

Measurement Guide

Land Mobile Radio Analyzer and Coverage Measurement

for Anritsu RF and Microwave Handheld Instruments

LMR Master™

	Analyzer	Coverage
Narrowband FM	Included	Included
P25/P25p2 Signal Analysis	Option 521	Option 522
NXDN Signal Analysis	Option 531	Option 532
dPMR Signal Analysis	Option 573	Option 572
TETRA Signal Analysis	Option 581	Option 582
DMR Signal Analysis	Option 591	Option 592
PTC-ITCR Signal Analysis	Option 721	Option 722
PTC-ACSES Signal Analysis	Option 731	Option 733

Note

Not all instrument models offer every option or every measurement within a given option. Please refer to the Technical Data Sheet of your instrument for available options and measurements within the options.



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Chapter 1 — General Information

1-1 Introduction

This Measurement Guide documents Land Mobile Radio signal analysis functions of the Anritsu LMR Master handheld instrument. Anritsu currently supports measurement of Narrowband FM Analog ([Chapter 2](#)) and digital transmitter Land Mobile Radio technologies including:

- P25 – Project 25 or APCO-25 ([Chapter 3](#))
- P25 Phase 2 ([Chapter 4](#))
- NXDN™ – Very Narrowband Common Air Interface ([Chapter 5](#))
- dPMR – Digital Private Mobile Radio ([Chapter 6](#))
- TETRA – Terrestrial Trunked Radio ([Chapter 7](#))
- DMR – ETSI Digital Mobile Radio ([Chapter 8](#))
- PTC – ITCR Positive Train Control ([Chapter 9](#))
- PTC – ACSES Positive Train Control ([Chapter 10](#))

Note

Not all instrument models offer every option or measurement mode. Please refer to your instrument's technical data sheet for available options and features.

The screen images and menus on your instrument may vary from what is shown in this measurement guide, and may be affected by instrument configuration, setup, and received measurement data.

1-2 Product Information, Compliance, and Safety

Read the Handheld Instruments Product Information, Compliance, and Safety Guide (PN: 10100-00065) for important safety, legal, and regulatory notices before operating the equipment. For additional information and literature covering your product, visit the product page of your instrument on <http://www.anritsu.com/> and select the Library tab.

Not all instrument models offer every option. Please refer to the Technical Data Sheet of your instrument for available options.

1-3 Contacting Anritsu

To contact Anritsu, please visit:

<http://www.anritsu.com/contact-us>

From here, you can select the latest sales, select service and support contact information in your country or region, provide feedback, complete a “Talk to Anritsu” form to have your questions answered, or obtain other services offered by Anritsu.

Updated product information can be found on the Anritsu web site:

<http://www.anritsu.com/>

Search for the product model number. The latest documentation is on the product page under the Library tab.

1-4 Measurement Guide Overview

This Measurement Guide details the following functions and options:

- [Chapter 2, “NBFM Analyzer”](#)
- [Chapter 3, “P25 Analyzer \(Option 521\)”](#)
- [Chapter 4, “P25 Phase 2 Analyzer \(Option 521\)”](#)
- [Chapter 5, “NXDN Analyzer \(Option 531\)”](#)
- [Chapter 6, “dPMR Analyzer \(Option 573\)”](#)
- [Chapter 7, “TETRA Analyzer \(Option 581\)”](#)
- [Chapter 8, “DMR Analyzer \(Option 591\)”](#)
- [Chapter 9, “PTC-ITCR Analyzer \(Option 721\)”](#)
- [Chapter 10, “PTC-ACSES Analyzer \(Option 731\)”](#)
- [Chapter 11, “LMR Coverage Mapping”](#)
- [Chapter 12, “High Power Input Protection”](#)

1-5 Selecting a Measurement Mode

Press the **Menu** button and select the measurement mode by tapping its icon on the touch screen.

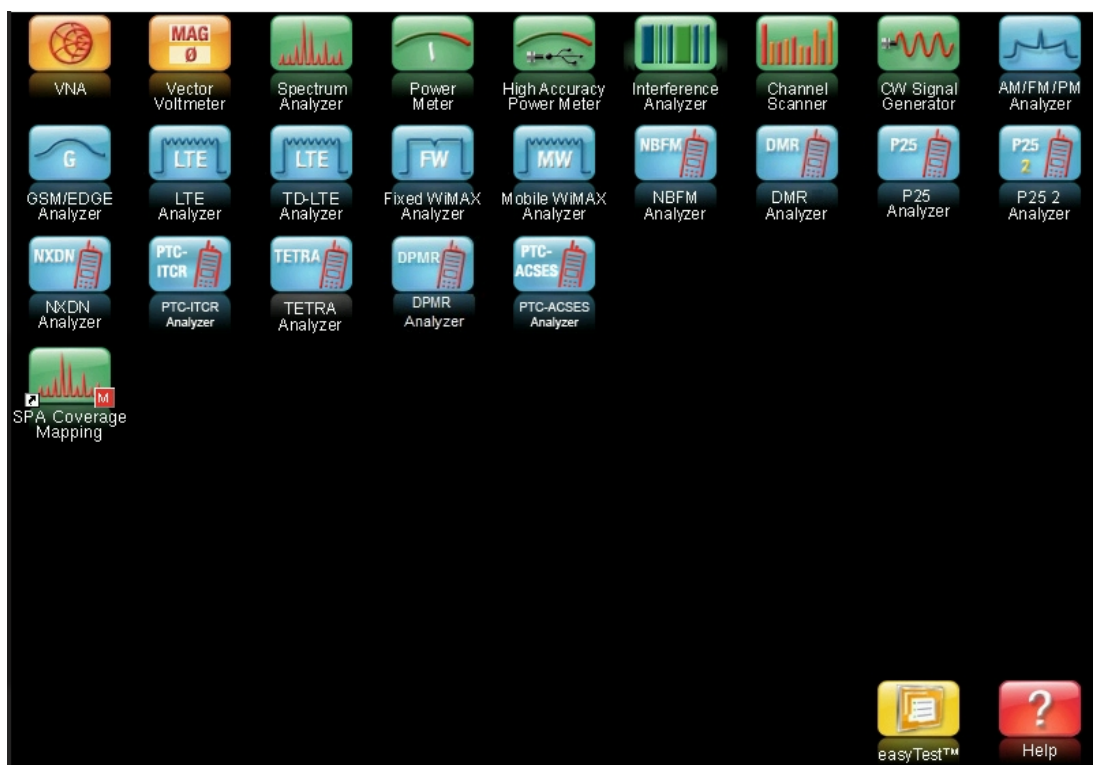


Figure 1-1. Menu Button Screen

You can also press the **Shift** key then the **Mode (9)** key, select the measurement from the list using the rotary knob or the **Arrow** keys, and then press **Enter**.

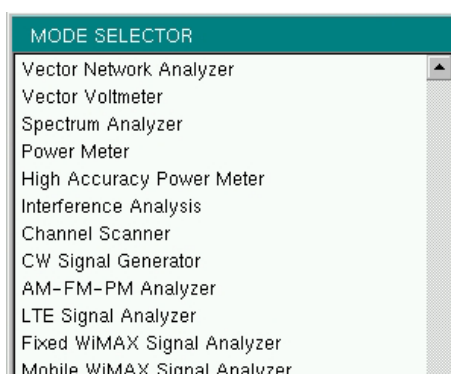


Figure 1-2. Measurement Mode Selector List

Note that the shortcut icons and modes include a selection for each application option installed in the instrument, as shipped from the factory. The Land Mobile Radio modes are: NBFM, DMR, P25, P25p2, NXDN, dPMR, PTC (ITCR and ACSES), and TETRA.

1-6 Multi-Screen View

The preset view in NBFM Analyzer, P25/P25p2 Analyzer, NXDN Analyzer, dPMR Analyzer, DMR Analyzer, PTC Analyzer (ITCR and ACSES), and TETRA Analyzer measurements is the four-measurement view (Figure 1-3). Tap once on an individual graph to make it active (red perimeter line).

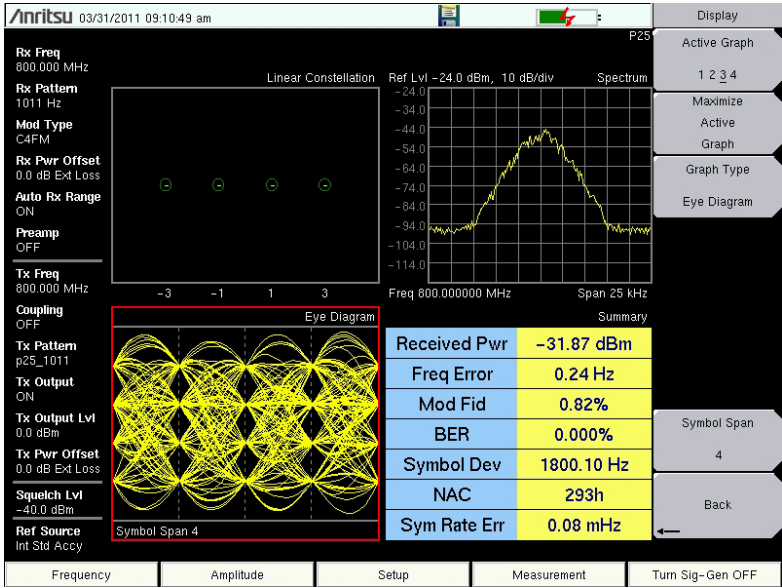


Figure 1-3. Four-Measurement View with the Eye Diagram as the Active Measurement

Tap twice on the active graph to display it in full screen view (Figure 1-4). Tap twice on the active graph again to return to four-measurement view.

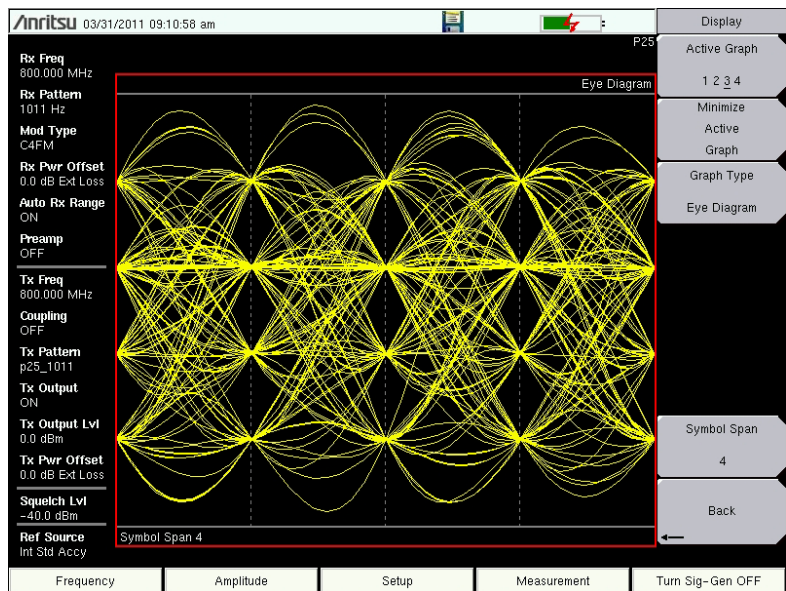


Figure 1-4. Eye Diagram as the Active Measurement in Full Screen View

The default view in Coverage Mapping (Chapter 11, “LMR Coverage Mapping”) is the map view.



Figure 1-5. Coverage Mapping

The two-measurement graph view (Figure 1-6) is also available when mapping. Tap once on a graph to make it the active graph (red perimeter line).

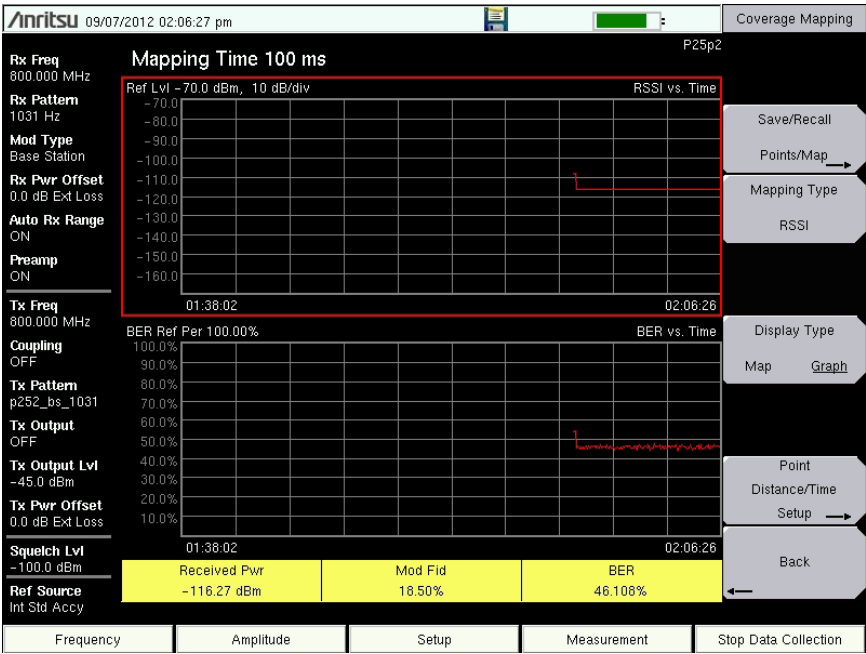


Figure 1-6. Two-Measurement Mapping View with RSSI as the Active Measurement

Tap the active graph twice to display it in full screen view (Figure 1-7). Tap the active graph twice again to return to the two measurement graph view.

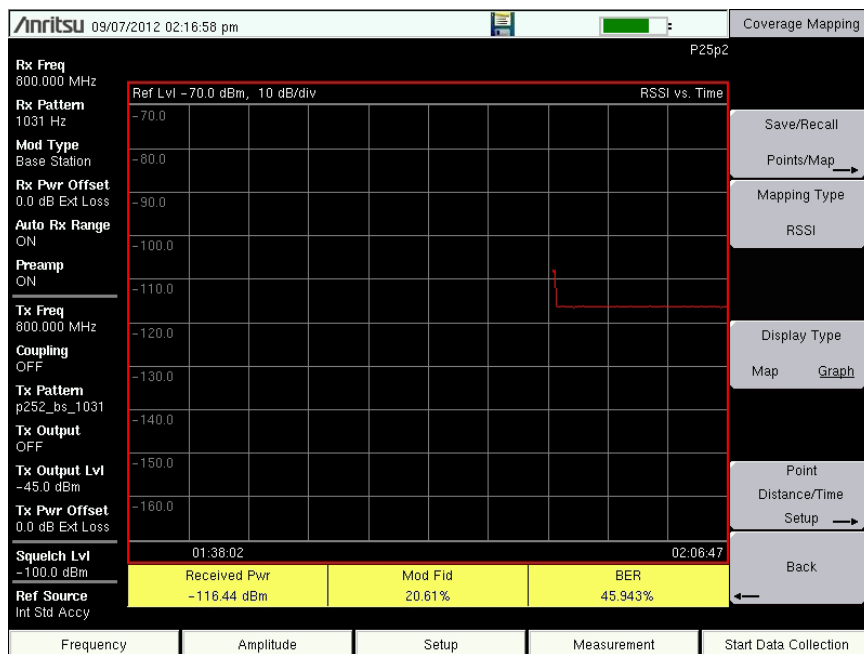


Figure 1-7. RSSI Mapping as the Active Measurement in Full Screen View

Note

Double-tapping on the screen must be performed within a time limit. Experimentation will provide you with the acceptable rhythm.

1-7 Coverage Mapping

The LMR Master has several coverage mapping options:

- For NBFM, P25, P25p2, NXDN, dPMR, DMR, PTC (ITCR and ACSES), and TETRA coverage mapping information, refer to [Chapter 11, “LMR Coverage Mapping”](#) in this document.
- For Spectrum Analyzer and AM/FM/PM coverage mapping information, refer to the *Spectrum Analyzer Measurement Guide*. The PDF document is available on the Anritsu web site: <http://www.anritsu.com>.

Chapter 2 — NBFM Analyzer

2-1 Introduction

The NBFM Analyzer option provides a method to verify the operation of analog FM land mobile radios and to confirm that such radios are compliant to regulatory standards for spectrum power.

The LMR Master NBFM measurements include the ability to display frequency spectrum, audio spectrum, and the audio waveforms. In addition, a summary graph displays numeric values of Carrier Power, Carrier Frequency, Frequency Error, Frequency Deviation (peak, RMS, or Average), Modulation Rate, Signal to Noise and Distortion ratio (SINAD), Total Harmonic Distortion (THD), Occupied Bandwidth, and squelch/tone type (CTCSS, DCS, DTMF) of the input signal.

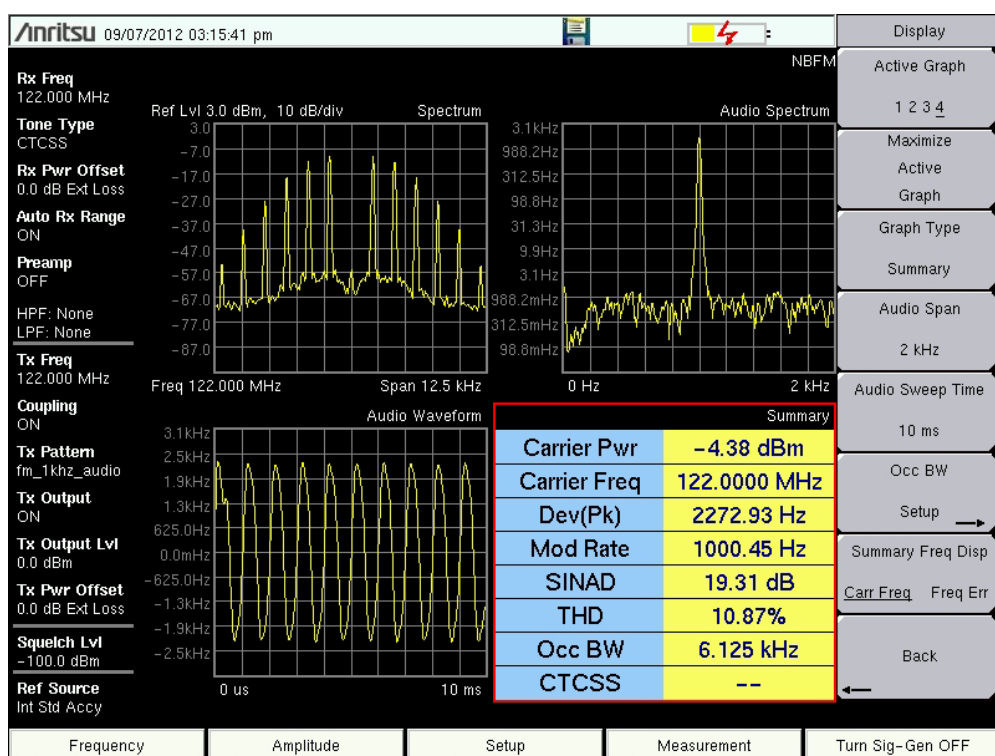


Figure 2-1. NBFM Analyzer Display

Other NBFM measurements include coverage mapping, metering of 20 dB Quieting, and metering of 12 dB SINAD.

NBFM Coverage measurements are described in [Chapter 11, “LMR Coverage Mapping”](#). NBFM coverage allows drive-testing of analog FM LMR systems while measuring and mapping RSSI, SINAD, External SINAD, and THD parameters.

Anritsu also supports Narrowband FM Analog (Chapter 2) and digital transmitter Land Mobile Radio technologies including P25 – Project 25 or APCO-25 (Chapter 3), P25 Phase 2 (Chapter 4), NXDN™ – Very Narrowband Common Air Interface (Chapter 5), dPMR – Digital Private Mobile Radio (Chapter 6), TETRA – Terrestrial Trunked Radio (Chapter 7), DMR – ETSI Digital Mobile Radio (Chapter 8), PTC-ITCR Positive Train Control (Chapter 9) and PTC-ACES (Chapter 10).

The LMR Master will analyze input signal strengths from +33 dBm (2.0 watts) down to levels approaching the sensitivity of LMR radios, with the ability to automatically adjust the analyzer input sensitivity based on input levels.

2-2 Transmitter Analysis Setup

- 1. On the LMR Master, press the **Menu** key then select the NBFM Analyzer icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight NBFM Analyzer and press **Enter**.

Caution

The maximum input power without damage is 2 watts (+33 dBm) to the RF In 50 Ohm connector. To prevent damage, use the Anritsu MA25200A High Power Tx/Rx Input Protector (Chapter 12, “High Power Input Protection”), a coupler, or an attenuator to reduce the input power to below this level when measuring high output power devices.

- 2. Connect the transmitter to the RF In 50 Ohm connector on the LMR Master using a high-power protection device, or connect an antenna with the appropriate frequency range to the RF In 50 Ohm connector on the LMR Master.
- 3. Press the **Amplitude** main menu key, then the Rx Power Offset submenu key to set the attenuation (or gain) of any devices between the radio under test and the LMR Master. Use the arrow keys, rotary knob, or the numeric keypad to enter the adjustment value, up to 100 dB, and then press either the **Loss** or **Gain** submenu key. The offset will be applied to the Carrier Power value in the Summary graph. For instance, if the transmitter under test is emitting 50 watts (+47 dBm) of power, and the External Attenuation value is 40 dB (such as from a 40 dB directional coupler), then the Carrier Power displayed will be +7 dBm.
- 4. Press the **Frequency** main menu key to set the LMR Master receiver center frequency (Rx Freq) of the measurement. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency. A second option is to use **Auto Scan** under the **Setup** main menu. Turn **Auto Scan** on and key the radio or transmitter. **Auto Scan** will find and display the highest power signal above +10 dBm (10 mW) between 10 MHz and 1.6 GHz in the center of the Spectrum graph. After the signal is found and displayed, set **Auto Scan** to Off to stop the LMR Master from scanning for a new signal.

Note

Typically, the Auto Scan feature will only work if the radio is cabled to the S412E. There is a lower-limit to the amount of power needed to make Auto Scan respond; the requirement is just above +10 dBm (10 milliwatts). This is the raw port level, the requirement increases by the amount of attenuation caused by the RF In protection device.

5. Press the **Setup** main menu key to select the tone type. Select CTCSS, DCS, or DTMF using the Tone Type key. Press the Filters submenu key and set the intermediate frequency bandwidth (IFBW) and bandwidth percentage (% IFBW). Filter the audio signal using the Low Pass Filter or High Pass Filter.
6. Press the **Measurement** key, then the NBFM Analyzer submenu key. Refer to [“NBFM Analyzer Graphs” on page 2-4](#) for information on the available graph types.

Note

Many of the displayed settings on the left side of the screen are used as menu shortcuts. Select a setting using the touch screen to display the menu and set the parameter for editing.

2-3 Receiver Analysis Setup

1. On the LMR Master, press the **Menu** key, then select the NBFM Signal Analyzer icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight NBFM Analyzer and press **Enter**.

Caution

The maximum output power from the Signal Generator Out connector is 1 mW (0 dBm) and the frequency range is 500 kHz to 1.6 GHz.

2. Connect with required attenuation the LMR Master Signal Generator Out 50 Ohm connector to the repeater/receiver or connect an antenna with the appropriate frequency range to the LMR Master Signal Generator Out connector.
3. Press the **Amplitude** main menu key, then the Tx Output Lvl submenu key to set the output power. Enter any output attenuation or gain using the Tx Power Offset key.
4. Press the **Frequency** main menu key to set the transmit frequency using the Tx Freq key. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.

If testing a repeater, you can bind the transmit frequency to the receive frequency by setting Rx/Tx Coupling to On and entering the Coupling Offset.

Note

When Rx/Tx Coupling is On, the Tx Freq submenu key is disabled.

5. Set the transmit pattern. Press the **Setup** main menu, then the Tx Pattern submenu key.
6. As needed, adjust the pattern with the pattern specific option buttons and modulation button in the **Setup** menu (CTSS Freq, DCS Type, CTSS Freq, DTMF Tone, and FM Deviation). Additional pattern adjustments (Tone Deviation and Mod Rate) are in the More submenu. Refer to [“Setup \(1/2\) Menu” on page 2-18](#) for additional information.
7. Press the **Turn Sig-Gen ON** main menu key to start the signal generator. Press the key again to turn off the signal generator.

2-4 NBFM Analyzer Graphs

The following NBFM Analyzer measurements are available on the LMR Master. From the **Measurements** main menu, press NBFM Analyzer twice. Press the Graph Type submenu key to select the measurement type.

Spectrum Graph

The spectrum view displays signal power (dBm) versus frequency. The frequency span is adjustable under the **Frequency** menu using the Span submenu. The reference level is adjusted with the **Amplitude** menu. Refer to “[Amplitude Menu](#)” on page 2-16 for details. [Figure 2-2](#) displays the same signal using a 25 kHz span and a 50 kHz span.

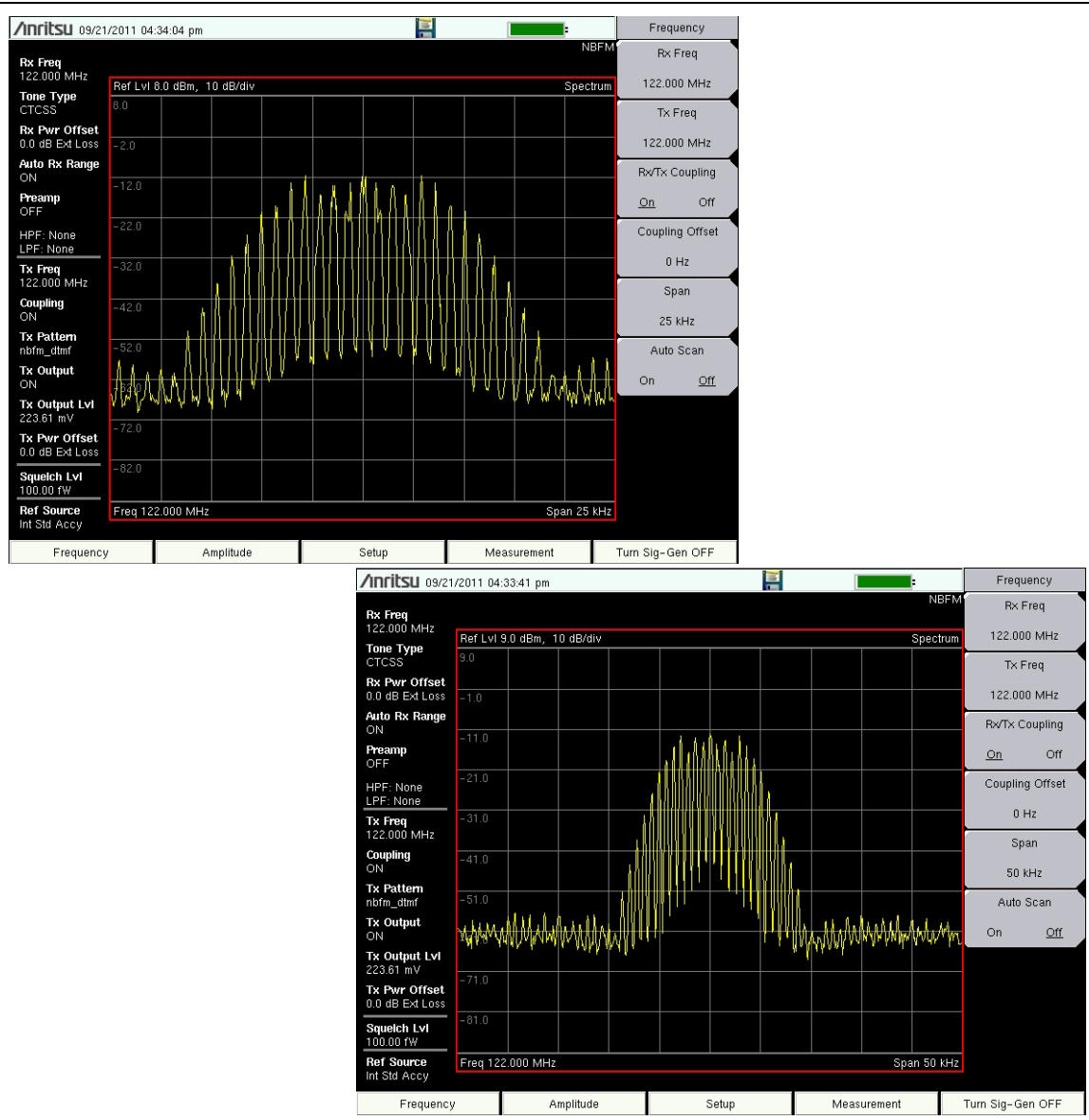


Figure 2-2. NBFM Spectrum Graph (25 kHz Span and 50 kHz Span)

Audio Spectrum Graph

The Audio Spectrum graph displays the frequency deviation in the audio. The Audio Spectrum span is adjustable in fixed increments using the **Audio Span** button (**Measurement** > NBFM Analyzer). The reference level setting is the product of the intermediate frequency bandwidth and percentage (**Setup** > **Filters**). **Figure 2-3** displays the same signal using a 2 kHz span and a 10 kHz span. High Pass and Low Pass Filters are available for masking either the tone (low pass) or audio (high pass) in both the Audio Spectrum graph and Audio Waveform graph.

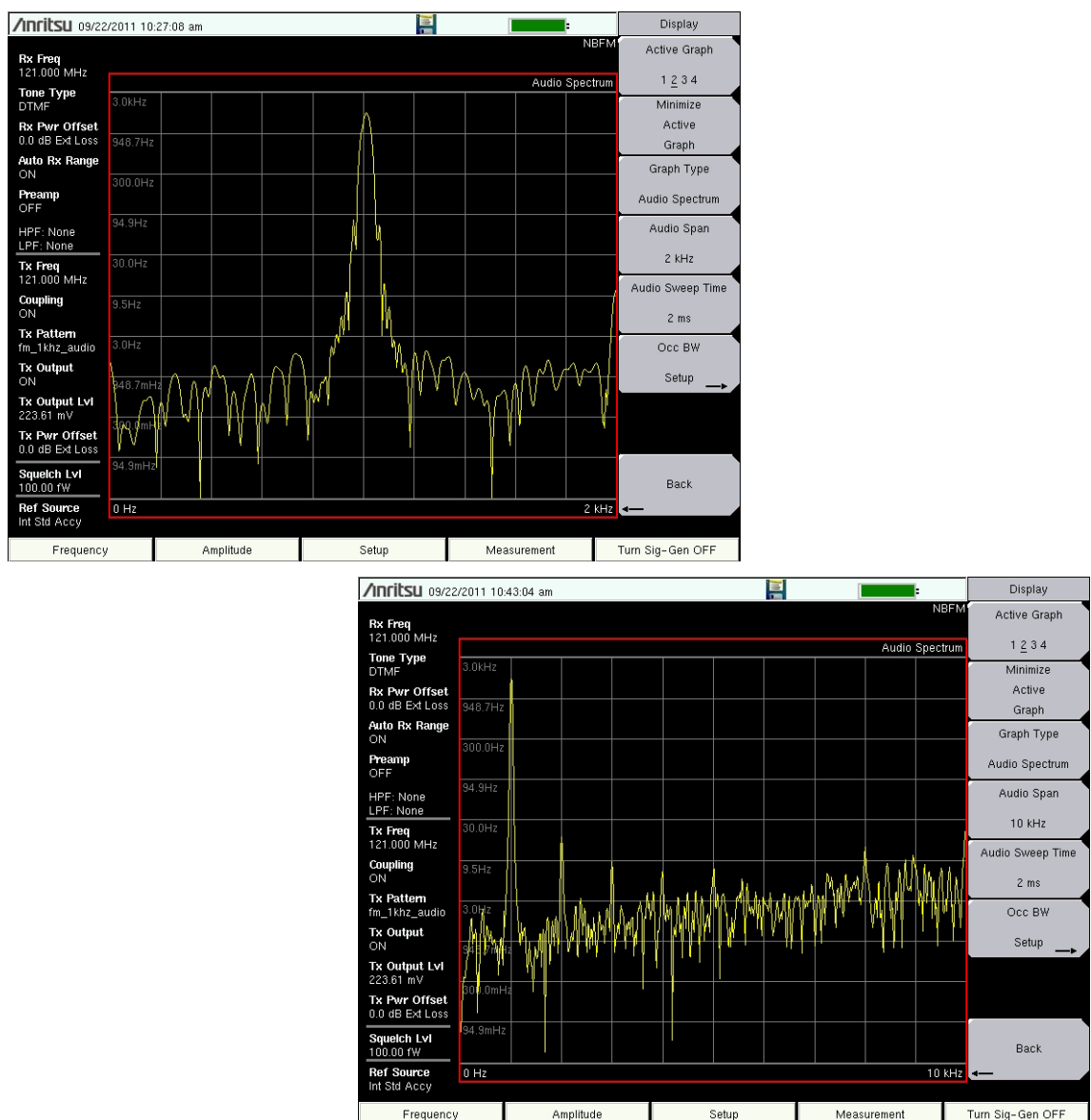


Figure 2-3. NBFM Audio Span (2 kHz and 10 kHz)

Audio Waveform Graph

The Audio Waveform graph displays a zero-span view of frequency deviation vs. time. The time span is adjustable from 50 μ s to 150 ms using the Audio Sweep Time button (**Measurement** > NBFM Analyzer). The reference level setting is the product of the intermediate frequency bandwidth and percentage (**Setup** > Filters). [Figure 2-4](#) shows a DCS tone after applying a 300 Hz low pass filter. High Pass and Low Pass Filters are available for masking either the tone (low pass) or audio (high pass) in both the Audio Spectrum graph and Audio Waveform graph.

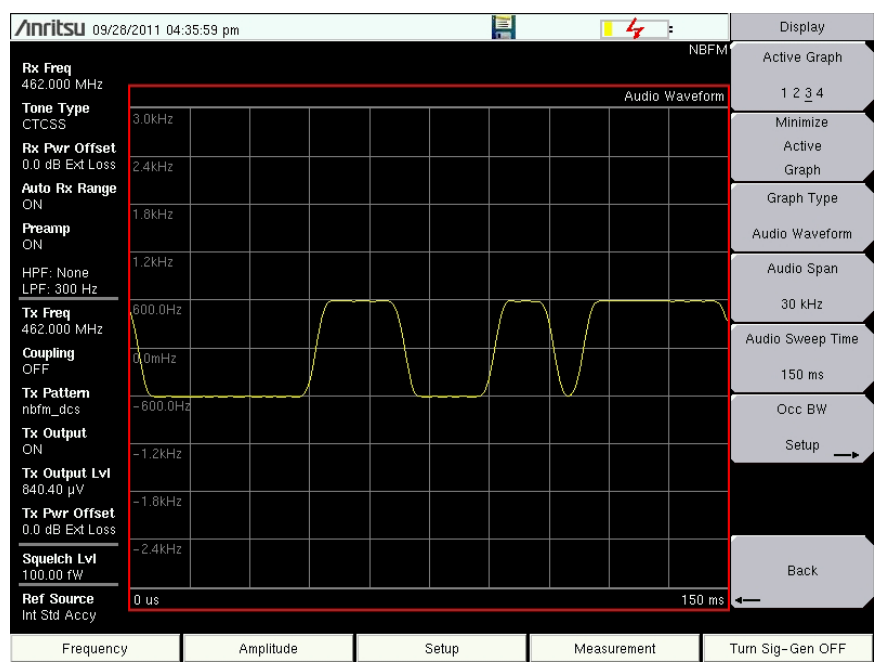


Figure 2-4. NBFM Audio Waveform Example

Summary Graph

The summary graph provides an overview of an NBFM radio transmitter. The graph displays numeric values of carrier power, carrier frequency, freq error, frequency deviation, modulation rate, Signal to Noise and Distortion ratio (SINAD), Total Harmonic Distortion (THD), occupied bandwidth, and squelch/tone type of the input signal. Select the **Tone Type** (CTCSS, DCS, or DTMF) under the **Setup** menu.

Toggle between viewing carrier frequency or frequency error using the **Measurements > NBFM Analyzer > Summary Freq Disp** submenu key.

The Carrier Power value in the summary graph can be changed between dBm, watts, and volts using the **Amplitude > Units > Rx Units** submenu key. This setting also applies to the squelch level setting.

The **Setup > Squelch Lvl** submenu key sets the squelch power level. When the carrier power is lower than the set squelch level, all summary graph measurements except for Carrier Pwr are blanked out (--). When the carrier power is above the squelch level, the measurements are displayed as shown in [Figure 2-5](#).

