling with a slow response time, but a greater dynamic range.

Display Mode (Tracking Generator submenu)

Activates a horizontal soft key menu where you can select the trace graphing mode.

Discrete Values	Normal, Freeze, Max Hold, Average
Default	Normal
Saved State	Saved with instrument state
Notes	Normal – The display updates continuously. Freeze – The display provides a snapshot of the current display indication and stops additional updates. In Freeze Mode, the R8200 reacquires data and updates the display whenever **Center Marker** or **Center Peak** is pressed. Max Hold – The display retains the highest peak signal amplitudes measured during successive sweeps. Average – The displayed signal amplitudes are a rolling average of the peak amplitudes measured on each successive sweep. The average consists of one to five sweeps, shown beside the mode indication.

Marker Mode (Tracking Generator submenu)

Activates a horizontal soft key menu where you can select the Tracking Generator Marker type and operating state.

Discrete Values	Off, Absolute, Delta
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. Absolute – Displays the frequency and absolute signal amplitude for each marker selected. Delta – Displays the frequency and amplitude difference between each pair of markers selected.

Marker Type (Tracking Generator submenu)

Activates a horizontal soft key menu where you can select the Marker Type.

Discrete Values	Point Cross, Vertical Bar, Horizontal Bar, Full Cross
Default	Point Cross
Saved State	Saved with instrument state
Notes	Point Cross – Displays a small cross with window over the marker point. Vertical Bar – Displays a vertical bar at the marker point. Horizontal Bar – Displays a horizontal bar at the marker point. Full Cross – Displays both a horizontal and vertical bar at the marker point.

Select Marker (Tracking Generator submenu)

Activates a horizontal soft key menu where you can select the active marker.

Discrete Values	1, 2, 3, 4
Default	1
Saved State	Saved with instrument state

Set Marker Frequency (Tracking Generator submenu)

Activates a horizontal soft key menu where you can select the vertical scale.

Range	Start Frequency to Stop Frequency
Default	400 MHz
Saved State	Saved with instrument state

Find Peak (Tracking Generator submenu)

Moves the active marker to the highest point on the waveform.

Find Valley (Tracking Generator submenu)

Moves the active marker to the lowest point on the waveform.

Center Marker (Tracking Generator submenu)

Centers the operating frequency and display around the active marker.

3 dB Marker (Tracking Generator submenu)

Activates a horizontal soft key menu where you can select the 3dB Marker mode.

Discrete Values	Off, Frequency, Delta
Default	Off
Saved State	Saved with instrument state
Notes	Off – Function is off. Frequency – This selection places a marker above and below center frequency where the signal is –3 dB below the peak amplitude measured at center frequency. The upper and lower frequencies are shown on the display. Delta – This selection places a marker above and below center frequency where the signal is –3 dB below the peak amplitude measured at center frequency. The difference between these two frequencies is shown on the display.

Output Level (Tracking Generator submenu)

Displays an Output Level dialog where you can set the RF Level of the Tracking Generator output at the active port.

Range	RF Gen Out port: –95 to 5 dBm RF In/Out port: –130 to –30 dBm
Default	–50 dBm
Saved State	Saved with instrument state

Attenuation (Tracking Generator submenu)

Displays an Attenuation dialog where you can set the input attenuation in dB.

Discrete Values	0 to 62 dB in 2 dB steps
Default	0 dB
Saved State	Saved with instrument state
Notes	Spec An and Bar Graphs are not available in Generate Mode.

Pre-Amplifier (Tracking Generator submenu)

Displays a Pre-Amplifier dialog where you can select the Pre-Amplifier power state.

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state
Notes	**AMP** appears next to the Attenuation setting in the RF Zone whenever the Pre-Amplifier is active. By default, the pre-amplifier Auto-Off feature disables the pre-amplifier for best accuracy during broadband power (Watt Meter) measurements. When enabled, avoid input overload and erroneous signal strength readings by using the pre-amplifier only under the following conditions:

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

Gen Port (Tracking Generator submenu)

Activates a horizontal soft key menu where you can select the vertical scale.

Discrete Values	RF In/Out, Gen Out
Default	Gen Out
Saved State	Saved with instrument state
Notes	If RF Level Offset is enabled, the Gen Port label is cyan-colored, indicating that Output Level amplitudes are adjusted by the Gen Port-specific offset.

Monitor Port (Tracking Generator submenu)

Activates a horizontal soft key menu where you can select the receiver's input.

Discrete Values	RF In/Out, Antenna
Default	Antenna
Saved State	Saved with instrument state
Notes	If RF Level Offset is enabled, the Mon Port label is cyan-colored, indicating that RX measurements are adjusted by the Mon Port-specific offset.

Normalize (Tracking Generator submenu)

Displays a Normalize dialog where you can set the operating state for normalization.

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state
Notes	Normalization creates a baseline for measuring system under test response by zeroing out the Spectrum Analyzer trace. When enabled, a visual indicator appears, and the trace color changes. To reset the baseline after changing any Tracking Generator parameters, select Off and then On again.

Single-Port VNA Soft Keys

In Single-Port VNA mode, the R8200 behaves like a stand-alone instrument with a full screen display. The following sections are organized by measurement display: Smith Chart (soft keys common to all VNA configurations), Calibration, Return Loss/VSWR, Distance To Fault soft keys.

- For soft keys unique to the Calibration display, see **"Calibration Soft Keys" on page 566**.
- Soft keys unique to the Return Loss/VSWR display are in **"Return Loss/VSWR Soft Keys" on page 550**.
- Soft keys unique to the Distance To Fault display are in **"Distance To Fault Soft Keys" on page 554**.

NOTE There are no soft keys unique to the Smith Chart.

This section lists soft keys that are common to all four VNA displays.

Select Display (Single-Port VNA submenu)

Activates a horizontal soft key menu where you can select the Single-Port VNA display mode.

Discrete Values	Return Loss/VSWR, Distance to Fault, Calibration, Smith Chart
Default	Return Loss/VSWR
Saved State	Saved with instrument state
Notes	Return Loss/VSWR – Opens the Return Loss/VSWR measurement display. Distance to Fault – Opens the Distance to Fault measurement display. Calibration – Opens the measurement Calibration display. Smith Chart – Opens the Smith Chart display.

Start Frequency (Single-Port VNA submenu)

Displays a dialog where you can set the Start Frequency.

Range	1 MHz to 5999.996 MHz
Default	1 MHz
Saved State	Saved with instrument state

Stop Frequency (Single-Port VNA submenu)

Displays a dialog where you can set the Stop Frequency.

Range	1.004 MHz to 6 GHz
Default	6 GHz
Saved State	Saved with instrument state

Center Frequency (Single-Port VNA submenu)

Displays a dialog where you can set the Center Frequency.

Range	1.002 MHz to 5.998 GHz
Default	3.0005 MHz
Saved State	Saved with instrument state

Span (Single-Port VNA submenu)

Displays a dialog where you can enter the Frequency Span.

Range	0.004 MHz to 6 GHz
Default	5.999 GHz
Saved State	Saved with instrument state

Output Level (Return Loss/VSWR submenu)

Displays an Output Level dialog where you can select the RF output level.

Discrete Values	High, Low
Default	High
Saved State	Saved with instrument state
Notes	High – Increase dynamic range, reduce noise. Low – Reduce cross-talk and interference.

Trigger Mode (Return Loss/VSWR submenu)

Activates a horizontal soft key menu where you can select the desired sweep type.

Discrete Values	Freeze, Single, Auto
Default	Auto
Saved State	Saved with instrument state
Notes	Freeze – Display sweeps stop, allowing further analysis of the captured input signal.

	Single – Display sweeps once after a key press is performed on the Single soft key. Auto – Display sweeps continuously when the input signal satisfies the Trigger Edge and Trigger Level settings.

Correction (Return Loss/VSWR submenu)

Displays the Correction dialog where you can enable or disable measurement correction established by the last calibration procedure.

Discrete Values	Off, On
Default	On
Saved State	Saved with instrument state
Notes	A calibration must be performed before trace correction is applied.

of Points (Return Loss/VSWR submenu)

Displays the # of Points dialog where you set the number of points in a sample.

Range	101 to 10001
Default	201
Saved State	Saved with instrument state
Notes	Set before Calibration. A large number of points will result in a higher fidelity sample, but will also result in a slower sweep time.

IFBW (Return Loss/VSWR submenu)

Displays the IFBW dialog where you can set the Intermediate Frequency Bandwidth of the Single Port VNA.

Discrete Values	10, 30, 100, 300 Hz and 1, 3, 10, 30, 100 kHz
Default	10 kHz
Saved State	Saved with instrument state
Notes	Set before calibration. Smaller IFBW increases resolution and lowers noise floor and increases the sweep time.

Averaging (Return Loss/VSWR submenu)

Displays a dialog where you can enable or disable averaging.

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state
Notes	Enabling Averaging lowers the noise floor and makes the trace less responsive to sudden changes.

Averaging Factor (Return Loss/VSWR submenu)

Displays dialog where you can set the averaging factor.

Range	1 to 999
Default	10
Saved State	Saved with instrument state
Notes	Setting a higher Averaging Factor increases the effect of averaging and decreases responsiveness. Setting a lower Averaging Factor decreases the effect of averaging and increases responsiveness.

Smoothing (Return Loss/VSWR submenu)

Displays a dialog where you can enable and disable trace smoothing.

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state
Notes	Averages each point with surrounding points to provide a smoother trace. Can result in misleading traces if not used judiciously.

Smoothing Aperture (Return Loss/VSWR submenu)

Displays a dialog where you can set the aperture of the smoothing algorithm.

Range	0.010 % to 20.000 %
Default	1.000 %
Saved State	Saved with instrument state

Return Loss/VSWR Soft Keys

The following soft keys are unique to the Single-Port VNA Return Loss/VSWR display.

Return Loss Ref Value (Return Loss/VSWR submenu)

Displays a dialog where you can set the Return Loss Ref Value for the top graticule.

Range	0 to 1000 dB
Default	0 dB
Saved State	Saved with instrument state

Return Loss Scale (Return Loss/VSWR submenu)

Displays a dialog where you can set the power scale on the vertical axis.

Range	0.001 to 200 dB/div
Default	1 dB/div
Saved State	Saved with instrument state

Return Loss Auto Scale (Return Loss/VSWR submenu)

Automatically scales the vertical axis of the return loss measurement display.

VSWR Ref Value (Return Loss/VSWR submenu)

Displays a dialog where you can set a reference value for the top graticule in the VSWR display.

Range	–1000 to 10001
Default	100
Saved State	Saved with instrument state

VSWR Scale (Return Loss/VSWR submenu)

Displays a dialog where you change the power scale for VSWR measurement display.

Range	0.001 to 1000
Default	1
Saved State	Saved with instrument state

VSWR Auto Scale (Return Loss/VSWR submenu)

Automatically scales the trace on the power or vertical axis.

Active Trace (Return Loss/VSWR submenu)

Displays a dialog where you can select the active trace.

Discrete Values	Return Loss, VSWR
Default	Return Loss
Saved State	Saved with instrument state

Marker Mode (Return Loss/VSWR submenu)

Activates a horizontal soft key menu where you can enable and define a marker for the active trace.

Discrete Values	Off, Absolute, Delta
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. Absolute – Displays the absolute amplitude at the marker position. Delta – Displays the difference in amplitude between marker positions.

Select Marker (Return Loss/VSWR submenu)

Activates a horizontal soft key menu where you can select a specific marker.

Discrete Values	1, 2, 3, 4, 5, 6, Ref
Default	1
Saved State	Saved with instrument state
Notes	Ref is only available in Delta marker mode.

Marker Frequency (Return Loss/VSWR submenu)

Displays a dialog where you can move the selected marker to a specific frequency.

Range	1 MHz to 6 GHz
Default	1 MHz
Saved State	Saved with instrument state

Marker On/Off (Return Loss/VSWR submenu)

Toggles the selected marker on or off.

Max Peak (Return Loss/VSWR submenu)

Moves the selected marker to the point representing maximum power on the trace.

Peak Excursion (Return Loss/VSWR submenu)

Displays a dialog where you can set the power level threshold that defines a point on the trace as a peak.

Range	0.001 to 1000 dB
Default	1 dB
Saved State	Saved with instrument state
Notes	If pressing the **Peak Right** or **Peak Left** buttons do not move the marker, lowering this value will enable their function.

Peak Left (Return Loss/VSWR submenu)

Moves the selected marker to the next lower frequency point on the trace whose power exceeds the peak excursion threshold.

Peak Right (Return Loss/VSWR submenu)

Moves the selected marker to the next higher frequency point on the trace whose power exceeds the peak excursion threshold.

Min Valley (Return Loss/VSWR submenu)

Moves the selected marker to the minimum power point on the trace.

Valley Left (Return Loss/VSWR submenu)

Moves the selected marker to the minimum power point on the trace at a lower frequency than the current marker position.

Valley Right (Return Loss/VSWR submenu)

Moves the selected marker to the minimum power point on the trace at a higher frequency than the current marker position.

Distance To Fault Soft Keys

The following soft keys are unique to the Single-Port VNA Distance To Fault display.

Response Type (Distance To Fault submenu)

Activates a horizontal soft key menu where you can select the type of response for the Distance To Fault measurement.

Discrete Values	Bandpass, Lowpass Impulse, Lowpass Step
Default	Bandpass
Saved State	Saved with instrument state
Notes	Bandpass – Ideal for devices such as bandpass filters that do not operate with DC current, as you can select an arbitrary sweep range and identify the location of mismatches. Lowpass Impulse – Ideal for devices such as cables that carry signals from DC current to high frequency RF. Simulates the results given by a Time Domain Reflectometer. The shape of the low-pass response indicates the nature of the discontinuity. Lowpass Step – Ideal for pulsed or digital transmission line faults. Integral of impulse response which relates to the impedance of the transmission line. Converts the square wave step response to a triangular waveform output as the capacitor in the RC circuit charges and discharges.

Maximum Length (Distance To Fault submenu)

Displays a dialog where you can set the maximum length of cable that will be measured.

Range	8 to 1000 m
Default	50 m
Saved State	Saved with instrument state

Start Distance (Distance To Fault submenu)

Displays a dialog where you can set the initial measurement point in meters from the R8200 along the cable under test.

Range	–1000 to 997.5 m
Default	0 m
Saved State	Saved with instrument state
Notes	Negative values may be entered to make it easier to see measurements around zero distance.

Stop Distance (Distance To Fault submenu)

Displays a dialog where you can set the farthest measurement point in meters from the R8200 along the cable under test.

Range	0 to 1000 m
Default	1 kHz
Saved State	Saved with instrument state

Output Level (Distance To Fault submenu)

Displays a dialog where you can select the RF output level of the swept stimulus.

Discrete Values	High, Low
Default	High
Saved State	Saved with instrument state
Notes	High – Increase dynamic range, reduce noise. Low – Reduce cross-talk and interference.

Trigger Mode (Distance To Fault submenu)

Activates a horizontal soft key menu where you can select the type of measurement trace triggering.

Discrete Values	Freeze, Single, Auto
Default	Auto
Saved State	Saved with instrument state
Notes	Freeze – Display sweeps stop, allowing further analysis of the captured input signal. Single – Display sweeps once when **Single** is pressed. Auto – Display sweeps continuously.

Correction (Distance To Fault submenu)

Displays a dialog where you can enable or disable measurement correction using the calibration data set recorded during the last measurement calibration.

Discrete Values	Off, On
Default	On
Saved State	Saved with instrument state
Notes	A calibration must be performed before measurement correction can be applied.

Center Frequency (Distance To Fault submenu)

Displays a dialog where you can set the center frequency for the measurement.

Range	1 MHz to 6 GHz
Default	3000.5 MHz
Saved State	Saved with instrument state

of Points (Distance To Fault submenu)

Displays a dialog where you can set the number of points to be used in a measurement sample.

Range	101 to 10001
Default	101

Saved State	Saved with instrument state
Notes	Set before Calibration. A large number of points will result in a higher fidelity sample, but will also result in a slower sweep time.

IFBW (Distance To Fault submenu)

Displays a dialog where you can select the intermediate frequency bandwidth for the current measurement.

Discrete Values	10, 30, 100, 300 Hz and 1, 3, 10, 30, 100 kHz
Default	10 kHz
Saved State	Saved with instrument state
Notes	Set before calibration. Smaller IFBW increases resolution and lowers noise floor but also increases sweep time.

Distance Units (Distance To Fault submenu)

Displays a dialog where you can toggle the distance units.

Discrete Values	m, ft
Default	m
Saved State	Saved with instrument state
Notes	Changing units will automatically convert relevant input fields into the selected units.

Ref Value (Distance To Fault submenu)

Displays a dialog where you can set the value for the top graticule on the vertical axis.

Discrete Values	–1000 to 1000 dB
Default	0 dB
Saved State	Saved with instrument state

Scale (Distance To Fault submenu)

Displays a dialog where you can set the power scale on the vertical axis.

Range	0.001 to 200 dB
Default	20 dB
Saved State	Saved with instrument state

Auto Scale (Distance To Fault submenu)

Automatically scales the trace on the power or vertical axis.

Cable List (Distance To Fault submenu)

Opens the Cable List.

Return (Cable List submenu)

Exits the Cable List.

Select (Cable List submenu)

Selects the highlighted cable and exits the Cable List.

Page Up (Cable List submenu)

Scrolls one page up in the Cable List.

Page Down (Cable List submenu)

Scrolls one page down in the Cable List.

New (Cable List submenu)

Opens the Cable List Editor.

Cable Description (Cable List submenu)

Displays the Cable Description dialog where you can enter a name for a new cable.

Discrete Values	A to Z, *, /, -, and 0 to 9
Saved State	Saved with instrument state

Velocity Factor (Cable List submenu)

Displays a dialog where you can set the velocity factor for a new cable.

Range	0.001 to 1
Default	1
Saved State	Saved with instrument state

Cable Loss 1 (Cable List submenu)

Displays a dialog where you can enter the first return loss value for a new cable in the Cable List Editor.

Range	0.001 to 200 dB
Default	20 dB
Saved State	Saved with instrument state

Frequency 1 (Cable List submenu)

Displays a dialog where you can enter the first return loss frequency for a new cable in the Cable List Editor.

Range	0 Hz to 6 GHz
Default	0 Hz
Saved State	Saved with instrument state

Cable Loss 2 (Cable List submenu)

Displays a dialog where you can enter the second return loss value for a new cable in the Cable List Editor.

Range	0.001 to 200 dB
Default	20 dB
Saved State	Saved with instrument state

Frequency 2 (Cable List submenu)

Displays a dialog where you can enter the second return loss frequency for a new cable in the Cable List Editor.

Range	0.001 to 200 dB
Default	20 dB
Saved State	Saved with instrument state

Cable Loss 3 (Cable List submenu)

Displays a dialog where you can enter the third return loss value for a new cable in the Cable List Editor.

Range	0.001 to 200 dB
Default	20 dB
Saved State	Saved with instrument state

Frequency 3 (Cable List submenu)

Displays a dialog where you can enter the third return loss frequency for a new cable in the Cable List Editor.

Range	0.001 to 200 dB
Default	20 dB
Saved State	Saved with instrument state

Save (Cable List submenu)

Saves the values entered for the new cable and exits the Cable List Editor.

Cancel (Cable List submenu)

Exits the Cable List Editor without saving any previously entered values.

Edit (Cable List submenu)

Opens the Cable List Editor where you can edit the parameters of the highlighted cable.

Delete (Cable List submenu)

Deletes the currently selected user-defined cable or resets the currently selected factory cable to its default values.

Velocity Factor (Cable List submenu)

Displays a dialog where you can change the velocity factor of the currently selected cable.

Discrete Values	100, 200, 500 Hz and 1, 2, 5,10 ,20 50 kHz
Default	1 kHz
Saved State	Saved with instrument state

Cable Loss (Cable List submenu)

Displays a dialog where you can set the cable loss frequency of the currently selected cable.

Discrete Values	100, 200, 500 Hz and 1, 2, 5, 10, 20, 50 kHz
Default	1 kHz
Saved State	Saved with instrument state

Marker Mode (Distance To Fault submenu)

Activates a horizontal soft key menu where you can enable and define a marker for the active trace.

Discrete Values	Off, Absolute, Delta
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. Absolute – Displays the frequency and absolute signal amplitude for each marker selected. Delta – Displays the frequency and amplitude difference between each pair of markers selected. Depending on the installed options, up to seven markers can be enabled and selected for positioning.

Select Marker (Distance To Fault submenu)

Activates a horizontal soft key menu where you can select a specific marker.

Discrete Values	1, 2, 3, 4, 5, 6, Ref
Default	1
Saved State	Saved with instrument state
Notes	Defines which marker acts as the reference for all Delta mode markers. It is only available in Delta marker mode.

Marker Frequency (Distance To Fault submenu)

Displays a dialog where you can set the active marker to a specific frequency.

Range	1 GHz to 6 GHz
Default	3.0005 GHz
Saved State	Saved with instrument state

Marker On/Off (Distance To Fault submenu)

Toggles the selected marker on or off.

Max Peak (Distance To Fault submenu)

Moves the selected marker to the point representing maximum power on the trace.

Peak Excursion (Distance To Fault submenu)

Displays a dialog where you can set the power level threshold that defines a point on the trace as a peak.

Range	0.001 to 1000 dB
Default	1 dB
Saved State	Saved with instrument state
Notes	If pressing the **Peak Right** or **Peak Left** buttons do not move the marker, lowering this value will enable their function.

Peak Left (Distance To Fault submenu)

Moves the selected marker to the next lower frequency point on the trace whose power exceeds the peak excursion threshold.

Peak Right (Distance To Fault submenu)

Moves the selected marker to the next higher frequency point on the trace whose power exceeds the peak excursion threshold.

Min Valley (Distance To Fault submenu)

Moves the selected marker to the minimum power point on the trace.

Valley Left (Distance To Fault submenu)

Moves the selected marker to the minimum power point on the trace at a lower frequency than the current marker position.

Valley Right (Distance To Fault submenu)

Moves the selected marker to the minimum power point on the trace at a higher frequency than the current marker position.

Calibration Soft Keys

The following soft keys are unique to the Single-Port VNA Calibration display.

Calibration Kit (Calibration submenu)

Activates the Calibration Kit Library. To select a calibration kit, highlight it using the arrow keys or the tuning knob.

Return (Calibration Kit submenu)

Exits the Calibration Kit Library.

Select (Calibration Kit submenu)

Selects the highlighted calibration kit and loads the characteristics unique to the standards contained in the kit.

New (Calibration Kit submenu)

Activates the Calibration Kit Library Editor where you can define a custom calibration kit for use with the R8200. Use the arrow keys and the tuning knob to move the cursor through the editor.

Name (Calibration Kit submenu)

Displays a dialog where you can enter a name for the calibration kit.

Description (Calibration Kit submenu)

Displays a dialog where you can enter a brief description for the calibration kit.

Edit Field (Calibration Kit submenu)

Displays a dialog where you can edit the value of the highlighted field.

Save (Calibration Kit submenu)

Saves the custom calibration kit and closes the Calibration Kit Library Editor.

Cancel (Calibration Kit submenu)

Closes the Editor without saving the previously entered values.

Edit (Calibration Kit submenu)

Activates the Calibration Kit Library Editor for the highlighted calibration kit.

Delete (Calibration Kit submenu)

Deletes the highlighted calibration kit.

Open (Calibration submenu)

Measures the standard open and saves its response to the calibration data set.

Short (Calibration submenu)

Measures the standard short and saves its response to the calibration data set.

Load (Calibration submenu)

Measures the standard load and saves its response to the calibration data set.

Apply (Calibration submenu)

Saves the current calibration data set and exits the Calibration display.

Cancel (Calibration submenu)

Closes the Calibration display without saving the current calibration.

Cable Fault Locator Soft Keys

In the Cable Fault Locator Instrument Mode, the R8200 emulates a stand-alone instrument.

Cable Type (Cable Fault Locator submenu)

Displays a Cable Type dialog, where you can select the Cable Fault Locator cable type.

Discrete Values	No Selection, LADDER LINE, TWIN-LEAD, COAXIAL-FPD, COAXIAL-SPD
Default	No Selection
Saved State	Saved with instrument state
Notes	Automatically populates the Cable Loss and Velocity Factor. If No Selection is chosen, the user should enter the specific data for the cable under test.

Center Frequency (Cable Fault Locator submenu)

Displays a Center Frequency dialog, where you can enter the Cable Fault Locator Center Frequency in MHz.

Range	250 kHz to 1 GHz
Default	500 MHz
Saved State	Saved with instrument state

Maximum Length (Cable Fault Locator submenu)

Displays a Maximum Length dialog where you can input the Maximum Length to optimize the RF parameters and FFT calculations.

Range	36.4 to 3047 m
Default	500 m
Saved State	Saved with instrument state
Notes	The entry units are determined by the Distance Units soft key.

Analyze (Cable Fault Locator submenu)

Activates a horizontal soft key menu where you can select the Cable Fault Locator operating mode.

Discrete Values	Off, Continuous, Single Sweep, Calibrate
Default	Off
Saved State	Saved with instrument state
Notes	Off – This selection disables the Cable Fault Locator to allow parameter entry. Continuous – The display provides continuous measurement updates. Single Sweep – The display provides one measurement update after a key press is performed on the Single Sweep soft key. Calibrate – The Cable Fault Locator performs a calibration to nullify effects from the RF directional coupler/splitter.

Cable Loss (Cable Fault Locator submenu)

When display is set to Mod Scope, pressing this soft key activates a horizontal soft key menu where you can select the vertical scale.

Range	0 to 2 dB/m
Default	0 dB/m
Saved State	Saved with instrument state
Notes	The entry units are determined by the Distance Units soft key.

Velocity Factor (Cable Fault Locator submenu)

Displays a Velocity Factor dialog where you can input the Cable Fault Locator Velocity Factor.

Range	0.001 to 1
Default	1
Saved State	Saved with instrument state
Notes	Changing this value will override cable under test's velocity factor if one has been loaded.

Display Mode (Cable Fault Locator submenu)

Activates a horizontal soft key menu where you can select the trace graphing mode.

Discrete Values	Normal, Freeze, Max Hold, Average
Default	Normal
Saved State	Saved with instrument state
Notes	Normal – The display updates continuously.

	Freeze – This selection provides a display snapshot of the first measurement sweep started by a **Continuous** or **Single Sweep** key press in the Analyze submenu, then stops additional display updates. If a measurement sweep is already in process during the key press, the display updates when complete and then freezes. Measurement sweeps completed and displayed before the Freeze key press are not frozen and will be overwritten by the first subsequent sweep. Max Hold – The display retains the highest peak signal amplitudes measured during successive sweeps. Average – The display shows a rolling average of the peak return loss amplitude measured on each successive sweep. The average consists of one to five sweeps, shown beside the mode indication.

Marker Mode (Cable Fault Locator submenu)

Activates a horizontal soft key menu where you can toggle Marker type and operating state.

Discrete Values	Off, Absolute, Delta
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. Absolute – This selection displays the frequency and absolute signal amplitude for each marker selected. Delta – This selection displays the frequency and amplitude difference between each pair of markers selected. Depending on the installed options, up to four markers can be enabled and selected for positioning while in Instrument Mode.

Toggle Marker (Cable Fault Locator submenu)

Toggles between Marker 1 and 2.

Notes	The active marker is moved using the arrow keys.

Find Peak (Cable Fault Locator submenu)

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

Distance Units (Cable Fault Locator submenu)

Displays a Distance Units dialog where you can toggle between meters and feet.

Discrete Values	m, ft
Default	m
Saved State	Saved with instrument state

Add Cable Type (Cable Fault Locator submenu)

Opens a menu where you can define a new cable for use with the Cable Fault Locator.

Notes	The soft key activates a new submenu for entering a Cable Description and the associated cable specifications. These include the cable Velocity Factor along with the Nominal Attenuation Units for three frequency points. Pressing the Next soft key advances the menu to each successive Frequency/Nominal Attenuation entry. The Back soft key returns to the previous entry menu.

Cable Description (Cable Fault Locator submenu)

Displays a Cable Description dialog where you can enter a name for your custom cable.

Velocity Factor (Cable Fault Locator submenu)

Displays a Velocity Factor dialog where you can enter

Range	0.001 to 1.000
Default	0.000
Saved State	Saved with instrument state

Nominal Attenuation Units (Cable Fault Locator submenu)

Displays a Nominal Attenuation Units dialog where you can select cable loss units.

Discrete Values	dB/m, dB/ft
Default	dB/m
Saved State	Saved with instrument state

Frequency 1 (Cable Fault Locator submenu)

Displays a Frequency dialog where you can set a cable loss frequency.

Range	0 to 3000 MHz
Default	0
Saved State	Saved with instrument state

Nominal Attenuation 1 (Cable Fault Locator submenu)

Displays a Nominal Attenuation dialog where you set a cable loss value.

Range	0.0000 to 1.0000 dB/m
Default	0
Saved State	Saved with instrument state
Notes	The entry units are determined by the Distance Units soft key.

Frequency 2 (Cable Fault Locator submenu)

Displays a Frequency dialog where you can set a cable loss frequency.

Range	0 to 3000 MHz
Default	0
Saved State	Saved with instrument state

Nominal Attenuation 2 (Cable Fault Locator submenu)

Displays a Nominal Attenuation dialog where you set a cable loss value.

Range	0.0000 to 1.0000 dB/m
Default	0
Saved State	Saved with instrument state
Notes	The entry units are determined by the Distance Units soft key.

Frequency 3 (Cable Fault Locator submenu)

Displays a Frequency dialog where you can set a cable loss frequency.

Range	0 to 3000 MHz
Default	0
Saved State	Saved with instrument state

Nominal Attenuation 3 (Cable Fault Locator submenu)

Displays a Nominal Attenuation dialog where you set a cable loss value.

Range	0.0000 to 1.0000 dB/m
Default	0
Saved State	Saved with instrument state
Notes	The entry units are determined by the Distance Units soft key.

Save New Cable (Cable Fault Locator submenu)

Saves the current new or edited cable to the analyzer.

Edit Cable (Cable Fault Locator submenu)

Opens a menu where you can edit the active Cable Type.

Notes	Factory cables cannot be edited.

Delete Cable (Cable Fault Locator submenu)

Opens a menu where you can delete the active Cable Type.

Discrete Values	Continue, Cancel
Notes	Factory cables cannot be deleted.

12 Test Mode Soft Keys

The Test Mode menu provides user presets, optional dedicated test modes for advanced transmission protocols, optional AutoTune automated test and alignment software for manufacturer-specific radios, and AutoScript, an internal monitor and control application. This chapter contains detailed descriptions of the soft keys accessible in each menu. Each soft key is defined, along with its range, discrete, default, and saved state values.

"Presets Soft Keys" on the next page enable loading, saving, and creating custom presets to expedite testing.

"Test Mode Soft Keys" on page 581 offer access to many digital mobile radio formats with links to their individual soft key references.

"AutoTune Soft Keys" on page 773 enable an optional automated test and alignment software application for manufacturer-specific radios.