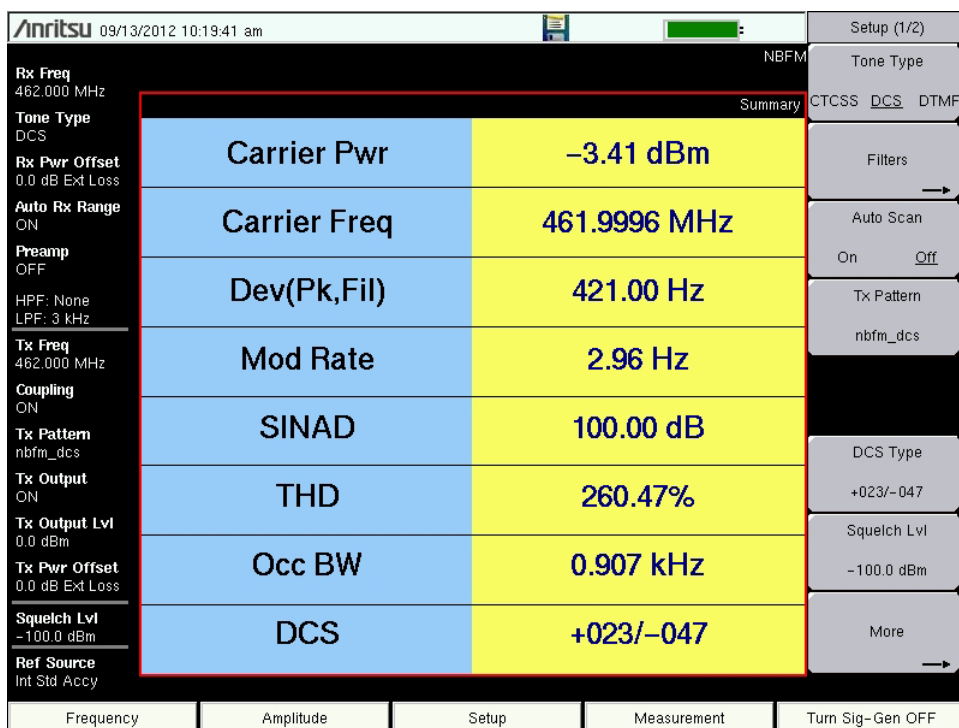


Figure 2-5. NBFM Summary Graph with Carrier Pwr Above the Squelch Level

Carrier Pwr in the Summary table is the integrated power of all the energy in the receiver bandwidth. Any peak amplitude reduction seen in the Spectrum display when compared to Carrier Pwr is a function of the instrument's RBW setting. The reduction is specified as: $10 \cdot \log(\text{Signal Bandwidth} / \text{Resolution Bandwidth})$.

2-5 NBFM Coverage

Refer to [Chapter 11, “LMR Coverage Mapping”](#).

2-6 20 dB Quieting

The LMR Master can measure FM receiver or radio sensitivity using the 20 dB quieting procedure.

1. Connect the LMR Master Signal Generator Out port to the radio antenna port. Use attenuation as required and lock out the radio transmit button during this procedure.
2. Adjust the TX Power Offset to account for the attenuation loss in the Signal Generator path.
3. Connect the LMR Master Audio In port to the radio loudspeaker or audio out connector ([Figure 2-6](#)).

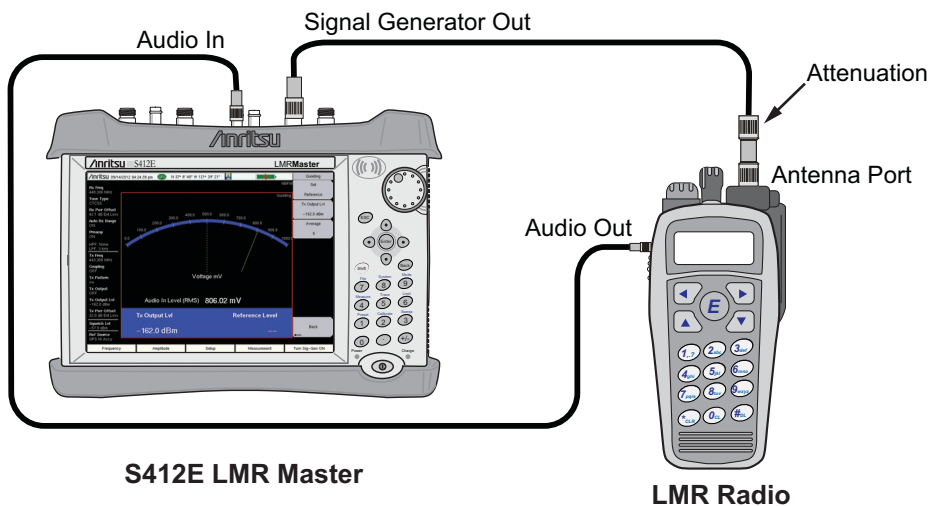


Figure 2-6. Setup for 20 dB Quieting and 12 dB SINAD

4. Set the LMR Master Tx Output Lvl to the minimum level (which will be -130 dBm + the value entered for Tx Power Offset) and the Tx Pattern to cw. Set the LMR Master Tx Freq to the radio receive frequency. Confirm that the LMR Master signal generator is Off (menu key displays **Turn Sig-Gen ON**).
5. On the LMR Master, press **Measurement > NBFM Quieting** (twice). The LMR Master displays the current voltage at the Audio In port and the current Tx Output level setting for the LMR Master signal generator.
6. Turn on the radio and set the radio audio level to the manufacturer's rated audio output level. The RMS voltage level present at the Audio In port is displayed below the meter for convenience. Refer to the radio maintenance manual to determine this level. This is the audio level used for measuring 20 dB quieting ([Figure 2-7 on page 2-9](#)).

7. Press the **Set Reference** key and note the **Reference Level** voltage displayed on the right side of the blue bar as shown in [Figure 2-8 on page 2-10](#). Setting the reference will automatically adjust the voltage scale such that the voltage displayed in the middle of the meter is 10 % (–20 dB) of the reference audio voltage.
8. Press the **Turn Sig-Gen ON** main menu key to start the LMR Master transmitter.
9. Increase the LMR Master Tx Output Lvl until the needle on the voltage meter is in the center of the display ([Figure 2-8](#)). The Audio In voltage level has decreased to 10 % of the reference level. The power level displayed on the left side of the blue bar is the 20 dB quieting antenna input power level.

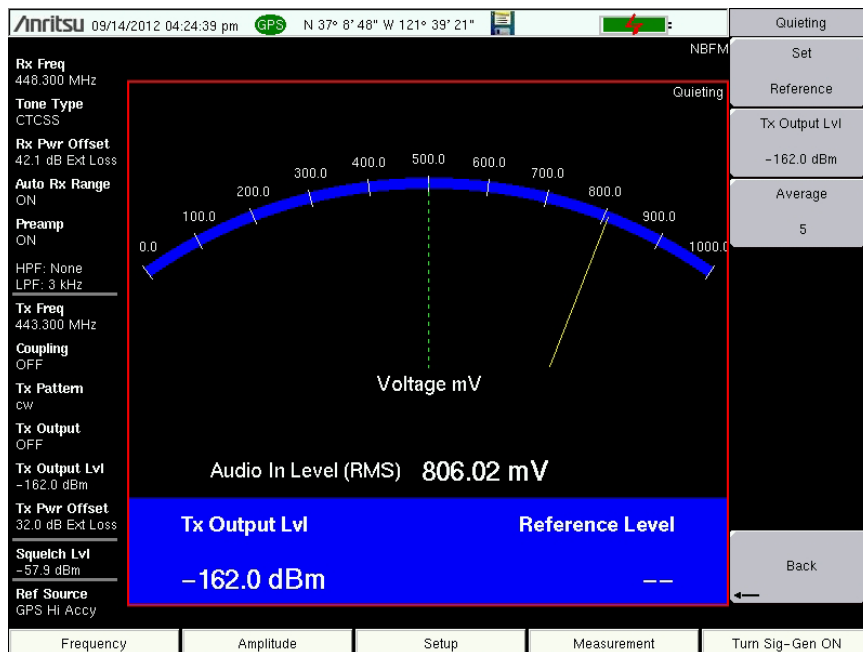


Figure 2-7. 20 dB Quieting, Ready to Set Reference Level

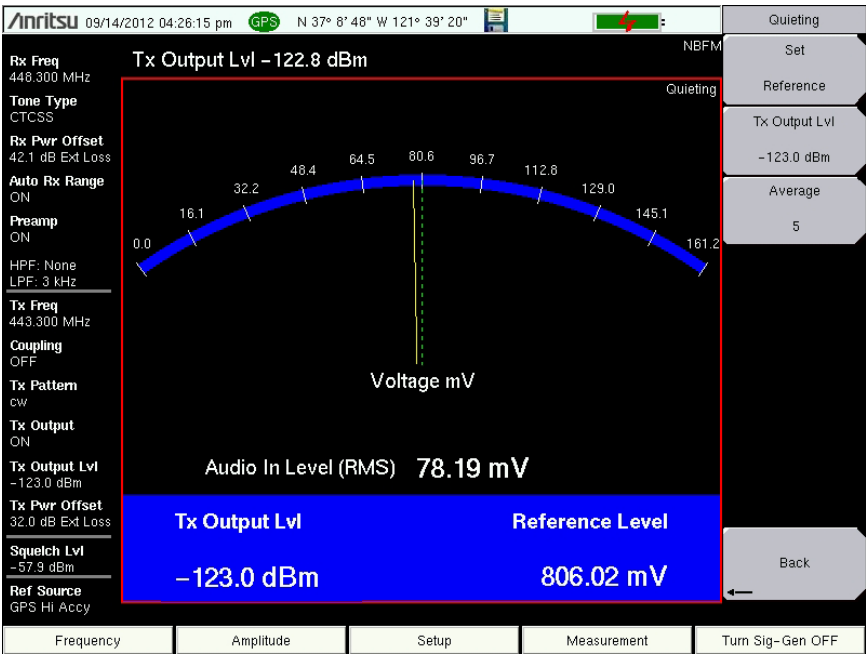


Figure 2-8. 20 dB Quieting After Increasing the LMR Master Sig-Gen Tx Output

2-7 12 dB SINAD

The LMR Master can measure FM receiver or radio sensitivity using the 12 dB SINAD procedure.

1. Connect the LMR Master Signal Generator Out port to the radio antenna port. Use attenuation as required and lock out the radio transmit button during this procedure.
2. Adjust the TX Power Offset to account for the attenuation loss in the Signal Generator path.
3. Connect the LMR Master Audio In port to the radio loudspeaker or audio out connector (Figure 2-6).
4. Set the LMR Master Tx Output Lvl to the minimum level (which will be $-130\text{ dBm} +$ the value entered for Tx Power Offset) and the Tx Pattern to fm_1khz_audio¹ with a deviation specified by the radio manufacturer. Set the LMR Master Tx Freq to the radio receive frequency. Confirm that the LMR Master signal generator is Off (menu key displays **Turn Sig-Gen ON**).
5. On the LMR Master, press **Measurement** > NBFM Quieting (twice). The LMR Master displays the current voltage at the Audio In port, the current Tx Output level setting for the LMR Master signal generator, and current SINAD, which should be close to 0 dB.
6. Turn on the radio and set the radio audio level to the manufacturer's rated audio output level. The RMS voltage level present at the Audio In port is displayed below the meter for convenience. Refer to the radio maintenance manual to determine this level. This is the audio level used for measuring 12 dB SINAD.
7. Press the **Turn Sig-Gen ON** main menu key to start the LMR Master transmitter (Figure 2-9).
8. Increase the LMR Master Tx Output Lvl until the needle on the SINAD meter is near the center of the display and equals 12 dB (Figure 2-10). The power level displayed on the left side of the blue bar is the 12 dB SINAD level.

1. For systems that require an unmute tone in addition to the audio for 12 dB SINAD testing, use one of the following Tx Patterns:

fm_1khz_ctsc (1 kHz audio plus a CTCSS unmute tone)
or
fm_1khz_DCS (1 kHz audio plus a DCS unmute tone)

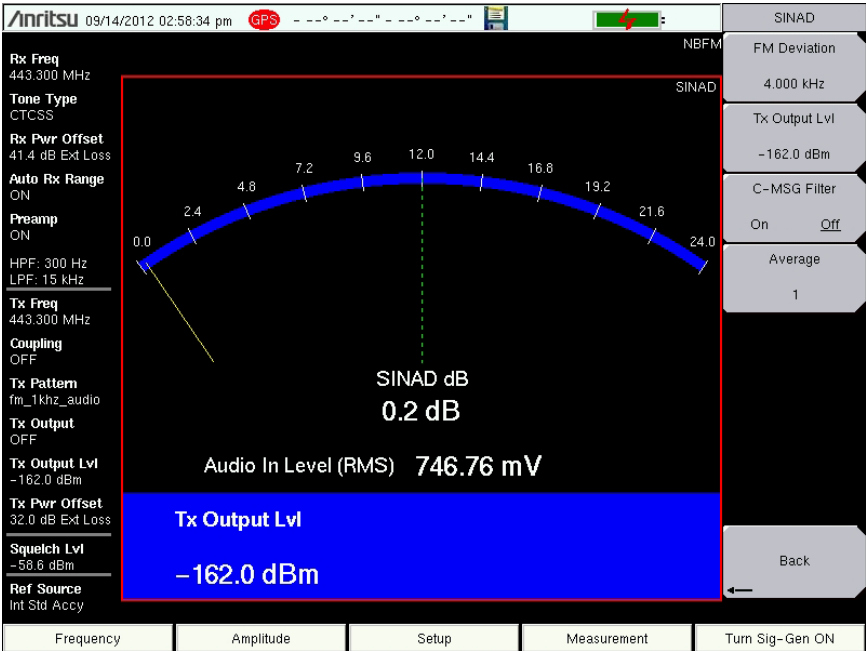


Figure 2-9. 12 dB SINAD with Signal Generator Off

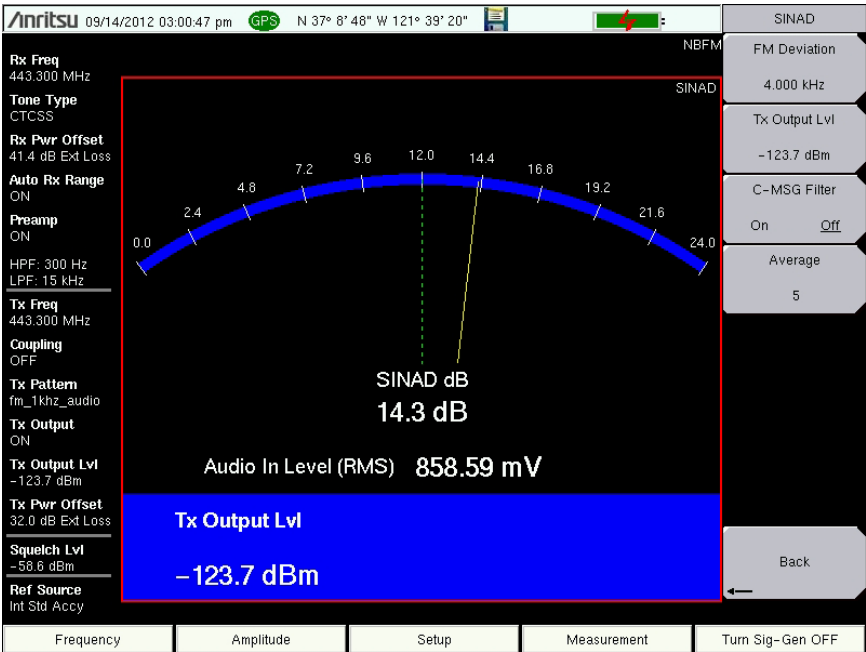


Figure 2-10. 12 dB SINAD with Signal Generator On and Meter Showing the SINAD Level

2-8 NBFM Analyzer Menus

Menu maps typically display all possible submenu keys, although some keys are displayed on the instruments only under special circumstances (refer to menu descriptions on the following pages).

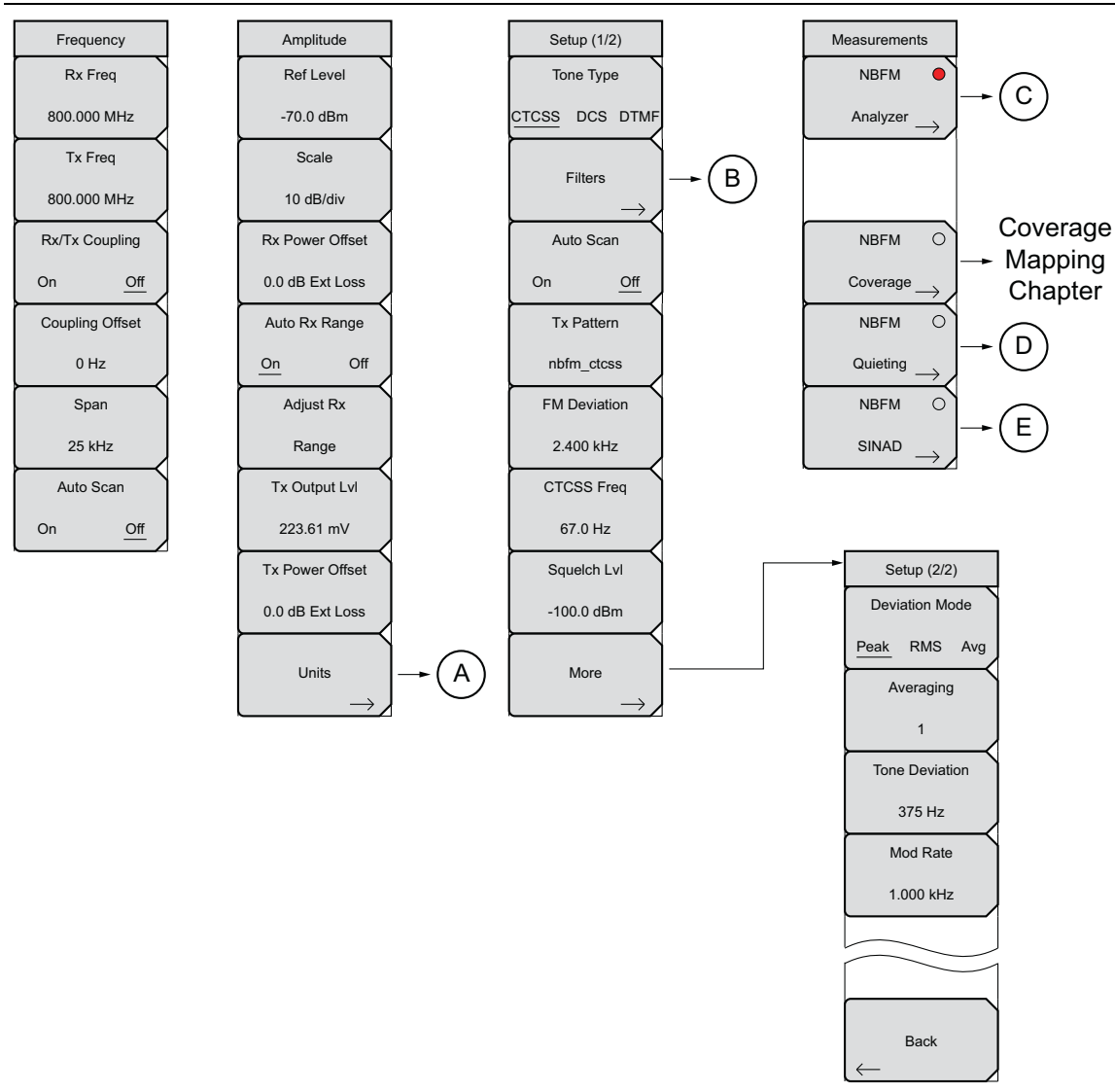


Figure 2-11. NBFM Analyzer Menu Layout (1 of 2)

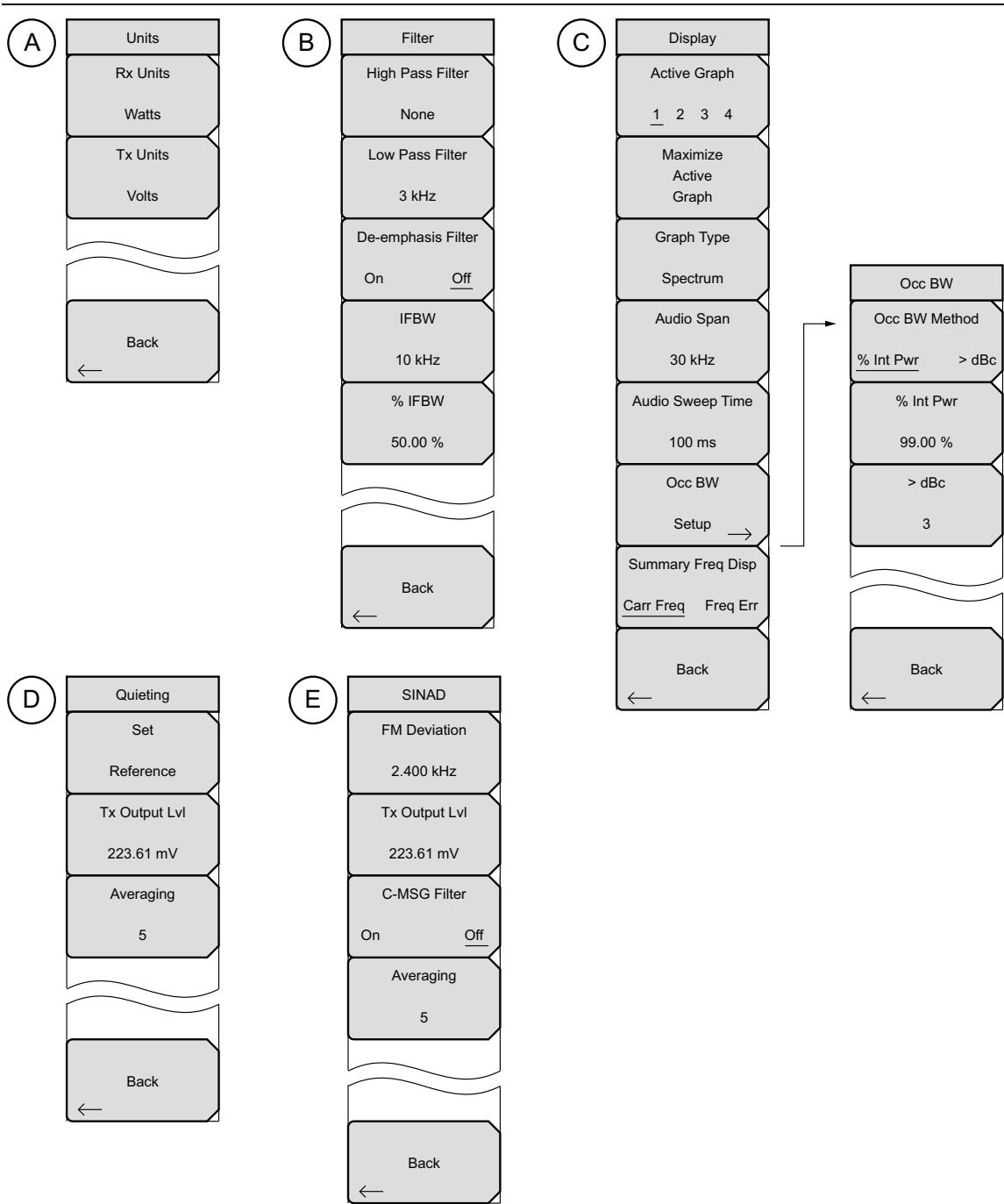


Figure 2-11. NBFM Analyzer Menu Layout (2 of 2)

Note Many of the displayed settings on the left side of the screen are used as menu shortcuts. Select a setting using the touch screen to display the menu and set the parameter for editing.

2-9 Frequency Menu

Key Sequence: **Frequency**

Frequency	Rx Freq: Sets the receiver frequency. Press the Rx Freq key (or the menu shortcut on the left side of the screen) and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, then the submenu key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the Enter key has the same effect as pressing the MHz submenu key.
Rx Freq 800.000 MHz	
Tx Freq 800.000 MHz	Tx Freq: Sets the signal generator frequency. Press the Tx Rx Freq key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, then the submenu key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the Enter key has the same effect as pressing the MHz submenu key.
Rx/Tx Coupling On <u>Off</u>	Rx/Tx Coupling: Couples the signal generator to the receiver frequency. When set to On, the Tx Freq key is disabled.
Coupling Offset 0 Hz	Coupling Offset: Sets the Offset of the signal generator frequency and the receiver frequency. This is functional only when Rx/Tx Coupling is set to On.
Span 25 kHz	Span: Sets the span of the Spectrum Graph. Span selections are 12.5 kHz, 25 kHz, and 50 kHz.
Auto Scan On <u>Off</u>	Auto Scan: Turning Auto Scan On will cause the Rx Frequency to self-adjust to match the highest power signal detected between 10 MHz and 1.6 GHz that is above +10 dBm (10 mW) in the center of the Spectrum graph. To lock the new Rx Frequency in place, toggle Auto Scan to Off.

Figure 2-12. NBFM Analyzer Frequency Menu

2-10 Amplitude Menu

Key Sequence: **Amplitude**

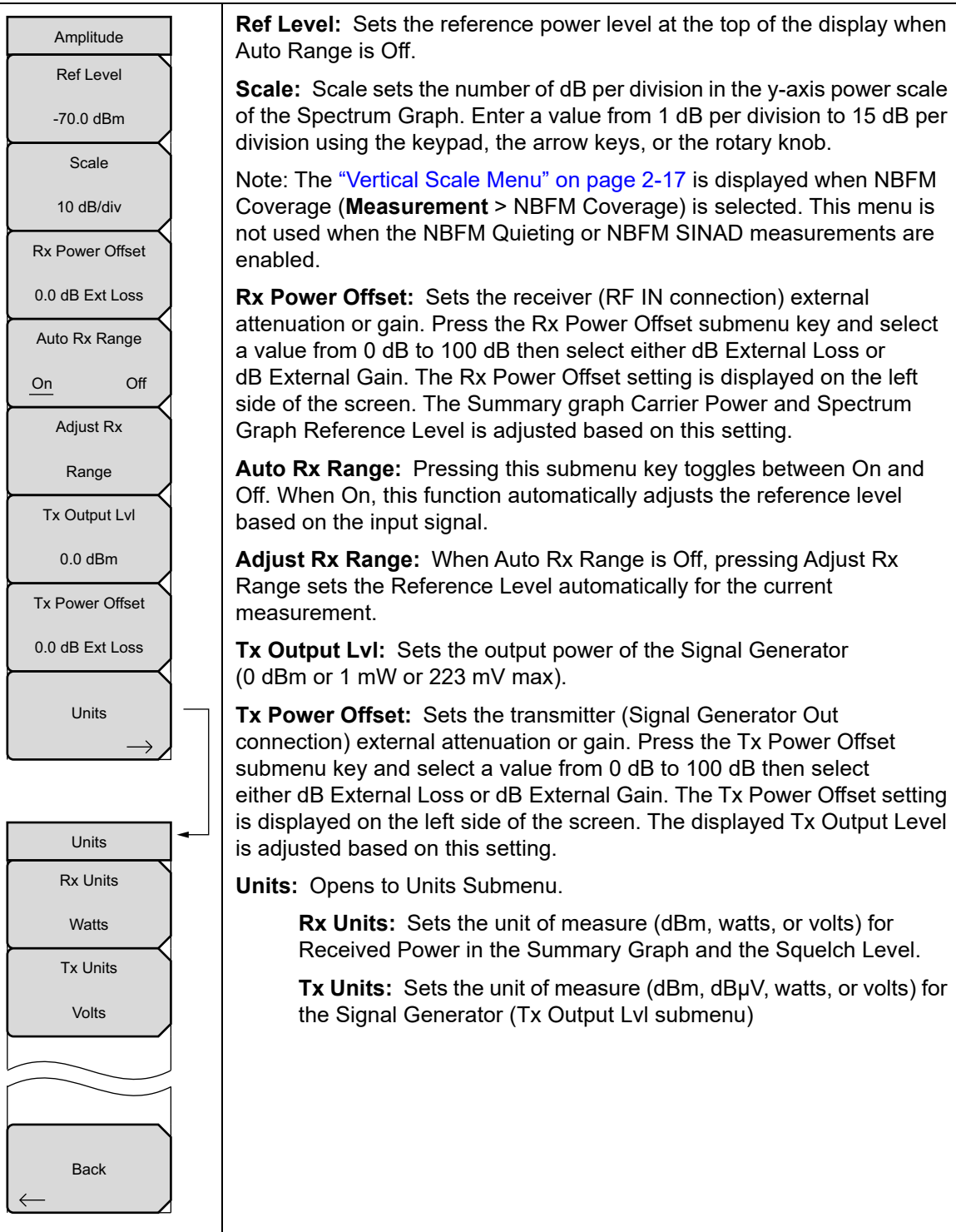


Figure 2-13. NBFM Analyzer Amplitude Menu

Vertical Scale Menu

Key Sequence: **Amplitude** > Vertical Scale

Vertical Scale	<p>RSSI Scale: Sets the number of dB per division in the y-axis power scale of the RSSI vs. Time graph in Coverage measurement. Enter a value from 1 dB per division to 15 dB per division using the keypad, the arrow keys, or the rotary knob. This setting is not used when the NBFM Quieting or NBFM SINAD measurements are enabled.</p> <p>SINAD Ref Level: Sets the reference power level at the top of the y-axis power scale of the SINAD vs. Time graph in Coverage measurement. Enter a value from 0 dB to 100 dB using the keypad, the arrow keys, or the rotary knob.</p> <p>THD Ref Level: Sets the Total Harmonic Distortion reference percentage value in Coverage measurement. Enter a value from 0.00 % to 100.00 % using the keypad, the arrow keys, or the rotary knob.</p> <p>EXT SINAD Ref Level: Sets the External SINAD reference power level in Coverage measurement. Enter a value from 0 dB to 100 dB using the keypad, the arrow keys, or the rotary knob.</p>
RSSI Scale	
10 dB/div	
SINAD Ref Level	
50.00 dB	
THD Ref Level	
100.00 %	
EXT SINAD Ref Level	
50.00 dB	
<hr/>	
Back	

Figure 2-14. Vertical Scale Menu

2-11 Setup (1/2) Menu

Key Sequence: Setup

Setup (1/2)	Tone Type: Sets the information displayed in the last row of the Summary table. Select Continuous Tone-Coded Squelch System (CTCSS) for transmitters or radios using an analog squelch system. Select Digital Coded Squelch (DCS) for systems using digital squelch settings.
Tone Type CTCSS DCS DTMF	Select DTMF and the LMR Master will decode the Dual-tone multi-frequency signalling sent by the radio or transmitter.
Filters →	Note: The frequency range for all 3 tone types is below the minimum spectrum display of the LMR Master in NBFM mode and also has no effect on the Tx Pattern selection.
Auto Scan On Off	Filters: Opens the “Filters Menu” on page 2-20.
Tx Pattern nbfm_ctcss	Auto Scan: Turning Auto Scan On causes the Rx Frequency to self-adjust to match the highest power signal detected between 10 MHz and 1.6 GHz that is above +10 dBm (10 mW) in the center of the Spectrum graph. To lock the new Rx Frequency in place, toggle Auto Scan to Off. This is available only in NBFM Analyzer measurements.
FM Deviation 2.400 kHz	Tx Pattern: Selects the transmitter pattern to send when the Turn Sig-Gen ON main menu key is selected. Select a pattern from the list box with the arrow keys or rotary knob and press Enter .
CTCSS Freq 67.0 Hz	Patterns include CW, CTCSS, DCS, DTMF, AM, and FM.
Squelch Lvl -100.0 dBm	CTCSS adds a low-pitch audio tone (selectable between 67 Hz to 254 Hz) on the transmitted signal. When CTCSS is selected as the Tx pattern, a submenu is displayed to set the CTCSS frequency, and the Tone Deviation is set using the More submenu.
More →	DCS superimposes a continuous stream of frequency shift keying (FSK) digital data on the transmitted signal at 134.4 bits per second. This data is referred to as a DCS word and is 23 bits. When DCS is selected as the Tx pattern, a submenu is displayed to set the DCS Type, and the Tone Deviation is set using the More submenu.
	When DTMF is selected as the Tx pattern, a DTMF digit (0 to 9, A to D, *, or #) is added to the transmitted signal. The digital consist of paired tones: a row tone (697 Hz to 941 Hz) and a column tone (1209 Hz to 1633 Hz). The DTMF Tone submenu is displayed to set the DTMF Tone. Set the FM Deviation and the Tone Deviation using the More submenu.
	When AM is selected as the Tx pattern, a submenu is displayed to set the percentage of Amplitude modulation. The range is 0 % to 100 %.
	When FM is selected as the TX pattern, a submenu is displayed to set the cycle count of the frequency deviation. The range is 0 Hz to 100 kHz.

Figure 2-15. NBFM Analyzer Setup Menu

Setup (1/2) Menu (continued)

Setup (1/2)	FM Deviation/AM Percentage: Display of this menu is based on the selected Tx Pattern.
Tone Type	When AM is selected as the Tx pattern, a submenu is displayed to set the percentage of Amplitude modulation. The range is 0 % to 100 %.
CTCSS DCS DTMF	When FM or DTMF is selected as the Tx pattern, a submenu is displayed to set the cycle count of the frequency deviation. The range is 0 Hz to 100 kHz.
Filters →	CTCSS Freq/DCS Type/DTMF Done: Display of this menu is based on the selected Tx Pattern.
Auto Scan	When CTCSS is selected as the Tx pattern, press the CTCSS submenu key to set the CTCSS frequency.
On Off	When DCS is selected as the Tx pattern, press the DCS Type submenu key to set the DCS Type.
Tx Pattern	When DTMF is selected as the Tx pattern, press the DTMF Tone submenu to set the DTMF character to transmit.
nbfm_ctcss	Note: The Tone Type submenu (top of Setup 1/2) is for the LMR Master receiver and has no effect on the Tx patterns.
FM Deviation	Squelch Lvl: Sets the squelch power level. When the Received Power is lower than the set squelch level, all summary graph measurements except for Received Pwr will be blanked out (--).
2.400 kHz	More: Opens the “Setup (2/2) Menu” on page 2-21.
CTCSS Freq	
67.0 Hz	
Squelch Lvl	
-100.0 dBm	
More →	

Figure 2-16. NBFM Analyzer Setup Menu

Filters Menu

Key Sequence: **Setup** > Filters

Filter

High Pass Filter

None

Low Pass Filter

3 kHz

De-emphasis Filter

On Off

IFBW

10 kHz

% IFBW

50.00 %

Back

←

High Pass Filter: Displays a dialog box to select the cutoff frequency for the high pass filter (attenuates frequencies below the cutoff setting). Cutoff frequency options are: None (default), 300 Hz, or 3 kHz.

Low Pass Filter: Displays a dialog box to select the cutoff frequency for the low pass filter (attenuates frequencies above the cutoff setting). Cutoff frequency options are: None, 300 Hz, 3 kHz (default), or 15 kHz.

Filtering adjusts the display in both the Audio Spectrum and Audio Waveform graphs. In addition, filtering will effect the Deviation and possibly the Mod Rate values in the Summary table.

De-emphasis Filter: This filter produces a 6 dB/octave frequency response, with a cutoff frequency of 212 Hz. FCC rules state that Part 90 analog FM systems must support the use of a 750 μs pre/de-emphasis filter to allow older PM radios to communicate with narrowband FM radios.

IFBW: . Displays a dialog box to select the intermediate frequency bandwidth. Bandwidth options are: 5 kHz, 6.25 kHz, 10 kHz, 12.5 kHz, 30 kHz (default), or 50 kHz.

% IFBW: Scales the IFBW between 1 % to 100 %.

Back: Returns to the [“Setup \(1/2\) Menu”](#) on page 2-18.

Figure 2-17. NBFM Filters Menu

Setup (2/2) Menu

Key Sequence: **Setup** > More

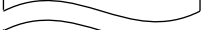
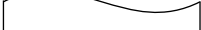
Setup (2/2)	<p>Deviation Mode: Sets the deviation mode displayed in the NBFM Analyzer measurement Summary table (third row down). Rotates between Peak Deviation, RMS deviation, and Average deviation.</p> <p>Averaging: Sets the refresh rate of the numerical values in the NBFM Summary window. Setting a higher number (25 maximum) will reduce measurement jitter.</p> <p>Tone Deviation: Sets the cycle count of the tone deviation. The range is 0 Hz to 100 kHz.</p> <p>Mod Rate: Use this menu to change the default 1 kHz modulation rate.</p> <p>Back: Returns to the “Setup (1/2) Menu” on page 2-18.</p>
Deviation Mode	
Peak RMS Avg	
Averaging	
1	
Tone Deviation	
375 Hz	
Mod Rate	
1.000 kHz	
	
	
Back	
←	

Figure 2-18. NBFM Filter Menu

2-12 Measurement Menu

Key Sequence: **Measurement**

Measurements

NBFM 

Analyzer →

NBFM 

Coverage →

NBFM 

Quieting →

NBFM 

SINAD →

NBFM Analyzer: Opens the “[Display Menu](#)” on page 2-23.

NBFM Coverage (Option 722 required): Opens the NBFM Coverage menu. Refer to [Chapter 11, “LMR Coverage Mapping”](#).

NBFM Quieting: Opens the “[Quieting Menu](#)” on page 2-24.

NBFM SINAD: Opens the “[SINAD Menu](#)” on page 2-25.

Figure 2-19. NBFM Analyzer Measurement Menu

Display Menu

Key Sequence: **Measurement** > NBFM Analyzer

Display	Active Graph 1 2 3 4: In Four Screen view, use this menu key to make the next graph (1 2 3 4) active. The current active graph is underlined and has a red perimeter line. Any of the four graphs can also be made active by tapping once on the touch screen.
Active Graph <u>1</u> 2 3 4	In Standard view (one graph displayed on the screen), the Active Graph key will change the display to the next graph type.
Maximize Active Graph	Maximize/Minimize Active Graph: The submenu key toggles between displaying the Four Screen view (4 graphs) and the Standard view (1 graph). Tapping twice on a selected graph also toggles between the two display options.
Graph Type Spectrum	Graph Type: The label on the bottom of this button displays the current active graph type. Pressing the button displays the list of graph types available for NBFM Analyzer measurements. Select the desired graph type with the arrow keys or rotatory knob and press Enter . The current active graph will be replaced with the new selection.
Audio Span 30 kHz	The four available graphs are displayed in the preset view: Spectrum, Audio Spectrum, Audio Waveform, and Summary.
Audio Sweep Time 100 ms	Refer to “NBFM Analyzer Graphs” on page 2-4 for additional information.
Occ BW Setup →	Audio Span: Use this menu to set the frequency span of the Audio Spectrum graph. Adjust using the predefined increments from 0.3 kHz to 30 kHz using the arrow keys, rotary knob, or the touchscreen.
Summary Freq Disp Carr Freq Freq Err	Audio Sweep Time: Use this menu to set the time length of the Audio Waveform graph. Adjust from 50 μs to 150 ms using the arrow keys, rotary knob, or the keypad.
Back ←	Occ BW: Displays the “Occ BW (Occupation Bandwidth) Menu” on page 2-24 .
	Summary Freq Disp: Use this menu to select which of the parameters (Carrier Frequency or Frequency Error) is displayed in the second row of the Summary graph.
	Back: Returns to the “Measurement Menu” on page 2-22 .

Figure 2-20. NBFM Analyzer Display Menu

Occ BW (Occupation Bandwidth) Menu

Key Sequence: **Measurement** > NBFM Analyzer > Occ BW Setup

<div><div>Occ BW</div><div>Occ BW Method</div><div>% Int Pwr > dBc</div><div>% Int Pwr</div><div>99.00 %</div><div>> dBc</div><div>3</div><div></div><div></div><div>Back</div><div>←</div></div>	<p>Occ BW Method: Toggle between % Int Pwr or > dBc.</p> <p>When using % integrated power method, the occupied frequency bandwidth is calculated as the bandwidth containing the specified percentage of the transmitted power.</p> <p>When using > dBc method, the occupied bandwidth is defined as the bandwidth between the upper frequency and lower frequency at which the signal level is a desired number of dB below the peak carrier level.</p> <p>% Int Pwr: Use the keypad, the directional arrow keys, or the rotary knob to enter the percent of power, from 0 % to 100 %. Only active when the Occ BW Method is set to % Int Pwr.</p> <p>> dBc: Use the keypad, the directional arrow keys, or the rotary knob to enter the dBc value (0 dBc to 100 dBc). Only active when the Occ BW Method is set to > dBc.</p> <p>Back: Returns to the “Display Menu” on page 2-23.</p>
---	--

Figure 2-21. NBFM Analyzer Display Menu

Quieting Menu

Key Sequence: **Measurement** > NBFM Quieting

<div><div>Quieting</div><div>Set</div><div>Reference</div><div>Tx Output Lvl</div><div>223.61 mV</div><div>Averaging</div><div>5</div><div></div><div></div><div>Back</div><div>←</div></div>	<p>Set Reference: Sets the reference level for FM sensitivity testing.</p> <p>Tx Output Lvl: Sets the output power of the Signal Generator (0 dBm or 1 mW or 223 mV max).</p> <p>Average: Sets the refresh rate of the measurement. Setting a higher number (10 maximum) will dampen the needle movement and reduce measurement jitter.</p> <p>Back: Returns to the “Measurement Menu” on page 2-22.</p>
---	--

Figure 2-22. NBFM Analyzer Display Menu

SINAD Menu

Key Sequence: **Measurement** > NBFM SINAD

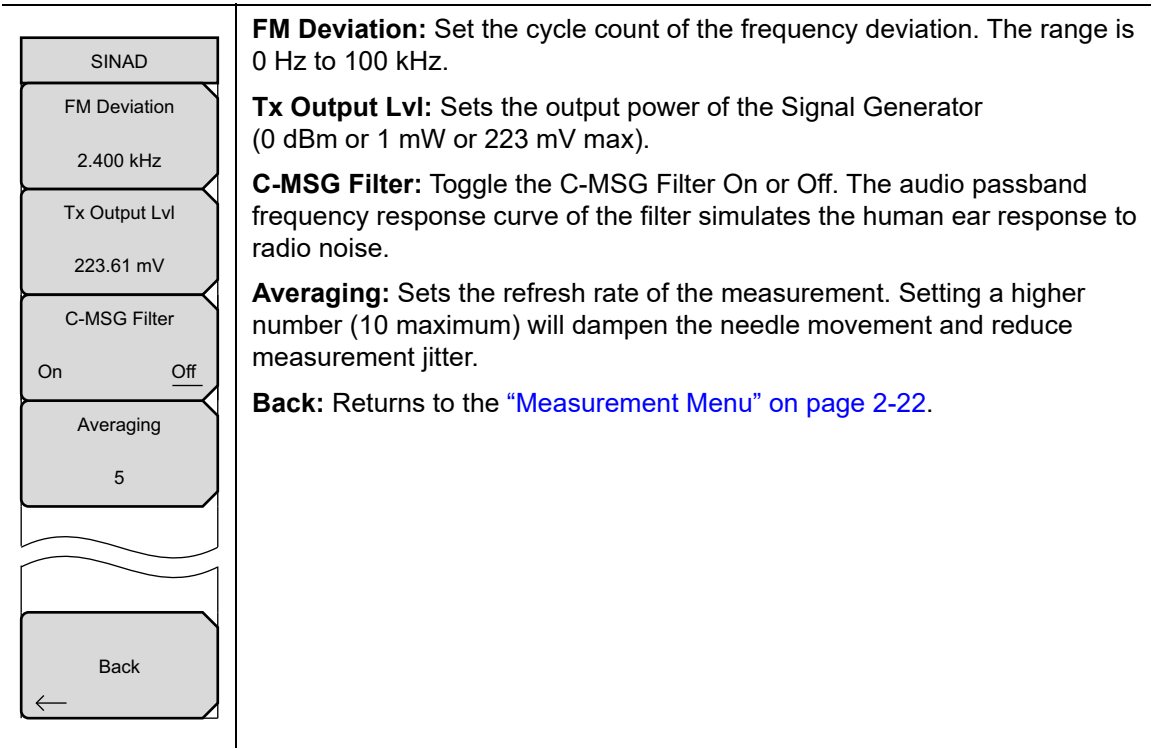


Figure 2-23. NBFM Analyzer Display Menu

2-13 Sweep Menu

Key Sequence: **Shift** > **Sweep (3)** key

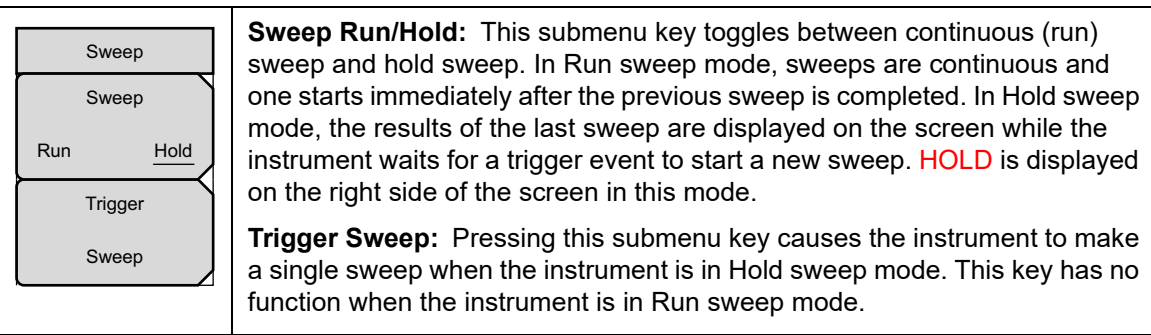


Figure 2-24. NBFM Analyzer Sweep Menu

2-14 Measure Menu

Key Sequence: **Shift** > **Measure** (4) key

Display the [“Measurement Menu” on page 2-22](#).

2-15 Trace Menu

This menu is not available in NBFM Analyzer measurement mode.

2-16 Limit Menu

This menu is not available in NBFM Analyzer measurement mode.

2-17 Other Menus

Preset, **Calibrate**, **File**, **System**, and **Mode** are described in the User Guide.

Chapter 3 — P25 Analyzer (Option 521)

Note

Option 521 include P25 demodulation (this Chapter) and P25 Phase 2 demodulation ([Chapter 4](#)).

3-1 Introduction

The P25 Analyzer option provides a method to verify the operation of APCO Project 25 (P25) and Linear Simulcast Modulation (LSM) tower, mobile, and portable radio transmitters. Option 521 includes the ability to display constellations, spectrum, histogram, and eye diagram graphs. In addition, a summary graph displays numeric values of received power, frequency error, modulation fidelity (Mod Fid), bit error rate (BER), symbol deviation, Network Access Code (NAC), symbol rate error of the input signal and control channel Signal-to-Interference-plus Noise Ratio (SINR). BER comparisons can be made to the Standard Tone or the Standard Transmitter Test (O.153) pattern, regular voice traffic using a proprietary algorithm, or a Message Error Rate (MER) can be computed using the control channel messages CRC checking. In addition, estimated BER on the control channel uses a proprietary algorithm.

The LMR Master will analyze input signal strengths from +33 dBm (2.0 watts) down to levels approaching the sensitivity of P25 radios, with the ability to automatically adjust the input sensitivity based on input levels.

3-2 Setup Procedure

Direct Connect to the Transmitter

1. Press the **Menu** key, then select the P25 Signal Analyzer icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight P25 Analyzer and press **Enter**.

Caution

The maximum input power without damage is 2 watts (+33 dBm) to the RF In 50 Ohm connector. To prevent damage, use the Anritsu MA25200A High Power Tx/Rx Input Protector ([Chapter 12, “High Power Input Protection”](#)), a coupler, or an attenuator to reduce the input power to below this level when measuring high output power devices.

2. Connect the transmitter to the RF In 50 Ohm connector on the LMR Master using a coupler or attenuator.
3. Press the **Frequency** main menu key to set the receiver center frequency (Rx Freq) of the measurement. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.

4. Press the **Setup** main menu key to select the modulation type and Rx pattern. Select C4FM modulation for Phase I systems or CQPSK for Phase II and LSM systems. Press the Rx pattern key to choose the pattern against which to measure error rates. 1011/1031 Hz and O.153 (V.52) will measure BER directly against the selected pattern. Voice uses a proprietary method to estimate BER from regular voice traffic. Ctrl Channel will produce a Message Err Rate (MER) based on the CRC checksums contained in Control Channel messages and estimated BER using a proprietary algorithm.
5. Press the **Amplitude** main menu key, then the Rx Power Offset submenu key to set the receiver attenuation (or gain). Use the arrow keys, rotary knob or the numeric keypad to enter the adjustment value, up to 100 dB and select either the Loss or Gain submenu key. The offset will be applied to the Received Power value in the Summary graph. For instance, if the transmitter under test is emitting 50 watts (+47 dBm) of power, and the External Attenuation value is 40 dB (such as from a 40 dB directional coupler), the Received Power displayed will be +7 dBm.
6. Press the **Measurement** key, then the P25 Analyzer submenu key. Select the Graph types to view with the Graph Type submenu key. The Symbol Span submenu is used to adjust the number of “eyes” displayed across the screen in the Eye Diagram graph. Refer to [“P25 Analyzer Graphs” on page 3-4](#) on the available graph types.

Over-the-Air (OTA) Analysis Setup

1. Press the **Menu** key, then select the P25 Signal Analyzer icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight P25 Analyzer and press **Enter**.

Caution	The maximum input power without damage is 2 watts (+33 dBm) to the RF In 50 Ohm connector. To prevent damage, use a coupler or attenuator to reduce the input power to below this level when measuring high output power devices.
----------------	---

2. Connect an antenna with the appropriate frequency range to the RF In 50 Ohm connector on the LMR Master.
3. Press the **Frequency** main menu key to set the center frequency of the measurement using the Rx Freq key. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.
4. Press the **Setup** main menu key to select the modulation type and Rx Pattern (BER pattern). Select C4FM modulation for Phase I systems or CQPSK for Phase II and LSM systems. Press the Rx Pattern key to choose the pattern against which to measure error rates. 1011 Hz and O.153 (V.52) will measure BER directly against the selected pattern. Voice uses a proprietary method to estimate BER from regular voice traffic. Ctrl Channel will produce a Message Err Rate (MER) based on the CRC checksums contained in Control Channel messages and estimated BER using a proprietary algorithm. Refer to [“P25 Analyzer Graphs” on page 3-4](#) on the available graph types.

Using the Signal Generator for Receiver or OTA Analysis

1. Press the **Menu** key then select the P25 Signal Analyzer icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight P25 Analyzer and press **Enter**.

Caution	The maximum output power from the Signal Generator Out connector is 1 mW (0 dBm) and the frequency range is 500 kHz to 1.6 GHz.
----------------	---

2. Direct connect the LMR Master Signal Generator Out 50 Ohm connector to the repeater/receiver or connect an antenna with the appropriate frequency range to the connector.
3. Press the **Frequency** main menu key to set the transmit frequency using the Tx Freq key. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.

If testing a P25 repeater, you can bind the transmit frequency to the receive frequency by setting Rx/Tx Coupling to On and entering the Coupling Offset.

Note	When Rx/Tx Coupling is on, the Tx Freq submenu key is disabled.
-------------	---

4. Press the **Amplitude** main menu key, then the Tx Output Lvl submenu key to set the output power. Enter any output attenuation or gain using the Tx Power Offset key.
5. Set the transmit pattern by pressing the **Setup** main menu key then the Tx Pattern submenu key. Available patterns are listed on the display and additional patterns can be downloaded via the **System** > Application Options menu.

Note	Set the Network Access Control (NAC) value that is sent on the standard P25 1011 Hz Tx patterns when testing receivers. 293 is the P25 system default value.
-------------	--

6. Press the **Turn Sig-Gen ON** main menu key to start the signal generator. Press the key again to turn off the signal generator.

Caution	The maximum output power from the Signal Generator Out connector is 1 mW.
----------------	---

3-3 P25 Analyzer Graphs

The following P25 Analyzer measurements are available on the LMR Master. From the **Measurements** main menu, press P25 Analyzer twice. Press the **Graph Type** submenu key to select the measurement type.

Constellation and Linear Constellation

Constellation view displays the demodulation information in an IQ format (Figure 3-1). The chart shows the relationship between the location of a constellation data point, its deviation frequency, and the information it carries.

Symbol: +3	Symbol: +1
Bit Information: 01	Bit Information: 00
Dev.: +1.8 kHz	Dev.: +600 Hz
Symbol: -3	Symbol: -1
Bit Information: 11	Bit Information: 10
Dev.: -1.8 kHz	Dev.: -600 Hz

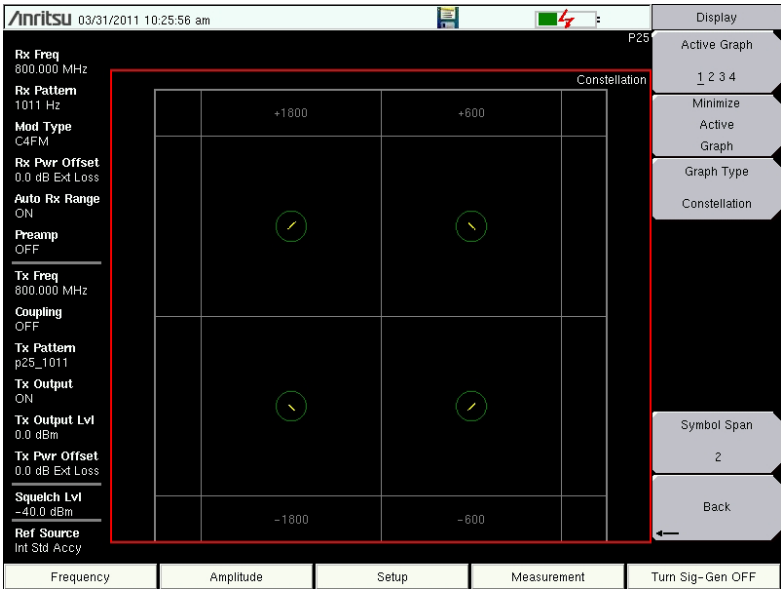


Figure 3-1. Constellation Diagram

Figure 3-2 shows the same information in the Linear Constellation View.

Symbol: -3	Symbol: -1	Symbol: +1	Symbol: +3
Bit Information: 11	Bit Information: 10	Bit Information: 00	Bit Information: 01
Dev.: -1.8 kHz	Dev.: -600 Hz	Dev.: +600 Hz	Dev.: +1.8 kHz

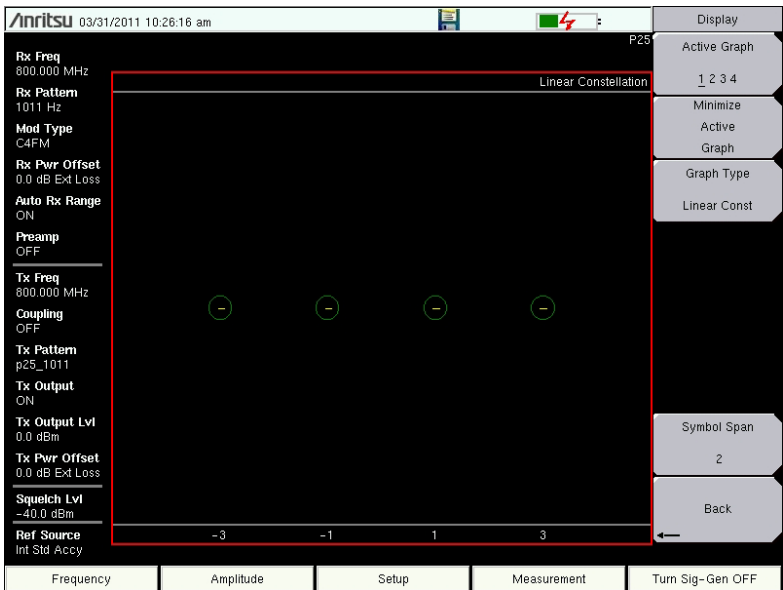


Figure 3-2. Linear Constellation Diagram

For input signals that are not P25 encoded, the LMR Master will still try to decode it and fit it to a symbol. This may cause some measurement results that are unexpected.

Histogram Graph

The Histogram graph displays a graphical representation of the symbols that are being received. The graph for each symbol represents the relative percentage that symbol was identified out of all the received symbols.

Each update of the screen is a separate representation of the latest data, rather than a cumulative total. The vertical scale is fixed at 0 % to 100 %, with each horizontal grid line representing 10 % of the total symbols received.

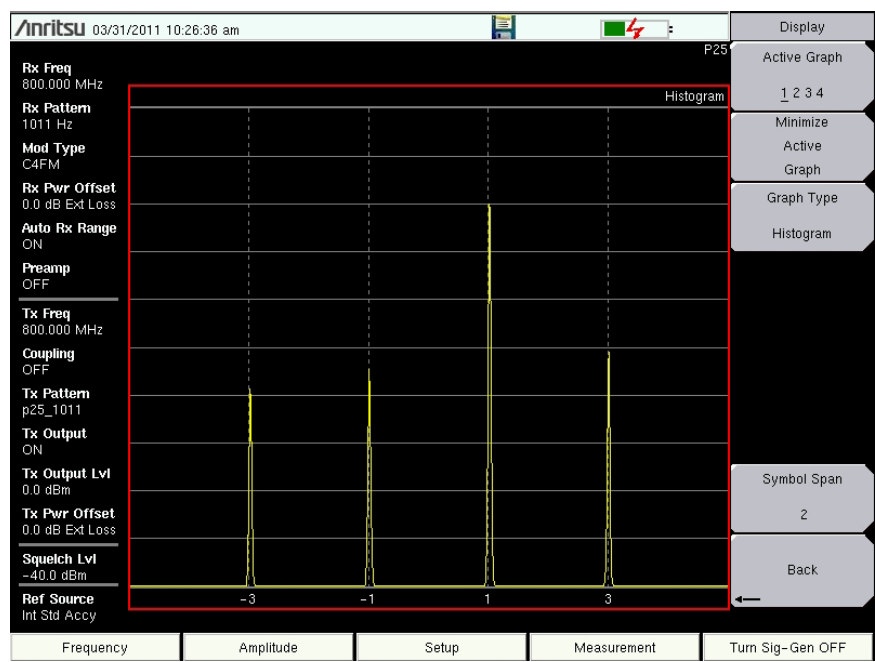


Figure 3-3. P25 Histogram

Spectrum Graph

The spectrum view displays a graphical representation of power (dBm) versus frequency. The spectrum display gives an indication if there are interferers present that may degrade the bit error rate of the P25 signal. The frequency span is adjustable under the **Frequency** menu. The reference level is adjusted with the **Amplitude** menu. Refer to [“Amplitude Menu” on page 3-19](#) for details. [Figure 3-4](#) displays the same signal using a 25 kHz span and a 500 kHz span.

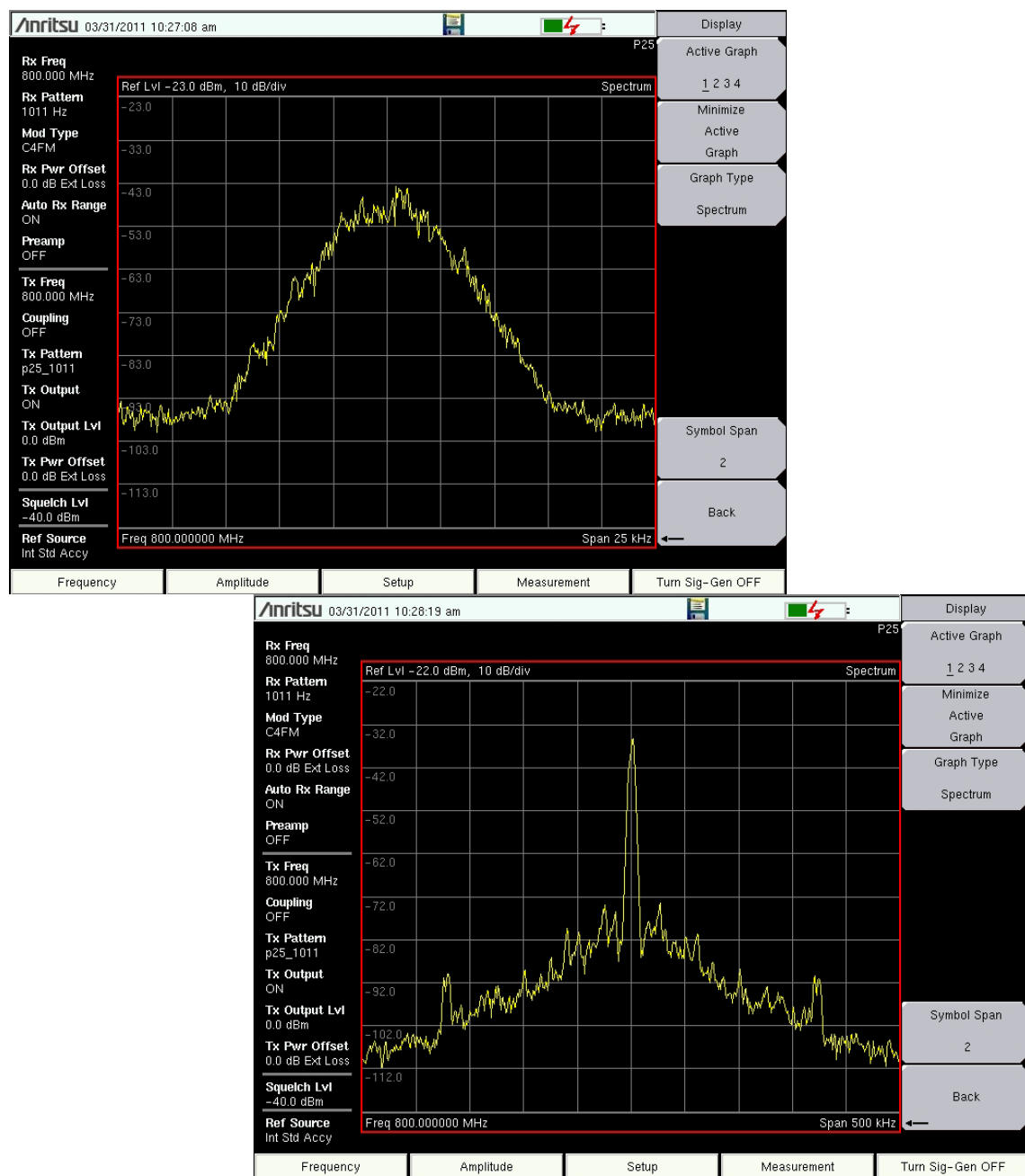


Figure 3-4. P25 Spectrum Graph (25 kHz Span and 500 kHz Span)

Eye Diagram

The eye diagram is an oscilloscope view of the P25 signal displaying the voltage of the signal vs. time. The diagram provides an indication of baseband fidelity of a P25 transmitter. With Over-the-air measurements, the Eye Diagram can indicate phase distortion from multipath. The number of “eyes” displayed is set with the Symbol Span key under the “Display Menu” on page 3-23.

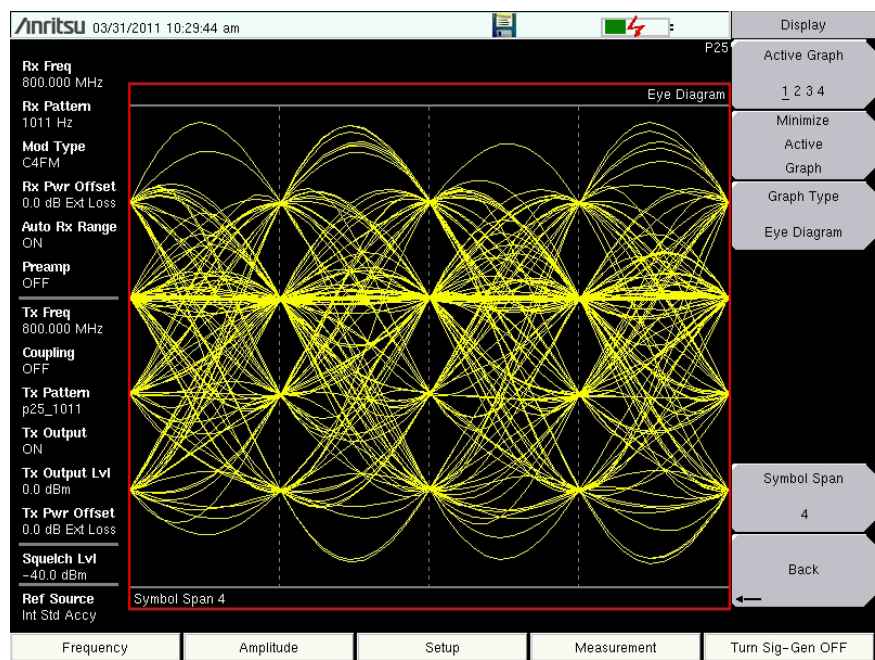


Figure 3-5. P25 Eye Diagram

Summary Graph

The summary graph provides an overview of a P25 transmitter. The graph displays numeric values of received power, frequency error, modulation fidelity (Mod Fid), bit error rate (BER), symbol deviation, Network Access Code (NAC), symbol rate error of the input signal and Signal-to-Interference-plus-Noise Ratio (SINR) when the input signal is control channel.

The Received Power value in the summary graph can be toggled to dBm, watts, or volts by using the **Amplitude** > Units > Rx Units submenu key. This setting also applies to the squelch level setting.

The **Setup** > Squelch Lvl submenu key sets the squelch power level. When the Received Power is lower than the set squelch level all summary graph measurements except for Received Pwr will be blanked out (--). When the Received Power is above the squelch level the measurements are displayed as shown in [Figure 3-6](#).

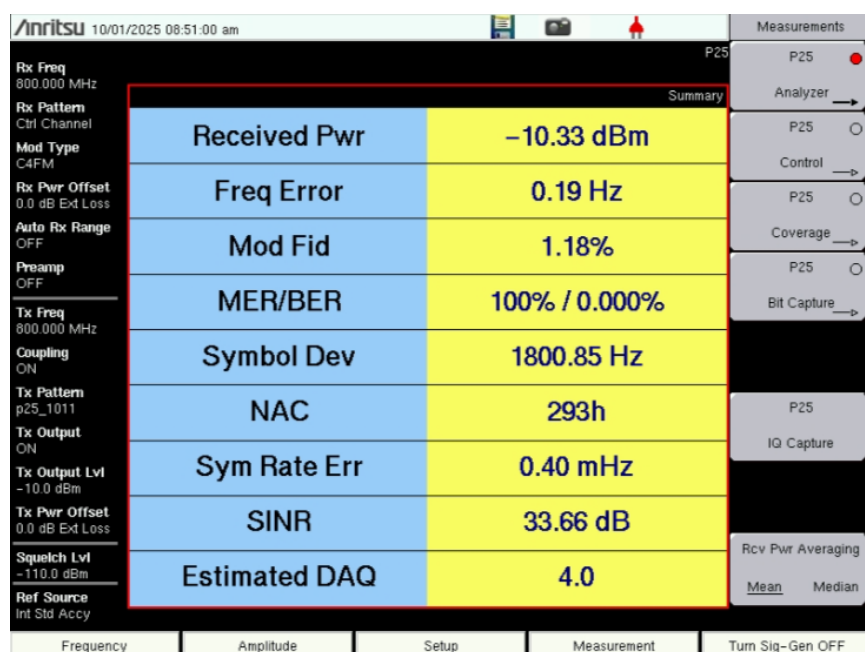


Figure 3-6. P25 Summary Graph with Received Pwr Above the Squelch Level

Received Pwr in the Summary table is the integrated power of all the energy in the receiver bandwidth. Any peak amplitude reduction seen in the Spectrum display when compared to Received Pwr is a function of the instrument's RBW setting. The reduction is specified as: $10 \cdot \log(\text{Signal Bandwidth} / \text{Resolution Bandwidth})$.

3-3 P25 Analyzer GraphsP25 Analyzer (Option 521)

Delivered Audio Quality (DAQ) is a subjective measurement where someone listens to an audio transmission and makes a judgment of the quality on a scale from 1-5. 1 is absolutely unusable and 5 is perfect. For in-building coverage, NFPA 1225 standard cites Table A.1 of the TIA TSB 88.1E standard which correlates BER and SINR measurements to the corresponding DAQ. Now that we have SINR for P25p1, having an Estimated DAQ measurement would be useful with in-building coverage customers. Refer to [Table 3-1](#) to verify the corresponding DAQ values based on the BER and SINR values.

Table 3-1. Estimated DAQ Values

Demodulation	Estimated DAQ = 4	Estimated DAQ = 3.4	Estimated DAQ = 3	Estimated DAQ = 0
C4FM	BER ≤ 1 and SINR ≥ 20	BER ≤ 2 and SINR ≥ 16.2	BER ≤ 2.6 and SINR ≥ 15.2	All other cases
CQPSK	BER ≤ 1 and SINR ≥ 20.5	BER ≤ 2 and SINR ≥ 17	BER ≤ 2.6 and SINR ≥ 15.7	All other cases

3-4 P25 Control Channel Measurements

Note

This measurement is captured on an external USB flash drive. The captured data file cannot be recalled and displayed on the instrument screen.

The LMR Master can log the decoded bits for control messages for either the voice channel or the control channel.

1. From the **Frequency** main menu, set the receiver frequency (Rx Freq).
2. From the **Setup** main menu, choose either Voice (downlink) or Ctrl Channel (uplink) as the Rx Pattern.
3. From the **Measurement** main menu press the P25 Control submenu key twice.
4. To log data, insert a formatted flash drive in the LMR Master and set Log Data to On.
5. The Hex Trigger menu and Hex Trigger Value menu are used to find a specific opcode in the Control Channel data.

To set the hex trigger value, press the **Set Trigger Value** menu. An on screen keyboard is displayed and with the numbers 0 to 9 and the letters A to F. Enter the two character hex value to search for. After entering the value, press **Enter** to set the trigger value. Press **Esc** to cancel entry or changing the current hex value.

Setting Hex Trigger to On will set the Sweep function to Hold when the hex trigger value is found in the first octet of a packet. The octet row with the found trigger value will be displayed in the middle of the table (Figure 3-7). If Log Data is set to On, all of the data on the screen is saved and Log Data is set to Off. When Sweep is set back to Run, the unit will continue to collect data and stop on the next instance of the hex trigger value. To continue to capture data to the USB flash drive, set Log Data back to On before setting Sweep to Run mode.

Figure 3-7 and Figure 3-8 are examples of the display screen measurement in Voice and Control. Valid Octet data is displayed in blue. Data displayed in red indicates a Cyclic Redundancy Check (CRC) error. P25 Control measurements include the following information:

NAC = Network Access Code

DUID = Data Unit Identifier

Control information in the voice channel also includes:

LC = link control data

LS = low speed data

KEY = key ID (part of encrypt sync word which identifies the encryption parameters)

MI = message ID (part of encrypt sync word)

ALG = algorithm ID (part of encrypt sync word)

When Log Data is set to On, the control channel information will be written to a data stamped folder inside the /usr folder on the root level of the USB flash drive. The file is named:

CTRL_LOGyearmonthdaytime.p25 (for Control data)

or

VOICE_LOGyearmonthdaytime.p25 (for Voice data)

Decoding Control Channel Measurements

Anritsu offers a Python script that will decode the logged hexadecimal Control Channel measurements. The script is available for download from the Anritsu web site and requires that the Python programming language is installed on your computer.

To decode control channel measurements with the Python script:

1. Install the Python programming language on a PC. Download the installer (<http://www.python.org/download/>) from the Python Programming Language web site.
2. Download the decoder script from the Anritsu web site:
 - a. Open the Anritsu home page (<http://www.anritsu.com>) with a web browser.
 - b. Type S412E in the search box to find the LMR Master S412E product page on the Anritsu web site. Click the product page link to display the LMR Master product page.
 - c. Click the Library tab. Under the Drivers/Software Downloads section, select **P25 Control Channel Decoder**. Next, click the **Download** button then **Save** to copy the file “p25_ctrl_decoder.zip” to your computer.
3. Unzip and launch the python script. The script file name is `p25_ctrl_decoder.py`.



4. Press the **Select File** button and select the control channel file that was saved on the USB flash drive. The Python script displays the CRC errors and writes a text file in the same location with the decoded control channel commands.

P25 Analyzer (Option 521)3-4 P25 Control Channel Measurements

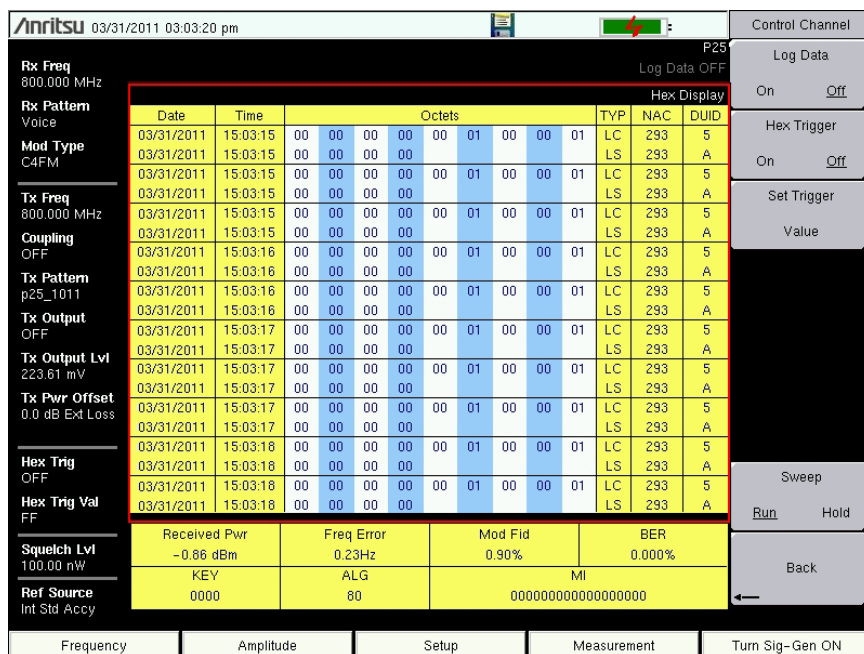


Figure 3-7. P25 Control Channel (Voice)

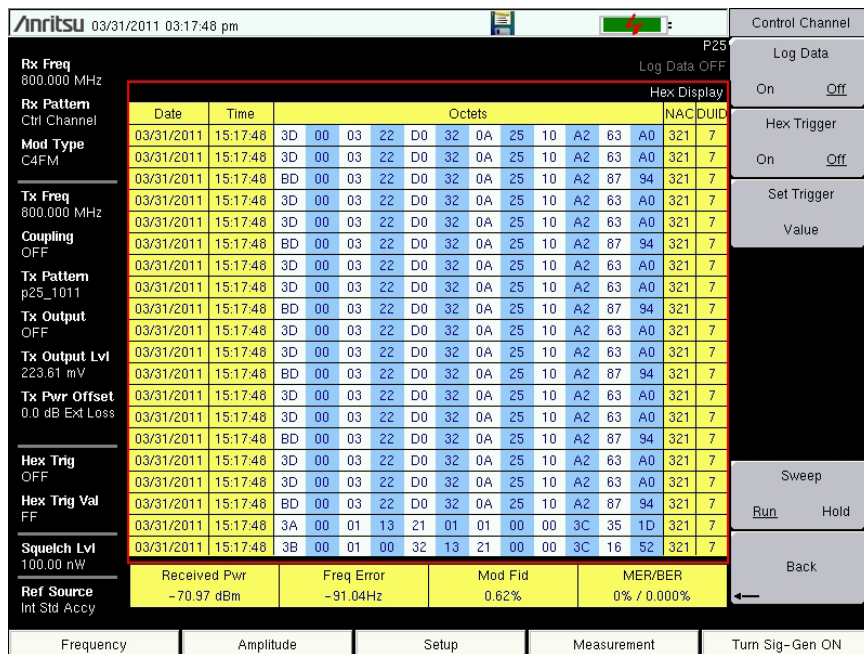


Figure 3-8. P25 Control Channel (Control)

3-5 P25 Coverage

Refer to Chapter 11, “LMR Coverage Mapping”.