"AutoScript Soft Keys" on page 781 enable monitor and control (M&C) script execution from within the R8200.

Presets Soft Keys

The Presets menu allows you to load, save, and create custom presets to expedite testing. Presets are a convenient tool for storing and recalling complex analyzer configurations. They are especially useful when several unique operating configurations are required in a test environment. Presets ensure a fast and accurate method of configuring the analyzer for multiple test applications. To save time and avoid errors, the R8200 can store over 100 preset configurations.

Save Configuration As (Presets submenu)

Displays a dialog where you can name a preset and store it.

Range	A-Z and 0-9
Saved State	Saved with instrument state
Notes	Presets are persistent across system cycles. If any Presets are present, they can be highlighted for further action using the arrow keys or the tuning knob. If no presets are present, the analyzer powers up in the default factory configuration. Otherwise, the last Preset loaded or saved before the unit was powered down is used to configure the analyzer. Names cannot have spaces or blanks between characters. Pressing **Enter** adds the new Preset to the list while **Esc** cancels the entry.

Load Selected Preset (Presets submenu)

Loads the highlighted preset and configures the analyzer per the preset file.

Notes	The selected Preset becomes the new default configuration on power up unless a different one is chosen or saved before powering down the analyzer.

Save As Selected Preset (Presets submenu)

Saves the current parameter configuration to the highlighted preset.

CAUTION This will overwrite the highlighted preset without prompting the user.

Load Factory Configuration (Presets submenu)

Configures the analyzer per the factory default settings.

Notes	This is the default on power up unless a different Preset is loaded or saved before powering down the analyzer.

Delete Selected Preset (Presets submenu)

Deletes the highlighted preset.

Notes	A prompt will be displayed to confirm you want to delete the highlighted preset.

Test Mode Soft Keys

Activates a horizontal soft key menu where you can select from a variety of test modes and applications including Standard (Monitor Mode), DMR, Project 25, P25 Trunk, NXDN, NXDN™ Trunk, TETRA Base Station, TETRA DMO, TETRA TMO, dPMR, P25 II, PTC-ITCR, PTC-ACSES, and AVIONICS.

Standard

Activates Monitor Mode. Refer to **"8 Monitor Mode Soft Keys" on page 330** for a complete soft key reference.

DMR

Activates the DMR Test Mode. Refer to **"DMR Zone Soft Keys" on page 583** for a complete soft key reference.

Project 25

Activates the Project 25 Test Mode. Refer to **"PROJECT 25 Zone Soft Keys" on page 602** for a complete soft key reference.

P25 Trunk

Activates the P25 Trunk Test Mode. Refer to **"P25 Trunk Zone Soft Keys" on page 625** for a complete soft key reference.

NXDN™

Activates the NXDN™ Test Mode. Refer to **"NXDN™ Zone Soft Keys" on page 639** for a complete soft key reference.

NXDN™ Trunk

Activates the NXDN™ Trunk Test Mode. Refer to **"NXDN™ Trunk Zone Soft Keys" on page 653** for a complete soft key reference.

TETRA Base Station

Activates the TETRA Base Station Test Mode. Refer to **"TETRA Base Station Test Mode Soft Keys" on page 663** for a complete soft key reference.

TETRA DMO

Activates the TETRA DMO Test Mode. Refer to **"TETRA DMO Zone Soft Keys" on page 679** for a complete soft key reference.

TETRA TMO

Activates the TETRA TMO Test Mode. Refer to **"TETRA TMO Test Mode Soft Keys" on page 691** for a complete soft key reference.

dPMR

Activates the dPMR Test Mode. Refer to **"dPMR Zone Soft Keys" on page 713** for a complete soft key reference.

P25 II

Activates the P25 II Test Mode. Refer to **"P25 II Zone Soft Keys" on page 726** for a complete soft key reference.

PTC-ITCR

Activates the PTC-ITCR Test Mode. Refer to **"PTC-ITCR Zone Soft Keys" on page 742** for a complete soft key reference.

PTC-ACSES

Activates the PTC-ACSES Test Mode. Refer to **"PTC-ACSES Zone Soft Keys" on page 747** for a complete soft key reference.

AVIONICS

Activates the AVIONICS Test Mode. Refer to **"AVIONICS Test Mode Soft Keys" on page 757** for a complete soft key reference.

DMR Zone Soft Keys

This section contains detailed descriptions of the soft keys accessible in the DMR Zone during transmitter testing with the R8200 in Monitor Mode, and receiver testing with the R8200 in Generate Mode. Each DMR soft key is defined, along with its range, discrete, default, and saved state values.

"DMR Zone Soft Keys for Transmitter Test" on the next page includes the parameters associated with testing the DMR radio's transmitter with the R8200 in Monitor Mode. For standard Monitor Mode soft key definitions, see **"8 Monitor Mode Soft Keys" on page 330**.

"DISPLAY Zone Soft Keys for DMR Transmitter Test" on page 587 includes the parameters associated with specialized display configurations for quick visual verification of DMR transmitter performance. For standard DISPLAY Zone soft key definitions, see **"DISPLAY Zone Soft Keys for Monitor Mode" on page 362**.

"METER Zone Soft Keys for DMR Transmitter Test" on page 593 includes the parameters associated with specialized metering configurations offering focused presentations of basic RF and baseband DMR transmitter characteristics. For standard METER Zone soft key definitions, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

"DMR Zone Soft Keys for Receiver Test" on page 594 includes the parameters associated with testing the DMR radio's receiver with the R8200 in Generate Mode. For standard Generate Mode soft key definitions, see **"9 Generate Mode Soft Keys" on page 390**.

DMR Zone Soft Keys for Transmitter Test

These tests are performed with the R8200 in Monitor Mode. During DMR transmitter tests, the DMR Zone contains the controls for the DMR receiver.

Voice Loopback (DMR submenu)

Activates a horizontal soft key menu where you can select the Voice Loopback mode (U.S. patent 5703479).

Discrete Values	Off, Play, Record, Record & Play
Default	Off
Saved State	Saved with instrument state
Notes	Only available when UUT Configuration is set to MS Test. Once enabled, the R8200 automatically records an input message when the radio under test transmits a signal above the squelch level setting. A Voice Loop progress bar in the DMR Zone is bold when Voice Loopback is enabled. The maximum length of the recording is 10 seconds, and a light green progress bar shows the recording's progress. The recording continues if the transmission is longer, but only the most recent is retained. When the radio is un-keyed, the R8200 automatically switches to Generate Mode and transmits the captured input message back to the radio. The position of the played back recording is displayed with a dark green progress bar. When the recorded message has been played and a three-second settling delay has passed, the analyzer automatically switches back to Monitor Mode so another message can be recorded. This provides a quick end–to-end test of the radio transmitter and receiver. Voice Loopback can also be used to quickly verify basic functionality of an encrypted message. The power Input Level of the received message is readjusted to maintain the power Output Level of the transmitted message. Voice Loopback overrides the Color Code (CC), Modulation Mode, and Test Pattern settings during playback. The R8200 captures and re-sends the Color Code, destination ID (address), and call

	type sent by the radio. For the radio to audibly reproduce the message, the radio must be set to a Group Call or an All Call channel. Off – Stops a recording or playback and disables the feature; the progress bar is grayed out. The last recording is preserved for the remainder of the session; it is lost if the R8200 is power cycled. Record (Monitor Mode only) – Disables the automatic switch to Generate Mode and subsequent playback. The last recording is automatically erased when a new input message is detected. Play (Generate Mode only) – Repeatedly plays and rewinds the last recorded message; speech recorded from a transmitting radio under test should be heard from its receiver if the radio is operating properly. This setting disables the automatic switch to Monitor Mode and subsequent recording. Record & Play – Automatically switches from Monitor Mode to Generate Mode to play a recording. It also switches from Generate Mode to Monitor Mode to make a new recording.

Mon Sync Pattern (DMR submenu)

Activates a horizontal soft key menu where you can select the DMR Mon Sync Pattern.

Discrete Values	MS Sourced Voice, MS Sourced Data, TDMA slot 1 Voice, TDMA slot 1 Data, TDMA slot 2 Voice, TDMA slot 2 Data
Default	MS Sourced Voice
Saved State	Saved with instrument state
Notes	BS Sourced Voice for a base station/repeater, or MS Sourced Voice for a portable/mobile station.

Copy CC to Generator (DMR submenu)

Sets the R8200 generator to use the last Color Code that was received in Monitor Mode.

Burst (DMR submenu)

Activates a horizontal soft key menu where you can select from a choice of six super frame bursts to display radio transmitter quality measurements.

Discrete Values	A, B, C, D, E, F
Default	A
Saved State	Saved with instrument state
Notes	The following measurements are made from the selected burst: Input Level, Constellation, Symbol Deviation, FSK Error, and Magnitude Error.

BER Test (DMR submenu)

Activates a horizontal soft key menu where you can control the operating state of Bit Error Rate Testing.

Discrete Values	Stop, Start
Default	Stop
Saved State	Saved with instrument state
Notes	This bit error rate test checks the modulation, encoding, and timing of the transmit signal during the data transmission period. When the BER Test is running, the radio transmitter under test must be placed into a Test Diagnostic Mode with the correct TX test pattern selected using the manufacturer's Radio Service Software (RSS) / MOTOTRBO™ Tuner. The test is done at nominal power with the radio transmitting the O.153 super frame test pattern into the service monitor. (It is acceptable to have an attenuator between the radio under test and the service monitor.) BER test results, the percentage of bit differences between the O.153 pattern and the bits of the synchronized TDMA slot of the received signal, are shown in the DMR Zone in the BER field.

UUT Configuration (DMR submenu)

Activates a horizontal soft key menu where you can select one of three UUT Configuration options.

Discrete Values	MS Test, BS Test, Repeater Live
Default	MS Test
Saved State	Saved with instrument state

DISPLAY Zone Soft Keys for DMR Transmitter Test

The DISPLAY Zone offers specialized displays during DMR transmitter testing with the R8200 in Monitor Mode. Their associated soft keys are described below.

Select Display (DISPLAY Zone menu)

Pressing this soft key activates a horizontal soft key menu where you can select the display mode.

Discrete Values	Spec An, Eye Diagram, Power Profile, Distribution Plot, Analysis Details, Protocol Details
Default	Spec An
Saved State	Saved with instrument state
Notes	Spec An is only available in Monitor Mode.

Spectrum Analyzer (DISPLAY Zone menu)

For Spectrum Analyzer soft key descriptions, see **"Spectrum Analyzer Soft Keys" on page 503**.

Eye Diagram (DISPLAY Zone menu)

Provides a visual display of the received signal and overlays the modulation response during two symbol periods over the four target crossing points for an ideal signal.

Saved State	Saved with instrument state
Notes	The Eye Diagram can indicate whether a transmitter has significant unbalances or offsets in the modulation circuitry by noting how tightly grouped the waveform is around the crossing points. Ensure that the Monitor Modulation Type in the Test Mode Zone (e.g., DMR Zone) is set for the expected receive signal in order to establish the appropriate symbol timing used to position the diagram on the horizontal axis.

Display Mode (Eye Diagram submenu)

When the display is set to Eye Diagram, pressing this soft key activates a horizontal soft key menu where you can select the Eye Diagram display mode.

Discrete Values	Normal, Fade Away
Default	Normal
Saved State	Saved with instrument state
Notes	Normal – Display updates continuously. Fade Away – Similar to the Persistence Mode on an Oscilloscope. The intensity of each trace fades away or decays as new traces are received. The effect is to intensify the display in the area where the waveform spends most of its time. Whenever the Display mode is changed, the R8200 reconfigures the presentation. This process takes approximately 10 seconds and is complete when the new setting appears in the Display mode field.

Power Profile (DISPLAY Zone menu)

Provides a power versus time plot of the transmitter.

Discrete Values	
Notes	The display is useful in assuring that near-far situations will not result in co-channel inter-slot interference on the alternate or non-transmission slot and that the power level will be adequate for acceptable BER performance. The scaling and position of the vertical power axis can be adjusted to inspect greater range or detail. The horizontal axis can be changed to view one or both slots including the additional ramp up/-down time. Display functions and markers are available for advanced analysis. See the Technical Specification: ETSI TS 102 361-1 Electromagnetic compatibility and Radio Spectrum Matters (ERM); Digital Mobile Radio (DMR) Systems; Part 1: "DMR Air Interface (AI) protocol," section 10.2.3 Burst timing on page 114.

Select View (Power Profile submenu)

When the display is set to Power Profile, pressing this soft key opens a horizontal soft key menu where you can select the slot(s) to view.

Discrete Values	Current, Alternate, Both
Default	Current
Saved State	Saved with instrument state

Notes	Although slots are alternating 30 milliseconds, the profile for a slot is 30.5 ms, divided into three regions for ramp-up (1.5 ms), burst (27.5 ms), and ramp-down (1.5 ms). Current – Provides the horizontal axis –0.25 ms to 30.25 ms with slot from 0 to 30 ms. Alternate – Provides the horizontal axis 29.75 ms to 60.25 ms with slot from 30 to 60 ms. Both – Provides the horizontal axis –0.25 ms to 60.25 ms with slots from 0 to 30 and 30 to 60 ms. Ramp times for a slot overlap the adjacent slots by 0.25 milliseconds.

Vertical Maximum (Power Profile submenu)

When the display is set to Power Profile, pressing this soft key opens the Vertical Scale dialog where you can adjust the maximum level for the top line of the vertical scale of the display.

Range	–120 dBm to +60 dBm in 1 dB increments
Default	50 dBm
Saved State	Saved with instrument state

Vertical Scale (Power Profile submenu)

When the display is set to Power Profile, pressing this soft key opens a horizontal soft key menu where you can select the vertical scale resolution for the display's major grid lines.

Range	10 dB/div, 5dB/div, 2 dB/div, 1 dB/div
Default	10 dB/div
Saved State	Saved with instrument state

Display Mode (Power Profile submenu)

When the display is set to Power Profile, pressing this soft key opens a horizontal soft key menu where you can select the display mode.

Discrete Values	Normal, Freeze, Max Hold, Average
Default	Normal
Saved State	Saved with instrument state
Notes	Normal – Display updates continuously. Freeze – Provides a snapshot of the current display indication and stops additional updates. In Freeze Mode, the R8200 reacquires data and updates the display whenever **Center Marker** or **Center Peak** is pressed. Max Hold – Enables the display to retain the highest peak signal amplitudes measured during successive sweeps. Average – Displays signal amplitudes as a rolling average of the peak amplitudes measured on each successive sweep. The average consists of one to five sweeps, shown beside the mode indication.

Marker Mode (Power Profile submenu)

When the display is set to Power Profile, pressing this soft key activates a horizontal soft key menu where you can select the Marker Mode.

Discrete Values	Off, Absolute, Delta, Delta dBm

Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. Absolute – Displays the frequency and absolute signal amplitude for each marker selected. Delta – Displays the frequency and amplitude difference between each pair of markers selected. Delta dBm – Displays the amplitude difference between each pair of markers selected. Depending on the installed options, up to four markers can be enabled and selected for positioning.

Toggle Marker (Power Profile submenu)

When the display is set to Power Profile, pressing this soft key cycles through the available markers to select a marker for repositioning along the trace using the horizontal arrow keys.

Distribution Plot (DISPLAY Zone menu)

Depicts the spread of symbols over time about each center. There are no configurable parameters for the distribution plot. For more information, see **"Distribution Plot" on page 153**.

Analysis Details (DISPLAY Zone menu)

Displays the measured deviation points for each data symbol and the Magnitude error for each data symbol. The nominal deviation points for each data symbol are provided on the screen as reference.

Protocol Details (DISPLAY Zone menu)

Details of the configuration during performance verification testing for documentation purposes.

METER Zone Soft Keys for DMR Transmitter Test

The METER Zone offers specialized meters during DMR transmitter testing with the R8200 in Monitor Mode. Their associated soft keys are described below.

Constellation (METER Zone menu)

Provides a visual representation of overall transmitter operation.

<table>
<tr><td>Saved State</td><td>Saved with instrument state</td></tr>
<tr><td>Notes</td><td>DMR radios broadcast voice and data using four frequency shift deviations of the carrier to represent symbols containing two data bits. Four red tick marks on the display represent the expected locations for the deviation states when the radio is transmitting data bit symbols using the modulation. White bars show the actual deviation measurement at symbol decision times. A tighter grouping around the red tick marks indicates more accurate transmitter performance.

The nominal deviation points for each data symbol are as follows:
<table>
<tr><th>Bits</th><th>Symbol</th><th>Deviation</th></tr>
<tr><td>01</td><td>+3</td><td>+1944 Hz</td></tr>
<tr><td>00</td><td>+1</td><td>+648 Hz</td></tr>
<tr><td>10</td><td>–1</td><td>–648 Hz</td></tr>
<tr><td>11</td><td>–3</td><td>+1944 Hz</td></tr>
</table></td></tr>
</table>

DMR Zone Soft Keys for Receiver Test

These tests are performed with the R8200 in Generate Mode. During DMR receiver tests, the DMR Zone contains controls for the DMR transmitter.

Voice Loopback (DMR submenu)

Activates a horizontal soft key menu where you can select the Voice Loopback mode.

Discrete Values	Off, Play, Record & Play
Default	Off
Saved State	Saved with instrument state
Notes	Only available when UUT Configuration is set to MS Test. Voice Loopback overrides the Color Code (CC), Modulation Mode, and Test Pattern settings during playback. The R8200 captures and resends the Color Code, destination ID (address), and call type sent by the radio. For the radio to audibly reproduce the message, the radio must be set to a Group Call or an All Call channel. Off – stops a recording or playback and disables the feature; the progress bar is grayed out. The last recording is preserved for the remainder of the session; it is lost if the R8200 is power cycled. Play – (Generate Mode only) repeatedly plays and rewinds the last recorded message; speech recorded from a transmitting radio under test should be heard from its receiver if the radio is operating properly. This setting disables the automatic switch to Monitor Mode and subsequent recording. Record & Play – automatically switches from Monitor Mode to Generate Mode to play a recording. It also switches from Generate Mode to Monitor Mode to make a new recording.

Color Code (DMR submenu)

Displays a dialog where you can set the DMR Color Code.

Range	0 to 15
Default	0
Saved State	Saved with instrument state
Notes	Color Code is digital ID information equivalent to CTCSS/PL and CDCSS/DPL of analog FM radio systems.

Modulation Mode (DMR submenu)

Activates a horizontal soft key menu where you can enable and disable DMR modulation.

Discrete Values	Off, Continuous
Default	Off
Saved State	Saved with instrument state

Test Pattern (DMR submenu)

Activates a horizontal soft key menu where you can select the DMR Test Pattern.

Discrete Values	1031 Hz Tone, Calibration (O.153 1%), O.153, Silence, BS Busy, BS Idle

Default	1031 Hz Tone
Saved State	Saved with instrument state
Notes	This field specifies the DMR-compliant test pattern generated by the R8200 to assess voice performance or test data transmission accuracy using BER measurements. When performing the BER test, the radio receiver under test must be placed in a Test Diagnostic Mode with the correct RX test pattern selected using the manufacturer's Radio Service Software (RSS) / MOTOTRBO™ Tuner to enable it to calculate BER internally. The calculated BER is then displayed by the radio or on the computer (as is the case for MOTOTRBO™ Tuner). For sensitivity tests, the R8200 can transmit a super frame test pattern, O.153 (V.52) for example, over its entire output power level range. This provides a measurement of the reference sensitivity (1% or 5% BER) for the radio. All patterns have the all-call destination with broadcast service option as a convenience to eliminate the need to reprogram the radio's ID. A horizontal submenu provides the following DMR compliant patterns: 1031 Hz Tone – A predefined super frame test pattern compatible with digital vocoder type AMBE+2™ that produces a 1031 Hz tone at the speaker of the receiver vocoder. It can be used to quickly check audio performance in the field. Calibration (O.153 1%) – A test pattern transmitted at the defined power level. –60 dBm for example, is used to verify internal BER calculations are operating correctly. The 1% BER super frame test pattern changes the value of every 100th O.153 information bit and the very last bit to yield 13 bit errors out of 1296 O.153 information bits (precisely 1.0030864%). O.153 – A super frame test pattern based on ITU-T O.153 (formerly CCITT V.52) used to perform BER calculations. Silence – A predefined super frame test pattern compatible with digital vocoder type AMBE+2™ that results in a silent output at the receiver vocoder. BS Busy – Emulates a base station that is fully occupied. If the radio is programmed to be compliant, when keyed the radio should report Base Station Busy. If not programmed to be com-

	pliant, the radio will transmit regardless of the base station busy signal. BS Idle - The radio searches for a signal from the base station before it will transmit. In Generate or Duplex Mode, the R8200 transmits two time slots, mimicking a base station that has no traffic on it. When PTT is pressed on the radio, the radio will transmit to the R8200. Without this test pattern the radio will not transmit.

UUT Configuration (DMR submenu)

Activates a horizontal soft key menu where you can select one of three UUT Configuration options.

Discrete Values	MS Test, BS Test, Repeater Live
Default	MS Test
Saved State	Saved with instrument state
Notes	MS Test – Use this selection when testing a user device (portable or mobile) BS Test – Use this selection when testing a base station or repeater while the BS is under control of test and diagnostic software. Repeater Live (option must be enabled) – Use this selection when testing a DMR repeater configured for normal operating mode. The Freedom DMR Live Repeater Test Mode configures the test analyzer to transmit a “wake” up burst at the repeater, synchronize to the repeater transmission and then transmit a selected test pattern into a selected slot. The analyzer will then perform all standard measurements on the repeated transmission. After the analyzer is synced to the repeater the technician can switch slots and adjust power output of analyzer to determine RX sensitivity of repeater.

Encode Configuration (DMR submenu)

When the UUT Configuration is set to Repeater Live, pressing this soft key opens the Transmit Configuration (Encoding) Table where you can enter Radio/Source ID, emergency, priority, slot number, slot to analyze, and call/target address.

Radio/Source ID (Encode Configuration submenu)

When the UUT Configuration is set to Repeater Live, pressing this soft key opens the Radio/Source ID dialog where you can set the Source ID transmitted in test patterns.

Range	1 to 16777216
Default	16777016
Saved State	Saved with instrument state

Emergency (Encode Configuration submenu)

When the UUT Configuration is set to Repeater Live, pressing this soft key opens the Emergency dialog where you can enable or disable the “Emergency” flag in the DMR standard Service Options field.

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state
Notes	Details of this field can be found in Table 7.11 of ETSI TS 102 361-2 v2.4.1 (2017-10). “Service Options” is available in the standard but it is not mandatory for use. Manufacturers may utilize propriety signaling methods for “Emergency” notifications. Check with the manufacture of the unit under test for the validity of the use of this feature.

Priority (Encode Configuration submenu)

When the UUT Configuration is set to Repeater Live, pressing this soft key opens the Priority dialog where you can select the priority level in the service options field.

Discrete Values	0, 1, 2, 3
Default	0
Saved State	Saved with instrument state
Notes	Where 0 = No priority and 3 = highest priority. Details of this field can be found in Table 7.11 of ETSI TS 102 361-2 v2.4.1 (2017-10). Service Options is available in the standard but its use is not mandatory. Manufacturers may utilize propriety signaling methods for Priority notifications. Check with the manufacture of the unit under test for the validity of the use of this feature.

Slot # (Encode Configuration submenu)

When the UUT Configuration is set to Repeater Live, pressing this soft key opens the Slot # dialog where you can select the slot to transmit into when testing with a repeater under Live Repeater Test Mode.

Discrete Values	1, 2
Default	1
Saved State	Saved with instrument state

Slot to Analyze (Encode Configuration submenu)

When the UUT Configuration is set to Repeater Live, pressing this soft key opens the Slot to Analyze dialog where you can select a slot for analysis.

Discrete Values	0, 1, 2
Default	0
Saved State	Saved with instrument state
Notes	0 – Automatic selection in which the analyzer will make measurements on same slot as in sync with based on “monitor sync pattern”. This is the recommended setting. When not set to 0 (Auto) the analyzer will sync to a slot with the expected monitor sync pattern then look to see if that slot matches the desired slot to analyze. If so, it will do nothing. If not, the analyzer will drop sync and attempt to sync to the opposite slot. Use this parameter only if both slots have the same “monitor sync pattern” and you want to see a specific slot. If the “monitor sync pattern” is only in ONE slot, and it does not match the requested slot to analyze, then the unit will repeatedly drop in and out of sync.

Target/Call Address (Encode Configuration submenu)

When the UUT Configuration is set to Repeater Live, pressing this soft key opens the Target/Call Address dialog where you can set the Call or Group ID in the transmission of the test pattern.

Range	0 to 16777215
Default	16777215 (All Call)
Saved State	Saved with instrument state

Reset to Defaults (Encode Configuration submenu)

When the UUT Configuration is set to Repeater Live, pressing this soft key resets all selections in the Encode Configuration Table to default values.

PROJECT 25 Zone Soft Keys

This section contains detailed descriptions of the soft keys accessible in the PROJECT 25 Zone during transmitter testing with the R8200 is in Monitor Mode, and receiver testing with the R8200 is in Generate or Duplex Mode. Each Project 25 soft key is defined, along with its range, discrete, default, and saved state values.

"PROJECT 25 Zone Soft Keys for Transmitter Test" on the next page includes the parameters associated with testing the Project 25 radio's transmitter with the R8200 in Monitor Mode. For standard Monitor Mode soft key definitions, see **"8 Monitor Mode Soft Keys" on page 330**.

"DISPLAY Zone Soft Keys for PROJECT 25 Transmitter Test" on page 606 includes the parameters associated with specialized display configurations for quick visual verification of Project 25 transmitter performance. For standard DISPLAY Zone soft key definitions, see **"DISPLAY Zone Soft Keys for Monitor Mode" on page 362**.

"METER Zone Soft Keys for PROJECT 25 Transmitter Test" on page 608 includes the parameters associated with specialized metering configurations offering focused presentations of basic RF and baseband Project 25 transmitter characteristics. For standard METER Zone soft key definitions, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

"PROJECT 25 Zone Soft Keys for Receiver Test" on page 614includes the parameters associated with testing the Project 25 radio's receiver with the R8200 in Generate or Duplex Mode. For standard Generate Mode soft key definitions, see **"9 Generate Mode Soft Keys" on page 390**. For standard Duplex Mode soft key definitions, see **"10 Duplex Mode Soft Keys" on page 440**.

PROJECT 25 Zone Soft Keys for Transmitter Test

These tests are performed with the R8200 in Monitor or Duplex Mode. During Project 25 transmitter tests, the PROJECT 25 Zone contains controls for the Project 25 receiver.

Mon Test Pattern (Project 25 submenu)

Activates a horizontal soft key menu where you can select the Project 25 monitor test pattern.

Discrete Values	1011 Hz Tone, Calibration (Tone 5%), Standard Tx (O.153/V.52), Silence, Modified 1011 Hz
Default	1011 Hz Tone
Saved State	Saved with instrument state
Notes	1011 Hz Tone – Standard tone framed test pattern of the 1011 Hz vocoder tone. Calibration (Tone 5%) – Test pattern derived from the standard 1011 Hz Tone test pattern to verify BER measurements are operating correctly. Every 20th bit is inverted to yield 172 errors out of 3456 bits resulting in a 4.976852% BER. Standard Tx (O.153/V.52) – Standard transmitter test pattern of continuously repeating 511-bit pseudo random number sequences based on ITU-T O.153 (formerly CCITT V.52). Silence – Framed test pattern for silence at the vocoder. Modified 1011 Hz – Provides 0% BER when testing a live base station.

Monitor Modulation Type (Project 25 submenu)

Activates a horizontal soft key menu where you can select the Project 25 monitor modulation type.

Discrete	C4FM, LSM, WCQPSK

Values	
Default	C4FM
Saved State	Saved with instrument state
Notes	The type specified is used in the DISPLAY Zone to enable selection of the Constellation Plot for complex modulation types (LSM and WCQPSK); it is also used by the Eye Diagram for horizontal positioning.

Reset Symbol Rate Error (Project 25 submenu)

Resets the R8200's symbol rate error.

Notes	This is necessary after the input signal changes such that it is discontinuous from when the measurement was started.

BER Test (Project 25 submenu)

Activates a horizontal soft key where you can stop or start bit error rate testing.

Discrete Values	Stop, Start
Default	Stop
Saved State	Saved with instrument state
Notes	When performing the BER test, the radio transmitter under test must be placed in a test diagnostic mode using the manufacturer's Radio Service Software (RSS). The transmission is compared against the Test Pattern specified in the P25 submenu. BER test results are shown as an error in % in the PROJECT 25 Zone.

Voice Loopback (Project 25 submenu)

Opens the Voice Loopback menu. Pressing this button a second time displays a dialog where you can enable and disable Voice Loopback.

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state
Notes	When performing the BER test, the radio transmitter under test must be placed in a test diagnostic mode using the manufacturer's Radio Service Software (RSS). The transmission is compared against the Test Pattern specified in the P25 submenu. BER test results are shown as an error in % in the PROJECT 25 Zone.

Play Last Recording (Voice Loopback submenu)

Pressing the soft key places the R8200 in Generate Mode and modulates the carrier with the most recently recorded voice channel data after the Voice Loopback function is enabled.

Saved State	Saved with instrument state
Notes	This selection appears only after a recording has been made. The total transmission time is equal to the length of recorded data, and a bar graph indicates the remaining transmission time during playback. Speech recorded from a transmitting P25 radio under test should be heard from its receiver if the radio is operating properly.

Record Duration (Voice Loopback submenu)

Sets the maximum length of a voice recording.

Range	1 to 10 s
Default	10 s
Saved State	Saved with instrument state
Notes	The recording continues if the transmission is longer than the duration, but only the most recent is retained.

Copy NAC to Generator (Project 25 submenu)

Sets the R8200 voice frame encoder's Network Access Code to the decoder's received NAC for transmission back to a radio under test so that the R8200 can receive transmissions from it.

DISPLAY Zone Soft Keys for PROJECT 25 Transmitter Test

The DISPLAY Zone offers specialized displays during Project 25 transmitter testing with the R8200 in Monitor Mode. Their associated soft keys are described below.

For Spectrum Analyzer and Oscilloscope soft key descriptions, see **"Spectrum Analyzer Soft Keys" on page 503** and **"Oscilloscope Soft Keys" on page 516**.

Select Display (DISPLAY Zone menu)

Pressing this soft key activates a horizontal soft key menu where you can select the display mode.

Discrete Values	Spec An, Oscilloscope, Bar Graphs, Eye Diagram, Voice Frame Decode, Constellation Plot, Distribution Plot
Default	Spec An
Saved State	Saved with instrument state
Notes	Spec An, Bar Graphs, Eye Diagram, Voice Frame Decode, Constellation Plot, and Distribution Plot are only available in Monitor and Duplex Mode.

Spectrum Analyzer (DISPLAY Zone menu)

For Spectrum Analyzer soft key descriptions, see **"Spectrum Analyzer Soft Keys" on page 503**.

Eye Diagram (DISPLAY Zone menu)

For Eye Diagram soft key descriptions, see **"Eye Diagram (DISPLAY Zone menu)" on page 588**.