3-6 P25 Bit Capture

Note

This measurement is captured on an external USB flash drive. The captured data file cannot be recalled and displayed on the instrument screen. There is a five second delay from initiating the bit capture (Log Data On) until the instrument starts logging data, then the instrument logs data in five second bursts with five second gaps between bursts. The data bursts are concatenated into a single log file.

The LMR Master can provide and log raw bits (pre Forward Error Correction) when the Rx Pattern is set to Voice.

- 1. From the **Frequency** main menu, set the receiver frequency (Rx Freq).
- 2. From the **Setup** main menu, choose Voice as the Rx Pattern.
- 3. From the **Measurement** main menu press the P25 Bit Capture submenu key twice.
- 4. To log data, insert a formatted USB flash drive in the LMR Master and set Log Data to On. The bit capture information will be written to a data stamped folder inside the /usr folder on the root level of the USB flash drive. The tab delimited text file contains the header and table information shown in Figure 3-9. The files are named:

BIT_CAP_LOGyearmonthdaytime.p25

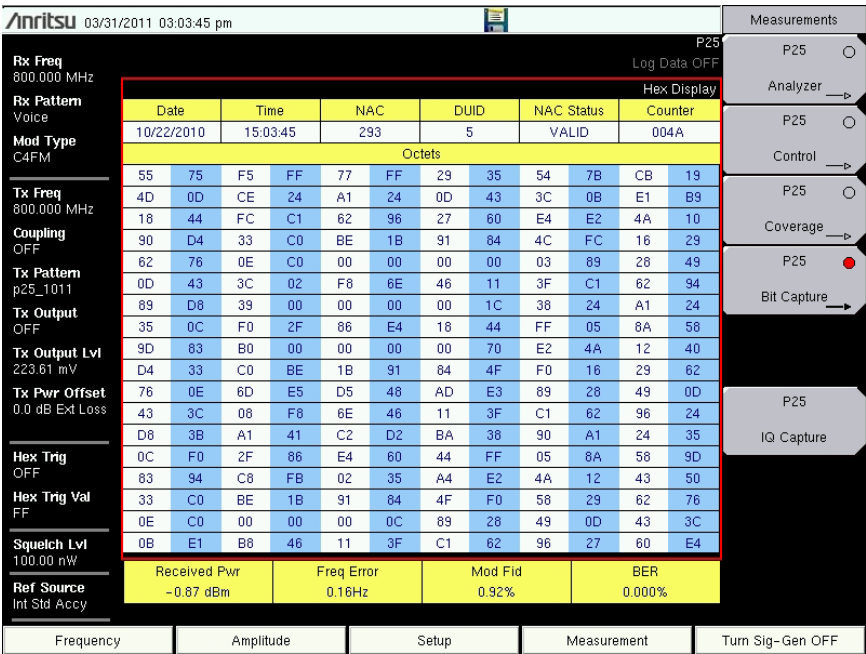


Figure 3-9. P25 Bit Capture Display

3-7 P25 IQ Data

Note	This measurement is captured on an external USB flash drive. The captured data file cannot be recalled and displayed on the instrument screen.
-------------	--

The LMR Master can capture and log P25 IQ data to a USB flash drive.

1. From the **Frequency** main menu, set the receiver frequency (Rx Freq).
2. From the **Setup** main menu, choose a Mod Type.

For C4FM modulation, interleaved Delta Phase data then Magnitude data is captured. For CQPSK modulation, interleaved I data then Q data is captured.

3. Insert a formatted USB flash drive into the LMR Master and from the **Measurement** main menu, press the P25 IQ Capture submenu key. After approximately 10 seconds, the instrument displays a message that the capture is complete.

The IQ data is sampled at 4,800 x 11 symbols per second. The saved file has an ASCII header and binary data (Figure 3-10). The data is written in 24-bit two's complement integers format. The header includes "SampleType" (I/Q for CQPSK or DeltaPhase/Mag for C4FM). The file is intended for post-processing in MATLAB or other data analysis software.

The file will be written to a data stamped folder inside the /usr folder on the root level of the USB flash drive. The file is named:

`IQ_CAPTUREyearmonthdaytime.p25`

Note	There is no display menu for P25 IQ Capture. The LMR Master will continue to display the previous measurement screen during IQ Capture.
-------------	---

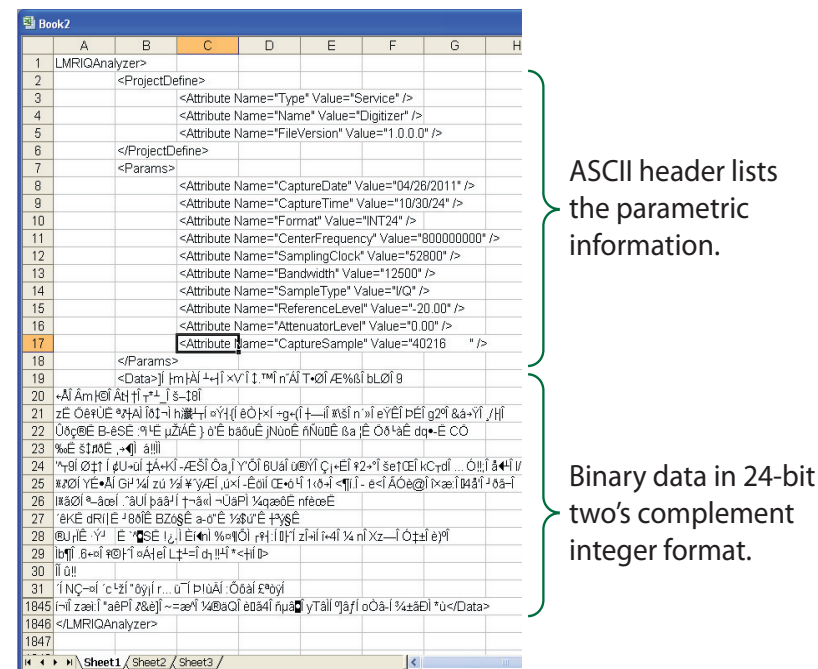


Figure 3-10. IQ Capture (CQPSK Modulation)

3-8 P25 Analyzer Menus

Menu maps typically display all possible submenu keys, although some keys are displayed on the instruments only under special circumstances (refer to menu descriptions on the following pages).

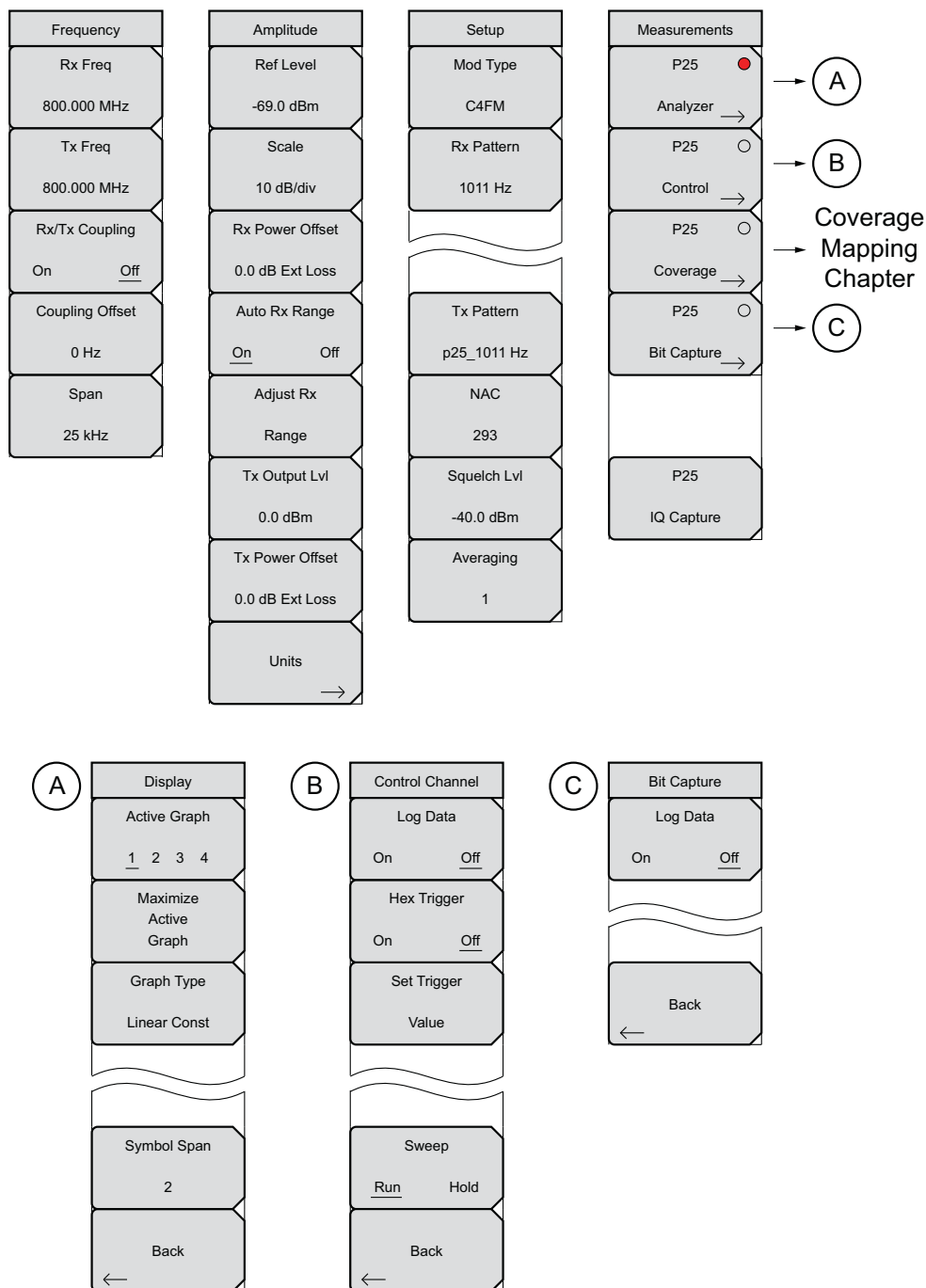


Figure 3-11. P25 Analyzer Menu Layout

3-9 Frequency Menu

Key Sequence: **Frequency**

Frequency	Rx Freq: Sets the receiver frequency. Press the Rx Freq key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the submenu key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the Enter key has the same effect as pressing the MHz submenu key.
Rx Freq 800.000 MHz	
Tx Freq 800.000 MHz	Tx Freq: Sets the signal generator frequency. Press Tx Rx Freq key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the submenu key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the Enter key has the same effect as pressing the MHz submenu key.
Rx/Tx Coupling On <u>Off</u>	
Coupling Offset 0 Hz	Rx/Tx Coupling: Couples the signal generator to the receiver frequency. When set to On the Tx Freq key is disabled.
Span 25 kHz	Coupling Offset: Sets the Offset of the signal generator frequency and the receiver frequency. Only functional when Rx/Tx Coupling is set to On. Span: Sets the span of the Spectrum Graph. Span selections are 25 kHz, 50 kHz, 100 kHz, 500 kHz, 1 MHz, and 5 MHz.

Figure 3-12. P25 Analyzer Frequency Menu

3-10 Amplitude Menu

Key Sequence: **Amplitude**

Amplitude	Ref Level: Sets the reference power level at the top of the display when Auto Range is Off.
Ref Level	
-69.0 dBm	
Scale	Scale: Scale sets the number of dB per division in the y-axis of the graticule. Enter a value from 1 dB per division to 15 dB per division using the keypad, the arrow keys, or the rotary knob. The y-axis power scale is shown on the left side of the display when viewing the Spectrum Graph.
10 dB/div	
Rx Power Offset	Note: The “Vertical Scale Menu” on page 3-20 is displayed when P25 Coverage (Measurement > P25 Coverage) is selected.
0.0 dB Ext Loss	
Auto Rx Range	Rx Power Offset: Sets the receiver (RF IN connection) external attenuation or gain. Press the Rx Power Offset submenu key and select a value from 0 dB to 100 dB then select either dB External Loss or dB External Gain.
On Off	
Adjust Rx	Auto Rx Range: Pressing this submenu key toggles between On and Off. When On, this function automatically adjusts the reference level based on the input signal.
Range	
Tx Output Lvl	Adjust Rx Range: When Auto Rx Range is Off, pressing Adjust Rx Range sets the Reference Level automatically for the current measurement.
0.0 dBm	
Tx Power Offset	Tx Output Lvl: Sets the output power of the Signal Generator (0 dBm or 1 mW or 223 mV max).
0.0 dB Ext Loss	
Units	Tx Power Offset: Sets the transmitter (Signal Generator Out connection) external attenuation or gain. Press the Rx Power Offset submenu key and select a value from 0 dB to 100 dB then select either dB External Loss or dB External Gain.
→	Units: Opens to Units Submenu.
Units	
Rx Units	Rx Units: Sets the unit of measure (dBm, watts, or volts) for Received Power in the Summary Graph and the Squelch Level.
dBm	
Tx Units	Tx Units: Sets the unit of measure (dBm, watts, or volts) for the Signal Generator (Tx Output Lvl submenu).
dBm	
Back	
←	

Figure 3-13. P25 Analyzer Amplitude Menu

Vertical Scale Menu

Key Sequence: **Amplitude** > Vertical Scale

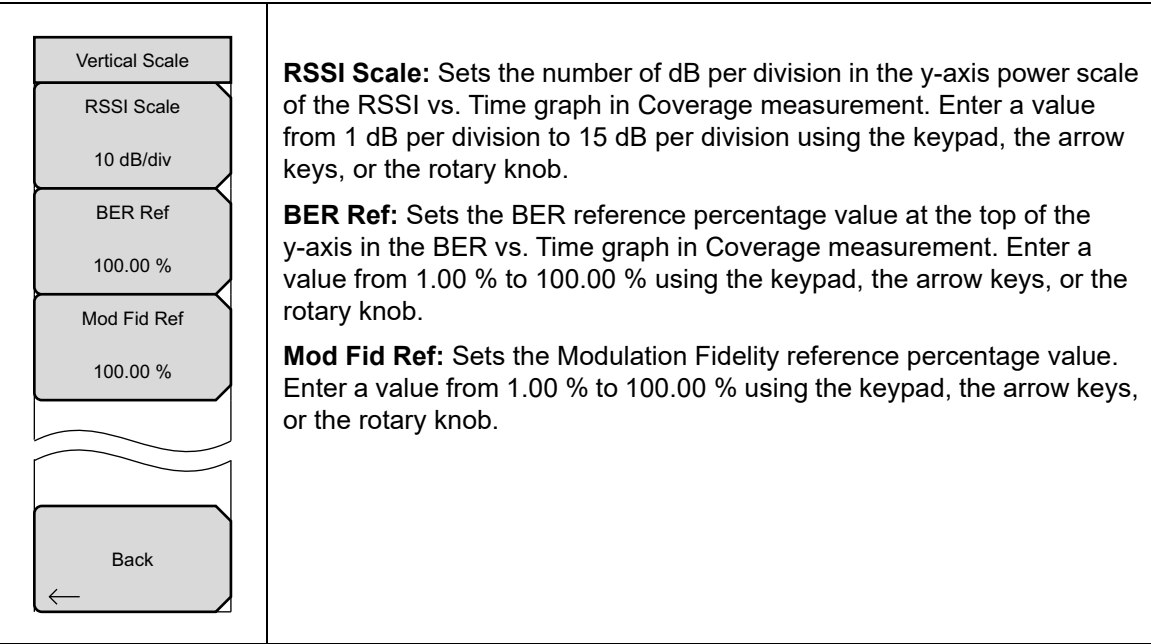


Figure 3-14. Vertical Scale Menu

3-11 Setup Menu

Key Sequence: **Setup**

Setup	Mod Type: Sets the type of modulation. The options are C4FM (Phase I, 12.5 kHz BW) or CQPSK (Phase I or Phase II, 6.25 kHz equivalent BW).
Mod Type	Rx Pattern: Selects the receiver Bit Error Rate pattern. Select a pattern from the list box with the arrow keys or rotary knob and press Enter . There are four available patterns:
C4FM	Automatic Frequency Control (1011 Hz)
Rx Pattern	Standard Transmitter Test (O.153 or V.52)
1011 Hz	Voice
	Ctrl (Control) Channel
	Tx Pattern: Selects the transmitter pattern to send when the Turn Sig-Gen ON main menu key is selected. Select a pattern from the list box with the arrow keys or rotary knob and press Enter . Refer to “Using the Signal Generator for Receiver or OTA Analysis” on page 3-3 for the list of available transmitter patterns.
Tx Pattern	NAC: Sets the Network Access Control (NAC) that is sent on the standard P25 1011 Hz Tx Pattern when testing receivers. 293 is the P25 system default value.
p25_1011	Squelch Lvl: Sets the squelch power level. When the Received Power is lower than the set squelch level, all summary graph measurements except for Received Pwr will be blanked out (--).
NAC	Averaging: Sets the refresh rate of the numerical values in the P25 Summary window. Setting a higher number (25 maximum) will reduce measurement jitter.
293	
Squelch Lvl	
-40.0 dBm	
Averaging	
1	

Figure 3-15. P25 Analyzer Setup Menu

3-12 Measurement Menu

Key Sequence: **Measurement**

Measurements

P25

Analyzer

P25

Control

P25

Coverage

P25

Bit Capture

P25

IQ Capture

Rcv Pwr Averaging

Mean Median

P25 Analyzer: Opens the “Display Menu” on page 3-23.

P25 Control: Opens the “Control Channel Menu” on page 3-24. This submenu key is valid only when Rx Pattern is set to Control Channel or Voice.

P25 Coverage (Option 522 required): Opens the P25 Coverage menu. Refer to [Chapter 11, “LMR Coverage Mapping”](#).

P25 Bit Capture: This submenu key is valid only when Rx Pattern is set to Voice. Pressing this key opens a submenu for logging data to a file. Make sure that a formatted USB flash drive is attached to the instrument before starting bit capture. The log files are saved in a time-stamped folder under the **usr** folder on the USB flash drive.

Set Log Data to On to start the bit capture. There is a five second delay from initiating the bit capture (Log Data On) until the instrument starts logging data, then the instrument logs data in five second bursts with five second gaps between bursts. The data bursts are concatenated into a single log file. Bit capture will continue until Log Data is set to Off or the USB flash drive is filled.

If Log Data is On, any of the following functions will stop the logging:

- Rx Frequency change
- Setup change
- Starting another measurement

P25 IQ Capture: Pressing this key starts the IQ data capture. Make sure that a formatted USB memory device is attached to the instrument before starting IQ Capture. When the capture is complete, a message is displayed. This may take a few seconds.

Rcv Pwr Averaging: Select Median to measure the RSSI value using the median of captured subsamples of the Rx signal, in accordance with TIA TSB-88.3 Rev. F. Select Mean to measure the RSSI value using the average of the subsamples of the Rx signal.

Figure 3-16. P25 Analyzer Measurement Menu

Display Menu

Key Sequence: **Measurement** > P25 Analyzer

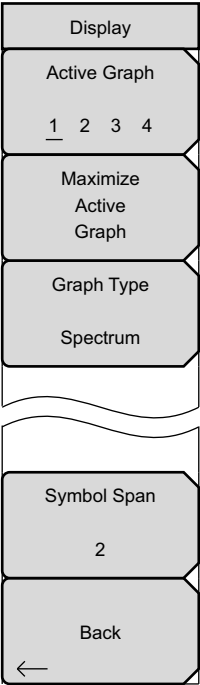
	<p>Active Graph 1 2 3 4: In Four Screen view use this menu to select which of the four graphs is active. The current active graph is underlined (1 2 3 4) and has a red perimeter line. Any of the four graphs can also be made active by tapping once on the touch screen. Repeatedly pressing the Active Graph submenu key will cycle the active graph, 1 through 4.</p> <p>In Standard view (one graph displayed on the screen) the Active Graphic key will rotate between the four graphs displayed in the Four Screen view.</p> <p>Maximize/Minimize Active Graph: The submenu key toggles between displaying the Four Screen (4 graphs) view and the Standard view (1 graph). Tapping twice on a selected graph also toggles between the two display options.</p> <p>Graph Type: The label on the bottom of this button displays the current active graph type. Pressing the button will open a list box of the graphs types available for P25 Analyzer measurements. Select the desired graph type with the arrow keys or rotatory knob and press Enter. The current active graph will be replaced with the new selection.</p> <p>Available graphs include:</p> <ul style="list-style-type: none">ConstellationSpectrumHistogramEye DiagramLinear ConstellationSummary <p>Refer to “P25 Analyzer Graphs” on page 3-4 for additional information.</p> <p>Symbol Span: Use this menu to adjust the number of symbols viewed across the screen in the Eye Diagram graph. Adjust from 2 and 5 using the keypad, the arrow keys, or the rotary knob. Keypad values entered outside of this range are ignored.</p> <p>Back: Returns to the “Measurement Menu” on page 3-22.</p>
---	---

Figure 3-17. P25 Analyzer Display Menu

Control Channel Menu

Key Sequence: **Measurement** > P25 Control

Control Channel

Log Data

OnOff

Hex Trigger

OnOff

Set Trigger

Value

Sweep

RunHold

Back

←

Log Data: Saves the measurements to an external USB flash drive. The external USB flash drive must be attached to one of the USB Type A connectors to Log data files.

The files are saved in a time-stamped folder under the **usr** folder on the USB flash drive.

If Log Data is On, any of the following functions will stop the logging:

- Rx Frequency change
- Setup change
- Starting another measurement

Hex Trigger: Turns On or Off the Hex Trigger set with the following command. Sweep will continue until the trigger value is detected. At that time Sweep will change from Run to Hold.

Set Trigger Value: Opens a touchscreen hexadecimal keyboard for setting the Trigger value.

Sweep: Toggles the frequency sweep of the LMR Master between Run and Hold. Save function as **Shift + Sweep (3)**.

Back: Returns to the [“Measurement Menu” on page 3-22](#).

Figure 3-18. P25 Control Channel Menu

3-13 Sweep Menu

Key Sequence: **Shift > Sweep (3)** key

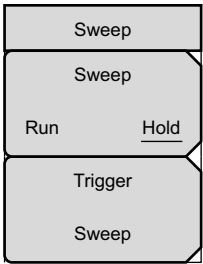
	<p>Sweep Run/Hold: This submenu key toggles between continuous (run) sweep and hold sweep. In Run sweep mode, sweeps are continuous and one starts immediately after the previous sweep is completed. In Hold sweep mode, the results of the last sweep are displayed on the screen while the instrument waits for a trigger event to start a new sweep. HOLD is displayed on the right side of the screen in this mode.</p> <p>Trigger Sweep: Pressing this submenu key causes the instrument to make a single sweep when the instrument is in Hold sweep mode. This key has no function when the instrument is in Run sweep mode.</p> <p>Trigger Sweep is not available in P25 Control and P25 Bit Capture measurements.</p>
---	--

Figure 3-19. P25 Analyzer Sweep Menu

3-14 Measure Menu

Key Sequence: **Shift > Measure (4)** key

Displays the [“Measurement Menu” on page 3-22.](#)

3-15 Trace Menu

This menu is not available in P25 Analyzer measurement mode.

3-16 Limit Menu

This menu is not available in P25 Analyzer measurement mode.

3-17 Other Menus

Preset, Calibrate, File, System and **Mode** are described in the User Guide.

Chapter 4 — P25 Phase 2 Analyzer (Option 521)

Note	Option 521 include P25 demodulation (Chapter 3) and P25 Phase 2 demodulation (this Chapter).
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4-1 Introduction

The P25 Phase 2 Analyzer option provides a method to verify the operation of APCO Project 25 Phase 2 (P25p2) and Linear Simulcast Modulation (LSM) tower, mobile, and portable radio transmitters. Option 521 includes the ability to display linear constellation, spectrum, histogram, power profile, and eye diagram graphs. In addition, summary graphs display demodulation, active and backup control channel, band plan, and adjacent site information.

The LMR Master will analyze input signal strengths from +33 dBm (2.0 watts) down to levels approaching the sensitivity of P25p2 radios, automatically adjusting the input sensitivity based on input levels.

4-2 Setup Procedure

Direct Connect to the Transmitter

1. Press the **Menu** key then select the P25 2 Signal Analyzer icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight P25p2 Analyzer and press **Enter**.

Caution	The maximum input power without damage is 2 watts (+33 dBm) to the RF In 50 Ohm connector. To prevent damage, use a coupler or attenuator to reduce the input power to below this level when measuring high output power devices.
----------------	---

2. Connect the transmitter to the RF In 50 Ohm connector on the LMR Master using a coupler or attenuator.
3. Press the **Frequency** main menu key to set the receiver center frequency (Rx Freq) of the measurement. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.
4. Press the **Setup** main menu key to select the modulation type. Select **Base Station** or **Mobile Station** using the Mod Type key. Press the Rx pattern key to choose the pattern against which to measure error rates. 1031 Hz will measure BER directly against the selected pattern. Voice uses a proprietary method to estimate BER from regular voice traffic. Ctrl Channel will produce a Message Err Rate (MER) based on the CRC

checksums contained in Control Channel messages and estimated BER using a proprietary algorithm.

5. Select the TDMA slot (0 or 1) using the Rx Slot submenu key.
6. Press the **Amplitude** main menu key, then the Rx Power Offset submenu key to set the receiver attenuation (or gain). Use the arrow keys, rotary knob or the numeric keypad to enter the adjustment value, up to 100 dB and select either the Loss or Gain submenu key. The offset will be applied to the Carrier Power value in the Demodulation Summary graph. For instance, if the transmitter under test is emitting 50 watts (+47 dBm) of power, and the External Attenuation value is 40 dB (such as from a 40 dB directional coupler) the Carrier Power displayed will be +7 dBm.
7. Press the **Measurement** key, then the P25p2 Analyzer submenu key. Select the Graph types to view with the Graph Type submenu key. The Symbol Span submenu is used to adjust the number of “eyes” displayed across the screen in the Eye Diagram graph. Refer to [“P25p2 Analyzer Graphs” on page 4-4](#) on the available graph types.

Over-the-Air (OTA) Analysis Setup

1. Press the **Menu** key then select the P25 2 Signal Analyzer icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight P25p2 Analyzer and press **Enter**.

Caution	The maximum input power without damage is 2 watts (+33 dBm) to the RF In 50 Ohm connector. To prevent damage, use a coupler or attenuator to reduce the input power to below this level when measuring high output power devices.
----------------	---

2. Connect an antenna with the appropriate frequency range to the RF In 50 Ohm connector on the LMR Master.
3. Press the **Frequency** main menu key to set the center frequency of the measurement using the Rx Freq key. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.
4. Press the **Setup** main menu key to select the modulation type. Select Base Station or Mobile Station using the Mod Type key. Press the Rx pattern key to choose the pattern against which to measure error rates. 1031 HZ will measure BER directly against the selected pattern. Voice uses a proprietary method to estimate BER from regular voice traffic. Ctrl Channel will produce a Message Err Rate (MER) based on the CRC checksums contained in Control Channel messages and estimated BER using a proprietary algorithm. Refer to [“P25p2 Analyzer Graphs” on page 4-4](#) on the available graph types.
5. Select the TDMA slot (0 or 1) using the Rx Slot submenu key.

Using the Signal Generator for Receiver or OTA Analysis

1. Press the **Menu** key then select the P25 2 Signal Analyzer icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight P25p2 Analyzer and press **Enter**.

Caution	The maximum output power from the Signal Generator Out connector is 1 mW (0 dBm) and the frequency range is 500 kHz to 1.6 GHz.
----------------	---

2. Direct connect the LMR Master Signal Generator Out 50 Ohm connector to the repeater/receiver or connect an antenna with the appropriate frequency range to the connector.
3. Press the **Frequency** main menu key to set the transmit frequency using the Tx Freq key. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.

If testing a P25p2 repeater, you can bind the transmit frequency to the receive frequency by setting Rx/Tx Coupling to On and entering the Coupling Offset.

Note	When Rx/Tx Coupling is on, the Tx Freq submenu key is disabled.
-------------	---

4. Press the **Amplitude** main menu key, then the Tx Output Lvl submenu key to set the output power. Enter any output attenuation or gain using the Tx Power Offset key.
5. Set the transmit pattern by pressing the **Setup** main menu key then the Tx Pattern submenu key. Available patterns are listed on the display and additional patterns can be downloaded via the **System** > Application Options menu.
6. Select the TDMA slot (0 or 1) using the Tx Slot submenu key.
7. Press the **Turn Sig-Gen ON** main menu key to start the signal generator. Press the key again to turn off the signal generator.

4-3 P25p2 Analyzer Graphs

The following P25p2 Analyzer measurements are available on the LMR Master. From the **Measurements** main menu press P25p2 Analyzer twice. Press the Graph Type submenu key to select the measurement type.

Linear Constellation

Linear constellation view displays the demodulation information in an IQ format for Base Station (Figure 4-1) and Mobile Station (Figure 4-2). The chart shows the relationship between the location of a constellation data point, its deviation frequency, and the information it carries.

Symbol:	-3	Symbol:	-1	Symbol:	+1	Symbol:	+3
Bit Information:	11	Bit Information:	10	Bit Information:	00	Bit Information:	01

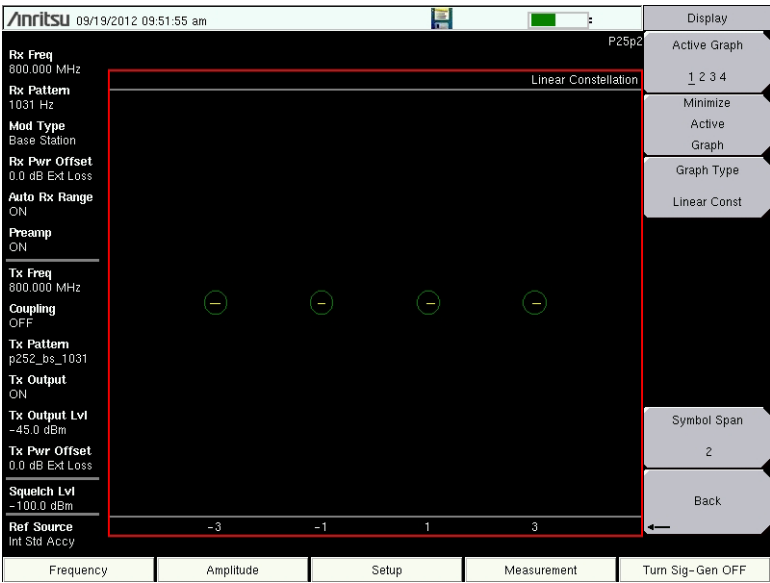


Figure 4-1. Linear Constellation Diagram (Base Station)

Symbol: -3	Symbol: -2	Symbol: -1	Symbol: 0	Symbol: +1	Symbol: +2	Symbol: +3
------------	------------	------------	-----------	------------	------------	------------



Figure 4-2. Linear Constellation Diagram (Mobile Station)

For input signals that are not P25p2 encoded, the LMR Master will still try to decode it and fit it to a symbol. This may cause some measurement results that are unexpected.

Histogram Graph

The Histogram graph displays a graphical representation of the symbols that are being received. The graph for each symbol represents the relative percentage that symbol was identified out of all the received symbols.

Each update of the screen is a separate representation of the latest data, rather than a cumulative total. The vertical scale is fixed at 0 to 100 %, with each horizontal grid line representing 10 % of the total symbols received.

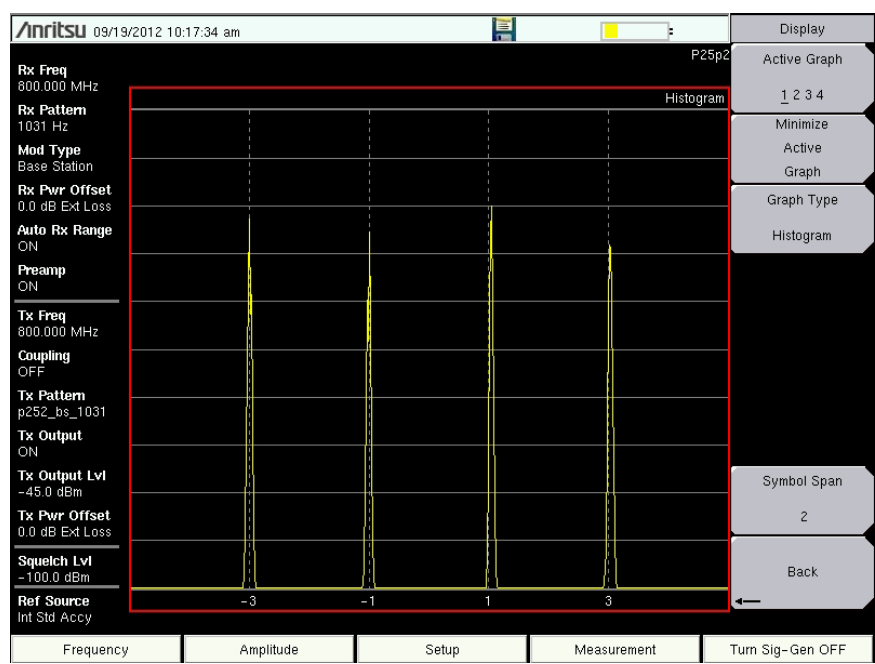


Figure 4-3. P25p2 Base Station Histogram

Spectrum Graph

The spectrum view displays a graphical representation of power (dBm) vs. frequency. The spectrum display gives an indication if there are interferers present that may degrade the bit error rate of the P25p2 signal. The frequency span is adjustable under the **Frequency** menu. The reference level is adjusted with the **Amplitude** menu. Refer to [“Amplitude Menu” on page 4-21](#) for details. [Figure 4-4](#) displays the same signal using a 25 kHz span and a 500 kHz span.

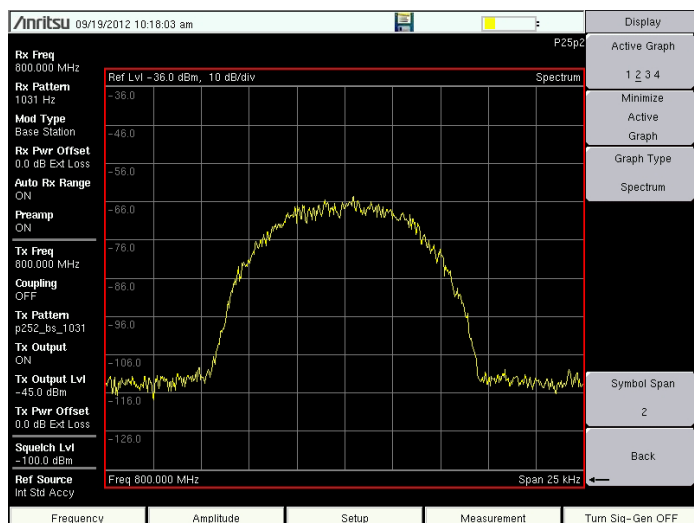
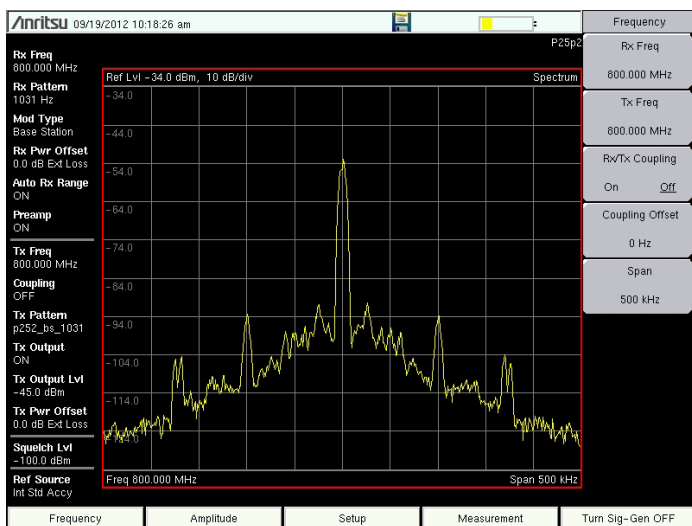


Figure 4-4. P25p2 Spectrum Graph (25 kHz Span and 500 kHz Span)

Eye Diagram

The eye diagram is an oscilloscope view of the P25p2 signal displaying the voltage of the signal vs. time. The diagram provides an indication of baseband fidelity of a P25p2 transmitter. With Over-the-air measurements the Eye Diagram can indicate phase distortion from multipath. The number of “eyes” displayed is set with the Symbol Span key under the “Display Menu” on page 4-26.

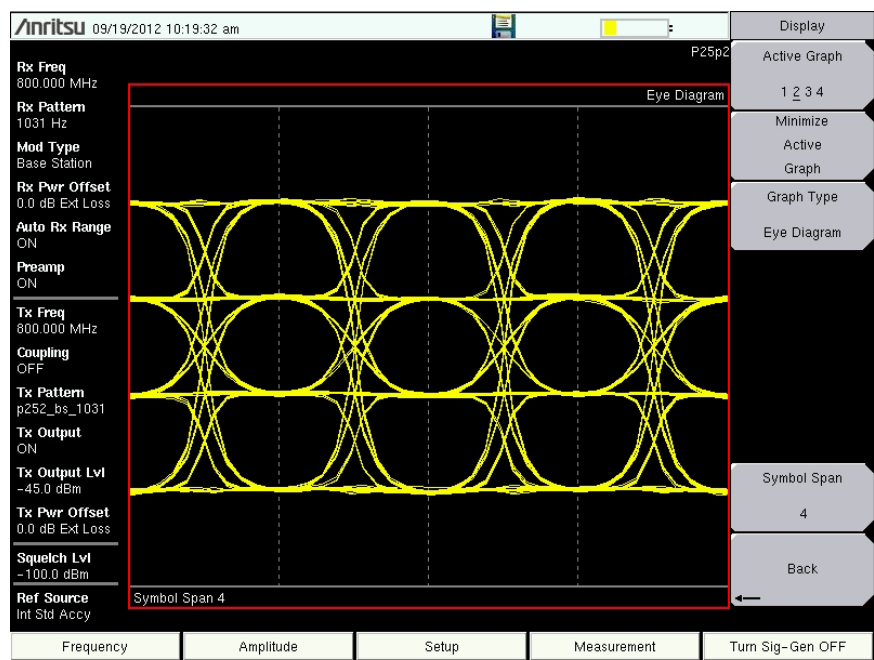


Figure 4-5. P25p2 Eye Diagram

Summary Graphs

The LMR Master offers several summary graphs to give a broad overview of many P25p2 transmitter details.

Demodulation Summary

The Demodulation Summary graph displays numeric values of received power, frequency error, modulation fidelity (Mod Fid), bit error rate (BER), symbol deviation, and symbol rate error of the input signal. When the RX Pattern is set to Control Channel, the summary graph displays message error ratio (MER/BER) in place of BER.

The Received Power value in the summary graph can be displayed in dBm, watts, or volts using the **Amplitude** > Units > Rx Units submenu key. This setting also applies to the squelch level setting.

The **Setup** > Squelch Lvl submenu key sets the squelch power level. When the Received Power is lower than the set squelch level, all summary graph measurements except for Received Pwr will be blanked out (--). When the Received Power is above the squelch level, the measurements are displayed as shown in [Figure 4-6](#).

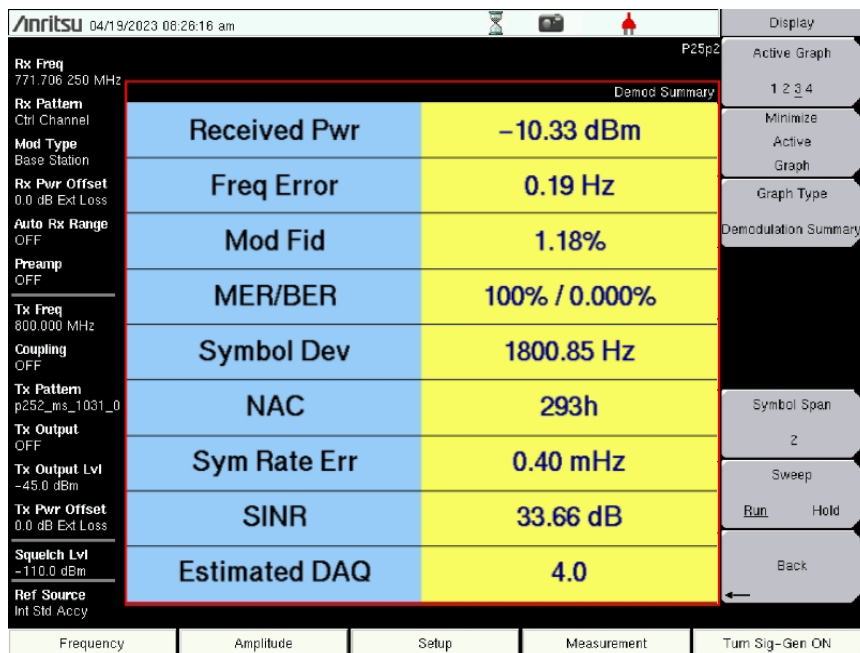


Figure 4-6. P25p2 Demodulation Summary Graph with Received Pwr Above the Squelch Level

Received Pwr in the summary table is the integrated power of all the energy in the receiver bandwidth. Any peak amplitude reduction seen in the Spectrum display when compared to Received Pwr is a function of the instruments RBW setting. The reduction is specified as: $10 \cdot \log(\text{Signal Bandwidth} / \text{Resolution Bandwidth})$.

4-3 P25p2 Analyzer GraphsP25 Phase 2 Analyzer (Option 521)

Delivered Audio Quality (DAQ) is a subjective measurement where someone listens to an audio transmission and makes a judgment of the quality on a scale from 1-5. 1 is absolutely unusable and 5 is perfect. For in-building coverage, NFPA 1225 standard cites Table A.1 of the TIA TSB 88.1E standard which correlates BER and SINR measurements to the corresponding DAQ. Now that we have SINR for P25p2, having an Estimated DAQ measurement would be useful with in-building coverage customers. Refer to [Table 4-1](#) to verify the corresponding DAQ values based on the BER and SINR values.

Table 4-1. Estimated DAQ Values

Demodulation	Estimated DAQ = 4	Estimated DAQ = 3.4	Estimated DAQ = 3	Estimated DAQ = 0
Base Station	BER ≤ 1.4 and SINR ≥ 21.6	BER ≤ 2.6 and SINR ≥ 18.7	BER ≤ 3.3 and SINR ≥ 17.5	All other cases
Mobile Station	BER ≤ 1.2 and SINR ≥ 19.8	BER ≤ 2.4 and SINR ≥ 16.4	BER ≤ 3.1 and SINR ≥ 15.2	All other cases

Active Control Channel Summary

The Active Control Channel Summary graph can be selected only when the Mod Type is set to Base Station and the RX Pattern is set to Ctrl Channel. This summary displays the hex value of the active system ID, wide area communications network (WACN) ID, network access control (NAC), site ID, and the current site status and manufacturer ID.

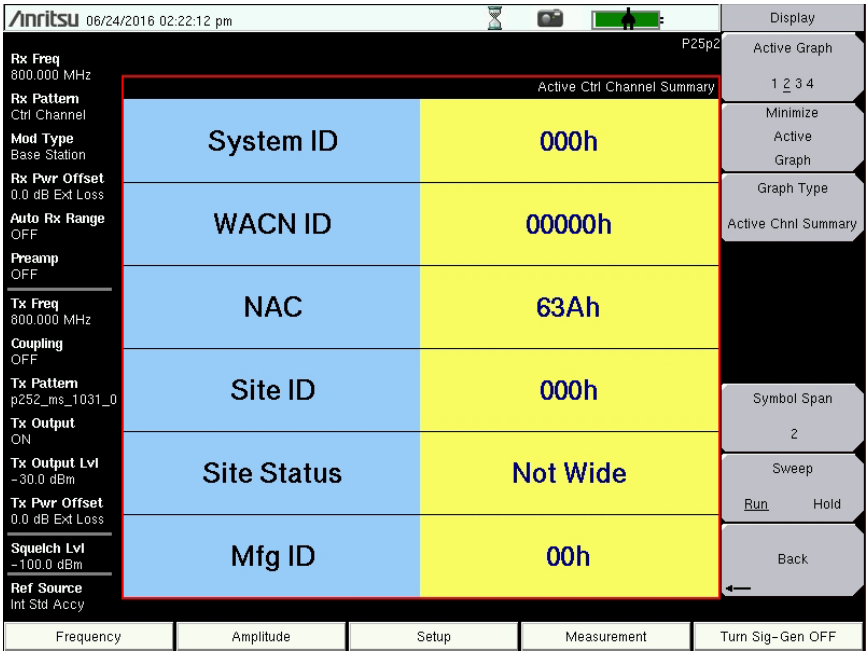


Figure 4-7. P25p2 Active Base Station Control Channel Summary

Band Plan Summary

The Band Plan Summary graph can be selected only when the Mod Type is set to Base Station and the RX Pattern is set to Ctrl Channel. This summary displays the band plan identifier, bandwidth, transmit offset, channel spacing, and base frequency.

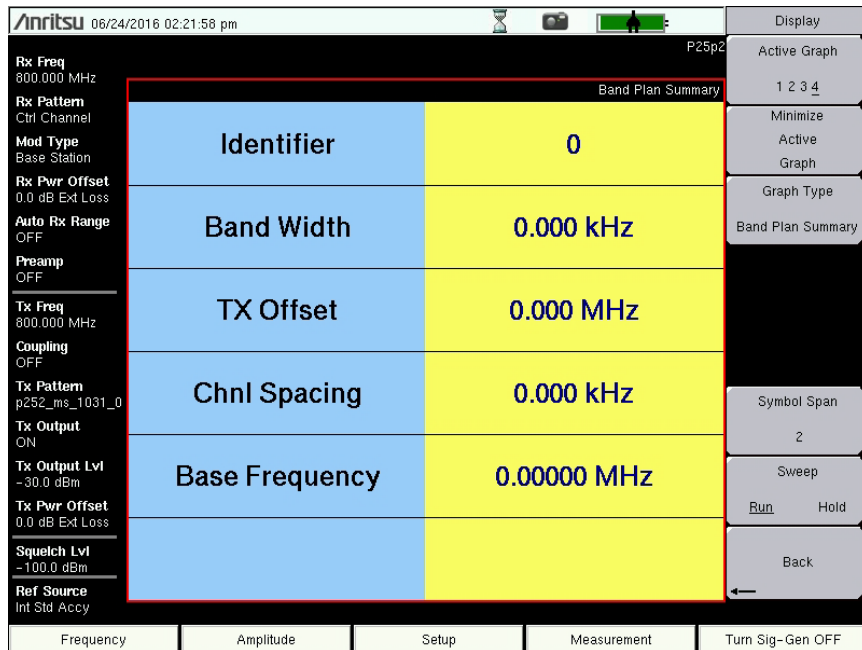


Figure 4-8. P25p2 Base Station Control Channel Band Plan Summary

Backup Control Channel Summary

The Backup Ctrl Channel Summary graph can be selected only when the Mod Type is set to Base Station and the RX Pattern is set to Ctrl Channel. This summary displays the hex values of the RF sub-system ID, site ID, channels A and B, and the manufacturer ID.

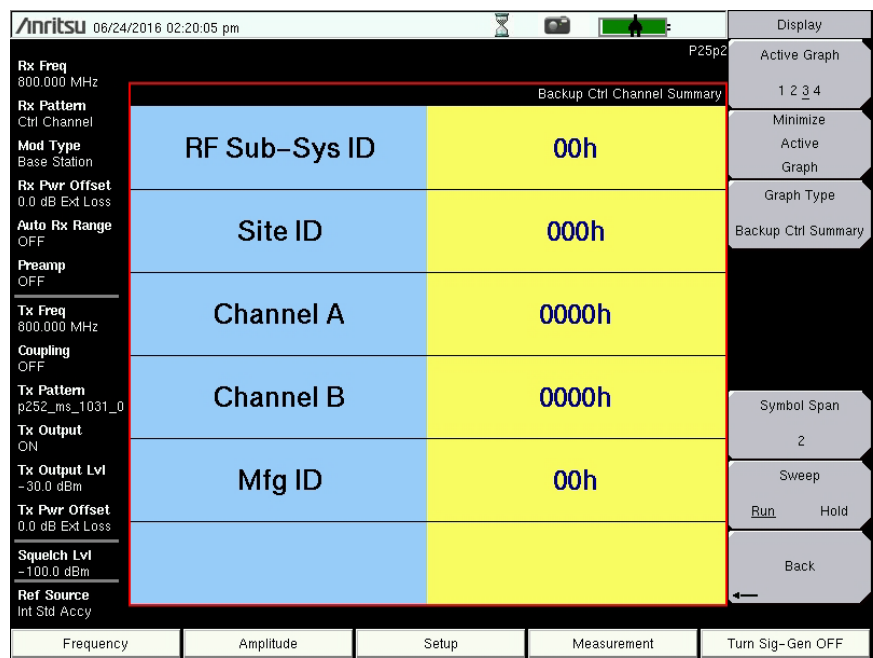


Figure 4-9. P25p2 Base Station Backup Control Channel Summary

Adjacent Site Summary

The Adjacent Site Summary graph can be selected only when the Mod Type is set to Base Station and the RX Pattern is set to Ctrl Channel. This summary displays the hex value of the adjacent site ID, sub system ID, channel, and the relative condition (F), common state (V), and RFSS state (A).

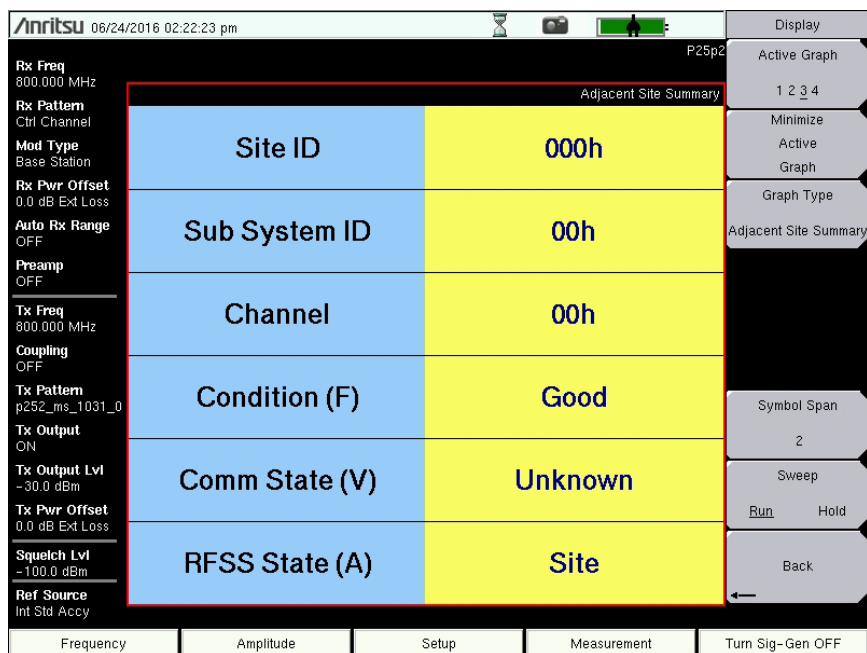


Figure 4-10. P25p2 Adjacent Base Station Control Channel Site Summary

Power Profile

The power profile graph is used with Mobile Station Mod Type to display a zero-span view of power vs. time of the selected Rx Slot.

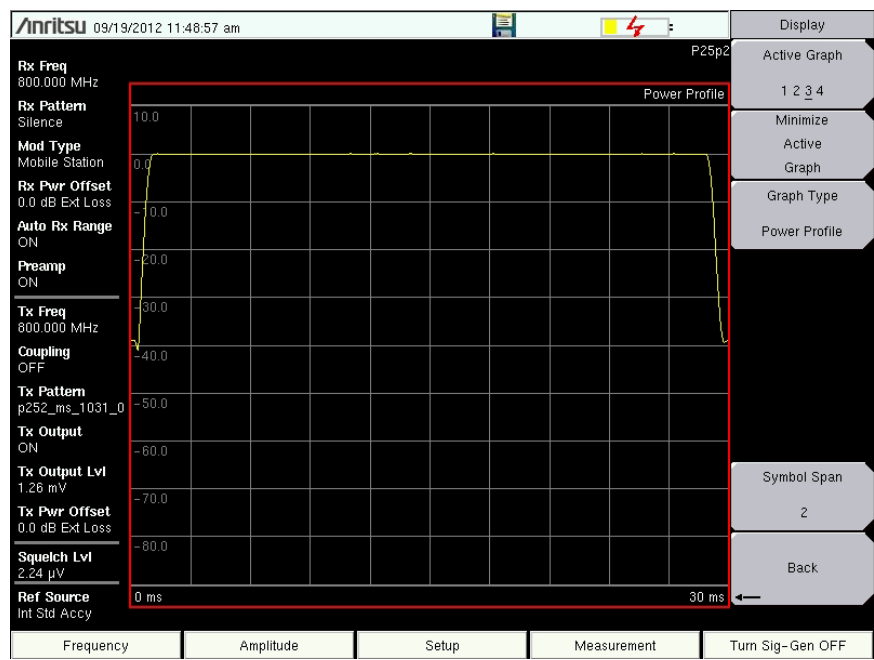


Figure 4-11. P25p2 Power Profile

4-4 P25p2 Control Measurement

Note

This measurement is captured on an external USB flash drive. The captured data file cannot be recalled and displayed on the instrument screen.

The LMR Master can log the decoded bits for control messages for either the voice channel or the control channel.

1. From the **Frequency** main menu, set the receiver frequency (Rx Freq).
2. From the **Setup** main menu, choose either Voice (downlink) or Ctrl Channel (uplink) as the Rx Pattern.
3. From the **Measurement** main menu press the P25p2 Control submenu key twice.
4. To log data, insert a formatted flash drive in the LMR Master and set Log Data to On.
5. The Hex Trigger menu and Hex Trigger Value menu are used to find a specific opcode in the Control Channel data.

To set the hex trigger value, press the **Set Trigger Value** menu. An on screen keyboard is displayed with the numbers 0 to 9 and the letters A to F. Enter the two-character hex value to search for. After entering the value, press **Enter** to set the trigger value. Press **Esc** to cancel entry or change the current hex value.

Setting Hex Trigger to On sets the Sweep function to Hold when the hex trigger value is found in the first octet of a packet. The octet row with the found trigger value is displayed in the middle of the table (Figure 4-12). If Log Data is set to On, then all of the data on the screen are saved, and Log Data is set to Off. When Sweep is set back to Run, the unit continues to collect data and stops on the next instance of the hex trigger value. To continue to capture data on the USB flash drive, set Log Data back to On before setting Sweep to Run mode.

Figure 4-12 and Figure 4-13 are examples of the display screen measurement in Voice and Control Channel. Valid Octet data is displayed in blue. Data displayed in red indicates a Cyclic Redundancy Check (CRC) error. P25p2 Control measurements include the following information:

CC = Color Code

DT = Data Type

KEY = key ID (part of encrypt sync word which identifies the encryption parameters)

ALG = algorithm ID (part of encrypt sync word)

MI = message ID (part of encrypt sync word)

Set Descrambling to On to decrypt the data stream based on the WACN ID, System ID, and Color Code settings.

When Log Data is set to On, the control channel information is written to a data stamped folder inside the /usr folder on the root level of the USB flash drive. The file is named:

CTRL_LOGyearmonthdaytime.p252 (for Control data)

or

VOICE_LOGyearmonthdaytime.p252 (for Voice data)

4-4 P25p2 Control Measurement P25 Phase 2 Analyzer (Option 521)

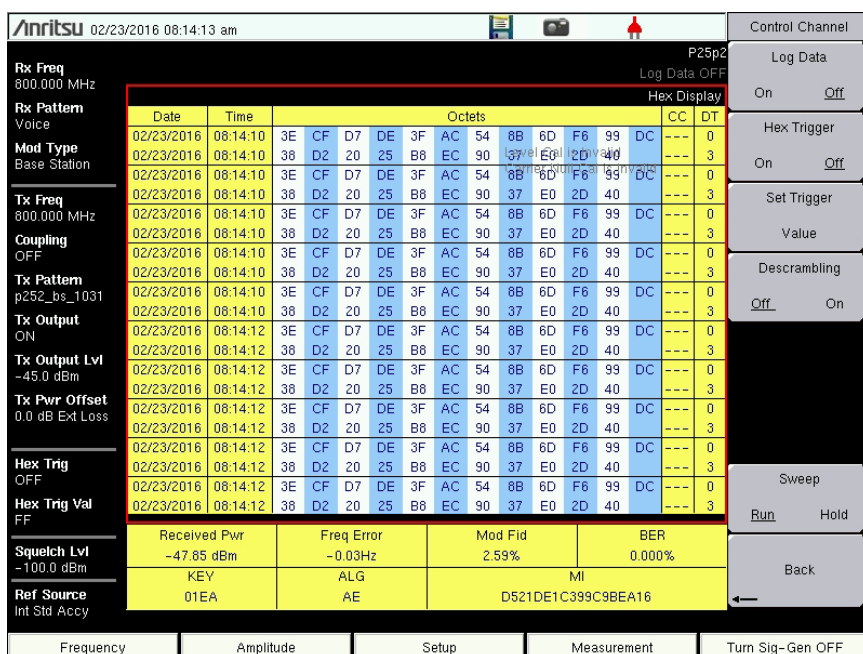


Figure 4-12. P25p2 Control Channel (Voice)

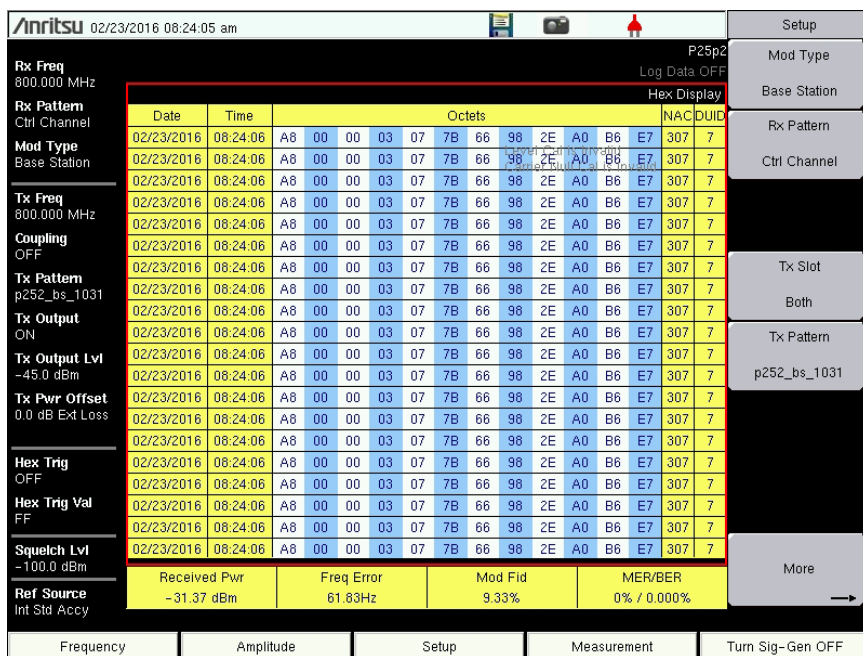


Figure 4-13. P25p2 Control Channel (Control)

4-5 P25p2 Coverage

Refer to [Chapter 11, “LMR Coverage Mapping”](#).

4-6 P25p2 Bit Capture

Note

This measurement is captured on an external USB flash drive. The captured data file cannot be recalled and displayed on the instrument screen.

The LMR Master can provide and log raw bits (pre Forward Error Correction) when the Rx Pattern is set to Voice.

1. From the **Frequency** main menu, set the receiver frequency (Rx Freq).
2. From the **Setup** main menu, choose Voice as the Rx Pattern.
3. From the **Measurement** main menu press the P25p2 Bit Capture submenu key twice.
4. To log data, insert a formatted USB flash drive in the LMR Master and set Descrambling to On to decrypt the data stream based on the WACN ID, System ID, and Color Code settings.
5. Set Log Data to On to start the bit capture. The information will be written to a data stamped folder inside the /usr folder on the root level of the USB flash drive. The tab delimited text file contains the header and table information shown in [Figure 4-14](#). The files are named:

BIT_CAP_LOGyearmonthdaytime.p252

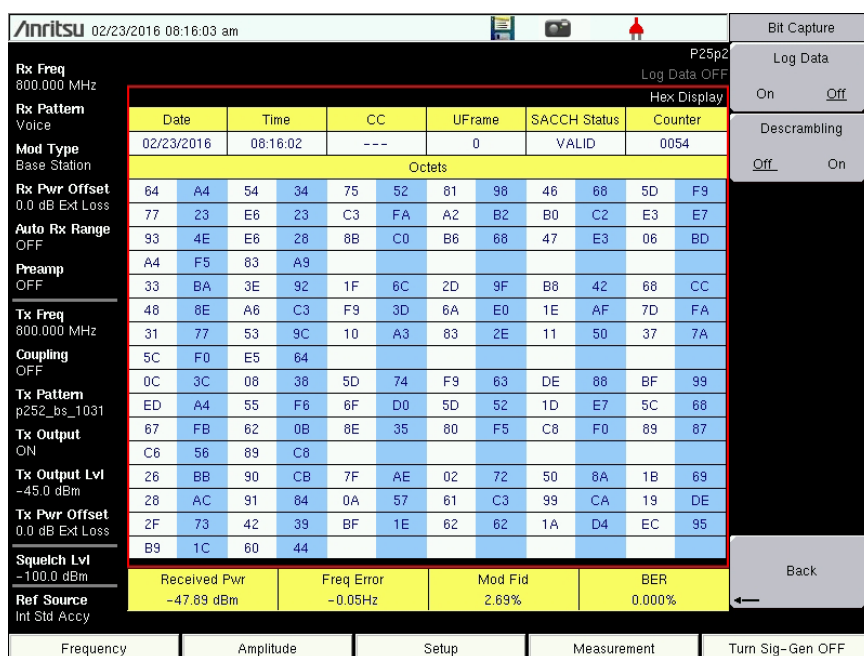


Figure 4-14. P25p2 Bit Capture Display

This measurement is captured on an external USB flash drive. The captured data file cannot be recalled and displayed on the instrument screen.

1. From the **Frequency** main menu, set the receiver frequency (Rx Freq).
2. Insert a formatted USB flash drive into the LMR Master and from the **Measurement** main menu, press the P25p2 IQ Capture submenu key. After approximately 10 seconds, the instrument displays a message that the capture is complete.

The file will be written to a data stamped folder inside the `/usr` folder on the root level of the USB flash drive. The file is named:

IQ_CAPTUREyearmonthdaytime.p252

There is no display menu for P25p2 IQ Capture. The LMR Master will continue to display the previous measurement screen during IQ Capture.

ASCII header lists the parametric information.

Binary data in 24-bit
two's complement
integer format.

Figure 4-15. IQ Capture

4-8 P25p2 Analyzer Menus

Menu maps typically display all possible submenu keys, although some keys are displayed on the instruments only under special circumstances (refer to menu descriptions on the following pages).

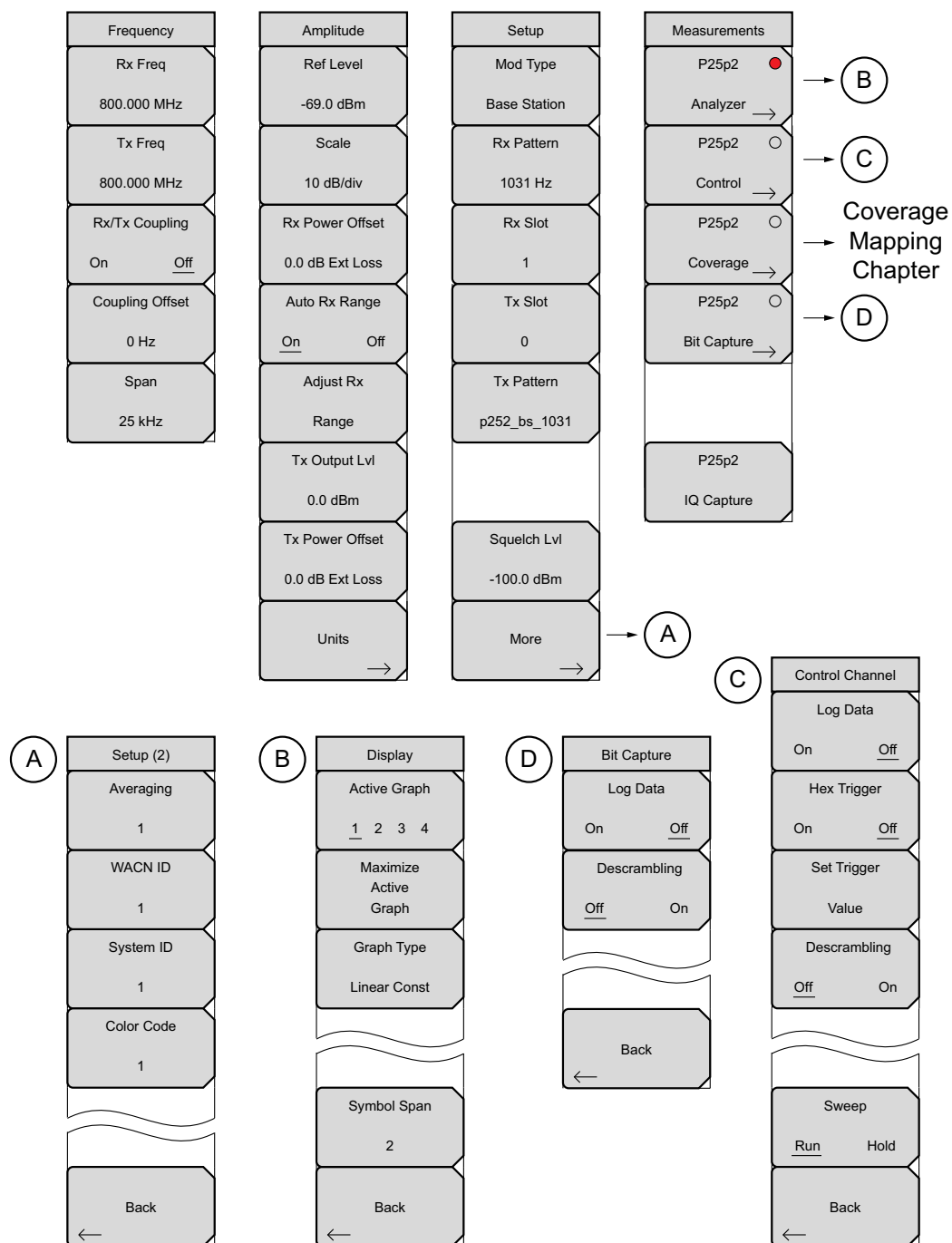


Figure 4-16. P25p2 Analyzer Menu Layout

4-9 Frequency Menu

Key Sequence: **Frequency**

Frequency	Rx Freq: Sets the receiver frequency. Press the Rx Freq key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, then the submenu key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the Enter key has the same effect as pressing the MHz submenu key.
Rx Freq 800.000 MHz	
Tx Freq 800.000 MHz	Tx Freq: Sets the signal generator frequency. Press the Tx Freq key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the submenu key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the Enter key has the same effect as pressing the MHz submenu key.
Rx/Tx Coupling On Off	
Coupling Offset 0 Hz	Rx/Tx Coupling: Couples the signal generator to the receiver frequency. When set to On the Tx Freq key is disabled.
Span 25 kHz	Coupling Offset: Sets the Offset of the signal generator frequency and the receiver frequency. Only functional when Rx/Tx Coupling is set to On. Span: Sets the span of the Spectrum Graph. Span selections are 25 kHz, 50 kHz, 100 kHz, 500 kHz, 1 MHz, and 5 MHz.

Figure 4-17. P25p2 Analyzer Frequency Menu

4-10 Amplitude Menu

Key Sequence: **Amplitude**

Amplitude	Ref Level: Sets the reference power level at the top of the display when Auto Range is Off.
Ref Level	
-69.0 dBm	
Scale	Scale: Scale sets the number of dB per division in the y-axis of the graticule. Enter a value from 1 dB per division to 15 dB per division using the keypad, the arrow keys, or the rotary knob. The y-axis power scale is shown on the left side of the display when viewing the Spectrum Graph.
10 dB/div	Note: The “ Vertical Scale Menu ” on page 4-22 is displayed when P25p2 Coverage (Measurement > P25p2 Coverage) is selected.
Rx Power Offset	Rx Power Offset: Sets the receiver (RF IN connection) external attenuation or gain. Press the Rx Power Offset submenu key and select a value from 0 dB to 100 dB then select either dB External Loss or dB External Gain.
0.0 dB Ext Loss	
Auto Rx Range	Auto Rx Range: Pressing this submenu key toggles between On and Off. When On, this function automatically adjusts the reference level based on the input signal.
On Off	
Adjust Rx	Adjust Rx Range: When Auto Rx Range is Off, pressing Adjust Rx Range sets the Reference Level automatically for the current measurement.
Range	
Tx Output Lvl	Tx Output Lvl: Sets the output power of the Signal Generator (0 dBm or 1 mW or 223 mV max).
0.0 dBm	
Tx Power Offset	Tx Power Offset: Sets the transmitter (Signal Generator Out connection) external attenuation or gain. Press the Rx Power Offset submenu key and select a value from 0 dB to 100 dB then select either dB External Loss or dB External Gain.
0.0 dB Ext Loss	
Units	Units: Opens to Units Submenu.
→	
Units	Rx Units: Sets the unit of measure (dBm, watts, or volts) for Received Power in the Demodulation Summary Graph and the Squelch Level.
Rx Units	
dBm	
Tx Units	Tx Units: Sets the unit of measure (dBm, watts, or volts) for the Signal Generator (Tx Output Lvl submenu).
dBm	
Back	
←	

Figure 4-18. P25p2 Analyzer Amplitude Menu

Vertical Scale Menu

Key Sequence: **Amplitude** > Vertical Scale

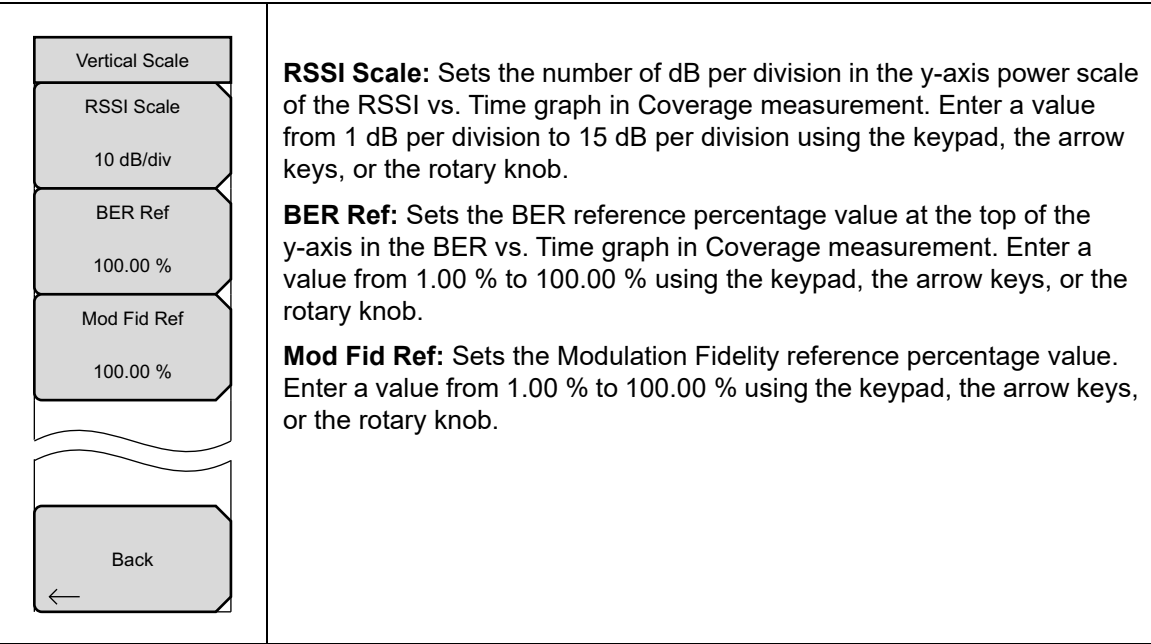


Figure 4-19. Vertical Scale Menu

4-11 Setup Menu

Key Sequence: **Setup**

Setup	Mod Type: Sets the type of modulation. The options are Mobile Station or Base Station.
Mod Type Base Station	Rx Pattern: Selects the receiver Bit Error Rate pattern. Select a pattern from the list box with the arrow keys or rotary knob and press Enter . There are four available patterns:
Rx Pattern 1031 Hz	Automatic Frequency Control (1031 Hz)
Rx Slot 1	Silence
Tx Slot 0	Voice
Tx Pattern p252_bs_1031	Ctrl (Control) Channel
Squelch Lvl -100.0 dBm	Rx Slot: Selects the receiver time slot 0 or 1 (not available when Rx pattern is set to Ctrl Channel).
More →	Tx Slot: Selects the LMR Master generator time slot (0 or 1) for the receiver.
	Tx Pattern: Selects the transmitter pattern to send when the Turn Sig-Gen ON main menu key is selected. Select a pattern from the list box with the arrow keys or rotary knob and press Enter . Refer to “Using the Signal Generator for Receiver or OTA Analysis” on page 4-3 for the list of available transmitter patterns.
	Squelch Lvl: Sets the squelch power level. When the received power is lower than the set squelch level, all demodulation summary graph measurements except for Received Pwr will be blanked out (--).
	More: Opens the “Setup (2/2) Menu” on page 4-24.

Figure 4-20. P25p2 Analyzer Setup Menu

Setup (2/2) Menu

Key Sequence: **Setup** > More

Setup (2/2)

Averaging

1

WACN ID

1

System ID

1

NAC

1

WACN 1h
System 1h
NAC 1h

Back

←

Averaging: Sets the refresh rate of the numerical values in the P25p2 demodulation summary graph. Setting a higher number (25 maximum) will reduce measurement jitter.

WACN ID: Sets the Wide Area Communication Network Identifier (WACN) value the LMR Master receiver looks for in the received P25 Phase 2 transmission.

System ID: Sets the System Identifier value the LMR Master receiver looks for in the received P25 Phase 2 transmission.

NAC: Sets the Network Access Code (NAC) in decimal number format. The LMR Master will only break squelch when the same NAC is encoded in the received P25 Phase 2 transmission.

WACN/System/NAC: Displays the equivalent hexadecimal number of the Wide Area Communication Network Identifier, System ID, and NAC decimal number set above.

Back: Returns to the [“Setup Menu” on page 4-23](#).