Voice Frame Decode (DISPLAY Zone menu)

Opens the Voice Frame Decode menu where you can observe the decoded data from the P25 embedded signaling.

Notes	Rotate the tuning knob CCW to view the frame history in the DISPLAY Zone. Frame # indicates the position. Clockwise exits history. The Voice Frame fields are from the header word and interspersed status symbols. For more information, see **"Voice Frame Decode" on page 168**.

Constellation Plot (DISPLAY Zone menu)

Displays the EVM measurement and a graph showing the symbol constellation on the complex I/Q plane, a visual representation of overall transmitter operation when Monitor Modulation Type is complex (e.g., LSM or WCQPSK).

Constellation Display Mode (Constellation Plot submenu)

Activates a horizontal soft key menu where can select the Constellation Display presentation.

Discrete Values	Symbols, Samples, Trajectories
Default	Trajectories
Saved State	Saved with instrument state

Notes	Symbols – Displays the samples at the optimal symbol decision times as white dots. Correct transmitter operation should group them tightly around the eight ideal phase points. Samples – In addition to the symbol points, samples between symbol times three times their number are displayed as blue dots. Trajectories – Instead of sample points, blue lines connect adjacent samples to approximate the continuous transmitter output throughout the burst.

Distribution Plot (DISPLAY Zone menu)

Displays a graph showing the distribution of symbol deviations of the received signal grouped into frequency bins of 10 Hz or less (i.e., the frequency offset versus the rate of occurrence of that frequency). Each plot consists of at least a second of the most current data available. The protocol consists of four symbol values (–3, –1, +1, +3) at proportional carrier deviations. The four ideal symbol deviations are labeled at grid lines. Additional grid lines half way between labels divide the plot into four equal regions and mark the thresholds where symbol decisions change from one to the other. For example, in low power conditions, noise may cause a symbol's deviation to appear in the adjacent region, thus causing a bit error.

All distribution amounts are displayed by automatic adjustment of the vertical axis scaling to show the full amount of symbols falling into each bin. Distribution amounts are the percentage of the number of symbols whose deviation falls within that point's frequency bin based on the number of symbols in the analysis population. The better a signal is, the more symbols will actually land in the ideal bin to increase its percentage. Deviations that are past the graph edge limits (e.g., for noise if no signal exists) are collected and shown in the bin at the limit.

METER Zone Soft Keys for PROJECT 25 Transmitter Test

The METER Zone offers specialized meters during PROJECT 25 transmitter testing with the R8200 in Monitor Mode. Their associated soft keys are described below.

Power Meter (METER Zone menu)

Opens the Power Meter display and submenu.

Range (Power Meter submenu)

When the meter is set to Power Meter, pressing this soft key activates a horizontal soft key menu where you can select the power meter range.

Discrete Values	5, 10, 50, 150 W
Default	50 W
Saved State	Saved with instrument state
Notes	For best accuracy, disable the Pre-amplifier in Monitor Mode and set the Gen Port in Generate Mode to RF In/Out.

Voltmeter (METER Zone menu)

Opens the Voltmeter display and submenu.

Select Voltmeter Mode (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the voltage mode for the Voltmeter.

Discrete Values	AC Volts, DC Volts
Default	AC Volts
Saved State	Saved with instrument state
Notes	AC Volts measures AC voltage applied to the Meter In port. The dBm computation assumes an impedance of 600Ω.

Coupling (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a Coupling dialog menu where you can select the input voltage coupling.

Discrete Values	DC, AC
Default	DC
Saved State	Saved with instrument state

AC Range (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter AC voltage range.

Discrete Values	Auto, 1 V, 10 V, 70 V
Default	Auto
Saved State	Saved with instrument state
Notes	The range on AC and DC must be 1 or 10 Volts to use 600 Ohm Input Impedance.

Set dBr Reference (Voltmeter submenu)

When the meter is set to Voltmeter and Voltmeter mode is set to AC, pressing this soft key sets a reference input voltage.

Notes	When selected, dBm measurements are frozen, and a dBr indicator appears. The dBr indicates the normalized measurement between the reference input voltage and the current input voltage.

Clear dBr Reference (Voltmeter submenu)

When the meter is set to Voltmeter and Voltmeter mode is set to AC, pressing this soft key clears the dBr reference input voltage.

Voltage Units (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter range.

Discrete Values	Volts (V), Millivolts (mV), Decibel Volts (dBV)
Default	Volts (V)
Saved State	Saved with instrument state

DC Range (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter DC voltage range.

Discrete Values	Auto, 1 V, 10 V, 70 V
Default	Auto
Saved State	Saved with instrument state
Notes	The range on AC and DC must be 1 or 10 Volts to use 600 Ohm Input Impedance.

Decoder (METER Zone menu)

Opens the Decoder display and submenu.

Select Decoder Type (Decoder submenu)

When the meter is set to Decoder, pressing this soft key activates a horizontal soft key menu where you can select the decoder type.

Discrete Values	Voice Frame Decode
Default	Voice Frame Decode
Saved State	Saved with instrument state

Input Decoding (Decoder submenu)

When the meter is set to Decoder, pressing this soft key displays a Input Decoding dialog menu where you can select which decoding source to use.

Discrete Values	Internal, External
Default	Internal
Saved State	Saved with instrument state

RF Scan (METER Zone menu)

Opens the RF Scan display and submenu.

Start Frequency (RF Scan submenu)

When the meter is set to RF Scan, pressing this key displays the Start Frequency dialog where you can input the start frequency to be used in the RF scan.

Range	1 to 2991 MHz
Default	400 MHz
Saved State	Saved with instrument state

Stop Frequency (RF Scan submenu)

When the meter is set to RF Scan, pressing this key displays the Stop Frequency dialog where you can input the start frequency to be used in the RF scan.

Range	1 to 2991 MHz
Default	600 MHz
Saved State	Saved with instrument state

Scan (RF Scan submenu)

When the meter is set to RF Scan, pressing this soft key activates a horizontal soft key menu where you can select the scanning mode.

Discrete Values	Off, Single, Auto
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates scanning. Single – Sweep the span defined by the Start and Stop Frequency parameters once. Auto – Continuously sweeps the span defined by the Start and Stop Frequency parameters .

PROJECT 25 Zone Soft Keys for Receiver Test

These tests are performed with the R8200 in Generate of Duplex Mode. During Project 25 receiver tests, the PROJECT 25 Zone contains controls for the Project 25 receiver.

Gen Test Pattern (Project 25 submenu)

Activates a horizontal soft key menu where you can select one of seven TIA/EIA-102.CAAA compliant predefined bit patterns for BER testing of a P25 radio in Receive mode.

Discrete Values	1011 Hz Tone, Calibration (Tone 5%), Standard Tx (O.153/V.52), Silence, Symbol Rate, Low Deviation, C4FM Fidelity
Default	1011 Hz Tone
Saved State	Saved with instrument state
Notes	To receive framed test patterns generated from the R8200, the radio under test must be programmed to the same Network Access Code (NAC). 293 is the default in the R8200; this will break the radio's selective squelch so the tone or pattern can be reproduced in the audio circuits. The following patterns are available: 1011 Hz Tone - Standard tone framed test pattern of the 1011 Hz vocoder tone. Calibration (Tone 5%) - Derived from the standard 1011 Hz Tone test pattern used to verify BER measurements are operating correctly. Every 20th bit is inverted to yield 172 errors out of 3456 bits resulting in a 4.976852% BER. Standard Tx (O.153/V.52) - Standard transmitter test pattern of continuously repeating 511-bit pseudorandom number sequences based on ITU-T O.153 (formerly CCITT V.52). Silence - Famed test pattern for silence at the vocoder. Symbol Rate - Maximum frequency deviation test pattern of a continuously repeating stream of high deviation symbols (+3, +3, –3, –3, …).

	Low Deviation - Continuously repeating stream of low deviation symbols (+1, +1, –1, –1, …) for a 1/3 maximum frequency deviation. C4FM Mod Fidelity - Continuously repeating 24 bit sequence (12 symbols) used for measuring C4FM modulation fidelity (+3, +3, -3, +1, +1, +3, –1, +3, –3, –1, –3,–3). Two additional TIA/EIA-102.CAAA compliant bit patterns can easily be created for testing a P25 radio in Receive Mode by using the procedure below: 1. Set Test Pattern to 1011 Hz Tone. 2. Set Voice Frame Encoder, Status Symbols as specified below. For compliance, the NAC and other voice frame fields should be defaults. Busy – Provides channel busy information. Idle – Provides channel idle information. Beware that one bit (2374) of this pattern will differ from TIA/EIA-102.CAAA (1.3.3.6 e) Standard Idle Test Pattern. These test patterns allow subscriber alignment for Automatic Frequency Control.

Generate Modulation Type (Project 25 submenu)

Displays the Generate Modulation Type dialog where you can select the desired type of modulation for the generated signal required by the receiver.

Discrete Values	C4FM, LSM, WCQPSK
Default	C4FM
Saved State	Saved with instrument state

Modulation Mode (Project 25 submenu)

Activates a horizontal soft key menu where you can enable and disable Project 25 modulation.

Discrete Values	Off, Continuous, Burst
Default	Off
Saved State	Saved with instrument state
Notes	Enabling a test pattern in Generate Mode will erase any previously captured Voice Recordings.

NAC (Project 25 submenu)

Displays the NAC dialog where you can set the Network Access Code (NAC) to match the radio or system under test.

Range	0x000 to 0xFFF
Default	0x293
Saved State	Saved with instrument state
Notes	In Generate Mode, the NAC soft key is hidden, and its display value is grayed out for unmodifiable test pattern selections (e.g., Calibration).

Voice Frame Encoder (Project 25 submenu)

Accesses a P25 Voice Frame Encoder to allow editing of embedded signaling information contained in the R8200 P25 voice frames, allowing the R8200 Voice Frame configuration to match the radio or system under test.

Notes	In Generate Mode, the Voice Frame Encoder soft key is hidden for unmodifiable test pattern selections (e.g., Calibration).

NAC (Voice Frame Encoder submenu)

Displays a dialog where you can set the Network Access Code (NAC) to match the radio or system under test.

Range	0x000 to 0xFFF
Default	0x293
Saved State	Saved with instrument state

Key ID (Voice Frame Encoder submenu)

When encryption is used, this key identifies the specific encryption key used when multiple keys are present on the encryption modules.

Range	0x0000 to 0xFFFF
Default	0x0000
Saved State	Saved with instrument state

Algorithm ID (Voice Frame Encoder submenu)

When encryption is used, this key identifies the specific encryption algorithm used in the system.

Discrete Values	0x00 to 0xFF
Default	0x80
Saved State	Saved with instrument state
Notes	Hexadecimal 80 is the default value, indicating no encryption algorithm is used. The range of values is from hexadecimal 00 to FF.

Status Symbols (Voice Frame Encoder submenu)

Activates a horizontal soft key menu where you can select the status of the inbound channel when the R8200 emulates a P25 repeater.

Discrete Values	0, 1, 2, 3
Default	0
Saved State	Saved with instrument state
Notes	0 – Unknown Talkaround 1 – Busy 2 – Unknown In/Out 3 – Idle

Low Speed Data (Voice Frame Encoder submenu)

Displays a dialog where you can enter custom user data not defined by the Common Air Interface (CAI).

Range	0x00000000 to 0xFFFFFFFF
Default	0x00000000
Saved State	Saved with instrument state

Talk Group ID (Voice Frame Encoder submenu)

Displays a dialog where you can select the Talk Group ID (TGID).

Discrete Values	0x0000 to 0xFFFF
Default	0x0001
Saved State	Saved with instrument state
Notes	The value entered is used for the header word as well as the Link Control word (if applicable).

MFID (Voice Frame Encoder submenu)

Displays a dialog where you can enter Manufacturer ID from assigned list.

Range	0x00 to 0xFF
Default	0x00
Saved State	Saved with instrument state
Notes	The value entered is used for the header word as well as the Link Control word (if applicable). The value entered is transmitted even if the Implicit MFID bit is set (SF=1); it is the receiver's responsibility to ignore it.

Raw (Hex) (Voice Frame Encoder submenu)

Displays the Raw (Hex) dialog where you can enter 18 hexadecimal digits into the Link Control Opcode field.

Range	Any 18-digit hexadecimal
Default	000000000001000001
Saved State	Saved with instrument state

Notes	RAW soft key is not displayed until Raw is chosen as the Link Control Opcode. 0 - GRP_V_CH_USR (Group Voice Channel User) message, which indicates the user of this channel for group voice traffic, has the following fields: SF (MFID Format), Service Options, S (Explicit Source ID), Source Address (SID). Note: Manufacturer's ID and Group Address are specified in the Voice Frame Setup above, MFID and Talk Group ID respectively.

The Voice Frame fields are from the header word and interspersed status symbols. Although encryption is not supported, Header Word fields and the Link Control Format (LCF) will be displayed correctly because they are not subject to encryption. Therefore, if these fields indicate encryption, other fields will not be displayed correctly. Fields that are subject to encryption include the vocoder information and Link Control information content. See the table below.

Field	Mnemonic	Bits	Notes
Network Identifier	NID	16	
Network Access Code	NAC	12	293=Default
Data Unit ID	DUID	4	0=Header Data Unit
Header Word		120	
Message Indicator	MI	72	Encryption is not supported
Manufacturer's ID	MFID	8	Also copied to Link Control
Algorithm ID	ALGID	8	Encryption is not supported
Key ID	KID	16	Encryption is not supported
Talk-group ID	TGID	16	Also copied to Link Control
Link Control	LC	72	Format varies
Low Speed Data	LSD	32	
Status Symbols (6)	SS	12	2 bits after every 70 bits

Link Control Opcode (Voice Frame Encoder submenu)

Displays a dialog where you can select the Link Control Opcode.

Discrete	Raw, 0 – LC_GRP_V_CH_USR, 3 – LC_U2U_V_CH_USR

Values	
Default	0 – LC_GRP_V_CH_USR
Saved State	Saved with instrument state
Notes	The User Voice Call fields are from the Link Control code word. Raw – Displays all nine bytes directly; subsequent fields display the same information in individual fields according to the Link Control opcode (LCO), if applicable. Raw allows the information fields to be entered directly as 18 hex digits. 0 – LC_GRP_V_CH_USR (Group Voice Channel User) – Indicates the user of this channel for group voice traffic on both inbound and outbound messages. 3 – LC_U2U_V_CH_USR (Unit to Unit Voice Channel User) – Indicates the user of this channel for unit to unit voice traffic, on both inbound and outbound messages and on conventional and trunked systems.

P25 Link Control Fields for LCO=1 are shown in the table below.

Field	Mnemonic	Bits	Notes
Format	LCF	8	
Protected flag	P	1	Encryption is not supported
Standard Format	SF	1	0=specification
Opcode	LCO	6	0=specification
Manufacturer's ID	MFID	8	Same as Header Word's MFID
Service Options		8	
Emergency	E	1	MSB
Protected	P	1	Encryption is not supported
Duplex	D	1	
Mode	M	1	
Reserved	R	1	

Field	Mnemonic	Bits	Notes
Priority Level		3	0 to 7 (lowest)
Reserved		8	
Group Address		16	Same as Header Word's TGID
Source Address		24	Also Source ID (SID)

P25 Link Control Fields for LCO=3 are shown in the table below.

Field	Mnemonic	Bits	Notes
Format	LCF	8	
Protected flag	P	1	Encryption is not supported
Standard Format	SF	1	0=specification
Opcode	LCO	6	3=specification
Manufacturer's ID	MFID	8	Same as Header Word
Service Options		8	
Emergency	E	1	Hex 80; MSB
Protected	P	1	Hex 40; Encryption is not supported
Duplex	D	1	Hex 20
Mode	M	1	Hex 10
Reserved	R	1	
Priority Level		3	00 to 07; highest to lowest
Target Address		24	Also Destination ID (DID)
Source Address		24	Also Source ID (SID)

SF – MFID Format (Voice Frame Encoder submenu)

Displays a dialog where you can select the SF – MFID Format.

Discrete Values	0 – Explicit Format, 1 – Standard MFID

Default	0 – Explicit Format
Saved State	Saved with instrument state
Notes	Not available when Link Control Opcode is set to Raw.

Service Options (Voice Frame Encoder submenu)

Displays a dialog where you can set the type of services in use by the subscriber unit.

Range	0x00 to 0xFF
Default	0x00
Saved State	Saved with instrument state
Notes	Not available when Link Control Opcode is set to Raw.

The Service Options entry is the hexadecimal sum of the values chosen from the table below.

Option	Status
E - Emergency	00 = Normal 80 = Emergency status requiring special processing
P – Protected (encrypted)	00 = Non-protected mode 40 = Protected mode
D – Duplex	00 = Half-duplex: the subscriber unit is capable of transmitting but not simultaneously receiving on the assigned channel. 20 = Full duplex: the subscriber unit is capable of transmitting and receiving simultaneously on the assigned channel.
M – Mode: data mode of service	00 = Circuit mode: the resources shall support circuit switch operation. 10 = Packet mode: the resources shall support packet switch operation.
R – Reserved	0 = Set by the sender and ignored by the receiver
P-L – Priority Level	0 – 7 = The relative importance attribute to the service that is being requested

S – Explicit Source ID (Voice Frame Encoder submenu)

Displays a dialog where you can select the Explicit Mode for the Source Address in the opcode.

Discrete Values	0 – Not Required, 1 – Required
Default	0 – Not Required
Saved State	Saved with instrument state
Notes	When set to “0- Not Required,” the Source ID address is sufficient to completely represent the requesting unit on the current P25 system. When set to “1 – Required,” the next Link Control message will have a Source ID extension carrying the complete SUID of the requesting unit.

Source Address (Voice Frame Encoder submenu)

Displays a dialog where you can enter the Source ID address of the requesting unit.

Range	0x000000 to 0xFFFFFF
Default	0x000001
Saved State	Saved with instrument state

Reset to Defaults (Voice Frame Encoder submenu)

Resets all Project 25 Voice Frame data fields to their default values.

Notes	All Voice Frame Encoder values are reset to default values without asking for confirmation.

P25 Trunk Zone Soft Keys

This section contains detailed descriptions of the soft keys accessible in the Project 25 Trunk Zone during transmitter testing with the R8200 is in Monitor Mode, and receiver testing with the R8200 is in Generate Mode. Each Project 25 Trunk soft key is defined, along with its range, discrete, default, and saved state values.

"P25 Trunk Zone Soft Keys" above includes the parameters associated with testing the Project 25 Trunk radio's transmitter with the R8200 in Monitor Mode. For standard Monitor Mode soft key definitions, see **"8 Monitor Mode Soft Keys" on page 330**.

"DISPLAY Zone Soft Keys for P25 Trunk for Transmitter Test" on page 637 includes the parameters associated with specialized display configurations for quick visual verification of P25 Trunk transmitter performance. For standard DISPLAY Zone soft key definitions, see **"DISPLAY Zone Soft Keys for Monitor Mode" on page 362**.

"METER Zone Soft Keys for P25 Trunk Transmitter Test" on page 638 includes the parameters associated with specialized metering configurations offering focused presentations of basic RF and baseband P25 Trunk transmitter characteristics. For standard METER Zone soft key definitions, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

P25 Trunk Zone Soft Keys for Transmitter Test

P25 Trunk Mode simulates the functions of a Project 25 central controller with the control and voice channel protocols needed for various tests. These tests are performed with the R8200 in Duplex Mode. During P25 Trunk tests, the P25 Trunk Zone contains the controls for the P25 Trunk transceiver.

Generate Modulation Type (P25 Trunk submenu)

Opens a horizontal soft key menu were you can select the desired type of modulation for the generated signal required by the P25 Trunk transceiver.

Discrete Values	C4FM, LSM, WCQPSK
Default	C4FM
Saved State	Saved with instrument state

NAC (P25 Trunk submenu)

Opens the NAC (Hex) dialog where you can enter the hexadecimal value for the Network Access Code to match the radio or system under test.

Range	000 to FFF
Default	293
Saved State	Saved with instrument state
Notes	In Generate Mode, the NAC soft key is hidden, and its display value is grayed out for unmodifiable test pattern selections (e.g., Calibration).

Voice Call (P25 Trunk submenu)

Initiates a Voice Call test.

Discrete Values	Stop, Start
Default	Stop
Saved State	Saved with instrument state
Notes	The R8200 sends out a control channel message causing the subscriber radio to transition to a voice channel. The analyzer transmits a 1011 Hz tone that can be heard on the radio's speaker to confirm this transition.

Send Call Alert (P25 Trunk submenu)

Initiates a call alert to the subscriber radio under test to verify it is capable of registering and receiving a call alert from a P25 base station.

Saved State	Saved with instrument state
Notes	Messages in the METER Zone Status field show the activity during a Call Alert.

WACN ID (P25 Trunk submenu)

Sets the hexadecimal value for the Wide Area Communication Network IDentity (WACN ID) of the P25 system being tested.

Range	00000 to FFFFF
Default	00001
Saved State	Saved with instrument state

SYSTEM ID (P25 Trunk submenu)

Sets the hexadecimal value for the System IDentity within the WACN of the P25 system under test.

Range	000 to FFF
Default	001
Saved State	Saved with instrument state

WUID (P25 Trunk submenu)

Sets the hexadecimal value for the Working Unit IDentity (e.g., ID in the system).

Range	000000 to FFFFFF
Default	000001
Saved State	Saved with instrument state

RFSS ID (P25 Trunk submenu)

Sets the hexadecimal value for the RF Subsystem ID of the core infrastructure providing P25 service within the Wide Area Communication Network.

Range	00 to FF
Default	01
Saved State	Saved with instrument state

WGID (P25 Trunk submenu)

Sets the hexadecimal value for the identity of the site within the RF Subsystem.

Range	0000 to FFFF
Default	0001
Saved State	Saved with instrument state

SITE ID (P25 Trunk submenu)

Sets the hexadecimal value for the identity of the site within the RF Subsystem.

Range	00 to FF
Default	01
Saved State	Saved with instrument state

Bandplan Table (P25 Trunk submenu)

Activates a submenu with a table that defines the channel characteristics for the P25 frequency band from the perspective of the radio.

Saved State	Saved with instrument state
Notes	All of the fields are used to create the Identifier Update (IDEN_UP/IDEN_UP_VU) TSBK for transmit to the radio; some are used by the R8200 to emulate the base station. The default plan can be customized with soft keys as described below. If necessary, use RSS to read system values from the radio.

Band (Bandplan Table submenu)

Opens a horizontal soft key menu where you can select the Identifier Update TSBK format.

Discrete Values	800 MHz, 700 MHz, UHF/VHF
Default	800 MHz
Saved State	Saved with instrument state

Set Bandplan to Defaults (Bandplan Table submenu)

Sets Base Frequency, Channel Spacing, TX Offset, and Channel Identifier values to system defaults according to the specified Band setting. The following table describes the Trunk Band default values.

Band	Base Frequency (MHz)	Last Frequency (MHz)	Channel Spacing	Transmit Offset	Channel Identifier
800 MHz	851.006250	876.600000	6.250	–45	1
700 MHz	762.006250	787.600000	6.250	+30	2
UHF/VHF	450.000000	475.593750	6.250	–45	3

Bandwidth (Bandplan Table submenu)

Opens a horizontal soft key menu where you can select the frequency for the current band.

Discrete Values	6.25 kHz, 12.5 kHz
Default	12.5 kHz
Saved State	Saved with instrument state

Base Frequency (Bandplan Table submenu)

Sets the radio’s receive frequency for channel number 0.

Range	250 kHz to 1 GHz
Default	851.006250 MHz
Saved State	Saved with instrument state

Channel Spacing (Bandplan Table submenu)

Sets the frequency distance between adjacent channels in 0.125 kHz increments.

Range	0.125 kHz to 511.875 kHz
Default	6.250 kHz
Saved State	Saved with instrument state
Notes	This is used to compute the channel frequency from the channel number (or vice versa).

Transmit Offset (Bandplan Table submenu)

Sets the frequency offset from the radio receive frequency to the radio transmit frequency.

Range	–99.99999 MHz to 99.9999 MHz
Default	–45 MHz
Saved State	Saved with instrument state
Notes	Conversely, the setting defines the offset from the base station transmit frequency to the base station receive frequency. Radio TX frequency = Radio RX frequency + Transmit Offset Base Station TX frequency = Base Station RX frequency – Transmit Offset

Channel Identifier (Bandplan Table submenu)

Sets the channel plan number.

Range	1 to 16
Default	1, 2, 3
Saved State	Saved with instrument state
Notes	This value is used as part of the channel definition in the voice channel grant message.

Identifier Update (P25 Trunk submenu)

Activates the Identifier Update that provides data to inform the subscriber unit of the parameters associated with a specific channel.

Discrete Values	On, Off
Default	Off
Saved State	Saved with instrument state
Notes	On – The IDEN_UP TSBK appropriate for the specified Bandplan (see Bandplan Table submenu) is transmitted on the control channel. The 700 MHz and 800 MHz bands use the 800/700 MHz format IDEN_UP TSBK with fields set as specified in the Bandplan Table; the UHF/VHF bands use the UHF/VHF MHz format IDEN_UP_VU TSBK. When Off – No IDEN_UP TSBK is transmitted on the control channel.

Control Chnl TX Frequency (P25 Trunk submenu)

Sets the base station control channel transmitter frequency.

Range	250 kHz to 1 GHz
Default	851.00625 MHz
Saved State	Saved with instrument state
Notes	The Control Chnl field displays the closest corresponding Control Channel number as determined by the Bandplan Table, which may result in a negative channel number if the specified frequency is less than the Bandplan Table's Base Frequency. The CCTx setting is updated accordingly or can be used to enter the channel number instead. Control Chnl TX Frequency = Radio Control Channel TX Frequency – Transmit Offset

Control Chnl RX Frequency (P25 Trunk submenu)

Sets the base station control channel receiver frequency.

Range	250 kHz to 1 GHz
Default	156 MHz
Saved State	Saved with instrument state

CCTx Channel (P25 Trunk submenu)

Sets the Control Channel number for the base station transmitter.

Range	0 to 4095
Default	0

Saved State	Saved with instrument state
Notes	The CCTx field displays the corresponding base station Control Channel Generate Frequency as determined by the Bandplan Table. The Control Chnl TX Frequency setting is updated accordingly or can be used to enter the frequency directly. Radio Generate Frequency = Base Frequency + Transmit Offset + Channel Spacing * CCTx Channel #

CCRx Channel (P25 Trunk submenu)

Sets the Control Channel number for the base station receiver.

Range	0 to 4095
Default	0
Saved State	Saved with instrument state

Voice Chnl TX Frequency (P25 Trunk submenu)

Sets the base station voice channel transmitter frequency .

Range	250 kHz to 1 GHz
Default	851.00625 MHz
Saved State	Saved with instrument state
Notes	The Voice Chnl field displays the closest corresponding Voice Channel number as determined by

	the Bandplan Table, which may result in a negative channel number if the specified frequency is less than the Bandplan Table's Base Frequency. The VCTx setting is updated accordingly or can be used to enter the channel number instead. Voice Chnl TX Frequency = Radio Voice Channel TX Frequency – Transmit Offset.

Voice Chnl RX Frequency (P25 Trunk submenu)

Set the base station voice channel receiver frequency.

Range	250 kHz to 1 GHz
Default	156 MHz
Saved State	Saved with instrument state

VCTx Channel (P25 Trunk submenu)

Sets the Voice Channel number for the base station transmitter.

Range	0 to 4095
Default	0
Saved State	Saved with instrument state

VCRx Channel (P25 Trunk submenu)

Sets the Voice Channel number for the base station receiver.

Range	0 to 4095
Default	0
Saved State	Saved with instrument state

Reset Symbol Rate Error (P25 Trunk submenu)

Resets the displayed symbol rate error to 0.00 MHz.

BER Test (P25 Trunk submenu)

Sets the operating state of the bit error rate test.

Discrete Values	Stop, Start
Default	Stop
Saved State	Saved with instrument state
Notes	Start – Displays a new P25 Trunk BER screen and submenu. When running, trunking operation ceases, and BER specific setting and display fields are available. Modulation Type, Modulation Mode, and Test Pattern settings are provided for testing receivers of base stations and radios that have been put into test mode with RSS. Stop – Ends the testing and restores the default screen/submenu. More in-depth BER testing of radios can be done in the R8200's Project 25 conventional Test Mode option. The Test Pattern setting, BER Test status, and calculated BER percentage are provided for testing base station and radio transmitters that have been put into Test Mode with RSS. Modulation Fidelity, Symbol Deviation, and Symbol Rate Error measurements are also available for the transmission signal being tested. BER test Monitor and Generate frequencies are specified via the RF Zone rather than the Bandplan Table.

BS Mode (P25 Trunk submenu)

Toggles the base station operation mode between implicit and explicit.

Discrete Values	Implicit, Explicit
Default	Implicit
Saved State	Saved with instrument state
Notes	Implicit – the radio in conjunction with the base station determine what channel/frequency pair the radio assigns to a particular network channel (a.k.a, Short Channel form). Explicit- the base station assigns the actual channel/frequency over the air by providing the exact TX and RX frequencies directly to the radio.

DISPLAY Zone Soft Keys for P25 Trunk for Transmitter Test

In P25 Trunk mode, the DISPLAY Zone shows the controls for the primary graticule measurement display or bar graphs. Use these soft keys to set your desired display.

Select Display (DISPLAY Zone menu)

Activates a horizontal soft key menu where you can select the display mode.

Discrete Values	Spec An, Oscilloscope, Eye Diagram, Distribution Plot
Default	Spec An
Saved State	Saved with instrument state

Spectrum Analyzer (DISPLAY Zone menu)

For Spectrum Analyzer soft key descriptions, see **"Spectrum Analyzer Soft Keys" on page 503**.

Oscilloscope (DISPLAY Zone menu)

For Oscilloscope soft key descriptions, see **"Oscilloscope Soft Keys" on page 516**.

Eye Diagram (DISPLAY Zone menu)

For Eye Diagram soft key descriptions, see **"Eye Diagram (DISPLAY Zone menu)" on page 588**.

Distribution Plot (DISPLAY Zone menu)

For Distribution Plot soft key descriptions, see **"Distribution Plot (DISPLAY Zone menu)" on page 592**.

METER Zone Soft Keys for P25 Trunk Transmitter Test

The METER Zone offers a specialized meter during P25 Trunk transmitter testing with the R8200 in Monitor Mode. The associated soft key is described below.

P25 Trunking Meter (METER Zone menu)

In P25 Trunk Test Mode, the METER Zone is preloaded with a P25 Trunking Meter.

NXDN™ Zone Soft Keys

This chapter contains detailed descriptions of the soft keys accessible in the NXDN™ Zone during transmitter testing with the R8200 is in Monitor Mode, and receiver testing with the R8200 is in Generate Mode. Each NXDN™ soft key is defined, along with its range, discrete, default, and saved state values.