Figure 4-21. P25p2 Analyzer Setup (2/2) Menu

4-12 Measurement Menu

Key Sequence: **Measurement**

<div>Measurements</div> <div><div>P25p2 </div><div>Analyzer →</div></div> <div><div>P25p2 </div><div>Control →</div></div> <div><div>P25p2 </div><div>Coverage →</div></div> <div><div>P25p2 </div><div>Bit Capture →</div></div> <div><div>P25p2</div><div>IQ Capture</div></div> <div><div>Rcv Pwr Averaging</div><div>Mean <u>Median</u></div></div>	<p>P25p2 Analyzer: Opens the “Display Menu” on page 4-26.</p> <p>P25p2 Control: Opens the “Control Channel Menu” on page 4-27. This submenu key is valid only when Rx Pattern is set to Control Channel or Voice.</p> <p>P25p2 Coverage (Option 522 required): Opens the P25p2 Coverage menu. Refer to Chapter 11, “LMR Coverage Mapping”.</p> <p>P25p2 Bit Capture: This submenu key is valid only when Rx Pattern is set to Voice. Pressing this key opens the “Bit Capture Menu” on page 4-28 for data logging.</p> <p>P25p2 IQ Capture: Pressing this key starts the IQ data capture. Make sure that a formatted USB flash drive is attached to the instrument before starting IQ Capture. When the capture is complete, a message is displayed. This may take a few seconds.</p> <p>Rcv Pwr Averaging: Select Median to measure the RSSI value using the median of captured subsamples of Rx signal, in accordance with TIA TSB-88.3 Rev. F. Select Mean to display the RSSI value using the average of the subsamples of the Rx signal.</p>
--	---

Figure 4-22. P25p2 Analyzer Measurement Menu

Display Menu

Key Sequence: **Measurement** > P25p2 Analyzer

Display

Active Graph

1 2 3 4

Maximize
Active
Graph

Graph Type

Spectrum

Symbol Span

2

Back

Active Graph 1 2 3 4: In Four Screen view use this menu to select which of the four graphs is active. The current active graph is underlined (1 2 3 4) and has a red perimeter line. Any of the four graphs can also be made active by tapping once on the touch screen. Repeatedly pressing the Active Graph submenu key will cycle the active graph, 1 through 4.

In Standard view (one graph displayed on the screen) the Active Graphic key will rotate between the four graphs displayed in the Four Screen view.

Maximize/Minimize Active Graph: The submenu key toggles between displaying the Four Screen (4 graphs) view and the Standard view (1 graph). Tapping twice on a selected graph also toggles between the two display options.

Graph Type: The label on the bottom of this button displays the current active graph type. Pressing the button will open a list box of the graphs types available for P25p2 Analyzer measurements. Select the desired graph type with the arrow keys or rotatory knob and press **Enter**. The current active graph will be replaced with the new selection.

Available graphs include:

- Linear Constellation
- Spectrum
- Histogram
- Eye Diagram
- Summary Graphs (demodulation, active and backup control channel, band plan, and adjacent site)
- Power Profile

Refer to “[P25p2 Analyzer Graphs](#)” on page 4-4 for additional information.

Symbol Span: Use this menu to adjust the number of symbols viewed across the screen in the Eye Diagram graph. Adjust from 2 and 5 using the keypad, the arrow keys, or the rotary knob. Keypad values entered outside of this range are ignored.

Back: Returns to the “[Measurement Menu](#)” on page 4-25.

Figure 4-23. P25p2 Analyzer Display Menu

Control Channel Menu

Key Sequence: **Measurement** > P25p2 Control

Control Channel	Log Data: Saves the measurements to an external USB flash drive. The external USB flash drive must be attached to one of the USB Type A connectors to Log data files.
Log Data	The files are saved in a time-stamped folder under the usr folder on the USB flash drive.
On Off	If Log Data is On, any of the following functions will stop the logging:
Hex Trigger	Rx Frequency change
On Off	Setup change
Set Trigger	Starting another measurement
Value	Hex Trigger: Turns On or Off the Hex Trigger set with the following command. Sweep will continue until the trigger value is detected. At that time Sweep will change from Run to Hold.
Descrambling	Set Trigger Value: Opens a touchscreen hexadecimal keyboard for setting the Trigger value.
Off On	Descrambling: Decrypts the bit capture stream based on the following parameters from the “Setup (2/2) Menu” on page 4-24:
Sweep	WACN ID: Sets the Wide Area Communication Network Identifier (WACN) value the LMR Master receiver looks for in the received P25 Phase 2 transmission.
Run Hold	System ID: Sets the System Identifier value the LMR Master receiver looks for in the received P25 Phase 2 transmission.
Back	Color Code: Sets the System Identifier value the LMR Master receiver looks for in the received P25 Phase 2 transmission.
←	Sweep: Toggles the frequency sweep of the LMR Master between Run and Hold. Save function as Shift + Sweep (3) .
	Back: Returns to the “Measurement Menu” on page 4-25.

Figure 4-24. P25p2 Control Channel Menu

Bit Capture Menu

Key Sequence: **Measurement** > P25p2 Bit Capture

Bit Capture

Log Data

On Off

Descrambling

Off On

Back

Log Data: Enables data logging. Make sure that a formatted USB flash drive is attached to the instrument before starting bit capture. Set Log Data to On to start the bit capture. Bit capture will continue until Log Data is set to Off or the USB flash drive is filled.

The files are saved in a time-stamped folder under the **usr** folder on the USB flash drive.

If Log Data is On, any of the following functions will stop the logging:

- Rx Frequency change
- Setup change
- Starting another measurement
- Selecting Log Data Off

Descrambling: Decrypts the bit capture stream based on the following parameters from the [“Setup \(2/2\) Menu” on page 4-24](#):

WACN ID: Sets the Wide Area Communication Network Identifier (WACN) value the LMR Master receiver looks for in the received P25 Phase 2 transmission.

System ID: Sets the System Identifier value the LMR Master receiver looks for in the received P25 Phase 2 transmission.

Color Code: Sets the System Identifier value the LMR Master receiver looks for in the received P25 Phase 2 transmission.

Back: Returns to the [“Measurement Menu” on page 4-25](#).

Figure 4-25. P25p2 Analyzer Display Menu

4-13 Sweep Menu

Key Sequence: **Shift > Sweep (3)** key

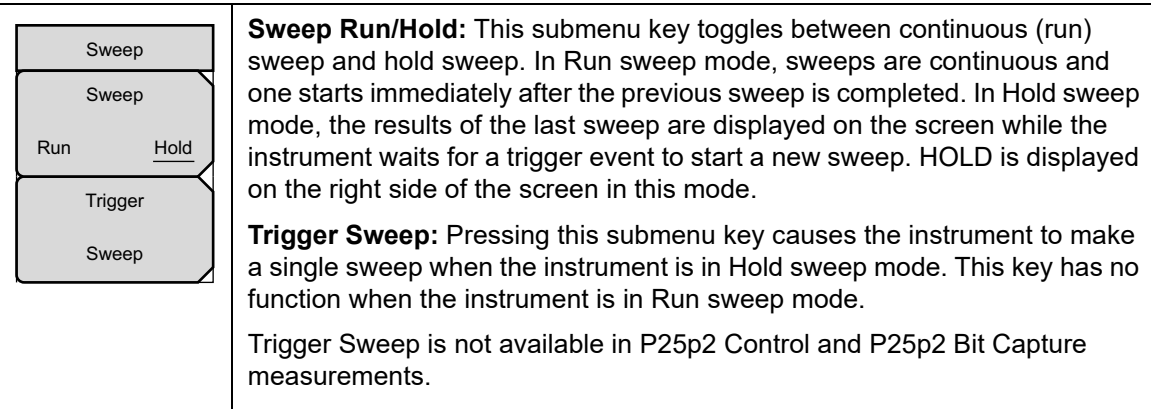


Figure 4-26. P25p2 Analyzer Sweep Menu

4-14 Measure Menu

Key Sequence: **Shift > Measure (4)** key

Displays the [“Measurement Menu” on page 4-25.](#)

4-15 Trace Menu

This menu is not available in P25p2 Analyzer measurement mode.

4-16 Limit Menu

This menu is not available in P25p2 Analyzer measurement mode.

4-17 Other Menus

Preset, Calibrate, File, System and **Mode** are described in the User Guide.

Chapter 5 — NXDN Analyzer (Option 531)

5-1 Introduction

The NXDN Analyzer option provides a method to verify the operation of NXDN tower, mobile, and portable radio transmitters. Option 531 includes the ability to display constellation, spectrum, histogram, and eye diagram graphs. In addition, a summary graph displays numeric values of received power, frequency error, modulation fidelity (Mod Fid), bit error rate (BER), symbol deviation, Radio Access Number (RAN), and symbol rate error of the input signal. BER comparisons can be made to the 1031 Hz Standard Tone or the Standard Transmitter Test (O.153) pattern, regular voice traffic using a proprietary algorithm, or a Message Error Rate (MER) can be computed using the control channel messages CRC checking. In addition, estimated BER on the control channel uses a proprietary algorithm.

The LMR Master will analyze input signal strengths from +33 dBm (2.0 watts) down to levels approaching the sensitivity of NXDN radios, automatically adjusting the input sensitivity based on input levels.

5-2 Setup Procedure

Direct Connect to the Transmitter

1. Press the **Menu** key then select the NXDN Analyzer icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight NXDN Analyzer and press **Enter**.

Caution

The maximum input power without damage is 2 watts (+33 dBm) to the RF In 50 Ohm connector. To prevent damage, use a coupler or attenuator to reduce the input power to below this level when measuring high output power devices.

2. Connect the transmitter to the RF In 50 Ohm connector on the LMR Master using a coupler or attenuator.
3. Press the **Frequency** main menu key to set the center frequency of the measurement. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.
4. Press the **Setup** main menu key to select the modulation bandwidth and Rx pattern. Select 12.5 kHz or 6.25 kHz modulation bandwidth. Press the Rx pattern key to choose the pattern against which to measure error rates. 1031 and O.153 (V.52) will measure BER directly against the selected pattern. Voice uses a proprietary method to estimate BER from regular voice traffic. Ctrl Channel will produce a Message Err Rate (MER) based on the CRC checksums contained in Control Channel messages and estimated BER using a proprietary algorithm.

5. Press the **Amplitude** main menu key, then the Rx Power Offset submenu key to set the receiver attenuation (or gain). Use the arrow keys, rotary knob or the numeric keypad to enter the adjustment value, up to 100 dB. The offset will be applied to the Received Power value in the Summary graph. For instance, if the transmitter under test is emitting 50 watts (+47 dBm) of power, and the External Attenuation value is 40 dB (such as from a 40 dB directional coupler) the Received Power displayed will be +7 dBm.
6. Press the **Measurement** key, then the NXDN Analyzer submenu key. Select the Graph types to view with the **Graph Type** submenu key. The **Symbol Span** submenu is used to adjust the number of “eyes” displayed across the screen in the Eye Diagram graph. Refer to [“NXDN Analyzer Graphs” on page 5-4](#) on the available graph types.

Over-the-Air (OTA) Analysis Setup

1. Press the **Menu** key then select the NXDN Analyzer icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight NXDN Analyzer and press **Enter**.

Caution	The maximum input power without damage is 2 watts (+33 dBm) to the RF In 50 Ohm connector. To prevent damage, use a coupler or attenuator to reduce the input power to below this level when measuring high output power devices.
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2. Connect an antenna with the appropriate frequency range to the RF In 50 Ohm connector on the LMR Master.
3. Press the **Frequency** main menu key to set the center frequency of the measurement. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.
4. Press the **Setup** main menu key to select the modulation bandwidth and Rx pattern (BER pattern). Select 12.5 kHz or 6.25 kHz modulation bandwidth. Press the Rx Pattern key to choose the pattern against which to measure error rates. 1031 and O.153 (V.52) will measure BER directly against the selected pattern. Voice uses a proprietary method to estimate BER from regular voice traffic. Ctrl Channel will produce a Message Err Rate (MER) based on the CRC checksums contained in Control Channel messages and estimated BER using a proprietary algorithm. Refer to [“NXDN Analyzer Graphs” on page 5-4](#) on the available graph types.

Using the Signal Generator for Receiver or OTA Analysis

1. Press the **Menu** key then select the NXDN Signal Analyzer icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight NXDN Analyzer and press **Enter**.

Caution	The maximum output power from the Signal Generator Out connector is 1 mW (0 dBm) and the frequency range is 500 kHz to 1.6 GHz.
----------------	---

2. Direct connect the LMR Master Signal Generator Out 50 Ohm connector to the repeater/receiver or connect an antenna with the appropriate frequency range to the connector.
3. Press the **Frequency** main menu key to set the transmit frequency using the Tx Freq key. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.

If testing an NXDN repeater, you can bind the transmit frequency to the receive frequency by setting Rx/Tx Coupling to On and entering the Coupling Offset.

Note	When Rx/Tx Coupling is on, the Tx Freq submenu key is disabled.
-------------	---

4. Press the **Amplitude** main menu key, then the Tx Output Lvl submenu key to set the output power. Enter any output attenuation or gain using the Tx Power Offset key.
5. Set the bandwidth by pressing the **Setup** main menu key and then the Mod Bandwidth submenu key. Set the signal generator pattern with the Tx Pattern submenu key. Available patterns are listed on the display and additional patterns can be downloaded via the **System** > Application Options menu.

Note	Set the Radio Access Number (RAN) value (Setup > RAN) that is sent on the standard NXDN 1013 Hz Tx pattern when testing receivers. Default value is 01.
-------------	---

The 9600 bps patterns are shown when the bandwidth is set to 12.5 kHz. The 6.25 kHz bandwidth setting displays the 4800 bps patterns.

6. Press the **Turn Sig-Gen ON** main menu key to start the signal generator. Press the key again to turn off the signal generator.

5-3 NXDN Analyzer Graphs

The following NXDN Analyzer measurements are available on the LMR Master. From the **Measurements** main menu press NXDN Analyzer twice. Press the Graph Type submenu key to select the measurement type.

Constellation and Linear Constellation

Constellation view displays the demodulation information in an IQ format (Figure 5-1). The charts show the relationship between the location of a constellation data point, its deviation frequency, and the information it carries.

NXDN definition for 6.25 kHz bandwidth (4800 bps)

Symbol:	+3	Symbol:	+1
Bit Information:	01	Bit Information:	00
Deviation:	+1050 Hz	Deviation:	+350 Hz
Symbol:	-3	Symbol:	-1
Bit Information:	11	Bit Information:	10
Deviation:	-1050 Hz	Deviation:	-350 Hz

NXDN definition for 12.5 kHz bandwidth (9600 bps)

Symbol:	+3	Symbol:	+1
Bit Information:	01	Bit Information:	00
Deviation:	+2400 Hz	Deviation:	+800 Hz
Symbol:	-3	Symbol:	-1
Bit Information:	11	Bit Information:	10
Deviation:	-2400 Hz	Deviation:	-800 Hz

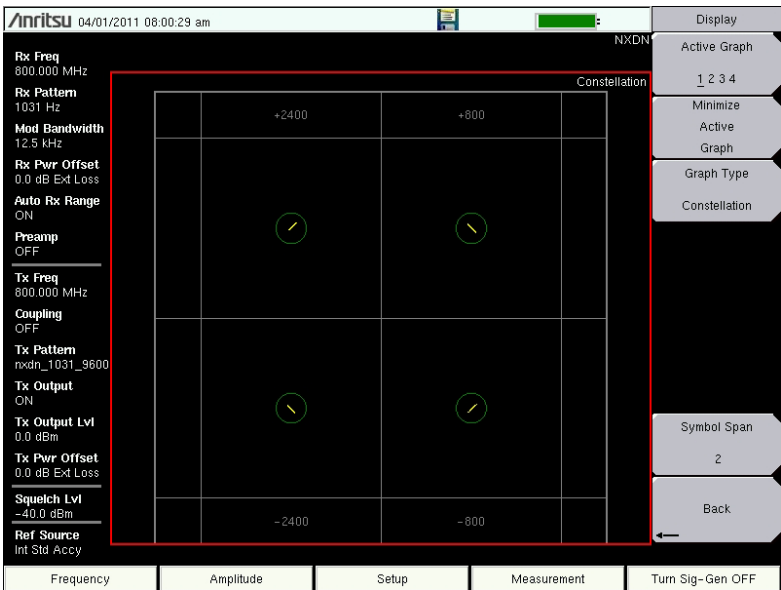


Figure 5-1. Constellation Diagram (12.5 kHz BW)

Figure 5-2 shows the same information is the Linear Constellation View.

NXDN definition for 6.25 kHz bandwidth (4800 bps)

Symbol:	-3	Symbol:	-1	Symbol:	+1	Symbol:	+3
Bit Information:	11	Bit Information:	10	Bit Information:	00	Bit Information:	01
Deviation:	-1050 Hz	Deviation:	-350 Hz	Deviation:	+350 Hz	Deviation:	+1050 Hz

NXDN definition for 12.5 kHz bandwidth (9600 bps)

Symbol:	-3	Symbol:	-1	Symbol:	+1	Symbol:	+3
Bit Information:	11	Bit Information:	10	Bit Information:	00	Bit Information:	01
Deviation:	-2400 Hz	Deviation:	-800 Hz	Deviation:	+800 Hz	Deviation:	+2400 Hz



Figure 5-2. Linear Constellation Diagram

For input signals that are not NXDN encoded, the LMR Master will still try to decode it and fit it to a symbol. This may cause some measurement results that are unexpected.

Histogram Graph

The Histogram graph displays a graphical representation of the symbols that are being received. The graph for each symbol represents the relative percentage that symbol was identified out of all the received symbols.

Each update of the screen is a separate representation of the latest data, rather than a cumulative total. The vertical scale is fixed at 0 to 100 %, with each horizontal grid line representing 10 % of the total symbols received.

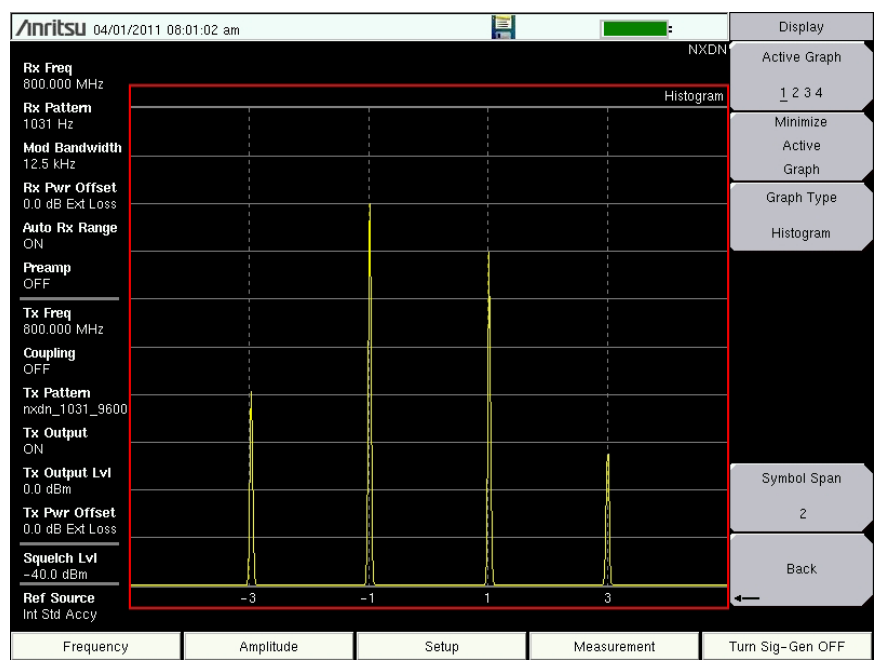


Figure 5-3. NXDN Histogram

Spectrum Graph

The spectrum view displays a graphical representation of power (dBm) vs. frequency. The spectrum display gives an indication if there are interferers present that may degrade the bit error rate of the NXDN signal. The frequency span is adjustable under the **Frequency** menu. The reference level is adjusted with the **Amplitude** menu. Refer to [“Amplitude Menu” on page 5-17](#) for details. [Figure 5-4](#) displays the same signal using a 25 kHz span and a 500 kHz span.

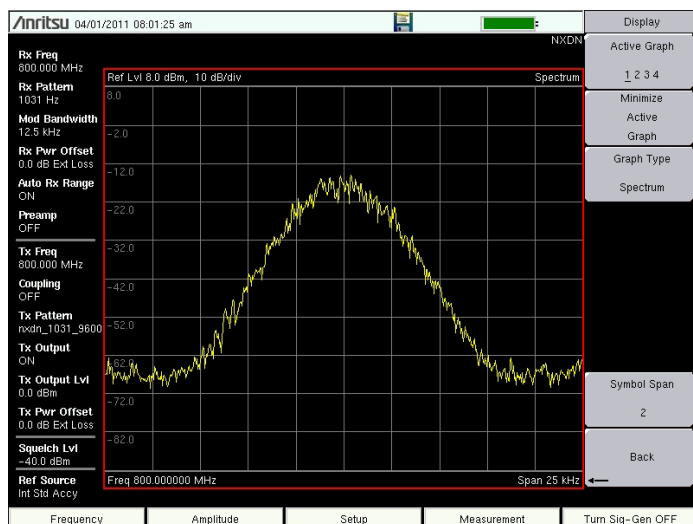
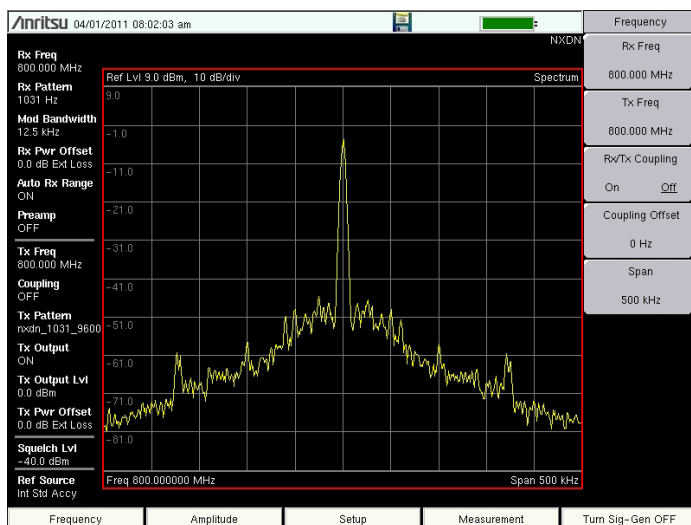


Figure 5-4. NXDN Spectrum Graph (25 kHz Span and 500 kHz Span)

Eye Diagram

The eye diagram is an oscilloscope view of the NXDN signal displaying the voltage of the signal vs. time. The diagram provides an indication of baseband fidelity of an NXDN transmitter. With Over-the-air measurements the Eye Diagram can indicate phase distortion from multipath. The number of “eyes” displayed is set with the Symbol Span key under the “Display Menu” on page 5-21.

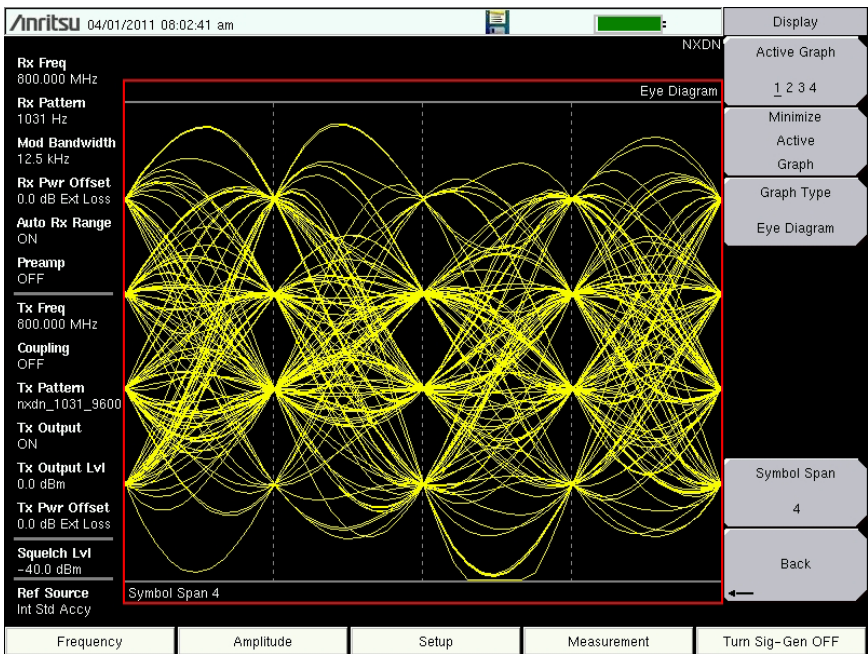


Figure 5-5. NXDN Eye Diagram

Summary Graph

The summary graph provides an overview of an NXDN transmitter. The graph displays numeric values of received power, frequency error, modulation fidelity (Mod Fid), bit error rate (BER), symbol deviation, Radio Access Number (RAN), and symbol rate error of the input signal.

The Received Power value in the summary graph can be toggled to dBm, watts, or volts by using the **Amplitude** > Units > Rx Units submenu key. This setting also applies to the squelch level setting.

The **Setup** > Squelch Lvl submenu key sets the squelch power level. When the Received Power is lower than the set squelch level all summary graph measurements except for Received Pwr will be blanked out (--). When the Received Power is above the squelch level, the measurements are displayed as shown in [Figure 5-6](#).

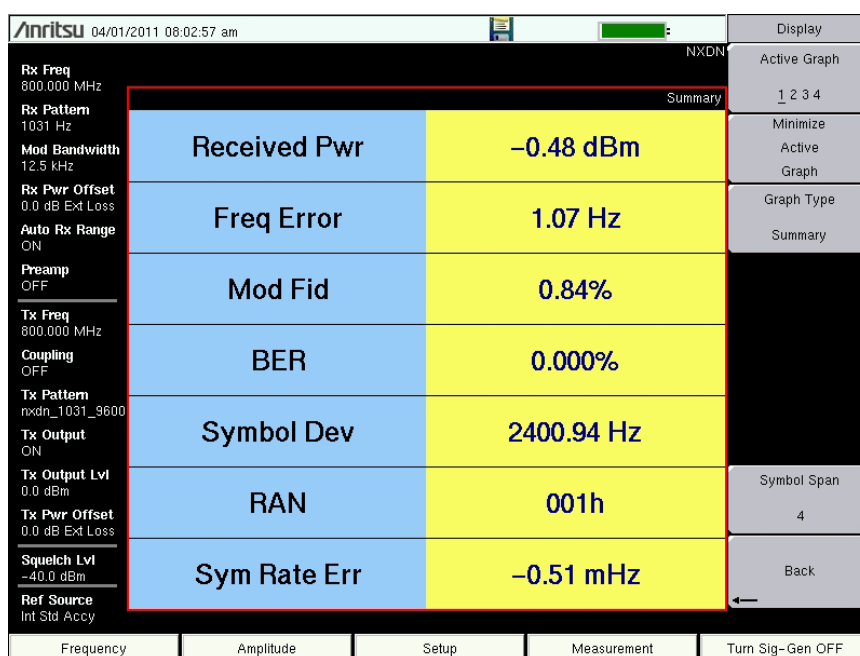


Figure 5-6. NXDN Summary Graph with Received Pwr Above the Squelch Level

Received Pwr in the Summary table is the integrated power of all the energy in the receiver bandwidth. Any peak amplitude reduction seen in the Spectrum display when compared to Received Pwr is a function of the instruments RBW setting. The reduction is specified as: $10 \cdot \log(\text{Signal Bandwidth} / \text{Resolution Bandwidth})$.

5-4 NXDN Control Measurement

Note This measurement is captured on an external USB flash drive. The captured data file can not be recalled and displayed on the instrument screen.

The LMR Master can log the decoded bits for control messages for either the voice channel or the control channel.

1. From the **Frequency** main menu, set the receiver frequency (Rx Freq).
2. From the **Setup** main menu, choose either Voice (downlink) or Ctrl Channel (uplink) as the Rx Pattern.
3. From the **Measurement** main menu press the NXDN Control submenu key twice.
4. To log data, insert a formatted USB flash drive in the LMR Master and set Log Data to On.
5. The Hex Trigger menu and Hex Trigger Value menu are used to find a specific opcode in the Control Channel data.

To set the hex trigger value, press the **Set Trigger Value** menu. An on screen keyboard is displayed with the numbers 0 to 9 and the letters A to F. Enter the two-character hex value to search for. After entering the value, press **Enter** to set the trigger value. Press **Esc** to cancel entry or changing the current hex value.

Setting Hex Trigger to On sets the Sweep function to Hold when the hex trigger value is found in the first octet of a packet. The octet row with the found trigger value is displayed in the middle of the table ([Figure 5-7 on page 5-12](#)). If Log Data is set to On, then all of the data on the screen are saved and Log Data is set to Off. When Sweep is set back to Run, the unit continues to collect data and stops on the next instance of the hex trigger value. To continue to capture data to the USB flash drive, set Log Data back to On before setting Sweep to Run mode.

[Figure 5-7](#) and [Figure 5-8](#) are examples of the display screen measurement in Voice and Control. Valid Octet data is displayed in blue. Data displayed in red indicates a Cyclic Redundancy Check (CRC) error. NXDN Control measurements include the following information:

RAN: Radio Access Number

STR: a 4-bit field which identifies the channel type

bits 0, 1 = structure field

bits 2, 3 = channel type (0 = CAC, 1 = SACCH, 2 = FACCH1, 3 = FACCH2)

When Log Data is set to On, the control channel information will be written to a data stamped folder inside the /usr folder on the root level of the USB flash drive. The file is named:

CTRL_LOGyearmonthdaytime.nxdn (for Control data)

or

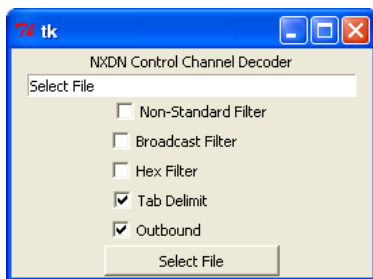
VOICE_LOGyearmonthdaytime.nxdn (for Voice data)

Decoding Control Channel Measurements

Anritsu offers a Python script that will decode the logged hexadecimal Control Channel measurements. The script is available for download from the Anritsu web site and requires that the Python programming language is installed on your computer.

To decode control channel measurements with the Python script:

1. Install the Python programming language on a PC. Download the installer (<http://www.python.org/download/>) from the Python Programming Language web site.
2. Download the decoder script from the Anritsu web site:
 - a. Open the Anritsu home page (<http://www.anritsu.com>) with a web browser.
 - b. Type S412E in the search box to find the LMR Master S412E product page on the Anritsu web site. Click the product page link to display the LMR Master product page.
 - c. Click the Library tab. Under the Drivers/Software Downloads section, select NXDN Control Channel Decoder. Next, click the Download button then **Save** to copy the file “dmr_ctrl_decoder.zip” to your computer.
3. Unzip and launch the python script. The script file name is `nxdn_ctrl_decoder.py`.



4. Press the **Select File** button and select the control channel file that was saved on the USB flash drive. The Python script will display the CRC errors and write a text file in the same location with the decoded control channel commands.

5-4 NXDN Control MeasurementNXDN Analyzer (Option 531)

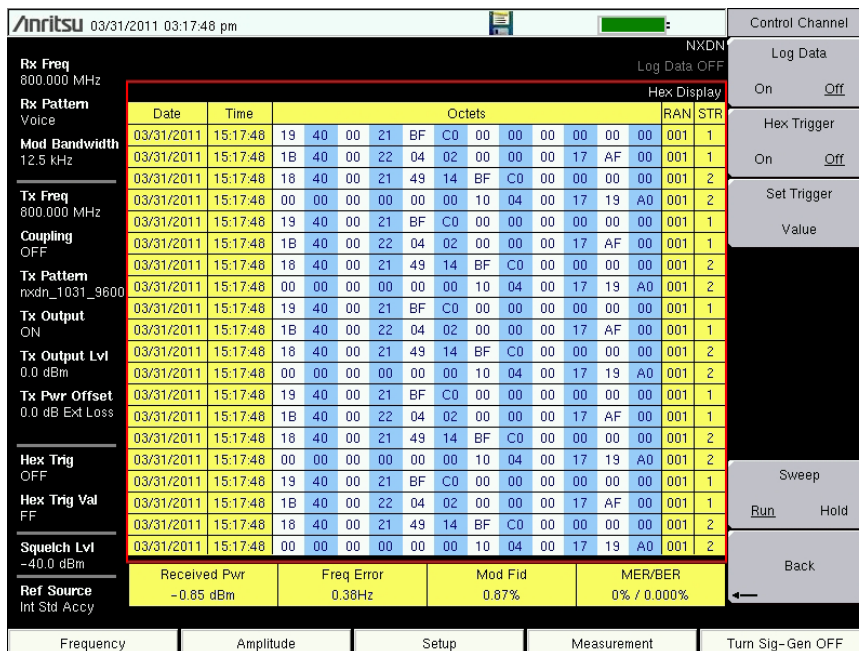


Figure 5-7. NXDN Control Channel (Voice)

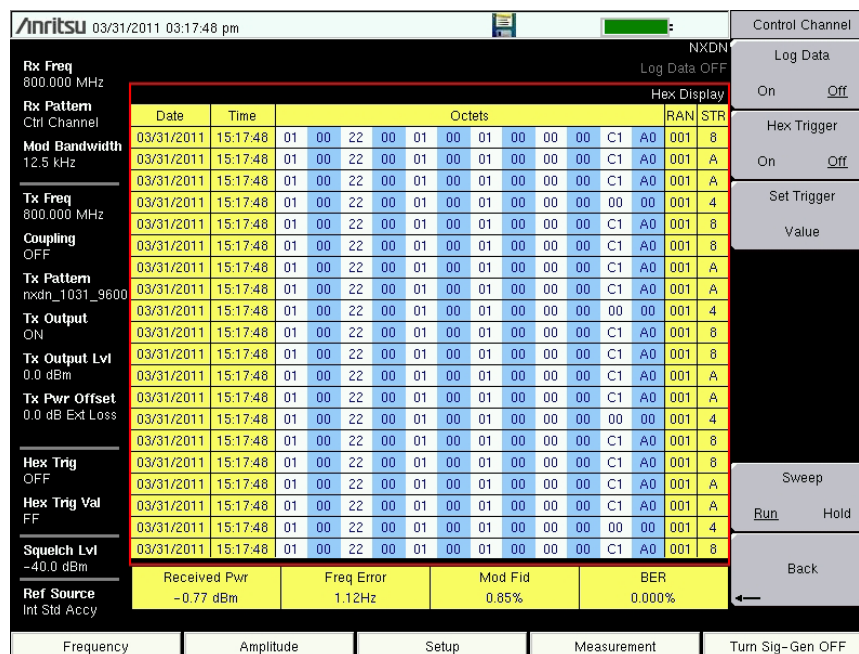


Figure 5-8. NXDN Control Channel (Control)

5-5 NXDN Bit Capture

Note This measurement is captured on an external USB flash drive. The captured data file can not be recalled and displayed on the instrument screen.

The LMR Master can provide and log raw bits (pre Forward Error Correction) when the Rx Pattern is set to Voice.

1. From the **Frequency** main menu, set the receiver frequency (Rx Freq).
2. From the **Setup** main menu, choose Voice as the Rx Pattern.
3. From the **Measurement** main menu press the NXDN Bit Capture submenu key twice.
4. To log data, insert a formatted USB flash drive in the LMR Master and set Log Data to On. The bit capture information will be written to a data stamped folder inside the /usr folder on the root level of the USB flash drive. The tab delimited text file contains the header and table information shown in [Figure 5-9](#). The files are named:

BIT_CAP_LOGyearmonthdaytime.nxdn

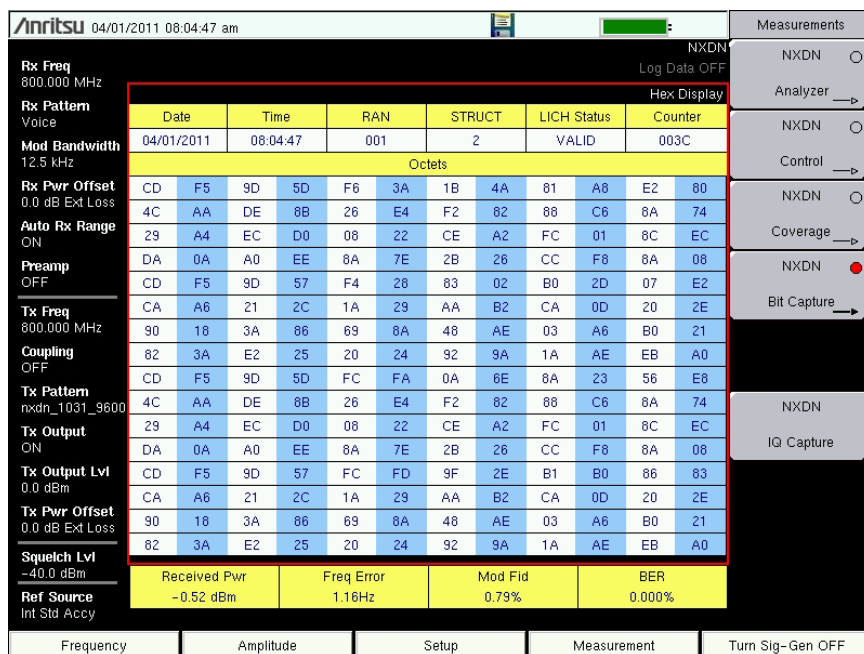


Figure 5-9. NXDN Bit Capture Display

5-6 NXDN IQ Data

Note This measurement is captured on an external USB flash drive. The captured data file can not be recalled and displayed on the instrument screen.

The LMR Master can capture and log NXDN IQ data to a USB flash drive.

- 1. From the **Frequency** main menu, set the receiver frequency (Rx Freq).
- 2. From the **Setup** main menu, choose a Mod Bandwidth.
- 3. Insert a formatted USB flash drive into the LMR Master and from the **Measurement** main menu, press the NXDN IQ Capture submenu key. After approximately 10 seconds the instrument will display a message that the capture is complete.

The IQ data is sampled at 2,400 x 11 (6.25 kHz BW) or 4,800 x 11 (12.5 kHz BW) symbols per second. The saved file has an ASCII header and binary data (Figure 5-10). The data is written in 24-bit two's complement integers format. Interleaved Delta Phase (I) data then Magnitude (Q) data is captured. The file is intended for post-processing in MATLAB or similar software.

The file will be written to a data stamped folder inside the /usr folder on the root level of the USB flash drive. The file is named:

IQ_CAPTUREyearmonthdaytime.nxdn

Note There is no display menu for NXDN IQ Capture. The LMR Master will continue to display the previous measurement screen during IQ Capture.

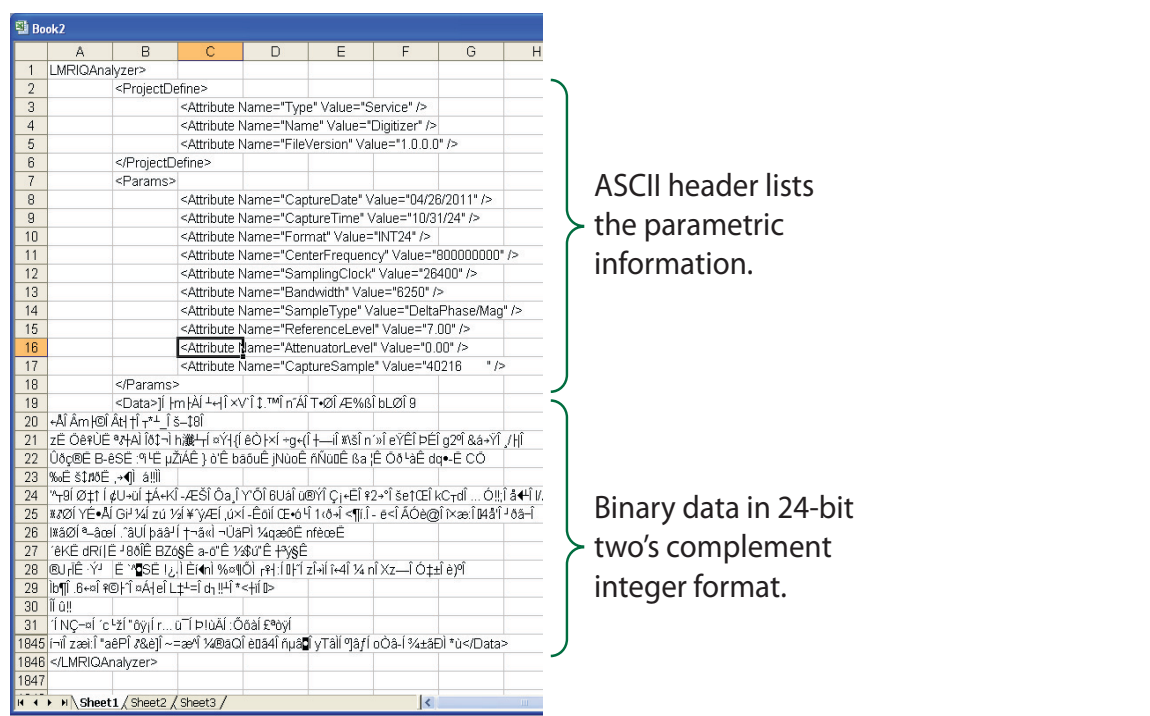


Figure 5-10. IQ Capture (6.25 kHz Bandwidth)

5-7 NXDN Analyzer Menus

Menu maps typically display all possible submenu keys, although some keys are displayed on the instruments only under special circumstances (refer to menu descriptions on the following pages).

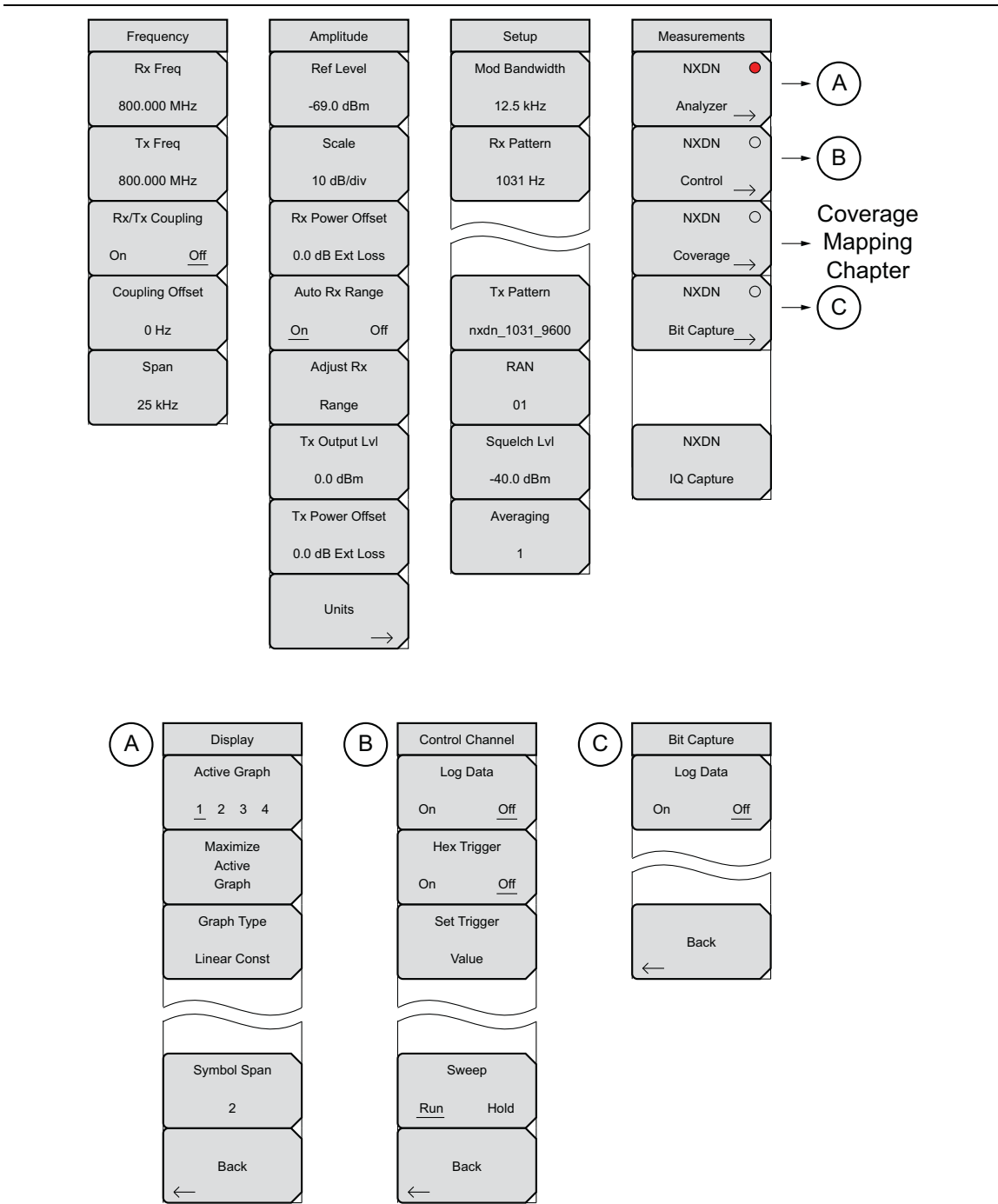


Figure 5-11. NXDN Analyzer Menu Layout

5-8 Frequency Menu

Key Sequence: **Frequency**

Frequency	Rx Freq: Sets the receiver frequency. Press the Rx Freq key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the submenu key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the Enter key has the same effect as pressing the MHz submenu key.
Rx Freq 800.000 MHz	
Tx Freq 800.000 MHz	Tx Freq: Sets the signal generator frequency. Press Tx Rx Freq key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the submenu key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the Enter key has the same effect as pressing the MHz submenu key.
Rx/Tx Coupling On Off	Rx/Tx Coupling: Couples the signal generator to the receiver frequency. When set to On the Tx Freq key is disabled.
Coupling Offset 0 Hz	Coupling Offset: Sets the Offset of the signal generator frequency and the receiver frequency. Only functional when Rx/Tx Coupling is set to On.
Span 25 kHz	Span: Sets the span of the Spectrum Graph. Span selections are 25 kHz, 50 kHz, 100 kHz, 500 kHz, 1 MHz, and 5 MHz.

Figure 5-12. NXDN Analyzer Frequency Menu

5-9 Amplitude Menu

Key Sequence: **Amplitude**

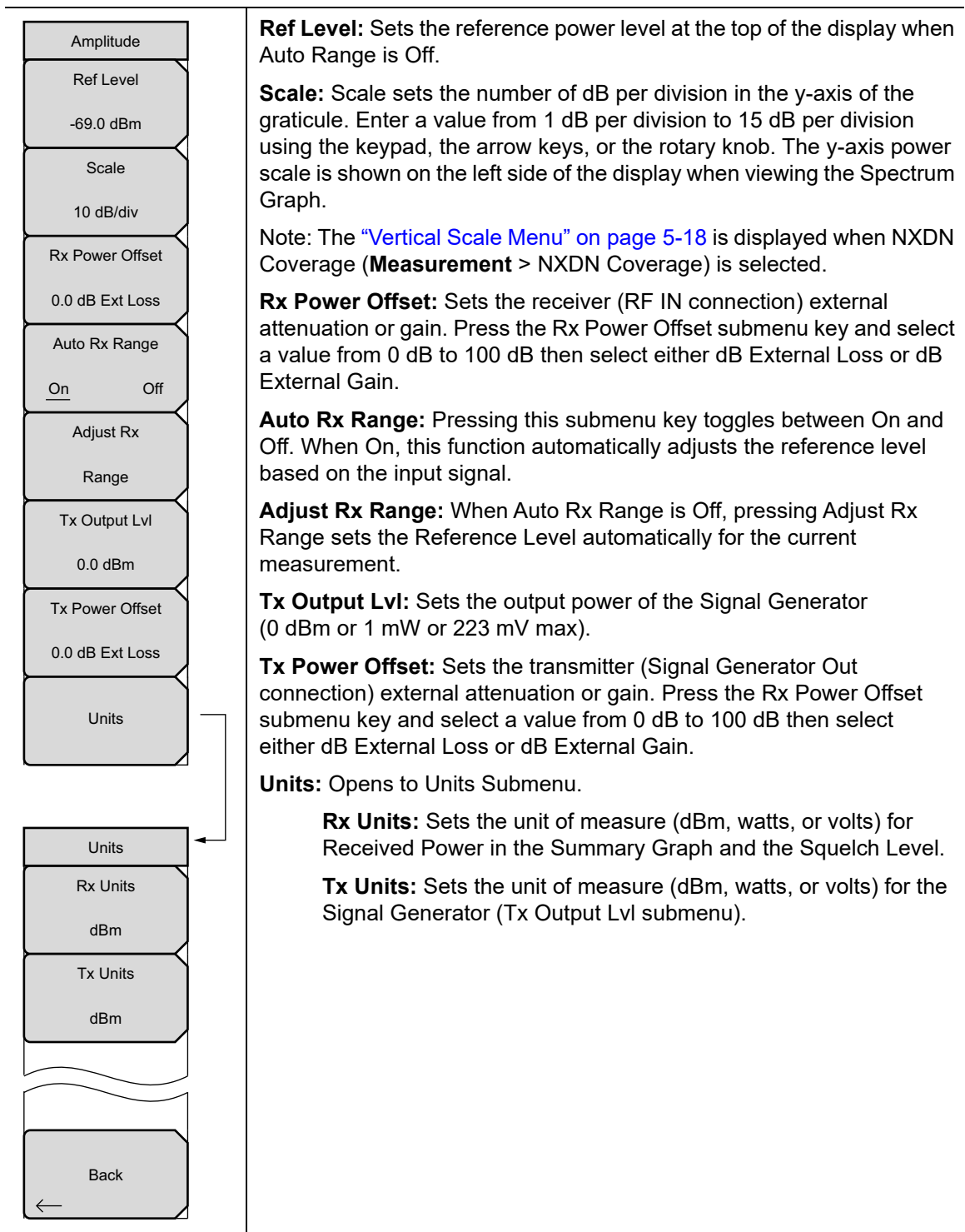


Figure 5-13. NXDN Analyzer Amplitude Menu

Vertical Scale Menu

Key Sequence: **Amplitude** > Vertical Scale

<div><div>Vertical Scale</div><div>RSSI Scale</div><div>10 dB/div</div><div>BER Ref</div><div>100.00 %</div><div>Mod Fid Ref</div><div>100.00 %</div><div></div><div></div><div>Back</div><div>←</div></div>	<p>RSSI Scale: Sets the number of dB per division in the y-axis power scale of the RSSI vs. Time graph in Coverage measurement. Enter a value from 1 dB per division to 15 dB per division using the keypad, the arrow keys, or the rotary knob.</p> <p>BER Ref: Sets the BER reference percentage value at the top of the y-axis in the BER vs. Time graph in Coverage measurement. Enter a value from 1.00 % to 100.00 % using the keypad, the arrow keys, or the rotary knob.</p> <p>Mod Fid Ref: Sets the Modulation Fidelity reference percentage value. Enter a value from 1.00 % to 100.00 % using the keypad, the arrow keys, or the rotary knob.</p>
--	--

Figure 5-14. Vertical Scale Menu

5-10 Setup Menu

Key Sequence: **Setup**

Setup	Mod Bandwidth: Sets the type of modulation bandwidth. This key toggles between 12.5 kHz and 6.25 kHz.
Mod Bandwidth	
12.5 kHz	
Rx Pattern	Rx Pattern: Selects the receiver Bit Error Rate pattern. Select a pattern from the list box with the arrow keys or rotary knob and press Enter . There are four available patterns:
1031 Hz	1031 Hz
	Standard Transmitter Test (O.153 or V.52)
	Voice
	Ctrl (Control) Channel
Tx Pattern	Tx Pattern: Selects the transmitter pattern to send when the Turn Sig-Gen ON main menu key is selected. Select a pattern from the list box with the arrow keys or rotary knob and press Enter .
nxdn_1031_9600	
RAN	RAN: Sets the Radio Access Number (RAN) that is sent on the standard NXDN 1031 Hz Tx Pattern when testing receivers.
01	
Squelch Lvl	Squelch Lvl: Sets the squelch power level. When the Received Power is lower than the set squelch level, all summary graph measurements except for Received Pwr will be blanked out (--).
-40.0 dBm	
Averaging	Averaging: Sets the refresh rate of the numerical values in the NXDN Summary window. Setting a higher number (25 maximum) will reduce measurement jitter.
1	

Figure 5-15. NXDN Analyzer Setup Menu

5-11 Measurement Menu

Key Sequence: **Measurement**

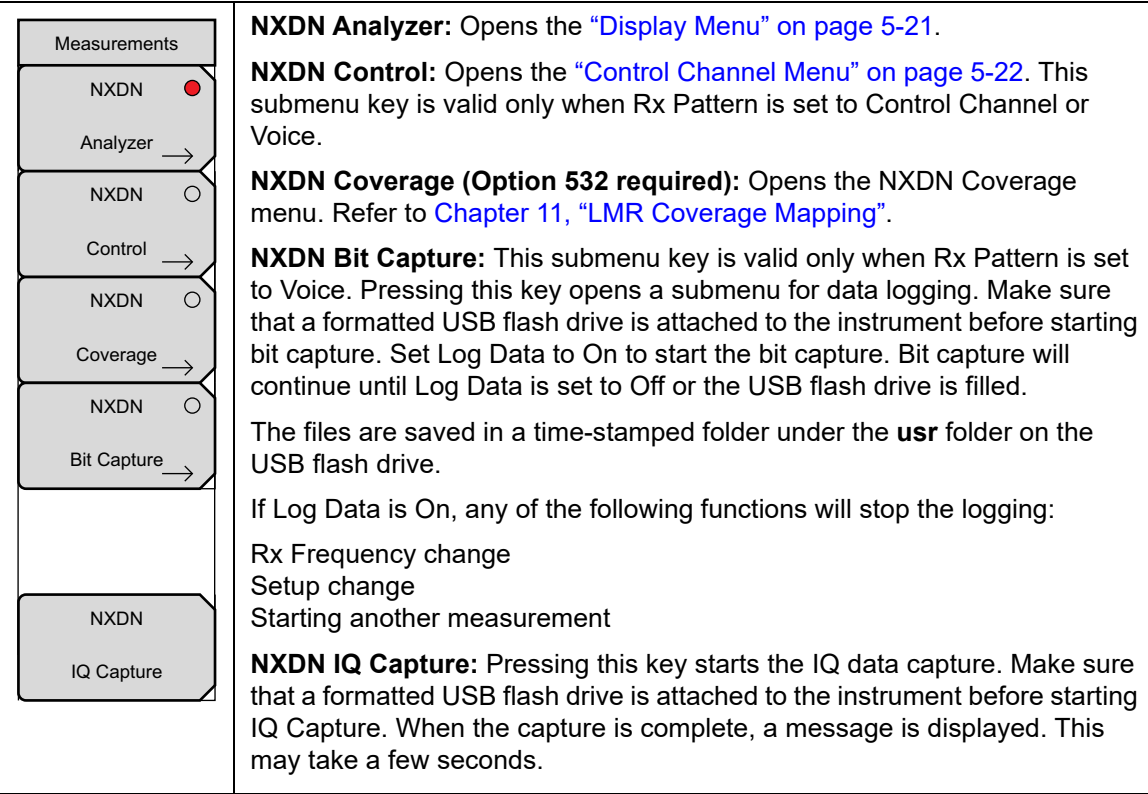


Figure 5-16. NXDN Analyzer Measurement Menu

Display Menu

Key Sequence: **Measurement** > NXDN Analyzer

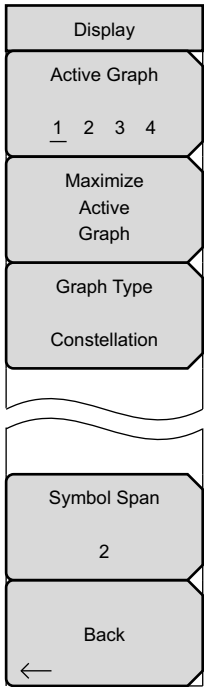
	<p>Active Graph 1 2 3 4: In Four Screen view use this menu to select which of the four graphs is active. The current active graph is underlined (1 2 3 4) and has a red perimeter line. Any of the four graphs can also be made active by tapping once on the touch screen. Repeatedly pressing the Active Graph submenu key will cycle the active graph, 1 through 4.</p> <p>In Standard view (one graph displayed on the screen) the Active Graphic key will rotate between the four graphs displayed in the Four Screen view.</p> <p>Maximize/Minimize Active Graph: The submenu key toggles between displaying the Four Screen (4 graphs) view and the Standard view (1 graph). Tapping twice on a selected graph also toggles between the two display options.</p> <p>Graph Type: The label on the bottom of this button displays the current active graph type. Pressing the button will open a list box of the graphs types available for NXDN Analyzer measurements. Select the desired graph type with the arrow keys or rotatory knob and press Enter. The current active graph will be replaced with the new selection.</p> <p>Available graphs include:</p> <ul style="list-style-type: none"> Constellation Spectrum Histogram Eye Diagram Linear Constellation Summary <p>Refer to “NXDN Analyzer Menus” on page 5-15 for additional information.</p> <p>Symbol Span: Use this menu to adjust the number of symbols viewed across the screen in the Eye Diagram graph. Adjust from 2 and 5 using the keypad, the arrow keys, or the rotary knob. Keypad values entered outside of this range are ignored.</p> <p>Back: Returns to the “Measurement Menu” on page 5-20.</p>
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Figure 5-17. NXDN Analyzer Display Menu

Control Channel Menu

Key Sequence: **Measurement** > NXDN Control

Control Channel

Log Data

OnOff

Hex Trigger

OnOff

Set Trigger

Value

Sweep

RunHold

Back

Log Data: Saves the measurements to an external USB flash drive. The external USB flash drive must be attached to one of the USB Type A connectors to Log data files.

The files are saved in a time-stamped folder under the **usr** folder on the USB flash drive.

If Log Data is On, any of the following functions will stop the logging:

- Rx Frequency change
- Setup change
- Starting another measurement

Hex Trigger: Turns On or Off the Hex Trigger set with the following command. Sweep will continue until the trigger value is detected. At that time Sweep will change from Run to Hold.

Set Trigger Value: Opens a touchscreen hexadecimal keyboard for setting the Trigger value.

Sweep: Toggles the frequency sweep of the LMR Master between Run and Hold. Save function as **Shift + Sweep (3)**.

Back: Returns to the [“Measurement Menu” on page 5-20](#).

Figure 5-18. NXDN Control Channel Menu

5-12 Sweep Menu

Key Sequence: **Shift** > **Sweep (3)** key

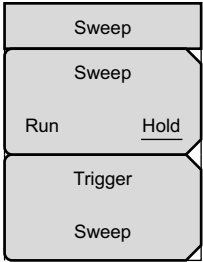
	<p>Sweep Run/Hold: This submenu key toggles between continuous (run) sweep and hold sweep. In Run sweep mode, sweeps are continuous and one starts immediately after the previous sweep is completed. In Hold sweep mode, the results of the last sweep are displayed on the screen while the instrument waits for a trigger event to start a new sweep. HOLD is displayed on the right side of the screen in this mode.</p> <p>Trigger Sweep: Pressing this submenu key causes the instrument to make a single sweep when the instrument is in Hold sweep mode. This key has no function when the instrument is in Run sweep mode.</p> <p>Trigger Sweep is not available in NXDN Control and NXDN Bit Capture measurements.</p>
---	---

Figure 5-19. NXDN Analyzer Sweep Menu

5-13 Measure Menu

Key Sequence: **Shift** > **Measure (4)** key

Display the [“Measurement Menu” on page 5-20.](#)

5-14 Trace Menu

This menu is not available in NXDN Analyzer measurement mode.

5-15 Limit Menu

This menu is not available in NXDN Analyzer measurement mode.

5-16 Other Menus

Preset, **Calibrate**, **File**, **System** and **Mode** are described in the User Guide.

Chapter 6 — dPMR Analyzer (Option 573)

6-1 Introduction

The dPMR Analyzer option provides a method to verify the operation of dPMR tower, mobile, and portable radio transmitters. Option 573 includes the ability to display constellation, spectrum, histogram, and eye diagram graphs. In addition, a summary graph displays numeric values of received power, frequency error, modulation fidelity (Mod Fid), symbol deviation, and symbol rate error of the input signal.

The LMR Master dPMR Analyzer and dPMR Coverage Mapping options are intended for use on over-the-air (OTA) signals. The LMR Master signal generator outputs CW, AM and FM signals while in the dPMR Analyzer mode.

The LMR Master will analyze input signal strengths from +33 dBm (2.0 watts) down to levels approaching the sensitivity of dPMR radios, automatically adjusting the input sensitivity based on input levels.

6-2 Setup Procedure

Direct Connect to the Transmitter

1. Press the **Menu** key then select the dPMR Analyzer icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight dPMR Analyzer and press **Enter**.

Caution	The maximum input power without damage is 2 watts (+33 dBm) to the RF In 50 ohm connector. To prevent damage, use a coupler or attenuator to reduce the input power to below this level when measuring high output power devices.
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2. Connect the transmitter to the RF In 50 Ohm connector on the LMR Master using a coupler or attenuator.
3. Press the **Frequency** main menu key to set the center frequency of the measurement. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.
4. The **Setup** main menu key shows the modulation bandwidth and allows setup of the squelch level and averaging.
5. Press the **Amplitude** main menu key, then the Rx Power Offset submenu key to set the receiver attenuation (or gain). Use the arrow keys, rotary knob or the numeric keypad to enter the adjustment value, up to 100 dB. The offset will be applied to the Received Power value in the Summary graph. For instance, if the transmitter under test is emitting 50 watts (+47 dBm) of power, and the External Attenuation value is 40 dB (such as from a 40 dB directional coupler) the Received Power displayed will be +7 dBm.

6. Press the **Measurement** key, then the dPMR Analyzer submenu key. Select the Graph types to view with the Graph Type submenu key. The Symbol Span submenu is used to adjust the number of “eyes” displayed across the screen in the Eye Diagram graph. Refer to “[dPMR Analyzer Graphs](#)” on page 6-3 for the available graph types.

Over-the-Air (OTA) Analysis Setup

1. Press the **Menu** key and then select the dPMR Analyzer icon, or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight dPMR Analyzer and press **Enter**.

Caution

The maximum input power without damage is 2 watts (+33 dBm) to the RF In 50 ohm connector. To prevent damage, use a coupler or attenuator to reduce the input power to below this level when measuring high output power devices.

2. Connect an antenna with the appropriate frequency range to the RF In 50 Ohm connector on the LMR Master.
3. Press the **Frequency** main menu key to set the center frequency of the measurement. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.
4. Press the **Amplitude** main menu key and insure the Rx Power Offset is set 0.0 dB, then set the Auto Rx Range to On.
5. Press the **Measurement** key, then the dPMR Analyzer submenu key. Select the Graph types to view with the Graph Type submenu key. The Symbol Span submenu is used to adjust the number of “eyes” displayed across the screen in the Eye Diagram graph. Refer to “[dPMR Analyzer Graphs](#)” on page 6-3 for the available graph types.

6-3 dPMR Analyzer Graphs

The following dPMR Analyzer measurements are available on the LMR Master. From the **Measurements** main menu press dPMR Analyzer twice. Press the Graph Type submenu key to select the measurement type.

Constellation and Linear Constellation

Constellation view displays the demodulation information in an IQ format (Figure 6-1). The charts show the relationship between the location of a constellation data point, its deviation frequency, and the information it carries.

Symbol: +3	Symbol: +1
Bit Information: 01	Bit Information: 00
Dev.: +1050 Hz	Dev.: +350 Hz

Symbol: -3	Symbol: -1
Bit Information: 11	Bit Information: 10
Dev.: -1050 Hz	Dev.: -350 Hz

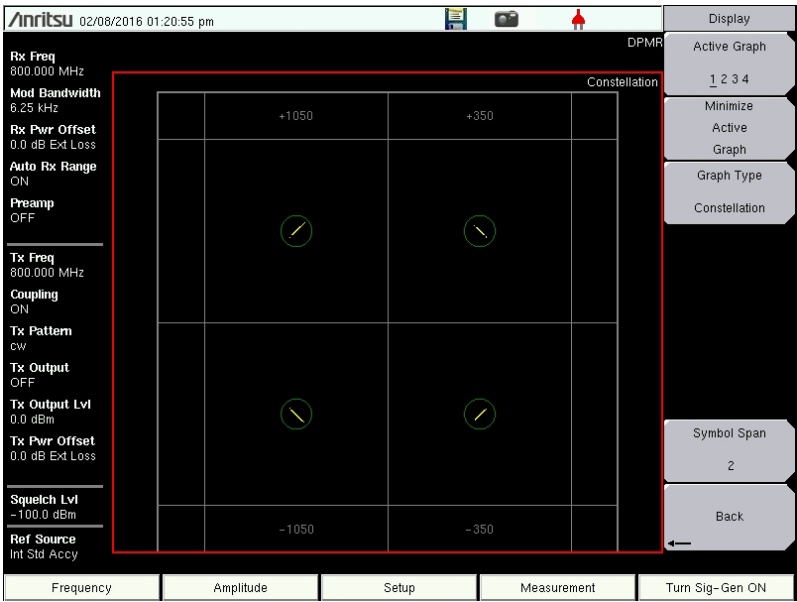


Figure 6-1. Constellation Diagram

6-3 dPMR Analyzer GraphsdPMR Analyzer (Option 573)

Figure 6-2 shows the same information is the Linear Constellation View.

Symbol: -3	Symbol: -1	Symbol: +1	Symbol: +3
Bit Information: 11	Bit Information: 10	Bit Information: 00	Bit Information: 01
Dev.: -1050 Hz	Dev.: -350 Hz	Dev.: +350 Hz	Dev.: +1050 Hz

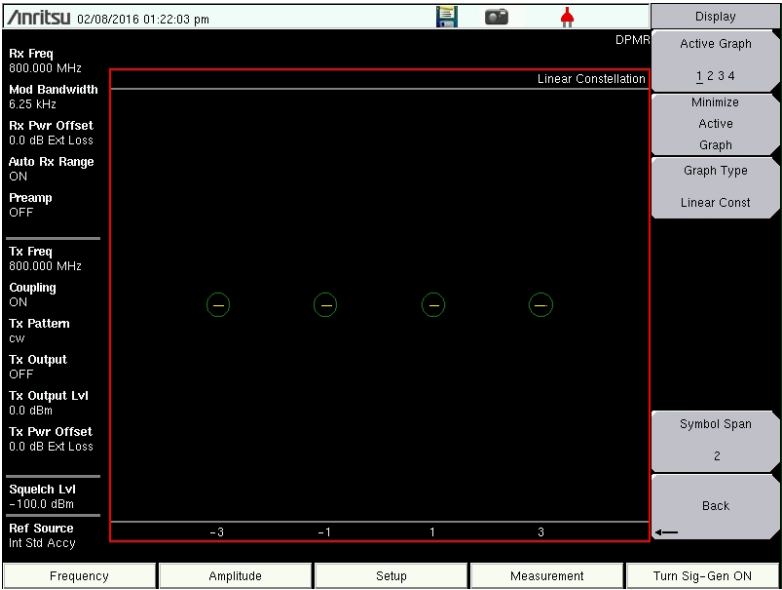


Figure 6-2. Linear Constellation Diagram

For input signals that are not dPMR encoded, the LMR Master will still try to decode it and fit it to a symbol. This may cause some measurement results that are unexpected.

Histogram Graph

The Histogram graph displays a graphical representation of the symbols that are being received. The graph for each symbol represents the relative percentage that symbol was identified out of all the received symbols.

Each update of the screen is a separate representation of the latest data, rather than a cumulative total. The vertical scale is fixed at 0 to 100 %, with each horizontal grid line representing 10 % of the total symbols received.

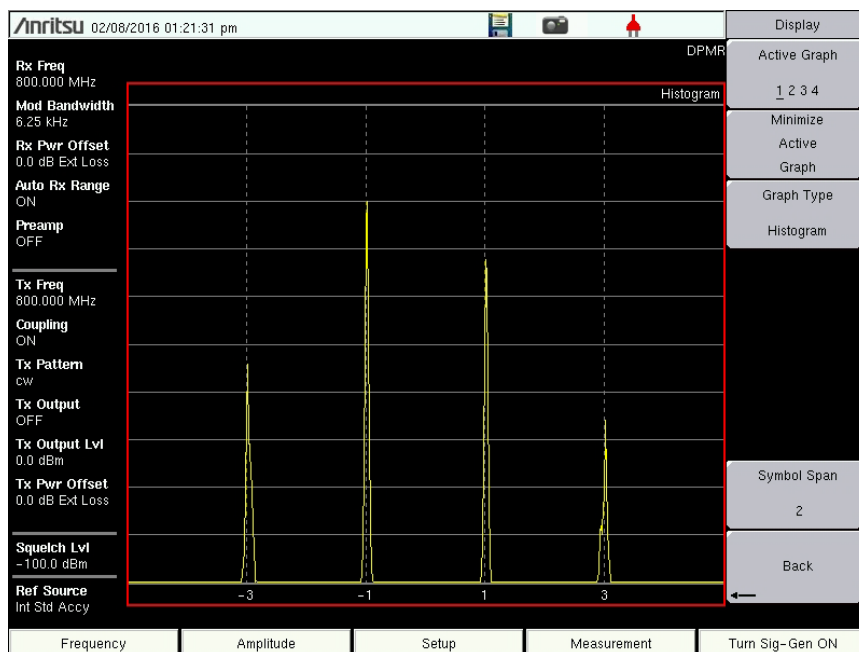


Figure 6-3. dPMR Histogram

Spectrum Graph

The spectrum view displays a graphical representation of power (dBm) vs. frequency. The spectrum display gives an indication if there are interferers present that may degrade the bit error rate of the dPMR signal. The frequency span is adjustable under the **Frequency** menu. The reference level is adjusted with the **Amplitude** menu. Refer to “[Amplitude Menu](#)” on page 6-13 for details. [Figure 6-4](#) displays a dPMR signal using a 25 kHz span.

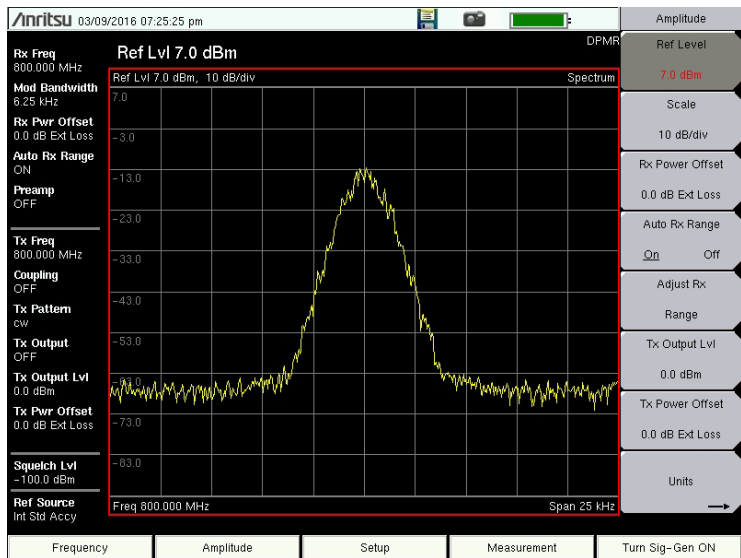


Figure 6-4. dPMR Spectrum Graph (25 kHz Span)

Eye Diagram

The eye diagram is an oscilloscope view of the dPMR signal displaying the voltage of the signal vs. time. The diagram provides an indication of baseband fidelity of an dPMR transmitter. With Over-the-air measurements the Eye Diagram can indicate phase distortion from multipath. The number of “eyes” displayed is set with the Symbol Span key under the “Display Menu” on page 6-17.

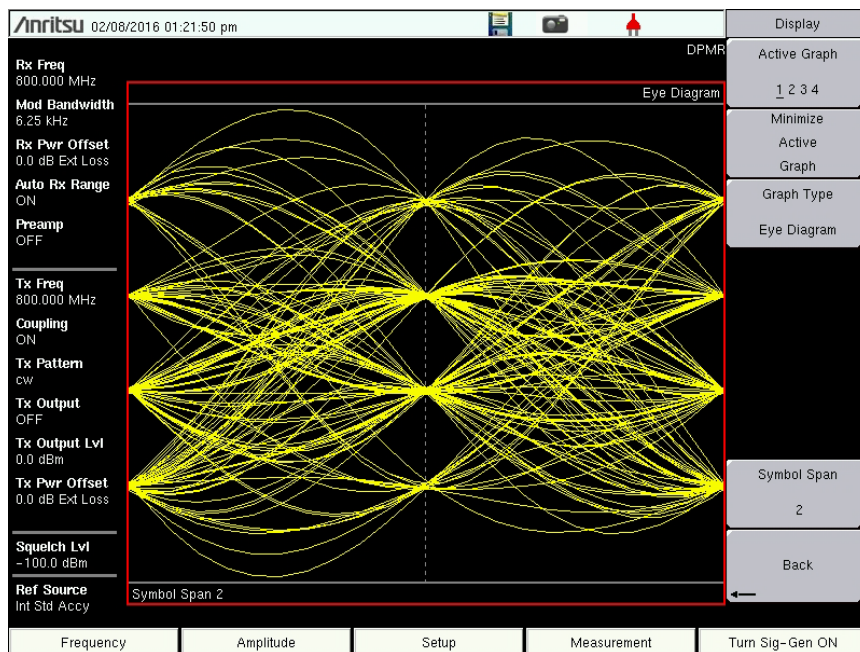


Figure 6-5. dPMR Eye Diagram

Summary Graph

The summary graph provides an overview of a DPMR transmitter. The graph displays numeric values of received power, frequency error, modulation fidelity (Mod Fid), symbol deviation, and symbol rate error of the input signal.

The Received Power value in the summary graph can be toggled to dBm, watts, or volts by using the **Amplitude** > Units > Rx Units keys. This setting also applies to the squelch level setting.

The **Setup** > Squelch Lvl submenu key sets the squelch power level. When the Received Power is lower than the set squelch level all summary graph measurements except for Received Pwr will be blanked out (--). When the Received Power is above the squelch level, the measurements are displayed as shown in [Figure 6-6](#).