"NXDN™ Zone Soft Keys for Transmitter Test" on the next page includes the parameters associated with testing the NXDN™ radio's transmitter with the R8200 in Monitor Mode. For standard Monitor Mode soft key definitions, see **"8 Monitor Mode Soft Keys" on page 330**.

"NXDN™ Zone Soft Keys" above includes the parameters associated with specialized display configurations for quick visual verification of NXDN™ transmitter performance. For standard DISPLAY Zone soft key definitions, see **"DISPLAY Zone Soft Keys for Monitor Mode" on page 362**.

"METER Zone Soft Keys for NXDN™ Transmitter Test" on page 644 includes the parameters associated with specialized metering configurations offering focused presentations of basic RF and baseband NXDN™ transmitter characteristics. For standard METER Zone soft key definitions, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

"NXDN™ Zone Soft Keys for Receiver Test" on page 649 includes the parameters associated with testing the NXDN™ radio's receiver with the R8200 in Generate Mode. For standard Generate Mode soft key definitions, see **"9 Generate Mode Soft Keys" on page 390**.

NXDN™ Zone Soft Keys for Transmitter Test

These tests are performed with the R8200 in Monitor Mode. During NXDN™ transmitter tests, the NXDN™ Zone contains controls for the NXDN™ receiver.

Bit Rate (NXDN™ submenu)

Selects the bit rate used by the NXDN™ radio.

Discrete Values	4800 bps, 9600 bps
Default	4800 bps
Saved State	Saved with instrument state
Notes	Use 4800 bps for 6.25 kHz channel and 9600 bps for 12.5 kHz channel.

Copy RAN to Generator (NXDN™ submenu)

Copies the Radio Access Number of the device under test to the generator.

Mon Test Pattern (NXDN™ submenu)

Provides selection of bit patterns for testing the radio in Transmit Mode while under Radio Service Software (RSS) control.

Discrete Values	1031 Hz Tone, 1011 Hz Tone, Calibration (0.153 2%), 511 (0.153/PN9)
Default	1031 Hz Tone
Saved State	Saved with instrument state

Notes	1031 Hz Tone is the framed test pattern of the 1031 Hz half-rate vocoder tone (NXDN™ CAI compliant). 1011 Hz Tone (Only selectable for Bit Rate 9600 bps) is the framed test pattern of the 1011 Hz full-rate vocoder tone (NXDN™ CAI compliant). Calibration (O.153 2%) is a test pattern derived from the 511 (O.153) pattern to yield a 2.005871% BER used to verify BER measurements are operating correctly. 511 (O.153/PN9) is the unframed test pattern of continuously repeating 511-bit pseudo random number sequences generated with a nine-bit shift register (PN9) based on ITU-T O.153 (formerly CCITT V.52) used to perform BER testing for checking the modulation, encoding, and timing of the transmit signal (NXDN™ CAI compliant).

BER Test (NXDN™ submenu)

Controls the operating state of Bit Error Rate (BER) testing.

Discrete Values	Stop, Start
Default	Stop
Saved State	Saved with instrument state
Notes	This Bit Error Rate test checks the modulation, encoding, and timing of the transmit signal during the data transmission period. When performing the BER Test, the radio transmitter under test must be placed into a test diagnostic mode with the correct TX test pattern selected using the manufacturer's Radio Service Software (RSS). The test is done at nominal power with the radio transmitting the test pattern into the service monitor. (It is acceptable to have an attenuator between the radio under test and the service monitor.) BER test results, the percentage of bit differences between the bits of the selected Test Pattern and the bits from the received synchronized FDMA signal, are shown in the NXDN™ Zone in the BER field.

Voice Loopback (NXDN™ submenu)

Enables the Voice Loopback NXDN™ feature (U.S. patent 5703479).

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state
Notes	Once enabled the R8200 automatically records voice channel data when the radio under test transmits a signal above the squelch level setting. A green Voice Playback Active indicator appears in the NXDN™ Zone when Voice Loopback is enabled on the Voice Loopback screen. The Record Duration setting determines the maximum length of the recording, and a bar graph meter shows the recording's progress. The recording continues if the transmission is longer than the duration, but only the most recent is retained. When the radio is un-keyed, the R8200 automatically switches to Generate Mode and transmits the captured voice channel information or speech back to the radio. This provides a quick end-to-end test of the NXDN™ radio transmitter and receiver. Voice channel recordings can be played back at any time by pressing the **Play Last Recording** soft key (this selection only appears after a recording has been made). Recorded information is lost if the is power cycled or if the Generate Mode is selected and a new test pattern is enabled by setting the Modulation Mode to Continuous or Burst.

Play Last Recording (Voice Loopback submenu)

Places the R8200 in Generate Mode and modulates the carrier with the most recently recorded voice channel data after the Voice Loopback function is enabled.

Saved State	Saved with instrument state
Notes	This selection appears only after a recording has been made. The total transmission time is equal to the length of recorded data, and a bar graph indicates the remaining transmission time during playback. Speech recorded from a transmitting NXDN™ radio under test should be heard from its receiver if the radio is operating properly.

Record Duration (Voice Loopback submenu)

Opens the Record Duration dialog where you can set the maximum length of a recording.

Discrete Values	1, 2, 3, 4, 5, 6, 7, 8, 9, 10 seconds
Default	5 seconds
Saved State	Saved with instrument state
Notes	If the transmission is longer than the configured time, only the most recent portion of the recording is retained.

DISPLAY Zone Soft Keys for NXDN™ Transmitter Test

In NXDN™ mode, the DISPLAY Zone shows the controls for the primary graticule measurement display or bar graphs. Use these soft keys to set your desired display.

Select Display (DISPLAY Zone menu)

Opens a horizontal soft key menu where you can select the display type.

Discrete Values	Spec An, Mod Scope, Oscilloscope, Bar Graphs, Eye Diagram
Default	Spec An
Saved State	Saved with instrument state
Notes	Spec An is only available in Monitor Mode.

Eye Diagram (DISPLAY Zone menu)

Provides a visual display of the received NXDN™ signal and overlays the modulation response during two symbol periods over the four target crossing points for an ideal NXDN™ signal. Navigate to the DISPLAY Zone while in NXDN™ mode to select the Eye Diagram for viewing with the other NXDN™ measurements on the main screen. The Eye Diagram can indicate whether a transmitter has significant unbalances or offsets in the modulation circuitry by noting how tightly grouped the waveform is around the crossing points.

Display Mode (Eye Diagram submenu)

Selects the display presentation.

Discrete Values	Normal, Fade Away
Default	Normal
Saved State	Saved with instrument state
Notes	Normal indicates that the display updates continuously. Fade Away is similar to the Persistence Mode on an Oscilloscope. The intensity of each trace fades away or decays as new traces are received. The effect is to intensify the display in the area where the waveform spends most of its time. Whenever the Display Mode is changed, the R8200 reconfigures the presentation. This process takes approximately 10 seconds and is complete when the new setting appears in the Display Mode field.

METER Zone Soft Keys for NXDN™ Transmitter Test

The METER Zone offers specialized meters during NXDN™ transmitter testing with the R8200. Their associated soft keys are described below.

Select Meter (METER Zone menu)

Opens a horizontal soft key menu where you can choose from a Power Meter, Voltmeter, or RF Scan Meter.

Discrete Values	Power Meter, Voltmeter, RF Scan Meter
Default	Power Meter
Saved State	Saved with instrument state

Power Meter (METER Zone menu)

Opens the Power Meter display and submenu.

Range (Power Meter submenu)

When the meter is set to Power Meter, pressing this soft key activates a horizontal soft key menu where you can select the power meter range.

Discrete Values	5, 10, 50, 150 W
Default	50 W
Saved State	Saved with instrument state
Notes	For best accuracy, disable the Pre-amplifier in Monitor Mode and set the Gen Port in Generate Mode to RF In/Out.

Voltmeter (METER Zone menu)

Opens the Voltmeter display and submenu.

Select Voltmeter Mode (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the voltage mode for the Voltmeter.

Discrete Values	AC Volts, DC Volts
Default	AC Volts
Saved State	Saved with instrument state
Notes	AC Volts measures AC voltage applied to the Meter In port. The dBm computation assumes an impedance of 600Ω.

Coupling (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a Coupling dialog menu where you can select the input voltage coupling.

Discrete Values	DC, AC
Default	DC
Saved State	Saved with instrument state

AC Range (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter AC voltage range.

Discrete Values	Auto, 1 V, 10 V, 70 V
Default	Auto
Saved State	Saved with instrument state
Notes	The range on AC and DC must be 1 or 10 Volts to use 600 Ohm Input Impedance.

Set dBr Reference (Voltmeter submenu)

When the meter is set to Voltmeter and Voltmeter mode is set to AC, pressing this soft key sets a reference input voltage.

Notes	When selected, dBm measurements are frozen, and a dBr indicator appears. The dBr indicates the normalized measurement between the reference input voltage and the current input voltage.

Clear dBr Reference (Voltmeter submenu)

When the meter is set to Voltmeter and Voltmeter mode is set to AC, pressing this soft key clears the dBr reference input voltage.

Voltage Units (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter range.

Discrete Values	Volts (V), Millivolts (mV), Decibel Volts (dBV)
Default	Volts (V)
Saved State	Saved with instrument state

DC Range (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter DC voltage range.

Discrete Values	Auto, 1 V, 10 V, 70 V
Default	Auto
Saved State	Saved with instrument state
Notes	The range on AC and DC must be 1 or 10 Volts to use 600 Ohm Input Impedance.

RF Scan (METER Zone menu)

Opens the RF Scan display and submenu.

Start Frequency (RF Scan submenu)

When the meter is set to RF Scan, pressing this key displays the Start Frequency dialog where you can input the start frequency to be used in the RF scan.

Range	1 to 2991 MHz
Default	400 MHz
Saved State	Saved with instrument state

Stop Frequency (RF Scan submenu)

When the meter is set to RF Scan, pressing this key displays the Stop Frequency dialog where you can input the start frequency to be used in the RF scan.

Range	1 to 2991 MHz
Default	600 MHz
Saved State	Saved with instrument state

Scan (RF Scan submenu)

When the meter is set to RF Scan, pressing this soft key activates a horizontal soft key menu where you can select the scanning mode.

Discrete Values	Off, Single, Auto
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates scanning. Single – Sweep the span defined by the Start and Stop Frequency parameters once. Auto – Continuously sweeps the span defined by the Start and Stop Frequency parameters .

NXDN™ Zone Soft Keys for Receiver Test

These tests are performed with the R8200 in Generate Mode. During NXDN™ receiver tests, the NXDN™ Zone contains controls for the NXDN™ transmitter.

Bit Rate (NXDN™ submenu)

Selects the bit rate used by the NXDN™ radio.

Discrete Values	4800 bps, 9600 bps
Default	4800 bps
Saved State	Saved with instrument state
Notes	Use 4800 bps for 6.25 kHz channel and 9600 bps for 12.5 kHz channel.

RAN (NXDN™ submenu)

Opens the RAN dialog where you can input a 6-bit Radio Access Number for the device under test.

Discrete Values	0 to 63
Default	1
Saved State	Saved with instrument state
Notes	Radio Access Number is a six-bit field in the NXDN™ protocol RTCH/RDCH frame. In a conventional system, it is digital ID information equivalent to CTCSS/PL and CDCSS/DPL of analog FM radio systems. Selecting a RAN value to use is equivalent to selecting a CTCSS/PL tone or DCS/DPL code in an analog system. The basic premise is that stations sharing the same frequency but using different numbers do not have to listen to each other. In the digital squelch scheme, a number is sent by a transmitter to control the squelch opening of a receiver. Then number is encoded and sent by the transmitter, then decoded and used by the receiver. When the scheme is used, the receiver must receive the programmed number or it will mute the audio output (i.e., the operator will not hear anything from the radio unless the transmission contained the programmed number). Selectable numbers are 0-63. Numbers 1-63 may be used to identify/access groups of radios. Zero is equivalent to digital CSQ; if the receiver uses zero, then all stations on the frequency are heard regardless of the transmitted number.

Gen Test Pattern (NXDN™ submenu)

Opens a horizontal soft key menu offering a selection of Generator bit patterns for testing the NXDN™ radio receiver.

Discrete Values	1031 Hz Tone, 1011 Hz Tone, Calibration (0.153 2%), 511 (0.153), 511 (0.153) Framed, Interference (Interfering Modulation Data Stream), Max Freq Deviation, 1/3 Freq Deviation
Default	1031 Hz Tone
Saved State	Saved with instrument state

Notes	1031 Hz Tone – Framed test pattern of the 1031 Hz half-rate vocoder tone (NXDN™ CAI compliant). 1011 Hz Tone (Only selectable for Bit Rate 9600 bps) – Framed test pattern of the 1011 Hz full-rate vocoder tone (NXDN™ CAI compliant). Calibration (O.153 2%) – Derived from the 511 (O.153) pattern to yield a 2.005871% BER used to verify BER measurements are operating correctly. 511 (O.153) - Unframed test pattern of continuously repeating 511-bit pseudo random number sequences generated with a nine-bit shift register (PN9) based on ITU-T O.153 (formerly CCITT V.52) used to perform BER testing for checking the modulation, encoding, and timing of the transmit signal (NXDN™ CAI compliant). 511 (O.153) Framed – Framed test pattern consisting of 73 384-bit frames that contain the 20-bit frame synchronization word and 364 bits of 52 copies of the 511-bit sequences (FSW + PN9) used to perform BER testing for checking the modulation, encoding, and timing of the transmit signal. Framed Interference (Interfering Modulation Data Stream) – 32767-bit pseudo-random number pattern defined by ITU-T. Max Freq Deviation – Maximum frequency deviation test pattern of a continuously repeating stream of high deviation symbols (+3, +3, –3, –3, …). 1/3 Freq Deviation – Continuously repeating stream of low deviation symbols (+1, +1, –1, –1, …) for a 1/3 maximum frequency deviation.

Modulation Mode (NXDN™ submenu)

Opens a horizontal soft key menu offering operating mode choices for Test Pattern modulation.

Discrete	Off, Continuous, Burst

Values	
Default	Off
Saved State	Saved with instrument state
Notes	Enabling a test pattern in Generate Mode will erase any previously captured Voice Recordings.

NXDN™ Trunk Zone Soft Keys

This chapter contains detailed descriptions of the soft keys accessible in the NXDN™ Trunk Zone during transmitter testing with the R8200 in Monitor Mode, and receiver testing with the R8200 in Generate Mode. Each NXDN™ Trunk soft key is defined, along with its range, discrete, default, and saved state values.

"NXDN™ Trunk Zone Soft Keys for Transmitter Test" on the next page includes the parameters associated with testing the NXDN™ Trunk radio's transmitter with the R8200 in Monitor Mode. For standard Monitor Mode soft key definitions, see **"8 Monitor Mode Soft Keys" on page 330**.

"DISPLAY Zone Soft Keys for NXDN™ Trunk" on page 661 includes the parameters associated with specialized display configurations for quick visual verification of DMR transmitter performance. For standard DISPLAY Zone soft key definitions, see **"DISPLAY Zone Soft Keys for Monitor Mode" on page 362**.

"METER Zone Soft Keys for NXDN™ Trunk Transmitter Test" on page 662 includes the parameters associated with specialized metering configurations offering focused presentations of basic RF and baseband NXDN™ Trunk transmitter characteristics. For standard METER Zone soft key definitions, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

NXDN™ Trunk Zone Soft Keys for Transmitter Test

During NXDN™ Trunk transmitter tests, the NXDN™ Trunk Zone contains controls for the NXDN™ Trunk receiver. During NXDN™ Trunk receiver tests, the NXDN™ Trunk Zone contains controls for the NXDN™ Trunk transmitter. These tests are performed with the R8200 in Duplex Mode.

Voice Call (NXDN™ Trunk submenu)

Controls the operating state of the Voice Call test.

Discrete Values	Stop, Start
Default	Stop
Saved State	Saved with instrument state
Notes	The R8200 sends out a control channel message causing the subscriber radio to transition to a voice channel. The analyzer transmits a 1031 Hz tone that should be heard on the radio to confirm this transition.

BER Test (NXDN™ Trunk submenu)

Controls the operating state of Bit Error Rate (BER) testing.

Discrete Values	Stop, Start
Default	Stop
Saved State	Saved with instrument state
Notes	Pressing Start displays a new NXDN™ Type C Trunk BER submenu. The default NXDN™ Type C Trunk Zone is changed to display BER specific data fields, including the Modulation Mode, selec-

	ted Test Pattern, BER Test status, and calculated BER percentage. The test patterns are provided for testing base stations and radios in test mode with RSS. More in-depth BER testing of radios can be done in the optional NXDN™ Test Mode. BER test Monitor and Generate Frequencies are specified via the RF Zone rather than the trunking-specific channel numbers.

Modulation Mode (BER Test submenu)

Controls the operating state of the BER modulation.

Discrete Values	Off, Continuous
Default	Off
Saved State	Saved with instrument state

Test Pattern (BER Test submenu)

Provides selection of an NXDN™ compliant predefined test pattern for BER testing of an NXDN™ radio in Transmit or Receive Mode.

Discrete Values	1031 Hz Tone, 1011 Hz Tone, Calibration (0.153 2%), 511 (0.153/PN9)
Default	1031 Hz Tone
Saved State	Saved with instrument state
Notes	Use BER Test to enable transmitter testing and Modulation Mode to control receiver testing. The following patterns are available:

	1031 Hz Tone is the framed test pattern of the 1031 Hz half-rate vocoder tone (NXDN™ CAI compliant). 1011 Hz Tone (Only selectable for Bit Rate 9600 bps) is the framed test pattern of the 1011 Hz full-rate vocoder tone (NXDN™ CAI compliant). Calibration (O.153 2%) is the test pattern derived from the 511 (O.153) pattern to yield a 2.005871% BER used to verify BER measurements are operating correctly. 511 (O.153/PN9) is the unframed test pattern of continuously repeating 511-bit pseudo random number sequences generated with a nine-bit shift register (PN9) based on ITU-T O.153 (formerly CCITT V.52) used to perform BER testing for checking the modulation, encoding, and timing of the transmit signal (NXDN™ CAI compliant).

BER Test (BER Test submenu)

Controls the operating state of the BER test.

Discrete Values	Stop, Start
Default	Stop
Saved State	Saved with instrument state
Notes	Pressing **Stop** ends the BER test and restores the default NXDN™ Type C Trunk submenu.

Send Status Inquiry (NXDN™ Trunk submenu)

Initiates a status inquiry to the subscriber radio under test to verify it is capable of registering and receiving a message from a NXDN™ base station.

Saved State	Saved with instrument state
Notes	Messages in METER Zone Status field show the activity during a Status Inquiry.

CCTx Channel (NXDN™ Trunk submenu)

Sets the Control Channel for the transmitter.

Range	0 to 1023
Default	1
Saved State	Saved with instrument state

VCTx Channel (NXDN™ Trunk submenu)

Sets the Voice Channel for the transmitter.

Range	0 to 1023
Default	1
Saved State	Saved with instrument state

Control Chnl TX Frequency (NXDN™ Trunk submenu)

Sets the base station control channel transmission frequency.

Range	250 kHz to 1 GHz

Default	851.00625 MHz
Saved State	Saved with instrument state
Notes	Control Chnl TX Frequency = Radio Control Channel TX Frequency – Transmit Offset.

Voice Chnl TX Frequency (NXDN™ Trunk submenu)

Sets the base station voice channel transmission frequency.

Range	250 kHz to 1 GHz
Default	851.00625 MHz
Saved State	Saved with instrument state
Notes	Voice Chnl TX Frequency = Radio Voice Channel TX Frequency – Transmit Offset

Transmit Offset (NXDN™ Trunk submenu)

Sets the frequency offset from the radio receive frequency to the radio transmit frequency in MHz.

Range	–99.99999 MHz to 99.9999 MHz
Default	–45 MHz
Saved State	Saved with instrument state
Notes	Defines the offset from the base station transmit frequency to the base station receive frequency. Radio TX frequency = Radio RX frequency + Transmit Offset Base Station TX frequency = Base Station RX frequency – Transmit Offset

System Code (NXDN™ Trunk submenu)

Sets the System Code within the NXDN™ system being tested.

Range	000 to 999
Default	1
Saved State	Saved with instrument state

Site Code (NXDN™ Trunk submenu)

Sets the identity of the site within the RF Subsystem.

Range	0 to 9
Default	1
Saved State	Saved with instrument state

Unit ID (NXDN™ Trunk submenu)

Sets the temporary Unit IDentity assigned by the R8200 to the subscriber unit being tested.

Range	0 to 65535
Default	1
Saved State	Saved with instrument state

Group ID (NXDN™ Trunk submenu)

Sets the temporary Group IDentity assigned by the R8200 to the subscriber unit being tested.

Range	0 to 65535
Default	1
Saved State	Saved with instrument state

Bit Rate (bps) (NXDN™ Trunk submenu)

Selects the system communication bit rate.

Discrete Values	4800 bps, 9600 bps
Default	4800 bps
Saved State	Saved with instrument state
Notes	4800 bps is used for 6.25kHz systems, and 9600 bps is used for 12.5kHz systems.

Voice Playback (NXDN™ Trunk submenu)

Sets the operating state of the Voice Playback feature.

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state
Notes	When the voice playback feature is turned On, voice traffic from the radio is recorded. At the end of the radio's transmission, the R8200 will initiate a voice call to the radio and replay the recorded audio. The feature may be turned Off if audio playback is not desired.

DISPLAY Zone Soft Keys for NXDN™ Trunk

In NXDN™ Trunk mode, the DISPLAY Zone shows the controls for the primary graticule measurement display or bar graphs. Use these soft keys to set your desired display.

Select Display (DISPLAY Zone menu)

Opens a horizontal soft key menu where you can select the display type.

Discrete Values	Spec An, Mod Scope, Oscilloscope, Bar Graphs, Eye Diagram
Default	Spec An
Saved State	Saved with instrument state
Notes	Spec An is only available in Monitor Mode.

Eye Diagram (DISPLAY Zone menu)

Provides a visual display of the received NXDN™ trunk signal and overlays the modulation response during two symbol periods over the four target crossing points for an ideal NXDN™ Trunk signal. Navigate to the DISPLAY Zone while in NXDN™ Trunk mode to select the Eye Diagram for viewing with the other NXDN™ measurements on the main screen. The Eye Diagram can indicate whether a transmitter has significant unbalances or offsets in the modulation circuitry by noting how tightly grouped the waveform is around the crossing points.

Display Mode (DISPLAY Zone menu)

Selects the display presentation.

Discrete Values	Normal, Fade Away

Default	Normal
Saved State	Saved with instrument state
Notes	Normal indicates that the display updates continuously. Fade Away is similar to the Persistence Mode on an Oscilloscope. The intensity of each trace fades away or decays as new traces are received. The effect is to intensify the display in the area where the waveform spends most of its time. Whenever the Display Mode is changed, the R8200 reconfigures the presentation. This process takes approximately 10 seconds and is complete when the new setting appears in the Display Mode field.

METER Zone Soft Keys for NXDN™ Trunk Transmitter Test

The METER Zone offers specialized meters during NXDN™ Trunk transmitter testing with the R8200 in Monitor Mode. Their associated soft keys are described below.

NXDN™ Trunking (METER Zone menu)

In NXDN™ Trunk Test Mode, the METER Zone is preloaded with a NXDN™ Trunking Meter.

TETRA Base Station Test Mode Soft Keys

This section contains detailed descriptions of the soft keys accessible in the TETRA Base Station Test Mode. Each TETRA Base Station soft key is defined, along with its range, discrete, default, and saved state values.

"TETRA Base Station Test Mode Soft Keys" above includes the parameters associated with testing the TETRA base station radio's transmitter while **"TETRA Base Station T1 Mode Soft Keys" on page 673** includes the parameters associated with testing the TETRA Base Station radio's transceiver.

TETRA Base Station

Opens the TETRA Base Station Test Mode Main Screen in Monitor Mode.

Discrete Values	Channel Plan, Test Limits, T1 Test, Main Screen
Default	Main Screen in Monitor Mode
Saved State	Saved with instrument state

Graphical Displays (TETRA Base Station submenu)

Opens a vertical submenu where you can choose between a number of display types.

Bar Charts (Graphical Displays submenu)

Displays graphical representations of measured parameters.

Spectrum (Graphical Displays submenu)

Opens a Spectrum Analyzer display preconfigured for TETRA Base Station. For a complete list of Spectrum submenu soft keys, see **"Spectrum Analyzer Soft Keys" on page 503**.

Power Profile (Graphical Displays submenu)

Displays a TDMA slot view with 2 markers for timing analysis.

Vertical Maximum (Power Profile submenu)

Adjusts the maximum level for the vertical scale of the display.

Range	–120 dBm to +60 dBm in 1 dB increments
Preset	50 dBm
Saved State	Saved with instrument state

Vertical Scale (Power Profile submenu)

Selects the vertical scale resolution for the display's major grid lines.

Range	1 dB/div to 10 dB/div
Preset	10 dB/div
Saved State	Saved with instrument state

Display Mode (Power Profile submenu)

Defines the display trace sweep mode.

Discrete Values	Max Hold, Average
Preset	Average
Saved State	Saved with instrument state
Notes	Max Hold retains the highest peak signal amplitudes measured during successive sweeps.

	Average displays signal amplitudes are a rolling average of the peak amplitudes measured on each successive sweep. The average consists of one to five sweeps, shown beside the mode indication.

Marker Mode (Power Profile submenu)

Defines the selected marker as Absolute or Delta.

Discrete Values	Absolute, Delta
Preset	Absolute
Saved State	Saved with instrument state
Notes	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 of both power and time between the markers.

Toggle Marker (Power Profile submenu)

Cycles through the available markers to select a marker for repositioning along the trace.

Constellation (Graphical Displays submenu)

Opens a Constellation Meter with Industry standard QPSK Constellations representing phase errors, amplitude errors, and I/Q Imbalance.

Upper Mini Graph (Graphical Displays submenu)

Displays a small Spectrum Analyzer, Power Profile, or Constellation Meter on the upper portion of the screen.

Discrete Values	Spectrum, Power Profile, Symbols, Trajectories
Default	Spectrum
Saved State	Saved with instrument state

Lower Mini Graph (Graphical Displays submenu)

Displays a small Spectrum Analyzer, Power Profile, or Constellation Meter on the lower portion of the screen.

Discrete Values	Spectrum, Power Profile, Symbols, Trajectories, Bar Graphs
Default	Power Profile
Saved State	Saved with instrument state

Test Mode (TETRA Base Station submenu)

Toggles between Monitor Mode (base station receiver) and T1 Mode (phase modulated transmission testing).

Discrete Values	Monitor Mode, T1 Mode
Default	Monitor Mode
Saved State	Saved with instrument state

Downlink Frequency (TETRA Base Station submenu)

Sets the base station main carrier frequency.

Range	250 kHz to 1 GHz
Default	390 kHz
Saved State	Saved with instrument state

Attenuation (TETRA Base Station submenu)

Displays the Attenuation dialog where you can select the desired input port attenuation for the receiver.

Range	0 to 62 dB in 2 dB increments
Default	0 dB
Saved State	Saved with instrument state

Average Readings (TETRA Base Station submenu)

Sets the number of measurement samples that are averaged when Averaging is activated.

Range	1 to 100
Default	10
Saved State	Saved with instrument state

Cable Offset (TETRA Base Station submenu)

Displays a dialog where you can specify the gains or losses between the RF In/Out port and the unit under test.

Range	–99.0 to 99 dB
Preset	0.0 dB
Saved State	Saved with instrument state
Notes	In the case of a loss, such as a cable or attenuator, enter a negative value. The affected field values will be increased to compensate. In Generate Mode, for example, if a –6.0 dB value is entered, the Output Level amplitude is increased by 6 dB. In Monitor Mode, for example, the Spectrum Analyzer trace is increased by 6 dB. In the case of a gain, such as an amplifier, enter a positive value. The affected fields will be decreased to compensate. In Generate Mode, for example, if a 10.0 dB value is entered, the Output Level amplitude will decrease by 10 dB. In Monitor Mode, for example, Watt Meter measurements will be reduced by 10 dB. This value is not used if Cable Offset is disabled (Off).

Gen Port

In T1 mode, opens the Gen Port dialog where you can choose the transmitter output.

Discrete Values	RF In/Out, RF Gen Out
Default	RF In/Out
Saved State	Saved with instrument state

Monitor Port (TETRA Base Station submenu)

Opens the Monitor Port dialog where you can choose the receiver input.

Discrete Values	RF In/Out, Antenna
Default	RF In/Out
Saved State	Saved with instrument state

Pre-Amp (TETRA Base Station submenu)

Opens the Pre-Amp dialog where you can control pre-amp activation.

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state

Test Limits (TETRA Base Station submenu)

Opens the Test Limits page where you can specify minimum and maximum measurement values for the test.

Limits Default (Test Limits & Bar Charts submenus)

Returns all Lower and Upper test limits to their default values.

RF Power Lower Limit (Test Limits & Bar Charts submenus)

Opens the RF Power Lower dialog where you can enter the desired value for the RF power lower limit.

Range	0 to 200 dB
Default	43 dB
Saved State	Saved with instrument state

RF Power Upper Limit (Test Limits & Bar Charts submenus)

Opens the RF Power Upper dialog where you can enter the desire value for the RF power upper limit.

Range	0 to 200 dB
Default	45 dB
Saved State	Saved with instrument state

Residual Carrier Power (Test Limits & Bar Charts submenus)

Opens the Residual Carrier dialog where you can set the percentage of maximum residual power.

Range	0 to 10 %
Default	5 %
Saved State	Saved with instrument state

Frequency Error (Test Limits & Bar Charts submenus)

Opens the Frequency Error dialog where you can set the percentage of maximum residual power.

Range	±200 Hz
Default	±100 Hz
Saved State	Saved with instrument state

RMS Vector (Test Limits & Bar Charts submenus)

Opens the RMS Vector dialog where you can set the percentage of maximum RMS vector error.

Range	0 to 50 %
Default	10 %
Saved State	Saved with instrument state

Peak Vector (Test Limits & Bar Charts submenus)

Opens the Peak Vector dialog where you can set the percentage of maximum peak vector error.

Range	0 to 50 %
Default	30 %
Saved State	Saved with instrument state

Uplink BER (Test Limits submenu)

Opens the Uplink BER dialog where you can set the maximum acceptable percentage of bit error rate for the Uplink Channel.

Range	0 to 10 %
Default	3 %
Saved State	Saved with instrument state

Uplink MER (Test Limits submenu)

Opens the Uplink MER dialog where you can set the maximum acceptable percentage of modulation error rate for the Uplink Channel.

Range	0 to 10 %
Default	3 %
Saved State	Saved with instrument state

Downlink BER (Test Limits submenu)

Opens the Downlink BER dialog where you can set the maximum acceptable percentage of bit error rate for the Downlink Channel.

Range	0 to 10 %
Default	3 %
Saved State	Saved with instrument state

Downlink MBR (Test Limits submenu)

Opens the Downlink MBR dialog where you can set the percentage of maximum bit rate for the Downlink Channel.

Range	0 to 10 %
Default	3 %
Saved State	Saved with instrument state

TX Test (TETRA Base Station submenu)

Opens the transmitter test setup page.

Burst Samples (TX Test submenu)

Defines the number of burst samples for the current transmitter test.

Range	1 to 1,000,000
Default	100
Saved State	Saved with instrument state

Start Test (TX Test submenu)

Executes the transmitter test.

Operator ID (Test Results submenu)

Displays a dialog where you can enter the Operator ID.

Range	A-Z and 0-9
Saved State	Saved with instrument state
Notes	By default, an Operator ID is required to begin testing (Start soft key appears after entry is made). This can be changed in the Preferences selection under the Tools menu.

Clear Results (Test Results submenu)

Clears the results of the selected test.

TETRA Base Station T1 Mode Soft Keys

During TETRA Base Station T1 Mode base station tests, the TETRA Base Station T1 Mode contains additional parameter controls for the TETRA Base Station Channel Plan and the T1 Test Table for offline transceiver performance verification using the manufacturer's Test Mode Software. These tests are performed with the R8200 in Duplex Mode.

T1 Test (TETRA Base Station submenu))

Opens the T1 Test table and submenu.

BS OEM (T1 Test submenu)

Defines the manufacturer of the base station under test.

Discrete Values	User Defined, Cassidian TB3, Motorola Dimetra, Motorola MTS 1
Default	User Defined
Saved State	Saved with instrument state

Uplink Signal Mode (T1 Test submenu)

Selects the communication mode from the portable to the base station.

Discrete Values	Auto, TX On, Transmit, Receive, Loopback, Manual Transmit, Manual Receive, Manual Loopback, Downlink T2 (No Scrambling)
Default	Auto
Saved State	Saved with instrument state

Uplink Signal Type (T1 Test submenu)

Selects the test channel type from the portable to the base station.

Discrete	Auto, TCH/7.2, SCH/F, STCH+STCH, SCH/HU+SCH/HU, TCH/S, TCH/2.4 N=1, TCH/4.8 N=1

Values	
Default	Auto
Saved State	Saved with instrument state

RF Output Level

In T1 Test Mode, opens the RF Output dialog where you can input the output power of the RF In/Out port.

Range	–130 to –30 dBm
Default	–40 dBm
Saved State	Saved with instrument state

Test Results (T1 Test submenu)

Opens the Radio Test Results screen and displays the results of the T1 base station tests.

Channel Plan (TETRA Base Station submenu)

Opens the Channel System Table where you can configure the base station channel plan.

BS OEM (Channel Plan submenu)

Defines the manufacturer of the base station under test.

Discrete Values	User Defined, Cassidian TB3, Motorola Dimetra, Motorola MTS 1
Default	User Defined
Saved State	Saved with instrument state

Downlink Frequency (Channel Plan submenu)

Sets the base station main carrier frequency.

Range	250 kHz to 1 GHz
Default	390 kHz
Saved State	Saved with instrument state

Channel (Channel Plan submenu)

Opens the Channel dialog where you can choose the channel number for the channel plan.

Range	–10000 to 10000
Default	3600
Saved State	Saved with instrument state

Band (Channel Plan submenu)

Opens the Band dialog where you can choose the band frequency for the channel plan.

Discrete Values	100 MHz, 300 MHz, 400 MHz, 450 MHz, 800 MHz, 900 MHz
Default	300 MHz
Saved State	Saved with instrument state

Channel Offset (Channel Plan submenu)

Opens the Channel Offset dialog where you can choose the frequency offset for the channel plan.

Discrete Values	0 Hz, 6.250 kHz, –6.25 kHz, 12.500 kHz, –12.500 kHz
Default	0 Hz
Saved State	Saved with instrument state

Duplex Offset (Channel Plan submenu)

Opens the Duplex Offset dialog where you can choose the band-dependent duplex offset for the channel plan.

Discrete Values	1.6 MHz (Band=100 MHz), 4.5 MHz (Band=100 MHz), 5 MHz (Band=400 MHz or 450 MHz), 10 MHz (Band=300 MHz, 400 MHz, or 450 MHz), 45 MHz (Band=800 MHz or 900 MHz)
Default	1.6 MHz (Band=100 MHz)
Saved State	Saved with instrument state
Dependencies	Band dependent

Operating Mode (Channel Plan submenu)

Opens the Operating Mode dialog where you can choose normal or reverse operation for the channel plan.

Discrete Values	Normal, Reverse
Default	Normal
Saved State	Saved with instrument state

MCC (Channel Plan submenu)

Opens the MCC dialog where you can choose the mobile country code for the channel plan.

Range	0 to 500
Default	0
Saved State	Saved with instrument state

MNC (Channel Plan submenu)

Opens the MCC dialog where you can choose the mobile network code for the channel plan.

Range	0 to 10000
Default	0
Saved State	Saved with instrument state

BCC (Channel Plan submenu)

Opens the BCC dialog where you can choose the broadcast control channel for the channel plan.

Range	0 to 10
Default	0
Saved State	Saved with instrument state

TETRA DMO Zone Soft Keys

This section contains detailed descriptions of the soft keys accessible in the TETRA DMO Zone during transmitter testing with the R8200 in Monitor Mode, and receiver testing with the R8200 in Generate Mode. Each TETRA DMO soft key is defined, along with its range, discrete, default, and saved state values.

"TETRA DMO Zone Soft Keys for Transmitter Test" on the next page includes the parameters associated with testing the TETRA Base Station radio's transmitter with the R8200 in Monitor Mode.

"DISPLAY Zone Soft Keys for TETRA DMO Transmitter Test" on page 681 includes the parameters associated with specialized display configurations for quick visual verification of TETRA DMO transmitter performance. For standard DISPLAY Zone soft key definitions, see **"DISPLAY Zone Soft Keys for Monitor Mode" on page 362**.

"METER Zone Soft Keys for TETRA DMO Transmitter Test" on page 686 includes the parameters associated with specialized metering configurations offering focused presentations of basic RF and baseband TETRA DMO transmitter characteristics. For standard METER Zone soft key definitions, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

"TETRA DMO Zone Soft Keys for Receiver Test" on page 689 includes the parameters associated with testing the TETRA Base Station radio's receiver with the R8200 in Generate Mode.

TETRA DMO Zone Soft Keys for Transmitter Test

During TETRA DMO transmitter tests, the TETRA DMO Zone contains controls for the TETRA DMO receiver. These tests are performed with the R8200 in Monitor Mode. For standard Monitor Mode soft key definitions, see **"8 Monitor Mode Soft Keys" on page 330**.

Reset Averaging (TETRA DMO submenu)

Resets all TETRA DMO measurements, history, and displays including parameter values in other zones.

Measurement Averaging (TETRA DMO submenu)

Configures the number of traces sweeps averaged to smooth selective readings.

Range	1 to 250
Default	1 (no averaging)
Saved State	Saved with instrument state
Notes	Samples are collected five to 17 times per second. Measurement averaging affects the following: RF Zone – Input Level TETRA Zone – Residual Carrier Magnitude, EVM (RMS), EVM (Peak), Unwanted Power

Unwanted Power Slot 3 (TETRA DMO submenu)

Configures the unwanted power measurement to help isolate its cause as systemic or transient in nature.

Discrete Values	No, Yes

Default	No
Saved State	Saved with instrument state
Notes	No – Computed measurement is the average power in slots 2 and 4 only, excluding active regions for adjacent slots. Yes – Compound measurement is the average power in slots 2, 3 and 4, excluding the active region(s) for slot 1. Unwanted power could be systemic or transient in nature. Use of this switch may be used to identify its nature. The average unwanted power of a systemic source will be the same for either setting, but transients in slot 2 or 4 will decrease for Yes (assuming slot 3 is not active).

DISPLAY Zone Soft Keys for TETRA DMO Transmitter Test

The DISPLAY Zone offers specialized displays during TETRA DMO transmitter testing with the R8200 in Monitor Mode. Their associated soft keys are described below.

Select Display (DISPLAY Zone menu)

Pressing this soft key activates a horizontal soft key menu where you can select the display mode.

Discrete Values	Spec An, Power Profile, Mod Spec/Constellation
Default	Spec An
Saved State	Saved with instrument state
Notes	Spec An is only available in Monitor Mode.

Power Profile (DISPLAY Zone menu)

Provides a power versus time plot of the transmitter.

Saved State	Saved with instrument state
Notes	The display is useful in assuring that near-far situations will not result in co-channel inter-slot interference on the alternate or non-transmission slot and that the power level will be adequate for acceptable BER performance. The scaling and position of the vertical power axis can be adjusted to inspect greater range or detail. The horizontal axis can be changed to view one or both slots including the additional ramp up/-down time. Display functions and markers are available for advanced analysis. See the Technical Specification: ETSI TS 102 361-1 Electromagnetic compatibility and Radio Spectrum Matters (ERM); Digital Mobile Radio (DMR) Systems; Part 1: "DMR Air Interface (AI) protocol," section 10.2.3 Burst timing on page 114.

Select View (Power Profile submenu)

Selects the timeslot(s) to view.

Discrete Values	Frame, Slot 1
Default	Frame
Saved State	Saved with instrument state
Notes	Although slots are approximately 14.167 milliseconds (i.e., 1.02 seconds per multiframe of 18), the profile for a slot is 14.778 ms, divided into three regions for ramp-up (0.889 ms), burst (13.056 ms), and ramp-down (0.833 ms). Slot 1 reveals a horizontal axis 0 ms to 14.78 ms with slot from 0 to 14.167 ms. Frame reveals a horizontal axis 0 ms to 57.278 ms with four slots starting at 0 ms. Ramp down time for a slot overlaps the adjacent slot by 0.611 milliseconds.

Vertical Maximum (Power Profile submenu)

Adjusts the maximum level for the vertical scale of the display.

Range	–120 dBm to +60 dBm in 1 dB increments
Default	50 dBm
Saved State	Saved with instrument state

Vertical Scale (Power Profile submenu)

Selects the vertical scale resolution for the display's major grid lines.

Range	1 dB/div to 10 dB/div
Default	10 dB/div
Saved State	Saved with instrument state

Mod Spec/Constellation (DISPLAY Zone menu)

Modulation Spectrum displays the power versus frequency (power spectral density) of the modulated symbols in the detected burst. Power is shown in dB relative to Input Level (0 dB); frequency is shown in kHz relative to Center Frequency (0 Hz). The measurement is done by over-sampling at the optimal symbol times and positions to exclude adverse effects of frequency error and residual carrier.

The Constellation Display provides a visual representation of overall transmitter operation. The constellation data represents just the data of the useful part of the burst. The measurement is done at the optimal symbol times and positions to exclude adverse effects of frequency error and residual carrier.

TETRA radios broadcast voice and data using four differential phase shift deviations from the carrier to represent symbols containing two data bits. One of four phase shifts relative to the carrier’s current phase yields eight phase points. The phase trajectory never passes through the origin, ensuring that signal amplitude never falls to zero during data

transmissions. The center of the eight red circles on the display represent the expected locations for the deviation states when the radio is transmitting data bit symbols using the modulation. White dots show the actual deviation measurement at symbol decision times. A tighter grouping within the red circles indicates more accurate transmitter performance. The radius of the circles is the 10% EVM (Peak) limit.

Constellation Display Mode (Mod Spec/Constellation submenu)

Activates a horizontal soft key menu where can select the Constellation Display presentation.

Discrete Values	Symbols, Samples, Trajectories
Default	Trajectories
Saved State	Saved with instrument state
Notes	Symbols – This choice displays only the samples at the optimal symbol decision times, displayed as white dots. Correct transmitter operation should group them tightly around the eight ideal phase points. Samples – In addition to the symbol points, samples between symbol times three times their number are displayed as blue dots. Trajectories – Instead of sample points, blue lines connect adjacent samples to approximate the continuous transmitter output throughout the burst.

Display Mode (Power Profile submenu)

Defines the trace sweep.

Discrete Values	Normal, Freeze, Max Hold, Average

Default	Normal
Saved State	Saved with instrument state
Notes	Normal – allows the display to update continuously. Freeze – provides a snapshot of the current display indication and stops additional updates. Max Hold – retains the highest peak signal amplitudes measured during successive sweeps. Average – displays signal amplitudes are a rolling average of the peak amplitudes measured on each successive sweep. The average consists of one to five sweeps, shown beside the mode indication.

Marker Mode (Power Profile submenu)

Defines the selected marker.

Discrete Values	Off, Absolute, Delta, Delta dBm
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. Absolute – Displays the frequency and absolute signal amplitude for each marker selected. Delta – Displays the frequency and amplitude difference between each pair of markers selected. Delta dBm – Displays the amplitude difference between each pair of markers selected. Depending on the installed options, up to four markers can be enabled and selected for positioning.

Toggle Marker (Power Profile submenu)

Cycles through the available markers to select a marker for repositioning along the trace.

METER Zone Soft Keys for TETRA DMO Transmitter Test

The METER Zone offers specialized meters during TETRA DMO transmitter testing with the R8200 in Monitor Mode. Their associated soft keys are described below.

Voltmeter (METER Zone menu)

Opens the Voltmeter display and submenu.

Select Voltmeter Mode (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the voltage mode for the Voltmeter.

Discrete Values	AC Volts, DC Volts
Default	AC Volts
Saved State	Saved with instrument state
Notes	AC Volts measures AC voltage applied to the Meter In port. The dBm computation assumes an impedance of 600Ω.

Coupling (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a Coupling dialog menu where you can select the input voltage coupling.

Discrete Values	DC, AC
Default	DC
Saved State	Saved with instrument state

AC Range (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter AC voltage range.

Discrete Values	Auto, 1 V, 10 V, 70 V
Default	Auto
Saved State	Saved with instrument state
Notes	The range on AC and DC must be 1 or 10 Volts to use 600 Ohm Input Impedance.

Set dBr Reference (Voltmeter submenu)

When the meter is set to Voltmeter and Voltmeter mode is set to AC, pressing this soft key sets a reference input voltage.

Notes	When selected, dBm measurements are frozen, and a dBr indicator appears. The dBr indicates the normalized measurement between the reference input voltage and the current input voltage.

Clear dBr Reference (Voltmeter submenu)

When the meter is set to Voltmeter and Voltmeter mode is set to AC, pressing this soft key clears the dBr reference input voltage.

Voltage Units (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter range.

Discrete Values	Volts (V), Millivolts (mV), Decibel Volts (dBV)
Default	Volts (V)
Saved State	Saved with instrument state

DC Range (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter DC voltage range.

Discrete Values	Auto, 1 V, 10 V, 70 V
Default	Auto
Saved State	Saved with instrument state
Notes	The range on AC and DC must be 1 or 10 Volts to use 600 Ohm Input Impedance.

TETRA DMO Zone Soft Keys for Receiver Test

During TETRA DMO receiver tests, the TETRA DMO Zone contains controls for the TETRA DMO transmitter. These tests are performed with the R8200 in Generate Mode. For standard Generate Mode soft key definitions, see **"9 Generate Mode Soft Keys" on page 390**.

Modulation Mode (TETRA DMO submenu)

Provides a horizontal soft key menu where you can control the operating state of the modulation.

Discrete Values	Off, Continuous
Default	Off
Saved State	Saved with instrument state

Test Pattern (TETRA DMO submenu)

Specifies the TETRA compliant test pattern generated by the R8200 to assess audio performance.

Discrete Values	1000 Hz Tone, Silence
Default	1000 Hz Tone
Saved State	Saved with instrument state
Notes	Audio patterns utilize digital vocoder type ACELP at a 7.2 kHz talk channel rate. For sensitivity tests, the R8200 can transmit the multiframe test pattern over its entire output power level range. This provides an estimate of the reference sensitivity for the radio. A horizontal submenu provides the following TETRA compliant patterns:

	1000 Hz Tone provides a predefined TETRA-compatible vocoder multiframe test pattern that produces a 1 kHz tone at the speaker of the receiver vocoder. It can be used to quickly check audio performance in the field. Silence provides a predefined TETRA-compatible vocoder multiframe test pattern that results in silence at the vocoder. All patterns use the Open TSI (O-TSI) destination (Open MNI and Open SSI) as a convenience to eliminate the need to reprogram the radio's talkgroup/ID.

TETRA TMO Test Mode Soft Keys

This section contains detailed descriptions of the soft keys accessible in the TETRA TMO Test Mode. Each TETRA TMO soft key is defined, along with its range, discrete, default, and saved state values. During TETRA TMO transmitter tests, the TETRA TMO Test Mode contains controls for the TETRA TMO receiver.

TETRA TMO (Main Screen)

Opens a horizontal soft key menu providing access to the TETRA TMO submenus.

Discrete Values	Call Mobile, Channel Plan, TX Test, RX Test, PLC Test, T1 Test, Main Screen
Default	Main Screen
Saved State	Saved with instrument state

Graphical Displays (Main Screen)

Opens a vertical submenu where you can choose between a number of display types.

Bar Charts (Graphical Displays submenu)

Displays graphical representations of measured parameters.

Limits Default (Bar Charts Test & Limits submenus)

Returns all Lower and Upper test limits to their default values.

RF Power Lower Limit (Bar Charts Test & Limits submenus)

Opens the RF Power Lower dialog where you can enter the desired value for the RF power lower limit.

Range	0 to 200 dB
Default	43 dB
Saved State	Saved with instrument state

RF Power Upper Limit (Bar Charts Test & Limits submenus)

Opens the RF Power Upper dialog where you can enter the desire value for the RF power upper limit.

Range	0 to 200 dB
Default	45 dB
Saved State	Saved with instrument state

Residual Carrier Power (Bar Charts Test & Limits submenus)

Opens the Residual Carrier dialog where you can set the percentage of maximum residual power.

Range	0 to 10 %
Default	5 %
Saved State	Saved with instrument state

Frequency Error (Bar Charts Test & Limits submenus)

Opens the Frequency Error dialog where you can set the percentage of maximum residual power.

Range	±200 Hz
Default	±100 Hz
Saved State	Saved with instrument state

RMS Vector (Bar Charts Test & Limits submenus)

Opens the RMS Vector dialog where you can set the percentage of maximum RMS vector error.

Range	0 to 50 %
Default	10 %
Saved State	Saved with instrument state

Peak Vector (Bar Charts Test & Limits submenus)

Opens the Peak Vector dialog where you can set the percentage of maximum peak vector error.

Range	0 to 50 %
Default	30 %
Saved State	Saved with instrument state

Spectrum (Graphical Displays submenu)

Opens a Spectrum Analyzer display preconfigured for TMO. For a complete list of Spectrum submenu soft keys, see **"Spectrum Analyzer Soft Keys" on page 503**.

Power Profile (Graphical Displays submenu)

Displays a TDMA slot view with 2 markers for timing analysis.

Vertical Maximum (Power Profile submenu)

Adjusts the maximum level for the vertical scale of the display.

Range	–120 dBm to +60 dBm in 1 dB increments
Preset	50 dBm
Saved State	Saved with instrument state

Vertical Scale (Power Profile submenu)

Selects the vertical scale resolution for the display's major grid lines.

Range	1 dB/div to 10 dB/div
Preset	10 dB/div
Saved State	Saved with instrument state

Display Mode (Power Profile submenu)

Defines the display trace sweep mode.

Discrete Values	Max Hold, Average
Preset	Average
Saved State	Saved with instrument state
Notes	Max Hold retains the highest peak signal amplitudes measured during successive sweeps.

	Average displays signal amplitudes are a rolling average of the peak amplitudes measured on each successive sweep. The average consists of one to five sweeps, shown beside the mode indication.

Marker Mode (Power Profile submenu)

Defines the selected marker as Absolute or Delta.

Discrete Values	Absolute, Delta
Preset	Absolute
Saved State	Saved with instrument state
Notes	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 of both power and time between the markers.

Toggle Marker (Power Profile submenu)

Cycles through the available markers to select a marker for repositioning along the trace.

Constellation (Graphical Displays submenu)

Opens a Constellation Display with Industry standard QPSK Constellations representing phase errors, amplitude errors, and I/Q Imbalance.

Upper Mini Graph (Graphical Displays submenu)

Displays a small Spectrum Analyzer, Power Profile, or Constellation Display on the upper portion of the main screen.

Discrete Values	Spectrum, Power Profile, Symbols, Trajectories
Default	Spectrum
Saved State	Saved with instrument state

Lower Mini Graph (Graphical Displays submenu)

Displays a small Spectrum Analyzer, Power Profile, Constellation, or Bar Graph on the lower portion of the main screen.

Discrete Values	Spectrum, Power Profile, Symbols, Trajectories, Bar Graphs
Default	Power Profile
Saved State	Saved with instrument state

Call Type (Main Screen)

Opens the Call Type dialog where you can choose the call type.

Discrete Values	Individual Duplex, Individual Simplex, Group, Phone, Emergency, SDS/DTMF/DGNA, Ambient Listening
Default	Individual Duplex
Saved State	Saved with instrument state
Notes	Individual Duplex is a Duplex bidirectional connection and can be used to make continuous measurements. Alternatively, Phone may be used.

Select Group (Main Screen)

Opens the Select Group dialog where you can choose the number associated with the group call.

Discrete Values	0
Default	0
Saved State	Saved with instrument state

Voice Loopback (Main Screen)

Opens the Voice Loopback dialog where you can select the content for Voice Loopback.

Discrete Values	Voice, 2.4kHz, 1.6kHz, 1kHz, 800Hz, 400Hz, Off
Default	Voice
Saved State	Saved with instrument state

RF Output Level (Main Screen)

In T1 test mode, opens the RF Output dialog where you can input the output power of the RF In/Out port.

Range	–130 to –30 dBm
Default	–40 dBm
Saved State	Saved with instrument state

Attenuation (Main Screen)

Displays the Attenuation dialog where you can select the desired input port attenuation for the receiver.

Discrete Values	0 to 62 dB in 2 dB steps
Default	0 dB
Saved State	Saved with instrument state

Average Readings (Main Screen)

Sets the number of measurement samples that are averaged when Averaging is activated.

Range	1 to 100
Default	10
Saved State	Saved with instrument state

Test Limits (Main Screen)

Opens the Test Limits page where you can specify minimum and maximum measurement values for the test.

Limits Default (Test Limits submenu)

Returns all Lower and Upper test limits to their default values.

Power Class (Test Limits submenu)

Opens the Power Class dialog where you can set the power class of the radio under test.

Discrete Values	2 (10 W), 2L (5.6 W), 3 (3 W), 3L (1.8 W), 4 (1 W), 4L (0.56 W)
Default	3L (1.8W)
Saved State	Saved with instrument state

Unwanted Power (Test Limits submenu)

Opens the Unwanted Power dialog where you can set the level for unwanted power for the radio under test.

Range	0 to –50 dBm
Default	–30 dBm
Saved State	Saved with instrument state

Residual Carrier Power (Test Limits submenu)

Opens the Residual Carrier dialog where you can set the percentage of maximum residual power.

Range	0 to 10 %
Default	5 %
Saved State	Saved with instrument state

Frequency Error (Test Limits submenu)

Opens the Frequency Error dialog where you can set the percentage of maximum residual power.

Range	±200 Hz
Default	±100 Hz
Saved State	Saved with instrument state

RMS Vector (Test Limits submenu)

Opens the RMS Vector dialog where you can set the percentage of maximum RMS vector error.

Range	0 to 50 %
Default	10 %
Saved State	Saved with instrument state

Peak Vector (Test Limits submenu)

Opens the Peak Vector dialog where you can set the percentage of maximum peak vector error.

Range	0 to 50 %
Default	30 %
Saved State	Saved with instrument state

Frame Align Symbols (Test Limits submenu)

Opens the Frame Align Symbols dialog where you can set the absolute value of symbol error.

Range	± 0.25 symbols
Default	0.25
Saved State	Saved with instrument state

RX Sensitivity (Test Limits submenu)

Opens the RX Sensitivity dialog where you can set the sensitivity for the receiver.

Range	0 to –125 dBm
Default	–114 dBm
Saved State	Saved with instrument state

MS T1 BER (Test Limits submenu)

Opens the MS T1 BER dialog where you can set the bit error rate percentage for the mobile station.

Range	0 to 10 %
Default	3 %
Saved State	Saved with instrument state

MS T1 MER (Test Limits submenu)

Opens the MS T1 MER dialog where you can set the modulation error rate percentage for the mobile station.

Range	0 to 10 %
Default	3 %
Saved State	Saved with instrument state

Sync (Main Screen)

Synchronizes the analyzer to the base station under test.

Command Registration (Main Screen)

Requests registration from the radio under test.

Call Mobile (Main Screen)

Initiates a call to the radio under test.

Release Call (Main Screen)

Terminates a call to the radio under test.

Channel Plan (Main Screen)

Opens the Channel Plan table and submenu.

Frequency (Channel Plan submenu)

Sets the channel plan carrier frequency.

Range	250 kHz to 1 GHz
Default	390 kHz
Saved State	Saved with instrument state

Band (Channel Plan submenu)

Opens the Band dialog where you can choose the frequency band for the channel plan.

Discrete Values	100 MHz, 300 MHz, 400 MHz, 450 MHz, 800 MHz, 900 MHz
Default	300 MHz
Saved State	Saved with instrument state

MCCH (Channel Plan submenu)

Opens the MCCH dialog where you can choose the channel number for the Main Control Channel for the channel plan.

Range	0 to 10000
Default	3600
Saved State	Saved with instrument state

TS (Channel Plan submenu)

Opens the TS dialog where you can choose the measurement timeslot for the channel plan.

Discrete Value	2, 3, 4
Default	2
Saved State	Saved with instrument state

Channel Offset (Channel Plan submenu)

Opens the Channel Offset dialog where you can choose the frequency offset for the channel plan.

Discrete Values	0 Hz, 6.250 kHz, –6.25 kHz, 12.500 kHz, –12.500 kHz
Default	0 Hz
Saved State	Saved with instrument state

Duplex Offset (Channel Plan submenu)

Opens the Duplex Offset dialog where you can choose the band-dependent Duplex Offset for the channel plan.

Discrete Values	1.6 MHz (Band=100 MHz), 4.5 MHz (Band=100 MHz), 5 MHz (Band=400 MHz or 450 MHz), 10 MHz (Band=300 MHz, 400 MHz, or 450 MHz), 45 MHz (Band=800 MHz or 900 MHz)
Default	10 MHz
Saved State	Saved with instrument state
Dependencies	Band dependent

Operating Mode (Channel Plan submenu)

Opens the Operating Mode dialog where you can choose Normal or Reverse Operation for the channel plan.

Discrete Values	Normal, Reverse
Default	Normal
Saved State	Saved with instrument state

Connection Mode (Channel Plan submenu)

Opens the Connection Mode dialog where you can choose Normal or Fallback Connection Mode for the channel plan.

Discrete Values	Normal, Fallback
Default	Normal
Saved State	Saved with instrument state

MCC (Channel Plan submenu)

Opens the MCC dialog where you can choose the Mobile Country Code for the channel plan.

Range	0 to 500
Default	262
Saved State	Saved with instrument state

MNC (Channel Plan submenu)

Opens the MCC dialog where you can choose the Mobile Network Code for the channel plan.

Range	0 to 10000
Default	1234
Saved State	Saved with instrument state

BCC (Channel Plan submenu)

Opens the BCC dialog where you can choose the Broadcast Control Channel for the channel plan.

Range	0 to 10
Default	5
Saved State	Saved with instrument state

Larea (Channel Plan submenu)

Opens the Larea dialog where you can choose the Local Area Code for the channel plan.

Discrete Values	0 to 100
Default	27
Saved State	Saved with instrument state

TX Test (Main Screen)

Opens the Transmitter Test Setup table and submenu.

Burst Samples (TX Test submenu)

Defines the number of burst samples for the current transmitter test.

Range	1 to 1,000,000
Default	100
Saved State	Saved with instrument state

Start Test (TX Test submenu)

Executes the transmitter test.

Test Results (TX Test submenu)

Opens the Radio Test Results screen and displays the results of the tests.

Operator ID (Test Results submenu)

Displays a dialog where you can enter the Operator ID.

Range	A-Z and 0-9
Saved State	Saved with instrument state
Notes	By default, an Operator ID is required to begin testing (Start soft key appears after entry is made). This can be changed in the Preferences selection under the Tools menu.

Mobile ID (Test Results submenu)

Displays a dialog where you can enter the Mobile ID.

Range	A-Z and 0-9
Saved State	Saved with instrument state

Clear Results (Test Results submenu)

Clears the current test results.

RX Test (Main Menu)

Opens the Receiver Sensitivity Test table and submenu.

Start Level (RX Test submenu)

Opens the Start Level dialog where you can enter the initial RF carrier level for the receiver sensitivity test.

Range	–130 to –30 dBm
Default	–100 dBm
Saved State	Saved with instrument state

Step Level (RX Test submenu)

Opens the Step Level dialog where you can enter the dB increments in which to decrease the RF carrier for the receiver sensitivity test.

Range	1 to 10 dB
Default	2 dB
Saved State	Saved with instrument state

Start RX Test (RX Test submenu)

Executes the receiver sensitivity test.

Test Results (RX Test submenu)

Opens the Radio Test Results screen and displays the results of the tests.

Operator ID (Test Results submenu)

Displays a dialog where you can enter the Operator ID.

Range	A-Z and 0-9
Saved State	Saved with instrument state
Notes	By default, an Operator ID is required to begin testing (Start soft key appears after entry is made). This can be changed in the Preferences selection under the Tools menu.

Mobile ID (Test Results submenu)

Displays a dialog where you can enter the Mobile ID.

Range	A-Z and 0-9
Saved State	Saved with instrument state
Notes	By default, an Operator ID is required to begin testing (Start soft key appears after entry is made). This can be changed in the Preferences selection under the Tools menu.

Clear Results (Test Results submenu)

Clears the current test results.

PLC Test (Main Menu)

Opens the Power Loop Control Test table and submenu.

Start PLC Test (PLC Test submenu)

Starts the PLC test.

Test Results (PLC Test submenu)

Opens the Radio Test Results screen and displays the results of the tests.

Operator ID (Test Results submenu)

Displays a dialog where you can enter the Operator ID.

Range	A-Z and 0-9
Saved State	Saved with instrument state
Notes	By default, an Operator ID is required to begin testing (Start soft key appears after entry is made). This can be changed in the Preferences selection under the Tools menu.

Mobile ID (Test Results submenu)

Displays a dialog where you can enter the Mobile ID.

Range	A-Z and 0-9
Saved State	Saved with instrument state

Clear Results (Test Results submenu)

Clears the current test results.

T1 Test (Main Menu)

Opens the T1 Test table and submenu.

T1 Burst Type (T1 Test submenu)

Displays the T1 Burst Type dialog where you can enter the base station burst type.

Discrete Values	TCH/7.2, SCH/F, BSCH+SCH/HD
Default	TCH/7.2
Saved State	Saved with instrument state

MS Mode (T1 Test submenu)

Opens the MS Mode dialog where you can set the mobile station test.

Discrete Values	MS TX Test, MS RX Test, RF Loopback
Default	MS TX Test
Saved State	Saved with instrument state

RF Output Level (T1 Test submenu)

In T1 test mode, opens the RF Output dialog where you can input the output power of the RF In/Out port.

Range	–130 to –30 dBm
Default	–90 dBm
Saved State	Saved with instrument state

Start Test (T1 Test submenu)

Initiates the T1 test.

Stop Test (T1 Test submenu)

Terminates the T1 test.

ETSI Test (T1 Test submenu)

Initiates the ETSI T1 test.

Test Results (T1 Test submenu)

Opens the Radio Test Results screen and displays the results of the tests.

Operator ID (Test Results submenu)

Displays a dialog where you can enter the Operator ID.

Range	A-Z and 0-9
Saved State	Saved with instrument state
Notes	By default, an Operator ID is required to begin testing (Start soft key appears after entry is made). This can be changed in the Preferences selection under the Tools menu.

Mobile ID (Test Results submenu)

Displays a dialog where you can enter the Mobile ID.

Range	A-Z and 0-9
Saved State	Saved with instrument state

Clear Results (Test Results submenu)

Clears the current test results.

dPMR Zone Soft Keys

This section contains detailed descriptions of the soft keys accessible in the dPMR Zone during transmitter testing with the R8200 in Monitor Mode, and receiver testing with the R8200 in Generate Mode. Each dPMR soft key is defined, along with its range, discrete, default, and saved state values.

"dPMR Zone Soft Keys" above includes the parameters associated with testing the dPMR radio's transmitter with the R8200 in Monitor Mode. For standard Monitor Mode soft key definitions, see **"8 Monitor Mode Soft Keys" on page 330**.

"DISPLAY Zone Soft Keys for dPMR Transmitter Test" on page 717 includes the parameters associated with specialized display configurations for quick visual verification of dPMR transmitter performance. For standard DISPLAY Zone soft key definitions, see **"DISPLAY Zone Soft Keys for Monitor Mode" on page 362**.

"METER Zone Soft Keys for dPMR Transmitter Test" on page 719 includes the parameters associated with specialized metering configurations offering focused presentations of basic RF and baseband dPMR transmitter characteristics. For standard METER Zone soft key definitions, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

"dPMR Zone Soft Keys for Receiver Test" on page 723 includes the parameters associated with testing the dPMR radio's receiver with the R8200 in Generate Mode. For standard Generate Mode soft key definitions, see **"9 Generate Mode Soft Keys" on page 390**.

dPMR Zone Soft Keys for Transmitter Test

During dPMR transmitter tests, the dPMR Zone contains controls for the dPMR receiver. These tests are performed with the R8200 in Monitor Mode.

Test Pattern (dPMR submenu)

Provides selection of bit patterns for testing the radio in Transmit Mode while under RSS control.

Discrete Values	Calibration (O.153 2%), 511 (O.153)
Default	Calibration (O.153 2%)
Saved State	Saved with instrument state
Notes	The following test patterns are available: Calibration (O.153 2%) is a test pattern derived from the 511 (O.153) pattern to yield a 2.005871% BER used to verify BER measurements are operating correctly. 511 (O.153) is the unframed test pattern of continuously repeating 511-bit pseudo random number sequences generated with a nine-bit shift register (PN9) based on ITU-T O.153 (formerly CCITT V.52) used to perform BER testing for checking the modulation, encoding, and timing of the transmit signal (dPMR CAI compliant).

BER Test (dPMR submenu)

Activates a horizontal soft key menu where you can control the operating state of bit error rate testing.

Discrete Values	Stop, Start

Default	Stop
Saved State	Saved with instrument state
Notes	This bit error rate test checks the modulation, encoding, and timing of the transmit signal during the data transmission period. When performing the BER Test, the radio transmitter under test must be placed into a test diagnostic mode with the correct TX test pattern selected using the manufacturer's Radio Service Software (RSS). The test is done at nominal power with the radio transmitting the test pattern into the service monitor. (It is acceptable to have an attenuator between the radio under test and the service monitor.) BER test results, the percentage of bit differences between the bits of the selected Test Pattern and the bits from the received synchronized FDMA signal, are shown in the dPMR Zone in the BER field.

Ideal Sym Dev (dPMR submenu)

Opens the Ideal Sym Dev dialog where you can set the ideal symbol deviation for the modulation.

Discrete Values	800 Hz to 2400 Hz
Default	1050 Hz
Saved State	Saved with instrument state

Filter (dPMR submenu)

Activates a horizontal soft key menu where you can control the filter type.

Discrete Values	ETSI, PDR
Default	ETSI
Saved State	Saved with instrument state

Voice Loopback (dPMR submenu)

Enables the Voice Loopback feature in dPMR Mode (U.S. patent 5703479).

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state
Notes	Once enabled the R8200 automatically records voice channel data when the radio under test transmits a signal above the squelch level setting. A green Voice Playback Active indicator appears in the Test Mode Zone when Voice Loopback is enabled on the Voice Loopback screen. The Record Duration setting determines the maximum length of the recording, and a bar graph meter shows the recording's progress. The recording continues if the transmission is longer than the duration, but only the most recent is retained. When the radio is un-keyed, the R8200 automatically switches to Generate Mode and transmits the captured voice channel information or speech back to the radio. This provides a quick end–to-end test of the dPMR radio transmitter and receiver. Voice channel recordings can be played back at any time by pressing the Play Last Recording soft key (this selection only appears after a recording has been made). Recorded information is lost if the R8200 is power cycled or if the Generate Mode is selected and a new test pattern is enabled by setting the modulation mode to Continuous or Burst.

Play Last Recording (Voice Loopback submenu)

Places the R8200 in Generate Mode and modulates the carrier with the most recently recorded voice channel data after the Voice Loopback function is enabled.

Saved State	Saved with instrument state
Notes	This selection appears only after a recording has been made. The total transmission time is equal to the length of recorded data, and a bar graph indicates the remaining transmission time during play-back. Speech recorded from a transmitting dPMR radio under test should be heard from its receiver if the radio is operating properly.

Record Duration (Voice Loopback submenu)

Sets the maximum length of a recording.

Range	1 to 10 seconds
Default	5 seconds
Saved State	Saved with instrument state
Notes	If the recording is longer than 10 seconds, only the most recent portion is retained.

DISPLAY Zone Soft Keys for dPMR Transmitter Test

The DISPLAY Zone offers specialized displays during dPMR transmitter testing with the R8200 in Monitor Mode. Their associated soft keys are described below.

Select Display (DISPLAY Zone menu)

Pressing this soft key activates a horizontal soft key menu where you can select the display mode.

Discrete Values	Spec An, Mode Scope, Oscilloscope, Bar Graphs, Eye Diagram
Default	Spec An
Saved State	Saved with instrument state

Eye Diagram (DISPLAY Zone menu)

Provides a visual display of the received dPMR signal and overlays the modulation response during two symbol periods over the four target crossing points for an ideal dPMR signal.

Saved State	Saved with instrument state
Notes	Navigate to the DISPLAY Zone while in dPMR Mode to select the Eye Diagram for viewing with the other dPMR measurements on the main screen. The Eye Diagram can indicate whether a transmitter has significant unbalances or offsets in the modulation circuitry by noting how tightly grouped the waveform is around the crossing points.

Display Mode (Eye Diagram submenu)

When the display is set to Eye Diagram, pressing this soft key activates a horizontal soft key menu where you can select the Eye Diagram display mode.

Discrete Values	Normal, Fade Away
Default	Normal
Saved State	Saved with instrument state
Notes	The following horizontal menu choices: Normal allows the display to update continuously. Fade Away is similar to the Persistence Mode on an Oscilloscope. The intensity of each trace fades away or decays as new traces are received. The effect is to intensify the display in the area where the waveform spends most of its time. Whenever the Display Mode is changed, the R8200 reconfigures the presentation. This process takes approximately 10 seconds and is complete when the new setting appears in the Display Mode field.

METER Zone Soft Keys for dPMR Transmitter Test

The METER Zone offers specialized meters during dPMR transmitter testing with the R8200 in Monitor Mode. Their associated soft keys are described below.

Power Meter (METER Zone menu)

Opens the Power Meter display and submenu.

Range (Power Meter submenu)

When the meter is set to Power Meter, pressing this soft key activates a horizontal soft key menu where you can select the power meter range.

Discrete Values	5, 10, 50, 150 W
Default	50 W
Saved State	Saved with instrument state
Notes	For best accuracy, disable the Pre-amplifier in Monitor Mode and set the Gen Port in Generate Mode to RF In/Out.

Voltmeter (METER Zone menu)

Opens the Voltmeter display and submenu.

Select Voltmeter Mode (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the voltage mode for the Voltmeter.

Discrete Values	AC Volts, DC Volts
Default	AC Volts
Saved State	Saved with instrument state
Notes	AC Volts measures AC voltage applied to the Meter In port. The dBm computation assumes an impedance of 600Ω.

Coupling (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a Coupling dialog menu where you can select the input voltage coupling.

Discrete Values	DC, AC
Default	DC
Saved State	Saved with instrument state

AC Range (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter AC voltage range.

Discrete Values	Auto, 1 V, 10 V, 70 V
Default	Auto
Saved State	Saved with instrument state
Notes	The range on AC and DC must be 1 or 10 Volts to use 600 Ohm Input Impedance.

Set dBr Reference (Voltmeter submenu)

When the meter is set to Voltmeter and Voltmeter mode is set to AC, pressing this soft key sets a reference input voltage.

Notes	When selected, dBm measurements are frozen, and a dBr indicator appears. The dBr indicates the normalized measurement between the reference input voltage and the current input voltage.

Clear dBr Reference (Voltmeter submenu)

When the meter is set to Voltmeter and Voltmeter mode is set to AC, pressing this soft key clears the dBr reference input voltage.

Voltage Units (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter range.

Discrete Values	Volts (V), Millivolts (mV), Decibel Volts (dBV)
Default	Volts (V)
Saved State	Saved with instrument state

DC Range (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter DC voltage range.

Discrete Values	Auto, 1 V, 10 V, 70 V
Default	Auto
Saved State	Saved with instrument state
Notes	The range on AC and DC must be 1 or 10 Volts to use 600 Ohm Input Impedance.

RF Scan (METER Zone menu)

Opens the RF Scan display and submenu.

Start Frequency (RF Scan submenu)

When the meter is set to RF Scan, pressing this key displays the Start Frequency dialog where you can input the start frequency to be used in the RF scan.

Range	1 to 2991 MHz
Default	400 MHz
Saved State	Saved with instrument state

Stop Frequency (RF Scan submenu)

When the meter is set to RF Scan, pressing this key displays the Stop Frequency dialog where you can input the start frequency to be used in the RF scan.

Range	1 to 2991 MHz
Default	600 MHz
Saved State	Saved with instrument state

Scan (RF Scan submenu)

When the meter is set to RF Scan, pressing this soft key activates a horizontal soft key menu where you can select the scanning mode.

Discrete Values	Off, Single, Auto
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates scanning. Single – Sweep the span defined by the Start and Stop Frequency parameters once. Auto – Continuously sweeps the span defined by the Start and Stop Frequency parameters .

dPMR Zone Soft Keys for Receiver Test

During dPMR receiver tests, the dPMR Zone contains controls for the dPMR transmitter. These tests are performed with the R8200 in Generate Mode.

Test Pattern (dPMR submenu)

Provides selection of bit patterns for testing the radio in Receive Mode.

Discrete Values	Calibration (0.153 2%), 511 (0.153), Interference, Max Freq Deviation, 1/3 Freq Deviation
Default	Calibration (0.153 2%)
Saved State	Saved with instrument state

Notes	Some test patterns may require the radio to be under RSS control. The following are available: Calibration (O.153 2%) is the test pattern derived from the 511 (O.153) pattern to yield a 2.005871% BER used to verify BER measurements are operating correctly. 511 (O.153) is the unframed test pattern of continuously repeating 511-bit pseudo random number sequences generated with a nine-bit shift register (PN9) based on ITU-T O.153 (formerly CCITT V.52) used to perform BER testing for checking the modulation, encoding, and timing of the transmit signal (dPMR CAI compliant). Interference, Interfering Modulation Data Stream is a 32767-bit pseudo-random number pattern defined by ITU-T. Max Freq Deviation is the maximum frequency deviation test pattern of a continuously repeating stream of high deviation symbols (+3, +3, –3, –3, …). 1/3 Freq Deviation is the test pattern of a continuously repeating stream of low deviation symbols (+1, +1, –1, –1, …) for a 1/3 maximum frequency deviation.

Modulation Mode (dPMR submenu)

Activates a horizontal menu where you can choose the modulation mode for the selected Test Pattern modulation.

Discrete Values	Off, Continuous, Burst
Default	Off
Saved State	Saved with instrument state
Notes	Enabling a test pattern in Generate Mode will erase any previously captured Voice Recordings.

Ideal Sym Dev (dPMR submenu)

Opens the Ideal Sym Dev dialog where you can set the ideal symbol deviation for the modulation.

Discrete Values	800 Hz to 2400 Hz
Default	1050 Hz
Saved State	Saved with instrument state

Filter (dPMR submenu)

Activates a horizontal soft key menu where you can control the filter type.

Discrete Values	ETSI, PDR
Default	ETSI
Saved State	Saved with instrument state

P25 II Zone Soft Keys

This section contains detailed descriptions of the soft keys accessible in the P25 II Zone during transmitter testing with the R8200 in Monitor Mode, and receiver testing with the R8200 in Generate Mode. Each P25 II soft key is defined, along with its range, discrete, default, and saved state values.

"P25 II Zone Soft Keys for Transmitter Test" on the next page includes the parameters associated with testing the P25 Phase 2 radio's transmitter with the R8200 in Monitor Mode. For standard Monitor Mode soft key definitions, see **"8 Monitor Mode Soft Keys" on page 330**.

"DISPLAY Zone Soft Keys for P25 Phase 2 Transmitter Test" on page 728 includes the parameters associated with specialized display configurations for quick visual verification of P25 Phase 2 transmitter performance. For standard DISPLAY Zone soft key definitions, see **"DISPLAY Zone Soft Keys for Monitor Mode" on page 362**.

"METER Zone Soft Keys for P25 Phase 2 Transmitter Test" on page 735 includes the parameters associated with specialized metering configurations offering focused presentations of basic RF and baseband P25 Phase 2 transmitter characteristics. For standard METER Zone soft key definitions, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

"P25 II Zone Soft Keys for Receiver Test" on page 739 includes the parameters associated with testing the P25 Phase 2 radio's receiver with the R8200 in Generate Mode. For standard Generate Mode soft key definitions, see **"9 Generate Mode Soft Keys" on page 390**.

P25 II Zone Soft Keys for Transmitter Test

During P25 Phase 2 transmitter tests, the P25 II Zone contains controls for the P25 Phase 2 receiver. These tests are performed with the R8200 in Monitor Mode.

Test Pattern (P25 II submenu)

Provides selection for one of three TIA-102.CCAA compliant predefined test patterns for BER testing of a P25 Phase 2 radio in Monitor Mode.

Discrete Values	1031 Hz Tone, Calibration (Tone 5%), Silence
Default	1031 Hz Tone
Saved State	Saved with instrument state
Notes	Each measurement uses an ultraframe (four consecutive superframes) of data. Outbound uses 10880 bits (0.009%/bit); inbound uses from 7252 to 7536 bits (~0.013%/bit) if there is no random-access SAACH to exclude. 1031 Hz Tone is the standard tone framed test pattern of the 1031 Hz vocoder tone for either modulation type and both logical channels. Calibration (Tone 5%) is the test pattern derived from the standard 1031 Hz Tone test pattern to verify BER measurements are operating correctly for either modulation type and both logical channels. The first of every 20 bits is inverted. However, the inbound BER is 4.992% if a random-access SACCH is received or 4.989% if not (rather than 5% since some of the 20 bits are not to be included in the comparison). Silence is the framed test pattern for silence at the vocoder for either modulation type and both logical channels.

Monitor Modulation Type (P25 II menu)

Selects the type of modulation of the received signal to be analyzed.

Discrete Values	HCPM, HDQPSK
Default	HCPM
Saved State	Saved with instrument state
Notes	HCPM (inbound) or HDQPSK (outbound). The type specified is also used in the DISPLAY Zone to enable selection of the Power Profile for inbound frames.

BER Test (P25 II menu)

Activates a horizontal soft key menu where you can control the operating state of bit error rate testing.

Discrete Values	Stop, Start
Default	Stop
Saved State	Saved with instrument state
Notes	When performing the BER test, the radio transmitter under test must be placed in a Test Diagnostic Mode using the manufacturer's Radio Service Software (RSS). The transmission is compared against the Test Pattern specified in the P25 II submenu. BER test results are shown as an error in % in the P25 II Zone.

DISPLAY Zone Soft Keys for P25 Phase 2 Transmitter Test

The DISPLAY Zone offers specialized displays during P25 Phase 2 transmitter testing with the R8200 in Monitor Mode. Their associated soft keys are described below.

Select Display (DISPLAY Zone menu)

Activates a horizontal soft key menu where you can select the display mode.

Discrete Values	Spec An, Oscilloscope, Bar Graphs, Eye Diagram, Power Profile, Distribution Plot
Default	Spec An
Saved State	Saved with instrument state

Eye Diagram (DISPLAY Zone menu)

The Eye Diagram provides a visual display of the received signal and overlays the modulation response during two symbol periods over the yellow target crossing points for an ideal signal. The Eye Diagram can indicate whether a transmitter has significant unbalances or offsets in the modulation circuitry by noting how tightly grouped the waveform is around the crossing points. Be sure that the Modulation Type in the P25 II Zone is set for the expected receive signal in order to establish the appropriate number of crossing points and symbol timing used to position the diagram on the horizontal axis. The center of the display is at symbol times for HDQPSK but halfway between symbol times for HCPM. Some overshoot caused by ISI is expected, more for HCPM. View the Eye Diagram with the other P25 measurements on the main screen by selecting it in the DISPLAY Zone.

Display Mode (Eye Diagram submenu)

When the display is set to Eye Diagram, pressing this soft key activates a horizontal soft key menu where you can select the Eye Diagram display mode.

Discrete Values	Normal, Fade Away
Default	Normal
Saved State	Saved with instrument state
Notes	The following horizontal menu choices: Normal allows the display to update continuously.

	Fade Away is similar to the Persistence Mode on an oscilloscope. The intensity of each trace fades away or decays as new traces are received. The effect is to intensify the display in the area where the waveform spends most of its time. Whenever the Display Mode is changed, the R8200 reconfigures the presentation. This process takes approximately 10 seconds and is complete when the new setting appears in the Display Mode field.

Power Profile (DISPLAY Zone menu)

Provides a power versus time plot for an HCPM transmitter (null slots are not transmitted for HDQPSK).

Saved State	Saved with instrument state
Notes	The display is useful in assuring that near-far situations will not result in co-channel inter-slot interference on the alternate or non-transmission slot and that the power level will be adequate for acceptable BER performance. The scaling and position of the vertical power axis can be adjusted to inspect greater range or detail. The horizontal axis can be changed to view one or both slots, including the additional ramp up/down time. Display functions and markers are available for advanced analysis. Overlays of slot centers and burst time regions are shown. See the transmitter power envelope standard: TIA-102.CCAA 2.2.17.3 TDMA Method of Measurement.

Select View (Power Profile submenu)

Selects the timeslot(s) to view.

Discrete Values	Frame, Slot 1, Slot 2

Default	Frame
Saved State	Saved with instrument state
Notes	Although slots are alternating 30 milliseconds, the profile for a slot is 30.4 ms, divided into three regions for ramp-up (1.2 ms), burst (28.0 ms), and ramp-down (1.2 ms). Frame – Displays the horizontal axis – 0.2 ms to 60.2 ms with slots from 0 to 30 and 30 to 60 ms. Slot 1 – Displays the horizontal axis – 0.2 ms to 30.2 ms with slot from 0 to 30 ms. Slot 2 – Displays the horizontal axis 29.8 ms to 60.2 ms with slot from 30 to 60 ms. Ramp up/-down times for a slot overlap the adjacent slots by 0.2 milliseconds.

Select Frame (Power Profile submenu)

Selects which frame of a superframe to view.

Discrete Values	1, 2, 3, 4, 5, 6
Default	1
Saved State	Saved with instrument state
Notes	See the asymmetrical superframe structure in Table 2.2.7.8.1.4-1. P25 Phase 2 Logical Channels (Inbound).

Vertical Maximum (Power Profile submenu)

When the display is set to Power Profile, pressing this soft key opens the Vertical Scale dialog where you can adjust the maximum level for the top line of the vertical scale of the display.

Range	–120 dBm to +60 dBm in 1 dB increments
Default	50 dBm
Saved State	Saved with instrument state

Vertical Scale (Power Profile submenu)

When the display is set to Power Profile, pressing this soft key opens a horizontal soft key menu where you can select the vertical scale resolution for the display's major grid lines.

Discrete Values	10 dB/div, 5dB/div, 2 dB/div, 1 dB/div
Default	10 dB/div
Saved State	Saved with instrument state

Display Mode (Power Profile submenu)

When the display is set to Power Profile, pressing this soft key opens a horizontal soft key menu where you can select the display mode.

Discrete Values	Normal, Freeze, Max Hold, Average
Default	Normal
Saved State	Saved with instrument state
Notes	Normal – Display to updates continuously.

	Freeze – Snapshot of the current display indication and stops additional updates. Max Hold – Display to retain the highest peak signal amplitudes measured during successive sweeps. Average – Displays signal amplitudes as a rolling average of the peak amplitudes measured on each successive sweep. The average consists of one to five sweeps, shown beside the mode indication.

Marker Mode (Power Profile submenu)

When the display is set to Power Profile, pressing this soft key activates a horizontal soft key menu where you can select the Marker type and operating state.

Discrete Values	Off, Absolute, Delta, Delta dBm
Default	Off
Saved State	Saved with instrument state
Notes	Off – Deactivates markers. Absolute – Displays the frequency and absolute signal amplitude for each marker selected. Delta – Displays the frequency and amplitude difference between each pair of markers selected. Delta dBm – Displays the amplitude difference between each pair of markers selected. Depending on the installed options, up to four markers can be enabled and selected for positioning.

Toggle Marker (Power Profile submenu)

When the display is set to Power Profile, pressing this soft key cycles through the available markers to select the active (yellow) marker for positional adjustment on the display.

Saved State	Saved with instrument state
Notes	The active marker is moved using the horizontal arrow keys.

Distribution Plot (DISPLAY Zone menu)

Displays a graph showing the distribution of symbol deviations of the received signal grouped into frequency bins, i.e., the frequency offset versus the rate of occurrence of that frequency (~10 Hz for HDQPSK; ~12 Hz for HCPM).

Saved State	Saved with instrument state
Notes	Each plot consists of about two seconds of the most current data available. HDQPSK consists of four symbol values (–3, –1, +1, +3) at proportional carrier deviations. The four ideal symbol deviations are labeled at gridlines with additional gridlines half way between them, dividing the plot into four equal regions and marking the thresholds where symbol decisions change from one to the other. For example, in low power conditions, noise may cause a symbol's deviation to appear in the adjacent region, thus causing a bit error. Be sure that the Modulation Type in the P25 II Test Zone is set for the expected receive signal in order to establish the appropriate horizontal range and symbol timing used to sample the deviation appropriately. Sampling is at symbol times for HDQPSK but halfway between symbol times for HCPM. ISI inherent in the modulations causes some overshoot exhibited by groups being further from center and having multiple peaks. All distribution amounts are displayed by automatic adjustment of the vertical axis scaling to show the full amount of symbols falling into each bin. Distribution amounts are the percentage of

	the number of symbols whose deviation falls within that point's frequency bin based on the number of symbols in the analysis population. The better a signal is, the more symbols will actually land in the ideal bin to increase its percentage. Deviations that are past the graph edge limits (e.g., for noise if there is no signal) are collected and shown in the bin at the limit.

METER Zone Soft Keys for P25 Phase 2 Transmitter Test

The METER Zone offers specialized meters during P25 Phase 2 transmitter testing with the R8200 in Monitor Mode. Their associated soft keys are described below.

Power Meter (METER Zone menu)

Opens the Power Meter display and submenu.

Range (Power Meter submenu)

When the meter is set to Power Meter, pressing this soft key activates a horizontal soft key menu where you can select the power meter range.

Discrete Values	5, 10, 50, 150 W
Default	50 W
Saved State	Saved with instrument state
Notes	For best accuracy, disable the Pre-amplifier in Monitor Mode and set the Gen Port in Generate Mode to RF In/Out.

Voltmeter (METER Zone menu)

Opens the Voltmeter display and submenu.

Select Voltmeter Mode (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the voltage mode for the Voltmeter.

Discrete Values	AC Volts, DC Volts
Default	AC Volts
Saved State	Saved with instrument state
Notes	AC Volts measures AC voltage applied to the Meter In port. The dBm computation assumes an impedance of 600Ω.

Coupling (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a Coupling dialog menu where you can select the input voltage coupling.

Discrete Values	DC, AC
Default	DC
Saved State	Saved with instrument state

AC Range (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter AC voltage range.

Discrete Values	Auto, 1 V, 10 V, 70 V
Default	Auto
Saved State	Saved with instrument state
Notes	The range on AC and DC must be 1 or 10 Volts to use 600 Ohm Input Impedance.

Set dBr Reference (Voltmeter submenu)

When the meter is set to Voltmeter and Voltmeter mode is set to AC, pressing this soft key sets a reference input voltage.

Notes	When selected, dBm measurements are frozen, and a dBr indicator appears. The dBr indicates the normalized measurement between the reference input voltage and the current input voltage.

Clear dBr Reference (Voltmeter submenu)

When the meter is set to Voltmeter and Voltmeter mode is set to AC, pressing this soft key clears the dBr reference input voltage.

Voltage Units (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter range.

Discrete Values	Volts (V), Millivolts (mV), Decibel Volts (dBV)
Default	Volts (V)
Saved State	Saved with instrument state

DC Range (Voltmeter submenu)

When the meter is set to Voltmeter, pressing this soft key activates a horizontal soft key menu where you can select the power meter DC voltage range.

Discrete Values	Auto, 1 V, 10 V, 70 V
Default	Auto
Saved State	Saved with instrument state
Notes	The range on AC and DC must be 1 or 10 Volts to use 600 Ohm Input Impedance.

Constellation (METER Zone menu)

Provides a visual representation of overall transmitter operation.

Saved State	Saved with instrument state
Notes	DMR radios broadcast voice and data using four frequency shift deviations of the carrier to represent symbols containing two data bits. Four red tick marks on the display represent the expected locations for the deviation states when the radio is transmitting data bit symbols using the modulation. White bars show the actual deviation measurement at symbol decision times. A tighter grouping around the red tick marks indicates more accurate transmitter performance. The nominal deviation points for each data symbol are as follows:

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

P25 II Zone Soft Keys for Receiver Test

During P25 Phase 2 receiver tests, the P25 II Zone contains controls for the P25 Phase 2 transmitter. These tests are performed with the R8200 in Generate Mode.

Test Pattern (P25 II submenu)

Provides selection for one of six TIA-102.CCAA compliant predefined bit patterns for BER testing of a P25 Phase 2 radio in Receive Mode.

Discrete Values	1031 Hz Tone, Calibration (Tone 5%), Silence, High Deviation, Low Deviation, Interference
Default	1031 Hz Tone
Saved State	Saved with instrument state
Notes	The following patterns are available: 1031 Hz Tone – Standard tone framed test pattern of the 1031 Hz vocoder tone for either modulation type and both logical channels. Calibration (Tone 5%) – Derived from the standard 1031 Hz Tone test pattern to verify BER measurements are operating correctly for both modulation types and both logical channels. The first of every 20 bits is inverted (i.e., ~5%). Silence – Framed test pattern for silence at the vocoder for either modulation type and both logical channels. High Deviation – Unframed maximum frequency deviation test pattern of a continuously repeating stream of high deviation symbols (+3, +3, –3, –3, …). Low Deviation – Unframed test pattern of a continuously repeating stream of low deviation symbols (+1, +1, –1, –1, …) for a 1/3 maximum frequency deviation. Interference – Unframed standard interference test pattern as defined by the phase 2 standard and described by the phase 1 (C4FM) standard as yielding a silence output at the receiver vocoder and balanced to have approximately equal positive and negative signal deviations.

Generate Modulation Type (P25 II submenu)

Selects the desired type of modulation for the generated signal required by the receiver.

Discrete Values	HCPM, HDQPSK
Default	HCPM
Saved State	Saved with instrument state

Modulation Mode (P25 II submenu)

Provides choice of Test Pattern modulation.

Discrete Values	Off, Continuous, Burst
Default	Off
Saved State	Saved with instrument state

LCH (P25 II submenu)

Selects which logical channel for the transmitter to use (HCPM only), with ramp down to no power (unused null slot) and ramp up to the next used slot.

Discrete Values	0, 1
Default	0

Saved State	Saved with instrument state
Notes	The logical channel uses either time slot according to the asymmetrical superframe format.

PTC-ITCR Zone Soft Keys

This section contains detailed descriptions of the soft keys accessible in the PTC-ITCR Zone during transmitter testing with the R8200 in Monitor Mode, and receiver testing with the R8200 in Generate Mode. Each PTC-ITCR soft key is defined, along with its range, discrete, default, and saved state values.

"PTC-ITCR Zone Soft Keys for Transceiver Test" on the next page includes the parameters associated with testing the PTC-ITCR radio's transceiver with the R8200 in Generate and Duplex Mode. For standard Generate Mode soft key definitions, see **"9 Generate Mode Soft Keys" on page 390**. For Duplex Mode, see **"10 Duplex Mode Soft Keys" on page 440**.

"DISPLAY Zone Soft Keys for PTC-ITCR Transceiver Test" on page 744 includes the parameters associated with specialized display configurations for quick visual verification of PTC-ITCR transmitter performance. For standard DISPLAY Zone soft key definitions, see **"DISPLAY Zone Soft Keys for Monitor Mode" on page 362**.

"METER Zone Soft Keys for PTC-ITCR Transceiver Test" on page 745 includes the parameters associated with specialized metering configurations offering focused presentations of basic RF and baseband PTC-ITCR transmitter characteristics. For standard METER Zone soft key definitions, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

PTC-ITCR Zone Soft Keys for Transceiver Test

During PTC-ITCR Test Mode, the PTC-ITCR Zone contains controls for the PTC-ITCR transceiver. These tests are performed with the R8200 in Generate and Duplex Mode.

Mon Symbol Rate (PTC-ITCR submenu)

Opens the Mon Symbol Rate dialog where you can select the monitor symbol rate.

Discrete Values	8000, 16000 sps
Default	16000 sps
Saved State	Saved with instrument state

Gen Symbol Rate (PTC-ITCR submenu)

Opens the Gen Symbol Rate dialog where you can select the Generator Symbol Rate.

Discrete Values	8000, 16000 sps
Default	8000 sps
Saved State	Saved with instrument state

BER Test (PTC-ITCR submenu)

Activates a horizontal soft key menu where you can control the operating state of Bit Error Rate Testing.

Discrete Values	Stop, Start
Default	Stop
Saved State	Saved with instrument state
Notes	This bit error rate test checks the modulation, encoding, and timing of the transmit signal during the data transmission period. When the BER Test is running, the radio transmitter under test must be placed into a Test Diagnostic Mode with the correct TX test pattern selected using the manufacturer's Radio Service Software (RSS). The test is done at nominal power with the radio transmitting the Standard O.153 super frame test pattern into the service monitor. (It is acceptable to have an attenuator between the radio under test and the service monitor.) BER test results, the percentage of bit differences between the Standard O.153 pattern and the bits of the synchronized TDMA slot of the received signal, are shown in the PTC-ITCR Zone BER field.

Modulation Mode (PTC-ITCR submenu)

Activates a horizontal soft key menu where you can enable and disable PTC-ITCR modulation.

Discrete Values	Off, Continuous
Default	Off
Saved State	Saved with instrument state

DISPLAY Zone Soft Keys for PTC-ITCR Transceiver Test

The DISPLAY Zone offers specialized displays during PTC-ITCR transmitter testing with the R8200 in Monitor Mode. Their associated soft keys are described below.

Select Display (DISPLAY Zone menu)

Pressing this soft key activates a horizontal soft key menu where you can select the display mode.

Discrete Values	Spec An, Eye Diagram, Power Profile, Constellation Plot, Distribution Plot
Default	Power Profile
Saved State	Saved with instrument state
Notes	Spec An is only available in Monitor Mode.

Spectrum Analyzer (DISPLAY Zone menu)

For Spectrum Analyzer soft key descriptions, see **"Spectrum Analyzer Soft Keys" on page 503**.

Eye Diagram (DISPLAY Zone menu)

For Eye Diagram soft key descriptions, see **"Eye Diagram (DISPLAY Zone menu)" on page 588**.

Power Profile (DISPLAY Zone menu)

For Power Profile soft key descriptions, see **"Power Profile (DISPLAY Zone menu)" on page 589**.

Constellation Plot (DISPLAY Zone menu)

For Constellation Plot soft key descriptions, see **"Constellation Plot (DISPLAY Zone menu)" on page 607**

Distribution Plot (DISPLAY Zone menu)

For Distribution Plot soft key descriptions, see **"Distribution Plot (DISPLAY Zone menu)" on page 608**.

METER Zone Soft Keys for PTC-ITCR Transceiver Test

The METER Zone offers specialized meters during PTC-ITCR transmitter testing with the R8200 in Monitor Mode. Their associated soft keys are described below.

Constellation (METER Zone menu)

Provides a visual representation of overall transmitter operation.

Saved State	Saved with instrument state
Notes	PTC-ITCR radios broadcast voice and data using four frequency shift deviations of the carrier to represent symbols containing two data bits. Four red tick marks on the display represent the expected locations for the deviation states when the radio is transmitting data bit symbols using the modulation. White tick marks show the actual deviation measurement at symbol decision times. A tighter grouping around the red tick marks indicates more accurate transmitter performance. The nominal deviation points for each data symbol are as follows:

Bits	Symbol	Deviation
01	+3	+ 3000 Hz
00	+1	+ 1000 Hz
10	–1	– 1000 Hz
11	–3	+ 3000 Hz

PTC-ACSES Zone Soft Keys

This chapter contains detailed descriptions of the soft keys accessible in the PTC-ACSES Zone during transmitter testing with the R8200 in Monitor Mode, and receiver testing with the R8200 in Generate Mode. Each PTC-ACSES soft key is defined, along with its range, discrete, default, and saved state values.

"PTC-ACSES Zone Soft Keys for Transceiver Test" on the next page includes the parameters associated with testing the PTC-ACSES radio's transmitter with the R8200 in Monitor Mode. For standard Monitor Mode soft key definitions, see **"8 Monitor Mode Soft Keys" on page 330**.

"DISPLAY Zone Soft Keys for PTC-ACSES Transceiver Test" on page 754 includes the parameters associated with specialized display configurations for quick visual verification of PTC-ACSES transmitter performance. For standard DISPLAY Zone soft key definitions, see **"DISPLAY Zone Soft Keys for Monitor Mode" on page 362**.

"METER Zone Soft Keys for PTC-ACSES Transceiver Test" on page 755 includes the parameters associated with specialized metering configurations offering focused presentations of basic RF and baseband PTC-ACSES transmitter characteristics. For standard METER Zone soft key definitions, see **"METER Zone Soft Keys for Monitor Mode" on page 380**.

PTC-ACSES Zone Soft Keys for Transceiver Test

These tests are performed with the R8200 in Duplex Mode. During PTC-ACSES Test Mode, the PTC-ACSES Zone contains controls for the PTC-ACSES transceiver.

Test Pattern (PTC-ACSES submenu)

Provides selection of bit patterns for testing the radio in Transmit Mode while under Radio Service Software (RSS) control.

Discrete Values	Standard, Calibration (O.153 5%)
Default	Standard
Saved State	Saved with instrument state
Notes	Standard selects the standard transmitter test pattern of continuously repeating 511-bit pseudo random number sequences based on ITU-T O.153 (formerly CCITT V.52). Calibration (O.153 2%) is a test pattern derived from the 511 (O.153) pattern to yield a 2.005871% BER used to verify BER measurements are operating correctly.

Radio Tx (PTC-ACSES submenu)

Opens a horizontal soft key menu offering operating mode choices for radio transmission.

Discrete Values	Off, Continuous
Default	Off
Saved State	Saved with instrument state

Modulation Mode (PTC-ACSES submenu)

Opens a horizontal soft key menu offering operating mode choices for Test Pattern modulation.

Discrete Values	Off, Continuous
Default	Off
Saved State	Saved with instrument state

Gen Symbol Deviation (PTC-ACSES submenu)

Opens the Gen Symbol Deviation dialog offering settings for the generator symbol deviation.

Discrete Values	Narrow, Wide
Default	Narrow
Saved State	Saved with instrument state

Gen Bit Errs (PTC-ACSES submenu)

Opens the Gen Bit Errs dialog offering settings for number of bit errors per timeslot.

Range	0 to 360
Default	0
Saved State	Saved with instrument state

BER Test (PTC-ACSES submenu)

Controls the operating state of Bit Error Rate (BER) testing.

Discrete Values	Stop, Start
Default	Stop
Saved State	Saved with instrument state
Notes	This Bit Error Rate test checks the modulation, encoding, and timing of the transmit signal during the data transmission period. When performing the BER Test, the radio transmitter under test must be placed into a test diagnostic mode with the correct TX test pattern selected using the manufacturer's Radio Service Software (RSS). The test is done at nominal power with the radio transmitting the test pattern into the service monitor. (It is acceptable to have an attenuator between the radio under test and the service monitor.) BER test results, the percentage of bit differences between the bits of the selected Test Pattern and the bits from the received synchronized FDMA signal, are shown in the PTC-ACSES Zone in the BER field.

Reset Tests (PTC-ACSES submenu)

Returns all measurements to default values.

Radio Configuration (PTC-ACSES submenu)

Opens the Radio Configuration table and submenu.

Power Level (Radio Configuration submenu)

Opens the Power Level dialog where you can set the power level of the radio under test.

Range	2 W to 25 W
Default	2 W
Saved State	Saved with instrument state

Duty Cycle (Radio Configuration submenu)

Opens the Duty Cycle dialog where you can set percentage for the duty cycle.

Discrete Values	100 %, 50 %, 25 %
Default	100 %
Saved State	Saved with instrument state

Timing (Radio Configuration submenu)

Opens the Timing dialog where you can set the timing source.

Discrete Values	OTA, GPS/PTP
Default	OTA
Saved State	Saved with instrument state

Tx Frequency (Radio Configuration submenu)

Opens the Tx Frequency dialog where you can set the frequency of the transmitter.

Range	250 kHz to 1 GHz
Default	500 kHz
Saved State	Saved with instrument state

Rx Frequency (Radio Configuration submenu)

Opens the Rx Frequency dialog where you can set the frequency of the receiver.

Range	250 kHz to 1 GHz
Default	500 kHz
Saved State	Saved with instrument state

IP Address (Radio Configuration submenu)

Opens IP Address dialog where you can set the IP Address for the radio under test.

Discrete Values	(a valid IP address)
Default	169.254.0.0
Saved State	Saved with instrument state

Tx Port (Radio Configuration submenu)

Opens the Tx Port dialog where you can set the transmit port value for the radio under test.

Discrete Values	0 to 65535
Default	50000
Saved State	Saved with instrument state

Rx Port (Radio Configuration submenu)

Opens the Rx Port dialog where you can set the receive port value for the radio under test.

Discrete Values	0 to 65535
Default	50001
Saved State	Saved with instrument state

ID (Radio Configuration submenu)

Opens the ID dialog where you can set the identifier for the radio under test.

Range	0 to 4294967295
Default	1
Saved State	Saved with instrument state

Data Logging (PTC-ACSES submenu)

Opens the Data Logging dialog where you can enable or disable data logging for the radio under test.

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state

DISPLAY Zone Soft Keys for PTC-ACSES Transceiver Test

The DISPLAY Zone offers specialized displays during PTC-ACSES transmitter testing with the R8200in Monitor Mode. Their associated soft keys are described below.

Select Display (DISPLAY Zone menu)

Pressing this soft key activates a horizontal soft key menu where you can select the display mode.

Discrete Values	Spec An, Eye Diagram, Power Profile, Slot Map
Default	Spec An
Saved State	Saved with instrument state
Notes	Spec An is only available in Monitor Mode.

Spectrum Analyzer (DISPLAY Zone menu)

For Spectrum Analyzer soft key descriptions, see **"Spectrum Analyzer Soft Keys" on page 503**.

Eye Diagram (DISPLAY Zone menu)

For Eye Diagram soft key descriptions, see **"Eye Diagram (DISPLAY Zone menu)" on page 588**.

Power Profile (DISPLAY Zone menu)

For Power Profile soft key descriptions, see **"Power Profile (DISPLAY Zone menu)" on page 589**.

Slot Map (DISPLAY Zone menu)

Opens the Slot Map were you can monitor timeslot error status by slot.

Data Type (Slot Map submenu)

Opens the Data Type dialog where you can choose between packet or bit error rate.

Discrete Values	PERs, BERs
Default	PERs
Saved State	Saved with instrument state
Notes	The selection of reported data is displayed in top right of slot map.

Reset (Slot Map submenu)

Resets all the displays on the Slot Map.

METER Zone Soft Keys for PTC-ACSES Transceiver Test

The METER Zone offers specialized meters during PTC-ACSES transmitter testing with the R8200 in Monitor Mode. Their associated soft keys are described below.

Constellation (METER Zone menu)

Provides a visual representation of overall transmitter operation.

Saved State	Saved with instrument state

Notes	PTC-ACSES radios broadcast voice and data using Gaussian Minimum Shift Keying (GMSK) modulation composed of four frequency shift deviations of the carrier to represent symbols containing two data bits. Four red tick marks on the display represent the expected locations for the deviation states when the radio is transmitting data bit symbols using the modulation. White tick marks show the actual deviation measurement at symbol decision times. A tighter grouping around the red tick marks indicates more accurate transmitter performance. The nominal deviation points for each data symbol are as follows:

Bits	Symbol	Deviation
01	+3	+3000 Hz
00	+1	+1500 Hz
10	–1	–1500 Hz
11	–3	3000 Hz

AVIONICS Test Mode Soft Keys

This section contains detailed descriptions of the soft keys accessible in AVIONICS Test Mode. Each AVIONICS soft key is defined, along with its range, discrete, default, and saved state values.

Select Signal (AVIONICS submenu)

Chooses the signal type for the radio under test.

Discrete Values	Localizer, Glide Slope, Markers, NDB/ADF, VOR, Selcal
Default	Localizer
Saved State	Saved with instrument state

Localizer (AVIONICS submenu)

Opens the Localizer display and submenu.

Glide Slope (AVIONICS submenu)

Opens the Glide Slope display and submenu.

Markers (AVIONICS submenu)

Opens the Markers display and submenu.

Saved State	Saved with instrument state
Notes	The Marker Beacon signal generates a continuous carrier at 75 MHz (default) amplitude modulated by a single tone. There are three user-selected tones from which to select. During start up, none of the beacon markers are selected by default. After selection of one the three markers (Outer, Middle, Inner), a continuous corresponding pure sine wave will transmit via the selected RF port.

NDB/ADF (AVIONICS submenu)

Opens the NDB/ADF display and submenu.

Saved State	Saved with instrument state
Notes	The Non-Directional Beacon/Automatic Direction Finder (NDB/ADF) signal transmits a 30 MHz (default) amplitude modulated by a Morse code string.

VOR (AVIONICS submenu)

Opens the VOR display and submenu.

Saved State	Saved with instrument state
Notes	Transmits a short/medium range navigation signal operating in the 108 to 117.95 MHz range of frequencies (with 50 kHz channel spacing). The VOR signal provides the aircraft with a bearing to the ground station location. The VOR signal may optionally include a three-letter code (derived from an Airport name, for example: London VOR is, “LON” and Dover VOR is, “DVR”). The code is modulated onto the carrier with a 1020 Hz tone that the crew can listen to as a Morse code signal. As VOR operates in the same frequency range as the ILS system (108 to 111.95 MHz), the two systems are differentiated by their frequency allocation within this range. VOR frequencies are allocated where the 100 kHz digit is always even for each of the 50 kHz increments (for example: 109.00, 109.05, 109.20, and 109.25 MHz, etc.). This pattern is applied from 108 to 111.95 MHz. Of the two types of VOR, Conventional and Doppler, the Freedom R8200 only supports the Conventional VOR Transmission. The conventional VOR (CVOR) station transmits two signals, omnidirectional and directional, on a continuous basis. The omnidirectional (reference) signal is the carrier wave frequency of the station, which contains a modulated continuous wave (MCW), 7-word-per-minute, Morse code station identifier and an AM voice channel. The 30 Hz reference

	signal is frequency-modulated on a 9960 Hz subcarrier with range of ± 480 Hz. The directional signal is radiated as a cardioid pattern rotating at 30 revolutions per second, which creates a 30 Hz AM signal. The direction signal is arranged to be in phase with the reference signal when the aircraft is due north (magnetic) of the VOR station. As the cardioid pattern rotates around the station, the two signals become out of phase on a progressive basis. The difference in phase angle between the reference and direction signals is displayed to the crew as a radial from the VOR station. The VOR system can also transmit specific bearing information, referred to as a *radial*, using the Bearing soft key. The pilot can select any radial from a given VOR navigation aid and fly to or from that station. VOR radials are referenced to magnetic north and are the basis of the *airways* used for navigation. The VOR feature of the avionics test mode is capable of receiving and analyzing the combined reference and direction signal.

Selcal (AVIONICS submenu)

Opens the Selcal table and submenu.

Saved State	Saved with instrument state
Notes	The SELCAL signal generated is comprised of two consecutive equal tone pulses, with each pulse containing two simultaneously transmitted tones. Each pulse, of 1-second duration, is separated by an interval of about 0.2 seconds. The tones are labeled with letters A through S, excluding I, N, and O

150 Hz (Localizer & Glide Slope submenus)

Opens the 150 Hz dialog where you can set the modulation tone for the 150 Hz ILS signal for the radio under test.

Range	0 Hz to 160 Hz
Default	150 Hz
Saved State	Saved with instrument state

90 Hz (Localizer & Glide Slope submenus)

Opens the 90 Hz dialog where you can set the modulation tone for the 90 Hz ILS signal for the radio under test.

Range	0 Hz to 110 Hz
Default	90 Hz
Saved State	Saved with instrument state

SDM (Localizer & Glide Slope submenus)

Opens the SDM dialog where you can set the sum of depth modulation percentage for the radio under test.

Range	30 % to 50 %
Default	40 %
Saved State	Saved with instrument state

DDM (Localizer & Glide Slope submenus)

Opens the DDM dialog where you can set the differential depth modulation percentage for the radio under test.

Range	70 % to 90 %
Default	80 %
Saved State	Saved with instrument state

DDM Presets (Localizer & Glide Slope submenus)

Opens the DDM Presets dialog where you can set the preset differential depth modulation percentage for the radio under test.

Discrete values	–15.5, –9.3, –4.5, 0, 4.5, 9.3, 15.5
Default	0
Saved State	Saved with instrument state

Flag Test (Localizer & Glide Slope submenus)

Changes the displayed color of the NAV Flag on the main screen and toggles between Red and Green, when the Flag Test input toggles Off and On.

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state
Notes	The Flag Test is Off (RED) by default and is used to turn the 150 Hz tone off. This results in the transmission of a pure sinewave of 90 Hz. Turning the 90 Hz tone Off and creating a pure 150 Hz

	sinewave can be accomplished manually by setting the DDM input to –40%. Flag Test turns green to indicate it is now On. Morse code can be overlaid on the following signals: Localizer, Glide Slope, and VOR. It can be turned ON/Off with the Morse code string representing an Airport code changed, A 3–5 digit Morse code signal for the Localizer and VOR is generated with a code tone frequency of 1020 Hz and 60% AM modulation. The code, which can be turned ON/Off, repeats at 0.3 s intervals with a duration of 300 ms. Digits A–Z, 0–9 can also be selected from a pre-populated Morse code table in the sub menu.

Ident Off/On (All submenus)

Toggles the operating state of the Morse Code IDENT signal.

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state

Ident Code (All submenus)

Opens the Ident Code dialog where you can enter the Morse Code Identification for the radio under test.

Discrete Values	A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, ,
Default	DFW
Saved State	Saved with instrument state

Localizer Channel (Localizer submenu)

Opens the Localizer Channel dialog where valid Localizer channel frequencies can be selected.

Discrete Values	108.1 MHz, 108.15 MHz, 108.3 MHz, 108.35 MHz, 108.5 MHz, 108.55 MHz, 108.7 MHz, 108.75 MHz, 108.9 MHz, 108.95 MHz, 109.1 MHz, 109.15 MHz, 109.3 MHz, 109.35 MHz, 109.5 MHz, 109.55 MHz, 109.7 MHz, 109.75 MHz, 109.9 MHz, 109.95 MHz, 110.1 MHz, 110.15 MHz, 110.3 MHz, 110.35 MHz, 110.5 MHz, 110.55 MHz, 110.7 MHz, 110.75 MHz, 110.9 MHz, 110.95 MHz, 111.1 MHz, 111.15 MHz, 111.3 MHz, 111.35 MHz, 111.5 MHz, 111.55 MHz, 111.7 MHz, 111.75 MHz, 111.9 MHz, 111.95 MHz
Default	108.1 MHz
Saved State	Saved with instrument state
Notes	For ILS signals, as well as VOR, only valid channel frequencies can be chosen from a predefined list.

Glider Channel (Glide Slope submenu)

Opens the Glider Channel dialog where valid Glider channel frequencies can be selected.

Discrete Values	334.70 MHz, 334.55 MHz, 334.10 MHz, 333.95 MHz, 329.90 MHz, 329.75 MHz, 330.50 MHz, 330.35 MHz, 329.30 MHz, 329.15 MHz, 331.40 MHz, 331.25 MHz, 332.00 MHz, 331.85 MHz, 332.60 MHz, 332.45 MHz, 333.20 MHz, 333.05 MHz, 333.80 MHz, 333.65 MHz, 334.40 MHz, 334.25 MHz, 335.00 MHz, 334.85 MHz, 329.60 MHz, 329.45 MHz, 330.20 MHz, 330.05 MHz, 330.80 MHz, 330.65 MHz, 331.70 MHz, 331.55 MHz, 332.30 MHz, 332.15 MHz, 332.90 MHz, 332.75 MHz, 333.50 MHz, 333.35 MHz, 331.10 MHz, 330.95 MHz
Default	334.70 MHz
Saved State	Saved with instrument state
Notes	For ILS signals, as well as VOR, only valid channel frequencies can be chosen from a predefined list.

VOR Channel (VOR submenu)

Opens the VOR Channel dialog where valid Glider channel frequencies can be selected.

Discrete Values	108.00 MHz, 108.05 MHz, 108.20 MHz, 108.25 MHz, 108.40 MHz, 108.45 MHz, 108.60 MHz, 108.65 MHz, 108.80 MHz, 108.85 MHz, 109.00 MHz, 109.05 MHz, 109.20 MHz, 109.25 MHz, 109.40 MHz, 109.45 MHz, 109.60 MHz, 109.65 MHz, 109.80 MHz, 109.85 MHz, 110.00 MHz, 110.05 MHz, 110.20 MHz, 110.25 MHz, 110.40 MHz, 110.45 MHz, 110.60 MHz, 110.65 MHz, 110.80 MHz, 110.85 MHz, 111.00 MHz, 111.05 MHz, 111.20 MHz, 111.25 MHz, 111.40 MHz, 111.45 MHz, 111.60 MHz, 111.65 MHz, 111.80 MHz, 111.85 MHz, 112.00 MHz, 112.05 MHz, 112.10 MHz, 112.15 MHz, 112.20 MHz, 112.25 MHz, 112.30 MHz, 112.35 MHz, 112.40 MHz, 112.45 MHz, 112.50 MHz, 112.55 MHz, 112.60 MHz, 112.65 MHz, 112.70 MHz, 112.75 MHz, 112.80 MHz, 112.85 MHz, 112.90 MHz, 112.95 MHz, 113.00 MHz, 113.05 MHz, 113.10 MHz, 113.15 MHz, 113.20 MHz, 113.25 MHz, 113.30 MHz, 113.35 MHz, 113.40 MHz, 113.45 MHz, 113.50 MHz, 113.55 MHz, 113.60 MHz, 113.65 MHz, 113.70 MHz, 113.75 MHz, 113.80 MHz, 113.85 MHz, 113.90 MHz, 113.95 MHz, 114.00 MHz, 114.05 MHz, 114.05 MHz, 114.10 MHz, 114.15 MHz, 114.20 MHz, 114.25 MHz, 114.30 MHz, 114.35 MHz, 114.40 MHz, 114.45 MHz, 114.50 MHz, 114.55 MHz, 114.60 MHz, 114.65 MHz, 114.70 MHz, 114.75 MHz, 114.80 MHz, 114.85 MHz, 114.90 MHz, 114.95 MHz, 115.00 MHz, 115.05 MHz, 115.10 MHz, 115.15 MHz, 115.20 MHz, 115.25 MHz, 115.30 MHz, 115.35 MHz, 115.40 MHz, 115.45 MHz, 115.50 MHz, 115.55 MHz, 115.60 MHz, 115.65 MHz, 115.70 MHz, 115.75 MHz, 115.80 MHz, 115.85 MHz, 115.90 MHz, 115.95 MHz, 116.00 MHz, 116.05 MHz, 116.10 MHz, 116.15 MHz, 116.20 MHz, 116.25 MHz, 116.30 MHz, 116.35 MHz, 116.40 MHz, 116.45 MHz, 116.50 MHz, 116.55 MHz, 116.60 MHz, 116.65 MHz, 116.70 MHz, 116.75 MHz, 116.80 MHz, 116.85 MHz, 116.90 MHz, 116.95 MHz, 117.00 MHz, 117.10 MHz, 117.15 MHz, 117.20 MHz, 117.25 MHz, 117.30 MHz, 117.35 MHz, 117.40 MHz, 117.45 MHz, 117.50 MHz, 117.55 MHz, 117.60 MHz, 117.65 MHz, 117.70 MHz, 117.75 MHz, 117.80 MHz, 117.85 MHz, 117.90 MHz, 117.95 MHz
Default	108.00 MHz
Saved State	Saved with instrument state
Notes	Only valid channel frequencies can be chosen from a predefined list.

RF Level (All submenus)

Opens the RF Level dialog where you can input the RF output power.

Range	–130 to –30 dBm
Default	–40 dBm
Saved State	Saved with instrument state

Gen Port (All submenus)

Opens the Gen Port dialog where you can choose the transmitter output.

Discrete Values	RF In/Out, RF Gen Out
Default	RF In/Out
Saved State	Saved with instrument state

Frequency (Markers submenu)

Opens the Frequency dialog where you can choose the Marker Beacon signal frequency.

Range	250 kHz to 1 GHz
Default	75 MHz
Saved State	Saved with instrument state

Outer Marker (Markers submenu)

Modulates the RF carrier with a 400 Hz tone.

Middle Marker (Markers submenu)

Modulates the RF carrier with a 1300 Hz tone.

Inner Marker (Markers submenu)

Modulates the RF carrier with a 3000 Hz tone.

AM Modulation Depth (Markers submenu)

Opens the AM Modulation dialog where you can set the AM modulation depth for the beacon.

Range	0 % to 100 %
Default	95 %
Saved State	Saved with instrument state

AM Depth Set Adjust (NDB/ADF submenu)

Opens the AM Depth Set Adjust dialog where you can set the AM Depth for the NDB signal.

Range	0 % to 100 %
Default	35 %
Saved State	Saved with instrument state

Modulation Tone (NDB/ADF submenu)

Transmits an amplitude modulated by a Morse code string.

Saved State	Saved with instrument state
Notes	The NDB/ADF signal can be repeated indefinitely when the Repeat Cycle flag is True.

Repeat Cycle (NDB/ADF submenu)

Opens the Repeat Cycle dialog where you can enable or disable repeating NDB/ADF signaling.

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state
Notes	When the Repeat Cycle flag is False, a single transmission of the user-specified Morse code is performed.

Bearing

Opens the Bearing dialog where you can adjust bearing by the selected increment.

Range	0 to 360 Deg
Default	0 Deg
Saved State	Saved with instrument state

Ref AM Depth (VOR submenu)

Opens the Ref AM Depth dialog where you can adjust the 30 Hz reference AM depth.

Range	20% to 30 %
Default	30 %
Saved State	Saved with instrument state

Reference Depth (VOR submenu)

Adjust and enter 9.960 Hz AM depth.

Range	20 % to 30 %
Default	30 %
Saved State	Saved with instrument state

Sub Frequency (VOR submenu)

Opens the Sub Frequency dialog where you can set the 9.960 Hz carrier frequency.

Range	9960 Hz ± 10%
Default	9960 Hz
Saved State	Saved with instrument state

Ref Deviation (VOR submenu)

Opens the Ref Deviation dialog where you can set the reference deviation.

Range	0 Hz to 500 Hz
Default	480 Hz
Saved State	Saved with instrument state

To/From

Select To/From and update directional flag.

Discrete Values	To, From
Default	To
Saved State	Saved with instrument state

Variable On/Off

Suppress variable signal component.

Discrete Values	On, Off
Default	On
Saved State	Saved with instrument state

Reference On/Off

Suppress reference signal component.

Discrete Values	On, Off
Default	On
Saved State	Saved with instrument state

sub-carrier On/Off

Suppress sub carrier signal component.

Discrete Values	On, Off
Default	On
Saved State	Saved with instrument state

Var Frequency (VOR submenu)

Opens the Var Frequency dialog where you can adjust the 30 Hz reference frequency.

Range	20 Hz to 40 Hz
Default	30 Hz
Saved State	Saved with instrument state

Slow/Fast (VOR submenu)

Controls the Slew Bearing in 1 degree increments.

Discrete Values	Slow, Fast
Default	Slow
Saved State	Saved with instrument state

Bearing Slew Rate (VOR submenu)

Slew bearing in 1 degree increments, 30 sec duration for 360 degrees.

Discrete Values	Slow, Fast
Default	Slow
Saved State	Saved with instrument state

Selcal Code (Selcal submenu)

Opens the Selcal Code dialog where you can enter a 4-letter Selective Calling System number identifying the aircraft.

Discrete Values	A, B, C, D, E, F, G, H, J, K, L, M, P, Q, R, S
Default	ABCD
Saved State	Saved with instrument state
Notes	The SELCAL signal generated is comprised of two consecutive equal tone pulses, with each pulse containing two simultaneously transmitted tones. Each pulse, of 1-second duration, is sep-

	arated by an interval of about 0.2 seconds. The tones are labeled with letters A through S, excluding I, N, and O. In order to generate a valid sequence pair, you must select four letters (2 sets of two letters), such as AB-CD with the following three tone restrictions: 1. A given letter can be used only once. 2. Letters cannot be not repeated, for example: ◦ AB-CD is a valid entry ◦ AA-BC and AB-BC are not valid selections 3. Letters in a pair must be entered in alphabetical order, for example: ◦ AB-CD and CD-AB are valid entries ◦ CD-BA is not a valid entry For an invalid SELCAL code entry, only a carrier is transmitted. No SELCAL signal is transmitted in this scenario.

AM Depth (Selcal submenu)

Opens the AM Depth dialog where you can enter depth of the Selcal amplitude modulation in percent.

Range	0 % to 40 %
Default	30 %
Saved State	Saved with instrument state

AutoTune Soft Keys

AutoTune is an optional automated test and alignment software application for manufacturer-specific radios embedded in the R8200, eliminating need for an external computer, simplifying setup and equipment costs for this function. A connection between an R8200 USB port and the radio under test controls the radio.

Operator ID (AutoTune submenu)

Displays a dialog where you can enter the Operator ID.

Range	A-Z and 0-9
Saved State	Saved with instrument state
Notes	By default, an Operator ID is required to begin testing (Start soft key appears after entry is made). This can be changed in the Preferences selection under the Tools menu.

Radio Make & Model (AutoTune submenu)

Displays a dialog where you can select the model radio to test.

Discrete Values	Motorola: XTL1500, XTL2500, XTL2500 High, XTL5000, XTL5000 High, XTS1500, XTS2500, XTS5000, APX1000, APX1500, APX2000, APX2500, APX4000, APX4500, APX6000, APX 6500, APX6500 High, APX7000, APX7500, APX7500 High, SRX2200, APX8000, APX8500, APX8500 High TRBO Mobile, TRBO Portable Kenwood: NX Mobile, NX Portable Harris: XG-75 Mobile, XG-75 Portable, XG-100 Mobile, XL Portable BKRelm: KNG-P150, KNG-P400, KNG-P500, KNG-P800, KNG S-Series Hytera: DMR Mobile, DMR Portable

	Technisonic: TDFM-9X00
Default	No Selection
Saved State	Saved with instrument state
Notes	By default, an Operator ID is required to begin testing (Start soft key appears after entry is made). This can be changed in the Preferences selection under the Tools submenu.

Activity (AutoTune submenu)

Displays a dialog where you can select the desired verification activity.

Discrete Values	Test Only, Test & Align
Default	Test Only
Saved State	Saved with instrument state
Notes	Test Only – Measures and compares the radio's performance against the manufacturer's test limits without alignment; then it indicates Pass/Fail in the Results column and displays detailed data in a test report. Test & Align – Performs a radio alignment, tests to the manufacturer's limits, and then provides Pass/Fail results and a test report.

Toggle Test Selection (AutoTune submenu)

Enables or disables the script highlighted by the marker (blue triangle) for AutoScript execution or procedure creation.

Select All (AutoTune submenu)

Selects all test types listed in the Test column.

Clear All (AutoTune submenu)

Clears all test selections.

Tools (AutoTune submenu)

Provides horizontal soft keys menu to access test limits, test reports, and set AutoTune operational preferences.

Discrete Values	Test Limits, Test Report, Preferences
Saved State	Saved with instrument state
Notes	Test Limits – Displays a screen and submenu for pass/fail limits of the selected radio make used to edit test limits for the manufacturer-specific radio under test. Each test type can be selected by positioning the blue indicating arrow with the vertical arrow keys or tuning knob. Edit Test Limit – Activates a data entry window where you can adjust the numeric value using the arrow keys, numeric keypad, and tuning knob. Test Report – Displays a screen and submenu of test logs used to view or delete the current or a previous test log, which contains a report for each test performed in a test session. Test logs are saved in *.csv format to allow exporting to a spreadsheet or other data manipulation program. Individual test logs and test reports can be imported from or exported to a flash memory drive attached to one of the USB ports on the R8200. Preferences – Displays a screen and submenu used to enable or disable automatic settings for Operator ID, Display Report, Unique Log Files, and Display Setup Diagrams.

Log Out Operator (AutoTune submenu)

Clears the Operator ID field when the operator is finished, ensure that the following test logs and reports are assigned to the following operator.

Load Default Test Limit Values (Test Limits submenu)

Resets all test limits for the currently-selected radio model to their factory default values.

Edit Test Limit (Test Limits submenu)

Activates a data entry window to adjust the numeric test limit value.

Save Changes (Test Limits submenu)

Stores the edited limits for use by all future activities.

Cancel Changes (Test Limits submenu)

Cancels the edited limits and exits the Test Limits editor.

Return (Test Limits submenu)

Returns to the main AutoTune menu.

Select Test Log to Open (Test Reports submenu)

Opens a previously saved Test Log that contains the test reports from a previous test session.

Select Test Report to Open (Test Reports submenu)

Opens an individual Test Report from within the current Test Log or a previously loaded one.

Export Test Report (Test Reports submenu)

Copies an individual Test Report from within the current Test Log to a USB drive.

Export All Test Report (Test Reports submenu)

Copies all Test Reports from within the current Test Log to a USB drive.

Export Test Log (Test Reports submenu)

Copies a previously saved Test Log that contains the test reports to a USB drive.

Export All Test Logs (Test Reports submenu)

Copies all previously saved Test Logs that contain the test reports to a USB drive.

Delete Test Log (Test Reports submenu)

Erases the current Test Log.

Return (Test Reports submenu)

Returns to the Main AutoTune menu.

Require Operator ID (Test Preferences submenu)

AutoTune requires the Operator ID to be set before testing can be initiated because it is logged in the test data and reported in the formatted test report.

Discrete Values	Yes, No
Default	Yes
Saved State	Saved with instrument state
Notes	If the field is blank, the operator is not recorded. Setting this preference to No will allow testing to be started without an Operator ID.

Display Report (Test Preferences submenu)

AutoTune will automatically display this screen at the completion of all tests.

Discrete Values	Yes, No

Default	Yes
Saved State	Saved with instrument state
Notes	AutoTune stores the results from each test in a comma-delimited log file. These results can be viewed at any time by pressing **Test Reports** on the AutoTune screen. Test Reports displays the logged test results in an easy to read format.

Unique Log Files (Test Preferences submenu)

Test log data is recorded and saved to a comma-delimited format filename based on the serial number of the radio under test (e.g., XTS5000_11124.csv).

Discrete Values	Yes, No
Default	Yes
Saved State	Saved with instrument state
Notes	Setting this preference to No will cause all test log data to be saved under a common log file name based on the radio make and model (e.g., XTS5000.csv). Recommended: Set to No if testing and reporting a batch of radios.

Display Setup Diagrams (Test Preferences submenu)

This setting controls the display of Test Setup Diagrams at the start of testing.

CAUTION If the radio under test requires the test setup to be changed during testing, this option will be ignored. In this situation, it is critical that the user review the diagrams to ensure that the cable setup is correct. Incorrect setup will result in false test failures and possibly damage the radio or analyzer.

Discrete Values	Yes, No
Default	Yes
Saved State	Saved with instrument state
Notes	When No, the diagrams will not be shown. Recommended: Yes

Save Preferences (Test Preferences submenu)

This selection stores the edited preferences for use by all future activities.

RF Level Offset (Test Preferences submenu)

When enabled, the R8200 applies the RF offset in the RF In/Out field next to it to the output levels and input power measurements used by AutoTune.

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state
Notes	When disabled (default), the value in the RF In/Out field is ignored. This field mirrors the RF Level Offset field described in System Settings. Recommended: Yes

RF In/Out Offset (Test Preferences submenu)

This field specifies the gain or loss between the RF In/Out port and the unit under test.

Discrete Values	–99.0 to 99 dB
Default	0.0
Saved State	Saved with instrument state
Notes	In the case of a loss, such as a cable or attenuator, enter a negative value. The affected field values will be increased to compensate. In Generate Mode, for example, if a –6.0 dB value is entered, the Output Level amplitude is increased by 6 dB. In Monitor Mode, for example, the input level is increased by 6 dB. In the case of a gain, such as an amplifier, enter a positive value. The affected fields will be decreased to compensate. In Generate Mode, for example, if a 10.0 dB value is entered, the Output Level amplitude will decrease by 10 dB. In Monitor Mode, for example, Wattmeter measurements will be reduced by 10 dB. This value is not used if RF Level Offset is disabled (Off). This field mirrors the RF In/Out field described in System Settings. Recommended: Yes

Cable Sweep Enable (Test Preferences submenu)

When enabled, the R8200 applies the frequency response data stored in the cable sweep file to the output levels and input power measurements used by AutoTune.

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state

Cable Sweep File (Test Preferences submenu)

Displays the Cable Sweep File dialog where you can select a cable sweep file associated with the test setup cable when compensating for the output levels and input power measurements used by AutoTune.

Return (Test Preferences submenu)

Exits the Test Preferences submenu and returns to the AutoTune Main menu.

AutoScript Soft Keys

AutoScript provides monitor and control (M&C) script execution from within the R8200. Using this feature, repetitive measurements normally requiring several keystrokes can be programmed into plain text scripts and the results written to an exportable log file. Scripts are imported into the R8200 using a USB drive and may be combined together to form procedures. Procedures can be saved and recalled to run a particular set of scripts.

View (AutoScript submenu)

Activates a horizontal soft key menu where you can toggle between the Scripts and Results menus.

Discrete Values	Scripts, Results
Default	Scripts
Saved State	Saved with instrument state

Toggle Selection

Enables or disables script selected by the selection marker (blue triangle) for AutoScript execution or procedure creation.

Saved State	Saved with instrument state
Notes	Move the selection marker with the tuning knob or arrow keys. If Start AutoScript or Save as Procedure soft keys are selected, only enabled scripts are utilized.

Start AutoScript

Begins execution of enabled scripts in the script list.

Saved State	Saved with instrument state
Notes	During execution, front panel button selections are ignored until AutoScript completes. An exception to this behavior is if an AutoScript prompt appears. In this case, soft keys are active to allow user input. Visible only when at least one script is enabled with Toggle Selection.

Move Up

Shifts script at selection marker up one row in script list while any script in row above selected script is shifted down into selected script's old row.

Move Down

Shifts script at selection marker down one row in script list while any script in row below selected script is shifted up into selected script's old row.

Copy Script

Duplicates the script at the selection marker into the next row so that it can be run more than once.

Saved State	Saved with instrument state
Notes	It may be moved up or down afterwards. The copy is only a reference to the script file and will not be retained if the R8200 Power is turned off. However, the duplication may be retained with Save as Procedure. Visible only when a script exists on the unit's hard drive.

Save As Procedure

Creates a newly-named procedure from enabled scripts in the script list.

Saved State	Saved with instrument state
Notes	Once created, the procedure is available for selection using the Load Procedure soft key. Visible only when a script exists on the unit's hard drive.

Refresh Scripts

Refreshes script list with currently available scripts imported to the unit's hard drive.

Saved State	Saved with instrument state
Notes	If a procedure was loaded before selecting this soft key, its scripts are replaced with the list of scripts currently available for execution on the unit. Visible only when a script exists on the unit's hard drive.

Export Procedure

Exports one or more procedures from the unit's hard drive to a USB drive.

Saved State	Saved with instrument state
Notes	When selected, a list of procedures available for export is provided. Visible only when a USB drive is inserted into the unit and at least one procedure is available for export.

Step Delay (AutoScript submenu)

Controls the delay between each script step or line in the script during script execution.

Range	0 to 60 s
Default	0 s
Saved State	Saved with instrument state

Script Delay (AutoScript submenu)

Controls the delay between each script selected for execution.

Discrete Values	0 to 60 s
Default	0 s
Saved State	Saved with instrument state

Record Result (AutoScript submenu)

Controls whether to send execution results to a file.

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state

Import Scripts

Import scripts from a USB drive to the unit's hard drive.

Saved State	Saved with instrument state
Notes	When selected, it provides a list of scripts available for import. Visible only when a USB drive containing scripts in the correct subfolder (*<USB_Drive>:\FREEDOM\AutoScript*) is inserted into the unit.

Delete Scripts

Deletes the selected script from the unit's hard drive and removes all references to it from the script list.

Saved State	Saved with instrument state
Notes	After being deleted, that script must be imported again to use it in AutoScript. Visible only when a script exists on the unit's hard drive.

Delete Procedure

Deletes the selected procedure from the unit's hard drive.

Saved State	Saved with instrument state
Notes	After being deleted, that procedure must be either imported again or recreated from available scripts on the unit's hard drive to be used in AutoScript. Visible only when a script exists on the unit's hard drive.

13 Settings Mode Soft Keys

The Settings menu is divided into six functional submenus concerned with global system settings, battery status, network setup for remote operation, messaging, versioning, and instrument options. This chapter contains detailed descriptions of the soft keys accessible in each. Each soft key is defined, along with its range, discrete, default, and saved state values.

"Settings Mode Soft Keys" on the next page enables access to R8200 battery status, message acknowledgement, hardware and software versioning, software updating, and instrument options.

"System Settings Soft Keys" on the next page enables configurable parameters for Cable Sweep, Measurement Averaging and Offsets, Attenuation, Pre-amplification, Pre-emphasis/De-emphasis, Metering Filters, Internal Audio Weighting, Global Language, Date, and Time, and default value restoration.

"Network Setup Soft Keys" on page 803 enables configurable parameters for connecting the R8200 to a network.

Settings Mode Soft Keys

The Settings Mode menu enables the display and configuration of battery status, message acknowledgment, hardware and software versioning, software updating, and instrument options.

System Settings (Settings submenu)

Activates submenus for system-wide settings.

System Settings Soft Keys

These soft keys enable the display and configuration of Cable Sweep, Measurement Averaging and Offsets, Attenuation, Pre-amplification, Pre-emphasis/De-emphasis, Metering Filters, Internal Audio Weighting, Global Language, Date, and Time, and default value restoration.

Cable Sweep Table (System Settings submenu)

Activates the Cable Sweep Table and submenu.

Notes	The Cable Sweep function provides an easy way for the user to determine the loss characteristics of a test cable across frequency and store that information within the R8200 with a user-defined name. Up to fifty cable files can be stored.

Enable (Cable Sweep Table submenu)

Displays a dialog where you can enable or disable cable sweeps.

Discrete Values	Off, On
Default	Off

Saved State	Saved with instrument state
Notes	When activated, the R8200 compensates for the return loss of the currently selected cable during the measurement sweep.

New Two Points (Cable Sweep Table submenu)

Opens a vertical soft key menu where you can enter cable loss values at 100 MHz and 1 GHz for a new cable.

Return to Table (New Two Points submenu)

Closes the Two Points entry menu without saving.

100 MHz Loss (New Two Points submenu)

Displays a dialog where you can enter a cable loss value associated with 100 MHz.

Range	–99 to 0 dB
Default	0 dB
Saved State	Saved with instrument state

1 GHz Loss (New Two Points submenu)

Displays a dialog where you can enter a cable loss value associated with 1 GHz.

Range	–99 to 0 dB
Default	0 dB
Saved State	Saved with instrument state

Save File As (New Two Points submenu)

Saves the entered cable properties for later use.

Discrete Values	A to Z, 0 to 9, and . (period symbol)
Saved State	Saved with instrument state
Notes	The name can be 16 characters long. It may contain uppercase text/numbers and some symbols.

New Multiple Points (Cable Sweep Table submenu)

Utilizes the Tracking Generator (R8-TG) to create a multi-point loss data measurement for use in cable sweeps.

Continue (New Multiple Points submenu)

Performs the cable measurement and continues to the next menu.

Notes	First used to measure the reference cable, then used to measure the cable loss.

Save File As (New Multiple Points submenu)

Saves the multi-point cable sweep for later use.

Notes	The name can be 16 characters long. It may contain uppercase text/numbers and some symbols. After the data is saved the screen will return to the Cable Sweep Table and you will be able to review the frequency response of the cable.

Edit (Cable Sweep Table submenu)

Displays a dialog where you can edit the name of the selected cable loss file.

Delete (Cable Sweep Table submenu)

Deletes the selected cable loss file.

Delete All Files (Cable Sweep Table submenu)

Deletes every cable loss file in the table.

Export (Cable Sweep Table submenu)

Exports a table of cable sweep files.

Saved State	Saved with instrument state
Notes	A USB drive must be plugged into the R8200 to see the Export or Import selections.

Import (Cable Sweep Table submenu)

Imports a table of cable sweep files.

Saved State	Saved with instrument state
Notes	A USB drive must be plugged into the R8200 to see the Export or Import selections.

Input Impedance (Cable Sweep Table submenu)

Selects the input impedance for the Meter In port.

Discrete Values	600 Ω, 1 M Ω
Default	1 M Ω
Saved State	Saved with instrument state
Notes	To prevent damage to the R8200, the 600 Ω input impedance is restricted to AC and DC ranges of 10 Volts or less. Both the AC and DC voltmeters must be set to a range of 10 Volts or less before 600 Ω can be selected.

Input Decoding (System Settings submenu)

Displays a dialog where you can switch between Internal and External decoding, the signal source used for the R8200 frequency counter and decode functions.

Discrete Values	Internal, External
Default	Internal
Saved State	Saved with instrument state
Notes	When set to Internal, the recovered audio or tones from a demodulated received signal are used as the signal source. The External setting directs an externally-applied signal at the Meter In port to the R8200 frequency counter and decode circuits.

Reference Clock Mode (System Settings submenu)

Selects the mode for the 10 MHz Ref In/Out connector on the R8200 side panel.

Discrete	Output, Input

Values	
Default	Output
Saved State	Saved with instrument state
Notes	Output – Routes the internal 10 MHz time base signal to the 10 MHz Ref In/Out connector for use as a frequency reference by external equipment. Input – Allows an external time base signal (5 MHz or 10 MHz) applied to the 10 MHz Ref In/Out connector to be routed into the R8200.

Analog Measurement Averaging (System Settings submenu)

Displays a dialog where you can enable or disable measurement averaging to smooth a number of analog readings.

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state
Notes	Analog Measurement Averaging affects the following: RF Zone – Frequency Error, Deviation DISPLAY Zone – Frequency Error Bar Graphs, Deviation Bar Graphs METER Zone – AC Volts, DC Volts, Internal Distortion, External Distortion, SINAD

Analog Averaging Samples (System Settings submenu)

Displays a dialog where you can adjust the number of analog averaging samples used in measurement averaging.

Range	2 to 100
Default	7
Saved State	Saved with instrument state

Digital Measurement Averaging (System Settings submenu)

Displays a dialog where you can enable or disable measurement averaging to smooth a number of digital readings.

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state
Notes	Digital Measurement Averaging affects the following: DMR Zone – Symbol Deviation, FSK Error; Magnitude Error PROJECT 25 Zone – Symbol Deviation, Modulation Fidelity P25 Trunk Zone – Symbol Deviation, Modulation Fidelity NXDN™ Zone – Symbol Deviation, Modulation Fidelity TETRA Zone – Averaging is controlled locally

Digital Averaging Samples (System Settings submenu)

Displays a dialog where you can adjust the number of Digital Averaging Samples used in measurement averaging.

Range	2 to 100
Default	7
Saved State	Saved with instrument state

Automatic Attenuation (System Settings submenu)

Displays a dialog where you can enable or disable Automatic Attenuation.

Discrete Values	Off, On
Default	On
Saved State	Saved with instrument state

Auto Attn Minimum (System Settings submenu)

Displays a dialog where you can set the Auto Attn Minimum value.

Discrete Values	0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34 dB
Default	0 dB
Saved State	Saved with instrument state

Auto Attn High Threshold (System Settings submenu)

Displays a dialog where you can set the Auto Attenuation high threshold value.

Range	–19 to 0 dB
Default	–10 dB
Saved State	Saved with instrument state

Auto Attn Low Threshold (System Settings submenu)

Displays a dialog where you can set the Auto Attenuation low threshold value.

Range	–40 to –21 dB
Default	–30 dB
Saved State	Saved with instrument state

Pre-Amplifier Auto Off (System Settings submenu)

Displays a dialog where you can enable or disable the Pre-Amplifier Auto Off.

Discrete Values	Disabled, Enabled
Default	Enabled
Saved State	Saved with instrument state
Notes	When enabled (default), the R8200 automatically switches off the Pre-Amplifier to maintain measurement accuracy when broadband RF power measurements are selected or detected. A message appears for several seconds acknowledging that the Pre-Amplifier will be turned off. If you choose to override the setting, an alert is displayed.

RF Level Offset (System Settings submenu)

Displays a dialog where you can enable or disable RF Level Offset.

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state
Notes	When enabled, the R8200 applies the RF offsets to various TX signals and RX measurements and displays this below the RF In/Out, RF Gen Out, and Antenna fields. When disabled (default), the values in the RF In/Out, RF Gen Out, and Antenna fields are ignored. Affected fields include: Output Level Tracking Generator Output Level Input Level Power Meter/Wattmeter Spectrum analyzer trace, in DISPLAY Zone and Spectrum Analyzer and Dual Display in Instrument Mode Tracking Generator trace DMR and TETRA Power Profile trace TETRA unwanted power AutoTune output and input levels

RF In/Out Offset (System Settings submenu)

Displays a dialog where you can specify the gains or losses between the RF In/Out port and the unit under test.

Range	–99 to 99 dB
Default	0 dB
Saved State	Saved with instrument state
Notes	In the case of a loss, such as a cable or attenuator, enter a negative value. The affected field values will be increased to compensate. In Generate Mode, for example, if a –6.0 dB value is entered, the Output Level amplitude is increased by 6 dB. In Monitor Mode, for example, the Spectrum Analyzer trace is increased by 6 dB. In the case of a gain, such as an amplifier, enter a positive value. The affected fields will be decreased to compensate. In Generate Mode, for example, if a 10.0 dB value is entered, the Output Level amplitude will decrease by 10 dB. In Monitor Mode, for example, Watt Meter measurements will be reduced by 10 dB. This value is not used if RF Level Offset is disabled (Off).

RF Gen Out Offset (System Settings submenu)

Displays a dialog where you set the RF Gen Out Offset value specifying the gains or losses between the RF Gen Out port and the unit under test.

Range	–99 to 99 dB
Default	0 dB
Saved State	Saved with instrument state
Notes	In the case of a loss, such as a cable or attenuator, enter a negative value. The affected field val-

	ues will be increased to compensate. For example, if a –6.0 dB value is entered, the Output Level amplitude is increased by 6 dB. In the case of a gain, such as an amplifier, enter a positive value. The affected fields will be decreased to compensate. For example, if a 10.0 dB value is entered, the Output Level amplitude will decrease by 10 dB. This value is not used if RF Level Offset is disabled (Off).

Cable Sweep Enable (System Settings submenu)

Displays a dialog where you can enable or disable cable sweep information.

Discrete Values	Off, On
Default	Off
Saved State	Saved with instrument state

Cable Sweep File (System Settings submenu)

Displays a dialog where you can select a Cable Sweep File for use in measurements.

Antenna Offset (System Settings submenu)

Displays a dialog where you can specify the gains or losses between the Antenna port and the unit under test.

Range	–99 to 99 dB
Default	0 dB

Saved State	Saved with instrument state
Notes	In the case of a loss, such as a cable or attenuator, enter a negative value. The affected field values will be increased to compensate. For example, if a –6.0 dB value is entered, the Spectrum Analyzer trace is increased by 6 dB. In the case of a gain, such as an amplifier, enter a positive value. The affected fields will be decreased to compensate. For example, if a 10.0 dB value is entered, the Spectrum Analyzer trace will be reduced by 10 dB. This value is not used if RF Level Offset is disabled (Off).

Mod Out DC Offset (System Settings submenu)

Displays a dialog where you can set the Mod Out DC Offset value.

Range	–300 to 300 mV
Default	0 mV
Saved State	Saved with instrument state

Pre/De-emphasis (System Settings submenu)

Displays a dialog where you can enable or disable Pre/De-emphasis, the emphasis network for internally-coupled audio signals.

Discrete Values	Off, On
Default	Off

Saved State	Saved with instrument state
Notes	When enabled, the R8200 applies pre-emphasis to audio signals before they modulate the RF carrier and de-emphasis to audio signals demodulated from the RF carrier.

Meter In Filter (System Settings submenu)

Displays a dialog where you can select various filters to apply to external audio signals measured at the Meter In port.

Discrete Values	None, C-Msg, CCITT, De-emphasis
Default	None
Saved State	Saved with instrument state
Notes	None – No filtering is applied to signal. C-Msg – Applies a C-Message weighting filter to signal. CCITT – Applies a ITU-T O.41 weighting filter to signal. De-emphasis – Applies de-emphasis filter to signal.

Internal Audio Weighting (System Settings submenu)

Displays a dialog where you can select various filters to apply to internal demodulated audio signals.

Discrete Values	None, C-Msg, CCITT
Default	None

Saved State	Saved with instrument state
Notes	None – No filtering is applied to signal. C-Msg – Applies a C-Message weighting filter to signal. CCITT – Applies a ITU-T O.41 weighting filter to signal.

Language (System Settings submenu)

Activates a horizontal soft key menu where you can select the service monitor's display language.

Discrete Values	English, Spanish
Default	English
Saved State	Saved with instrument state

Date (System Settings submenu)

Displays a dialog where you can set the R8200's date in month, day, year (MM.DD.YYYY) notation.

Notes	Date/Time settings are not applied until **Apply Date/Time Changes** is pressed.

Time (System Settings submenu)

Displays a dialog where you can set the R8200 system clock in 24-hour notation.

Notes	Date/Time settings are not applied until **Apply Date/Time Changes** is pressed.

Apply Date/Time Changes (System Settings submenu)

Saves the entered date/time changes to the R8200 system clock.

Reset to Defaults (System Settings submenu)

Resets all R8200 system settings to the factory defaults.

Battery Status (Settings submenu)

The Battery Status menu displays the current serial number, battery life, and cycle count if a battery is installed.

Network Setup Soft Keys

The soft keys enable connecting the R8200 to a network.

Network Setup (Settings submenu)

Opens a vertical soft key menu where you can configure the R8200 for remote operation.

Network Connection (Network Setup submenu)

Displays a dialog where you can enable or disable the Network Connection.

Discrete Values	Disable, Enable
Default	Disable
Saved State	Saved with instrument state
Notes	When the network connection is enabled, the R8200 may be controlled by the other computers on the network without restriction. It is strongly recommended that the R8200 be protected from unauthorized access through the use of external security measures.

DHCP (Network Setup submenu)

Displays a dialog where you can enable or disable DHCP (or Dynamic Host Configuration Protocol) by which an IP address is assigned to the R8200 during boot by a DHCP server on the Local Area Network.

Discrete Values	Off, On
Default	On
Saved State	Saved with instrument state
Notes	When the R8200 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. When DHCP is on, the fields for IP Address, Subnet Mask, and Default Gateway are populated with their respective values from the DHCP server.

IP Address (Network Setup submenu)

Applies the user-defined IP address to the R8200.

Subnet Mask (Network Setup submenu)

Displays a dialog where you can set the Communications System Analyzer Subnet Mask.

Use this key to enter the subnet mask address assigned to the R8200 by the network administrator.

Range	000.000.000.000 to 255.255.255.255
Default	000.000.000.000
Saved State	Saved with instrument state

Default Gateway (Network Setup submenu)

Displays a dialog where you can set the Communications System Analyzer Default Gateway.

Use this key to enter the Default Gateway address assigned to the R8200 by the network administrator.

Range	000.000.000.000 to 255.255.255.255
Default	000.000.000.000
Saved State	Saved with instrument state
Notes	This is the address of the router that passes data outside the subnet to which the R8200 is attached.

Acknowledge Message (Settings submenu)

The Acknowledge Message soft key is used to acknowledge and clear messages that appear at the bottom of the R8200 screen.

Notes	Use the tuning knob or arrow keys to select a message.

About (Settings submenu)

The About menu is used to view the R8200 software and driver versions.

Notes	This information is important when interacting with Freedom Communication Technologies personnel to resolve technical issues or determine if a firmware upgrade is required. The system version uniquely identifies the combination of subsystem Versions and Protocols shown by their respective soft keys.

Protocols (About submenu)

Displays a menu listing all installed optional communication protocols and their associated versions.

Versions (About submenu)

Displays the R8200's hardware, library, and firmware versions.

Main (Protocol & Versions submenus)

Returns to the Main About menu listing basic system info and contact information.

Search for Updates (About submenu)

Searches external USB storage devices for software updates.

Notes	The R8200 firmware can be upgraded in the field using a USB thumb drive. **CAUTION** Firmware changes can significantly affect analyzer operation and should be performed carefully. An improperly executed firmware upgrade can render the analyzer inoperable. It is recommended that Freedom Communication Technologies support personnel be consulted and involved in firmware upgrades of the R8200. Pressing the Search for Updates soft key initiates a search for firmware updates on a USB Flash Drive attached to the any of the analyzer's USB ports. In order for the R8200 to recognize an attached thumb drive, security features such as password protection or encryption must be disabled. Details of the firmware update process are not included in this manual since they tend to evolve with analyzer development. The latest and correct update procedure is provided with each firmware revision made available.

Options (Settings submenu)

The Options menu is used to view the R8200's enabled options and to activate additional options.

Notes	These include enhanced features for the main R8200 system along with additional radio communication protocols or special test functions.

Enter Option Key (Options submenu)

Provides a means for entering a unit-specific 16-digit number key to enable additional options purchased after the original order.

Range	0 to 9, A to Z, ., *, #
Saved State	Saved with instrument state

Glossary

+

+/-

Plus or minus

A

A

Ampere

AC

Alternating Current

ACELP

Algebraic Code-Excited Linear Prediction

AM

Amplitude Modulation

AMBE

DVSI Advanced Multi-Band Excitation

APCO

Association of Public-Safety Communications Officials

APIPA

Automatic Private IP Addressing

AUTO

Automatic

B

BER

Bit Error Rate

BIOS

Basic Input/Output System

BNC

Coaxial RF Connector

bps

Bits Per Second

BW

Bandwidth

C

C

Celsius

C4FM

Continuous 4 Level FM

CAI

Common Air Interface

CCIR

International Radio Consultative Committee

CCITT

International Telegraph and Telephone Consultative Committee

Cm

Centimeters

CMOS

Complementary Metal Oxide Semiconductor

CRLF

Carriage-return-line feed

CTCSS

Continuous Tone-Coded Squelch System

CW

Continuous Wave

D

dB

Decibel

dBc

Decibel (referred to carrier)

dBm

Decibel (referred to 1 mW into 50 Ω)

DC

Direct Current

Demod

Demodulation

DHCP

Dynamic Host Configuration Protocol

Div

Division

DMO

TETRA Direct Mode Operation (inter-radio)

DMR

ETSI Digital Mobile Radio

DNS

Domain Name System/Server

DPL

Digital Private Line, a Motorola registered trademark

DQPSK

Differential Quadrature Phase-Shift Keying

DTMF

Dual-tone multi-frequency

DVM

Digital Voltmeter

E

e.g.

example given; for example

EEA

Electronic Engineering Association

EIA

Electronics Industry Association

ETSI

European Telecommunications Standards Institute

F

FFT

Fast Fourier Transform

FM

Frequency Modulation

FREQ

Frequency

FSK

Frequency Shift Keying

FTP

File Transfer Protocol

G

GHz

Gigahertz

H

HPF

High Pass Filter

HTTP

Hyper-Text Transfer Protocol

Hz

Hertz

I

i.e.

that is to say; in other words

I/O

Input and/or Output

IC

Integrated Circuit

ICMP

Internet Control Message Protocol

ID

Identification

IEEE

Institute of Electrical and Electronics Engineers

IF

Intermediate Frequency

inbound

Tx from mobile into base station

IP

Internet Protocol

ISI

Inter-Symbol Interference

K

kHz

Kilohertz

Kohm

Kilo Ohm

L

LC

Link Control

LCD

Liquid Crystal Display

LED

Light-Emitting Diode

LPF

Low Pass Filter

Lvl

Level

M

MAC

Media Access Control

MAX

Maximum

MB

Megabytes

MHz

Megahertz

MIC

Microphone

MIN

Minimum

MNI

TETRA Mobile Network Identity

ms

Millisecond

MSB

Most Significant Bit

mV

Millivolt

mW

Milliwatt

N

n

Number

N/A

Not Applicable

NAC

Network Access Code

NaN

Not a Number

NI

National Instruments Corporation

NVM

Non-volatile memory

O

O.153

ITU O series recommendation

opcode

Operation Code

outbound

Tx out of base to mobile station

P

P25

Project 25

PC

Personal Computer

PCT

Percent

PL

Private Line, a Motorola registered trademark

Q

QAM

Quadrature Amplitude Modulation

R

RAN

Radio Access Number

RBW

Resolution Bandwidth

RDCH

RF Direct Traffic Channel

REF

Reference

RF

Radio Frequency

RMS

Root-Mean-Square

RS

Receiver Specification

RSS

Radio Service Software

RTCH

RF Traffic Channel

S

S/N

Signal to Noise

SACCH

Slow Associated Control Channel

SEC

Second

SEQ

Sequence

SINAD

Ratio of (Signal + Noise + Distortion) / (Noise + Distortion)

SSB

Single Sideband

SSI

TETRA Short Subscriber Identity

STD

Standard

SW

Switch

Synth

Synthesizer

T

TCP

Transmission Control Protocol

TDMA

Time Division Multiple Access

TETRA

ETSI TErrestrial Trunked RAdio

TIA

Telecommunications Industry Association

TMO

TETRA Trunked Mode Operation

TSBK

Trunking Signaling Block-/Data Unit

TSI

TETRA Subscriber Identity (MNI+SSI)

TX

Transmitter

U

UHF

Ultra High Frequency

us

Microsecond

USB

Universal Serial Bus

uV

Microvolt

V

V

Volts

VAC

Volts Alternating Current

VDC

Volts Direct Current

VGA

Video Graphics Array

vocoder

voice encoder / decoder

VRMS

Volts (root-mean-square)

vs.

versus

W

W

Watts

Z

ZVEI

Zentral-Verband der Elektro-Industrie (a German Electronics Industry Association)