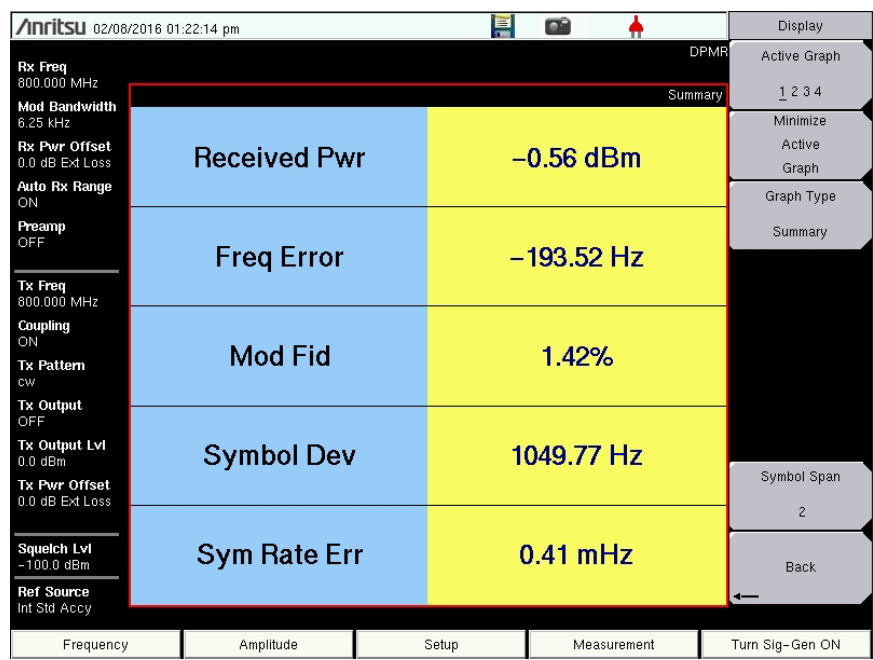


Figure 6-6. dPMR Summary Graph with Received Pwr Above the Squelch Level

Received Pwr in the Summary table is the integrated power of all the energy in the receiver bandwidth. Any peak amplitude reduction seen in the Spectrum display when compared to Received Pwr is a function of the instruments RBW setting. The reduction is specified as: $10 \cdot \log(\text{Signal Bandwidth} / \text{Resolution Bandwidth})$.

6-4 dPMR IQ Data

Note	This measurement is captured on an external USB flash drive. The captured data file can not be recalled and displayed on the instrument screen.
-------------	---

The LMR Master can capture and log dPMR IQ data to a USB flash drive.

1. From the **Frequency** main menu, set the receiver frequency (Rx Freq).
2. Press the **Amplitude** main menu key and insure the Rx Power Offset is set 0.0 dB, then set the Auto Rx Range to On.
3. Insert a formatted USB flash drive into the LMR Master and from the **Measurement** main menu, press the dPMR IQ Capture submenu key. After approximately 10 seconds the instrument will display a message that the capture is complete.

The IQ data is sampled at 2,400 x 11 (6.25 kHz BW) symbols per second. The saved file has an ASCII header and binary data (Figure 6-7). The data is written in 24-bit two's complement integers format. Interleaved Delta Phase (I) data then Magnitude (Q) data is captured. The file is intended for post-processing in MATLAB or similar software.

The file will be written to a data stamped folder inside the /usr folder on the root level of the USB flash drive. The file is named:

IQ_CAPTUREyearmonthdaytime.dpmr

Note	There is no display menu for dPMR IQ Capture. The LMR Master will continue to display the previous measurement screen during IQ Capture.
-------------	--

6-5 dPMR Analyzer Menus

Menu maps typically display all possible submenu keys, although some keys are displayed on the instruments only under special circumstances (refer to menu descriptions on the following pages).

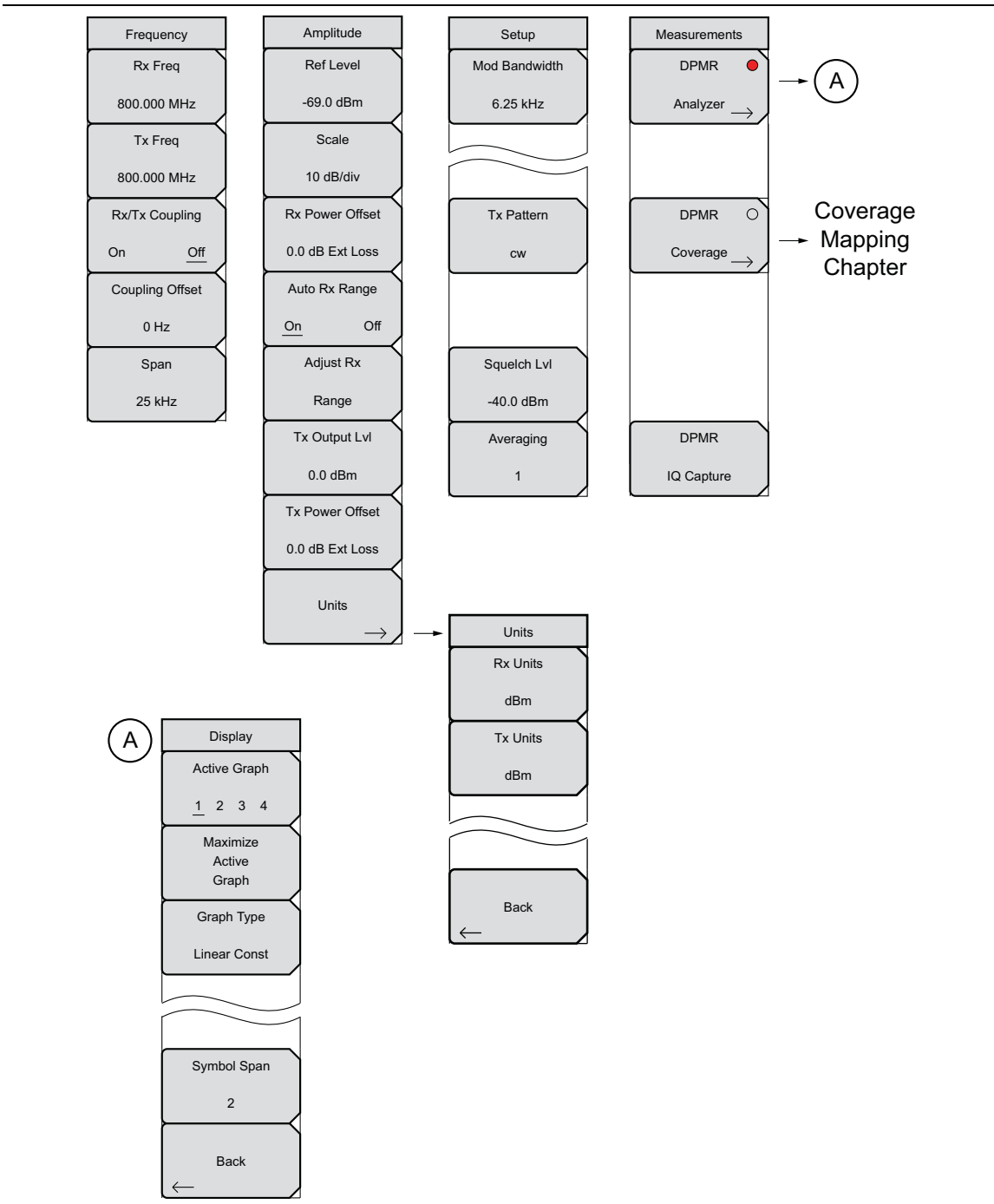


Figure 6-8. dPMR Analyzer Menu Layout

6-6 Frequency Menu

Key Sequence: **Frequency**

Frequency	Rx Freq: Sets the receiver frequency. Press the Rx Freq key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the submenu key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the Enter key has the same effect as pressing the MHz submenu key.
Rx Freq 800.000 MHz	
Tx Freq 800.000 MHz	Tx Freq: Sets the signal generator frequency. Press Tx Rx Freq key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the submenu key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the Enter key has the same effect as pressing the MHz submenu key.
Rx/Tx Coupling On Off	Rx/Tx Coupling: Couples the signal generator to the receiver frequency. When set to On the Tx Freq key is disabled.
Coupling Offset 0 Hz	Coupling Offset: Sets the Offset of the signal generator frequency and the receiver frequency. Only functional when Rx/Tx Coupling is set to On.
Span 25 kHz	Span: Sets the span of the Spectrum Graph. Span selections are 25 kHz, 50 kHz, 100 kHz, 500 kHz, 1 MHz, and 5 MHz.

Figure 6-9. dPMR Analyzer Frequency Menu

6-7 Amplitude Menu

Key Sequence: **Amplitude**

Amplitude

Ref Level

-69.0 dBm

Scale

10 dB/div

Rx Power Offset

0.0 dB Ext Loss

Auto Rx Range

On Off

Adjust Rx

Range

Tx Output Lvl

0.0 dBm

Tx Power Offset

0.0 dB Ext Loss

Units

Units

Rx Units

dBm

Tx Units

dBm

Back

Ref Level: Sets the reference power level at the top of the display when Auto Range is Off.

Scale: Scale sets the number of dB per division in the y-axis of the graticule. Enter a value from 1 dB per division to 15 dB per division using the keypad, the arrow keys, or the rotary knob. The y-axis power scale is shown on the left side of the display when viewing the Spectrum Graph.

Note: The [“Vertical Scale Menu” on page 6-14](#) is displayed when dPMR Coverage (**Measurement** > dPMR Coverage) is selected.

Rx Power Offset: Sets the receiver (RF IN connection) external attenuation or gain. Press the Rx Power Offset submenu key and select a value from 0 dB to 100 dB then select either dB External Loss or dB External Gain.

Auto Rx Range: Pressing this submenu key toggles between On and Off. When On, this function automatically adjusts the reference level based on the input signal.

Adjust Rx Range: When Auto Rx Range is Off, pressing Adjust Rx Range sets the Reference Level automatically for the current measurement.

Tx Output Lvl: Sets the output power of the Signal Generator (0 dBm or 1 mW or 223 mV max).

Tx Power Offset: Sets the transmitter (Signal Generator Out connection) external attenuation or gain. Press the Rx Power Offset submenu key and select a value from 0 dB to 100 dB then select either dB External Loss or dB External Gain.

Units: Opens to Units Submenu.

Rx Units: Sets the unit of measure (dBm, watts, or volts) for Received Power in the Summary Graph and the Squelch Level.

Tx Units: Sets the unit of measure (dBm, watts, or volts) for the Signal Generator (Tx Output Lvl submenu).

Figure 6-10. dPMR Analyzer Amplitude Menu

Vertical Scale Menu

Key Sequence: **Amplitude** > Vertical Scale

Note

Note: The “Vertical Scale Menu” is displayed when dPMR Coverage (Measurement > dPMR Coverage) is selected.

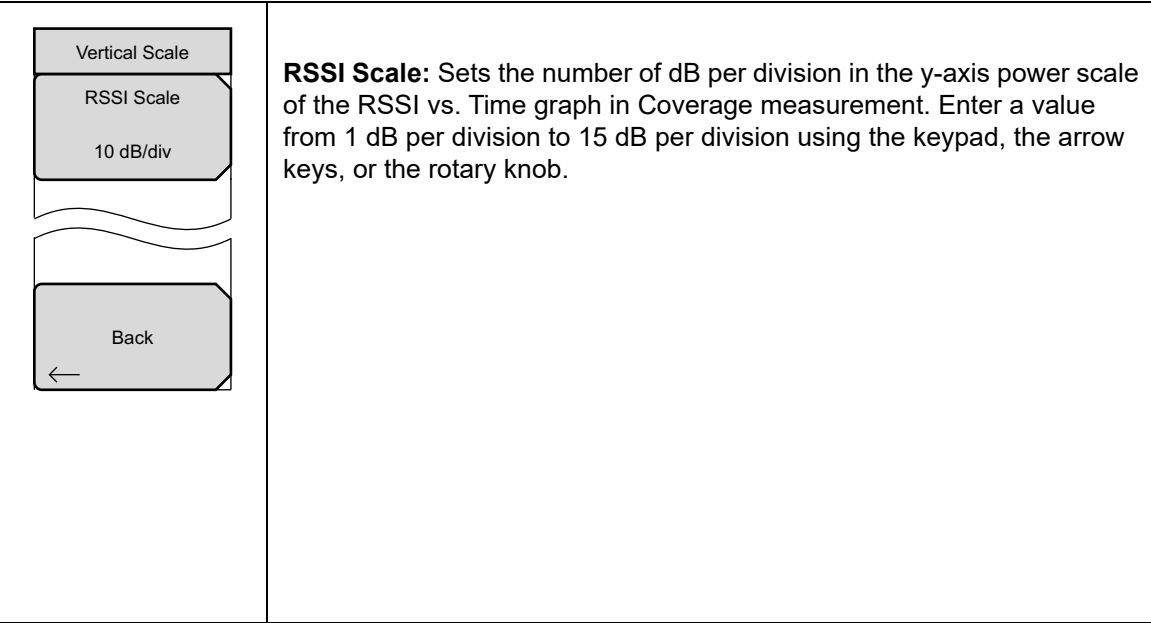


Figure 6-11. Vertical Scale Menu

6-8 Setup Menu

Key Sequence: **Setup**

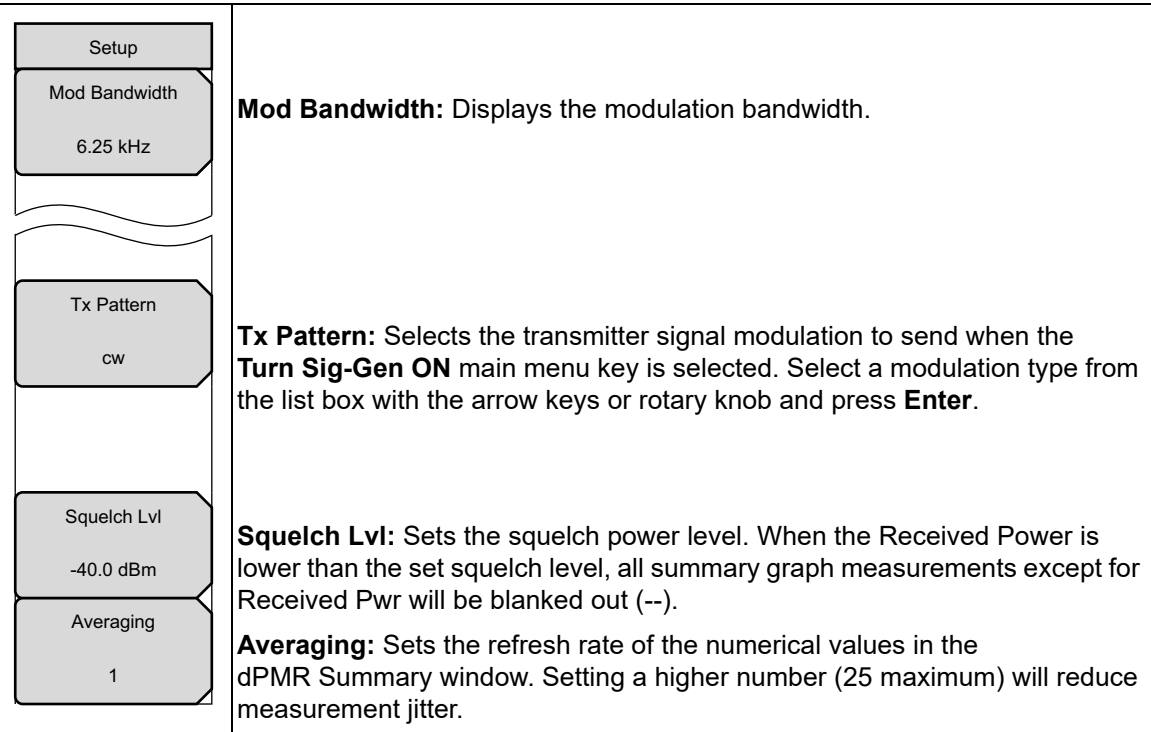


Figure 6-12. dPMR Analyzer Setup Menu

6-9 Measurement Menu

Key Sequence: **Measurement**

<div>Measurements</div> <div>DPMR </div> <div>Analyzer →</div>	dPMR Analyzer: Opens the “ Display Menu ” on page 6-17.
<div>DPMR </div> <div>Coverage →</div>	dPMR Coverage (Option 572 required): Opens the dPMR Coverage menu. Refer to Chapter 11, “LMR Coverage Mapping” .
<div>DPMR</div> <div>IQ Capture</div>	dPMR IQ Capture: Pressing this key starts the IQ data capture. Make sure that a formatted USB flash drive is attached to the instrument before starting IQ Capture. When the capture is complete, a message is displayed. This may take a few seconds.

Figure 6-13. dPMR Analyzer Measurement Menu

Display Menu

Key Sequence: **Measurement** > dPMR Analyzer

<div><div>Display</div><div>Active Graph</div><div>1 2 3 4</div><div>Maximize Active Graph</div><div>Graph Type</div><div>Constellation</div><div></div><div>Symbol Span</div><div>2</div><div>Back</div></div>	<p>Active Graph 1 2 3 4: In Four Screen view use this menu to select which of the four graphs is active. The current active graph is underlined (1 2 3 4) and has a red perimeter line. Any of the four graphs can also be made active by tapping once on the touch screen. Repeatedly pressing the Active Graph submenu key will cycle the active graph, 1 through 4.</p> <p>In Standard view (one graph displayed on the screen) the Active Graphic key will rotate between the four graphs displayed in the Four Screen view.</p> <p>Maximize/Minimize Active Graph: The submenu key toggles between displaying the Four Screen (4 graphs) view and the Standard view (1 graph). Tapping twice on a selected graph also toggles between the two display options.</p> <p>Graph Type: The label on the bottom of this button displays the current active graph type. Pressing the button will open a list box of the graphs types available for dPMR Analyzer measurements. Select the desired graph type with the arrow keys or rotatory knob and press Enter. The current active graph will be replaced with the new selection.</p> <p>Available graphs include:</p> <ul style="list-style-type: none">ConstellationSpectrumHistogramEye DiagramLinear ConstellationSummary <p>Refer to “dPMR Analyzer Menus” on page 6-11 for additional information.</p> <p>Symbol Span: Use this menu to adjust the number of symbols viewed across the screen in the Eye Diagram graph. Adjust from 2 and 5 using the keypad, the arrow keys, or the rotary knob. Keypad values entered outside of this range are ignored.</p> <p>Back: Returns to the “Measurement Menu” on page 6-16.</p>
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Figure 6-14. dPMR Analyzer Display Menu

6-10 Sweep Menu

Key Sequence: **Shift > Sweep (3)** key

Sweep

Sweep

RunHold

Trigger

Sweep

Sweep Run/Hold: This submenu key toggles between continuous (run) sweep and hold sweep. In Run sweep mode, sweeps are continuous and one starts immediately after the previous sweep is completed. In Hold sweep mode, the results of the last sweep are displayed on the screen while the instrument waits for a trigger event to start a new sweep. **HOLD** is displayed on the right side of the screen in this mode.

Trigger Sweep: Pressing this submenu key causes the instrument to make a single sweep when the instrument is in Hold sweep mode. This key has no function when the instrument is in Run sweep mode.

Trigger Sweep is not available in dPMR Control and dPMR Bit Capture measurements.

Figure 6-15. dPMR Analyzer Sweep Menu

6-11 Measure Menu

Key Sequence: **Shift > Measure (4)** key

Display the [“Measurement Menu” on page 6-16](#).

6-12 Trace Menu

This menu is not available in dPMR Analyzer measurement mode.

6-13 Limit Menu

This menu is not available in dPMR Analyzer measurement mode.

6-14 Other Menus

Preset, Calibrate, File, System and **Mode** are described in the User Guide.

Chapter 7 — TETRA Analyzer (Option 581)

7-1 Introduction

The TETRA Analyzer option provides a method to verify the operation of TETRA repeater transmitters. Option 581 includes the ability to display constellation, spectrum, histogram, and eye diagram graphs. In addition, a summary graph displays numeric values of received power, frequency error, error vector magnitude (EVM), IQ imbalance, phase and magnitude errors, and symbol rate error of the input signal. The analyzer also reports the base station extended color code (BS ECC), mobile color code (Mobile CC), mobile network code (Mobile NC), base color code (Base CC), location area code (LAC), and mobile station maximum transmit power (MS Max TX Pwr) permitted on a channel from the TETRA transmitter.

The LMR Master TETRA Analyzer and TETRA Coverage Mapping options are intended for use on over-the-air (OTA) signals. The LMR Master signal generator outputs CW, AM and FM signals while in the TETRA Analyzer mode.

The LMR Master will analyze input signal strengths from +33 dBm (2.0 watts) down to levels approaching the sensitivity of TETRA radios, automatically adjusting the input sensitivity based on input levels.

7-2 Over-the-Air (OTA) Analysis Setup

1. Press the **Menu** key then select the TETRA Analyzer icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight TETRA Analyzer and press **Enter**.

Caution	The maximum input power without damage is 2 watts (+33 dBm) to the RF In 50 Ohm connector. To prevent damage, use a coupler or attenuator to reduce the input power to below this level when measuring nearby high output power devices.
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2. Connect an antenna with the appropriate frequency range to the RF In 50 Ohm connector on the LMR Master.
3. Press the **Frequency** main menu key to set the center frequency of the measurement. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.
4. Press the **Setup** main menu key to select the appropriate numeric squelch level for OTA measurements. TETRA analysis uses a proprietary method to estimate BER from the TETRA base station data stream. Refer to [“TETRA Analyzer Graphs” on page 7-3](#) for the available graph types.

Using the Signal Generator for Receiver or OTA Analysis

1. Press the **Menu** key then select the TETRA Signal Analyzer icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight TETRA Analyzer and press **Enter**.

Caution	The maximum output power from the Signal Generator Out connector is 1 mW (0 dBm) and the frequency range is 500 kHz to 1.6 GHz.
----------------	---

2. Direct connect the LMR Master Signal Generator Out 50 Ohm connector to the repeater/receiver or connect an antenna with the appropriate frequency range to the connector.
3. Press the **Frequency** main menu key to set the transmit frequency using the Tx Freq key. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.

If testing an TETRA repeater, you can bind the transmit frequency to the receive frequency by setting Rx/Tx Coupling to On and entering the Coupling Offset.

Note	When Rx/Tx Coupling is on, the Tx Freq submenu key is disabled.
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4. Press the **Amplitude** main menu key, then the Tx Output Lvl submenu key to set the output power. Enter any output attenuation or gain using the Tx Power Offset key.
5. Set the bandwidth by pressing the **Setup** main menu key and then the Mod Bandwidth submenu key. Set the signal generator pattern with the Tx Pattern submenu key. Available patterns are listed on the display and additional patterns can be downloaded via the **System** > Application Options menu.
6. Press the **Turn Sig-Gen ON** main menu key to start the signal generator. Press the key again to turn off the signal generator.

7-3 TETRA Analyzer Graphs

This section briefly describes TETRA Analyzer measurements that are available on the LMR Master. From the **Measurements** main menu press the TETRA Analyzer submenu key. If necessary, press the key a second time to show the Display menu. Press the **Graph Type** submenu key to select the graph type.

Constellation

Selecting Constellation as the Graph Type displays the demodulation information in an IQ format (Figure 7-1). Note that for input signals that are not TETRA encoded, the LMR Master will still try to decode them and fit them to a symbol. This may result in measurement values that are unexpected.

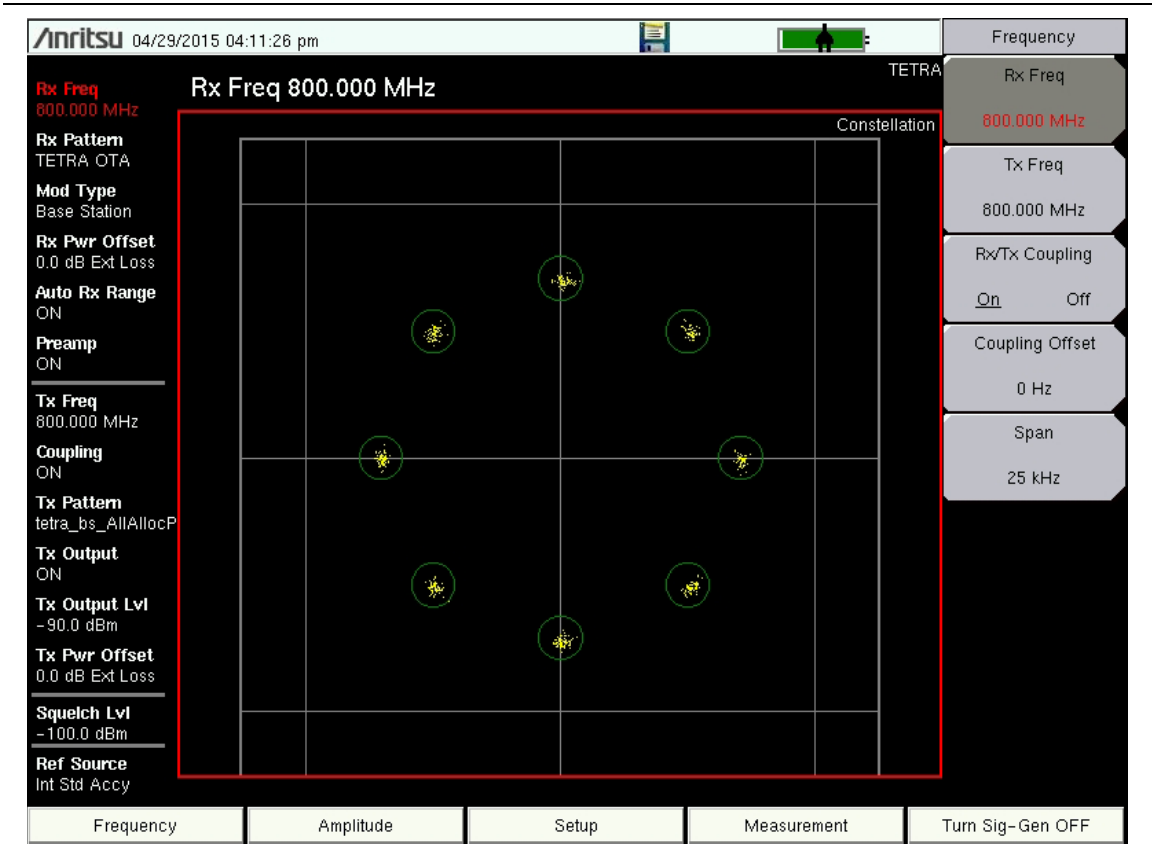


Figure 7-1. Constellation Diagram

Spectrum Graph

The spectrum view displays a graphical representation of power (dBm) vs. frequency. The spectrum display gives an indication if there are interferers present that may degrade the bit error rate of the TETRA signal. The frequency span is adjustable under the **Frequency** menu. The reference level is adjusted with the **Amplitude** menu. Refer to “[Amplitude Menu](#)” on page 7-27 for details. [Figure 7-2](#) displays the same signal using a 25 kHz span and a 500 kHz span.

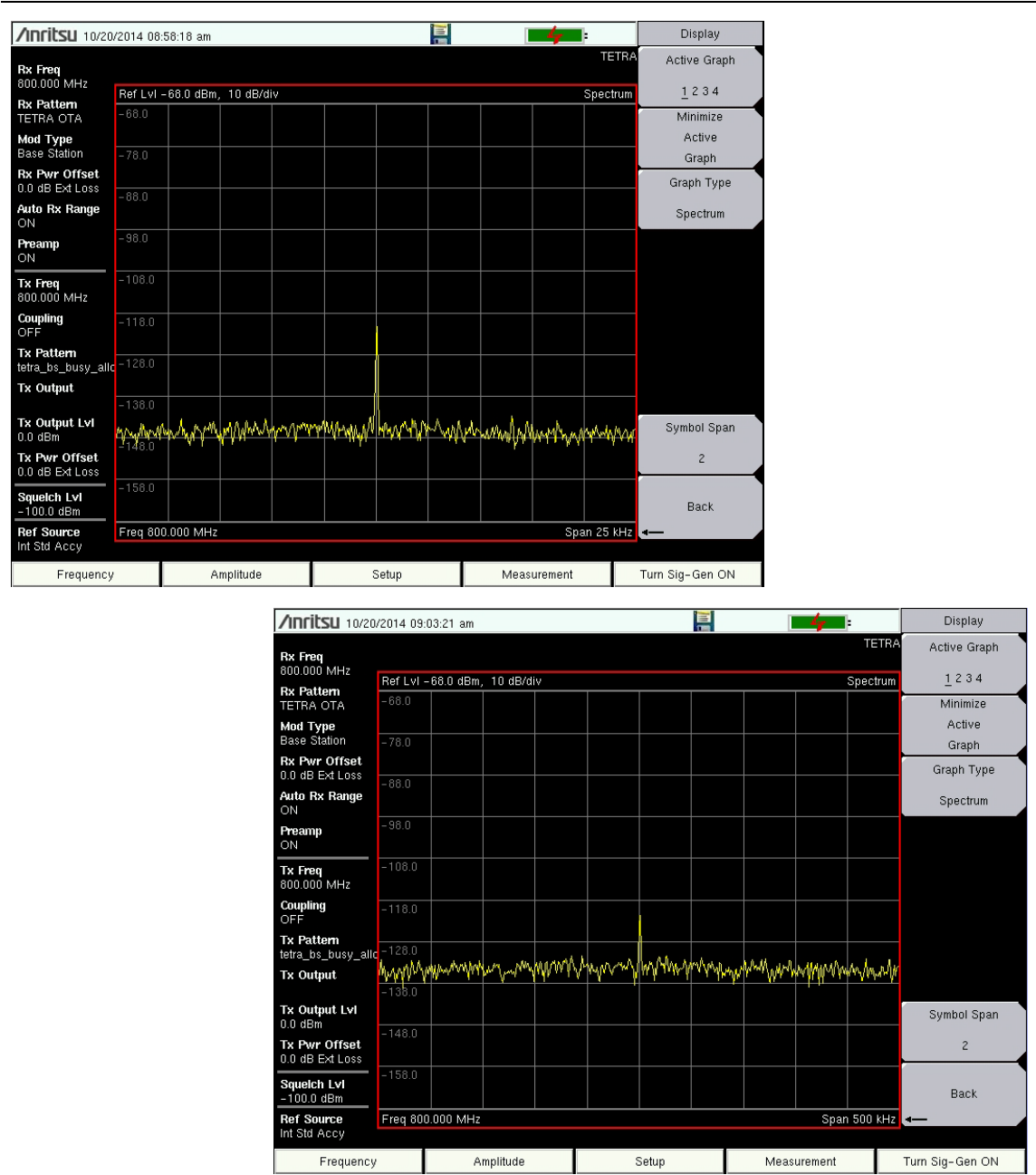


Figure 7-2. TETRA Spectrum Graph (25 kHz Span and 500 kHz Span)

Eye Diagram

The eye diagram is an oscilloscope view of the TETRA signal displaying the voltage of the signal vs. time. The diagram provides an indication of baseband fidelity of a TETRA transmitter. With over-the-air measurements, the Eye Diagram can indicate phase distortion from multipath. The number of “eyes” displayed is set with the Symbol Span key under the “Display Menu” on page 7-33.

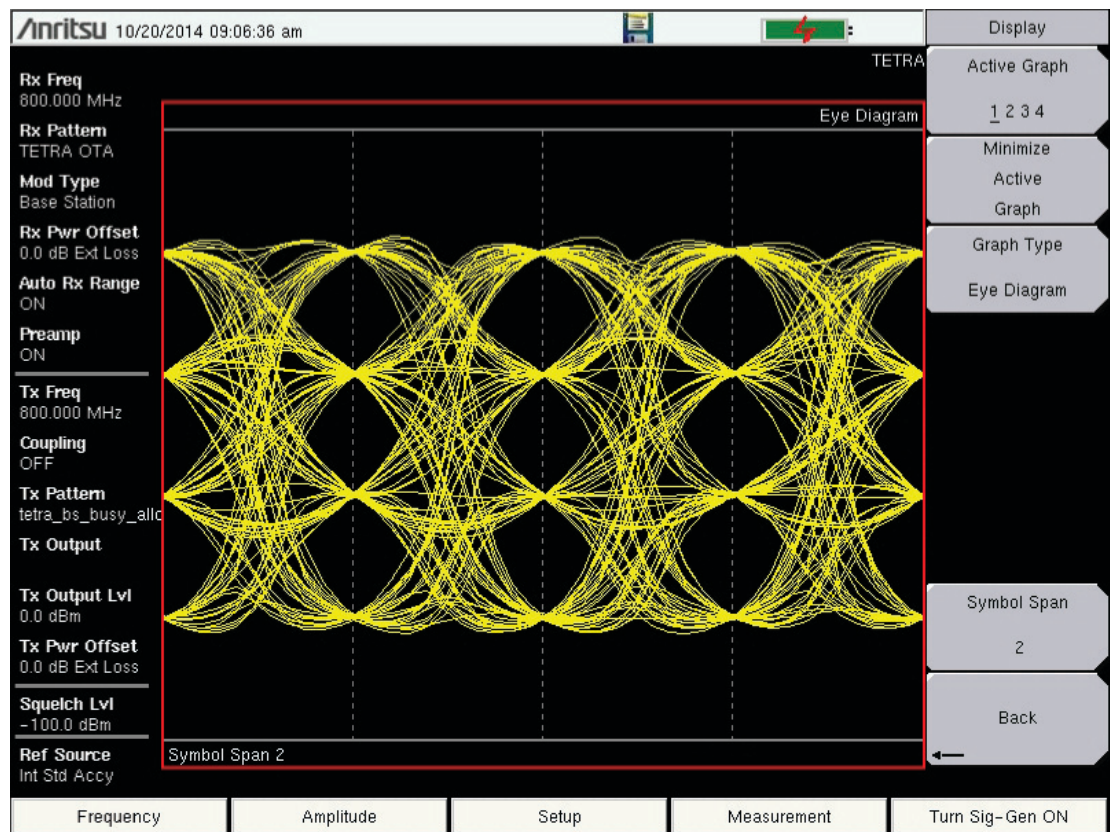


Figure 7-3. TETRA Eye Diagram

Summary and TETRA Summary Graphs

These two summary displays provide measured and decoded values in a table format.

Summary Graph

The Summary graph provides an overview of the measurements made on the signal received from a downlink TETRA transmitter. This graph displays numeric values of received power, frequency error, RMS and peak vector error magnitude (EVM), bit error rate, residual carrier magnitude, IQ imbalance, phase and magnitude errors, and symbol rate error of the input signal.

The Received Power value in the Summary graph can be toggled to dBm, watts, or volts by using the key sequence: **Amplitude** > Units > Rx Units. The selected unit also applies to the squelch level setting.

The key sequence: **Setup** > Squelch Lvl sets the squelch power level. When the Received Power is lower than the set squelch level, all values in both summary displays except for Received Pwr are blanked out (– –). When the Received Power is above the squelch level, the measurements for this graph are displayed as shown in [Figure 7-4](#).

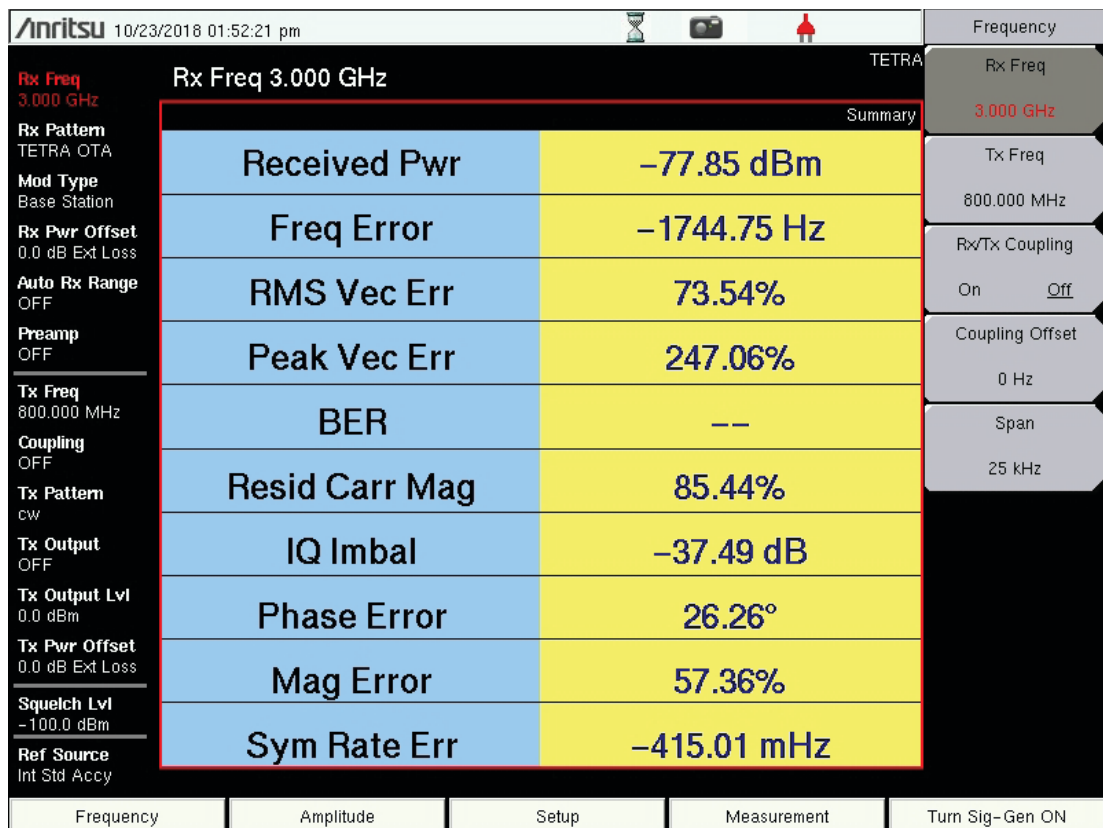


Figure 7-4. Summary Graph (with Received Power Above the Squelch Level)

Received Pwr in the Summary table is the integrated power of all the energy in the receiver bandwidth. Any peak amplitude reduction seen in the Spectrum display when compared to Received Pwr is a function of the instrument RBW setting. The reduction is specified as: $10 \cdot \log(\text{Signal Bandwidth} / \text{Resolution Bandwidth})$.

TETRA Summary Graph

The TETRA Summary graph is only available with Base Station modulation type. It reports the base station extended color code (BS ECC), mobile color code (Mobile CC), mobile network code (Mobile NC), base color code (Base CC), location area code (LAC), and mobile station maximum transmit power (MS Max TX Pwr) permitted on a channel from the TETRA transmitter.

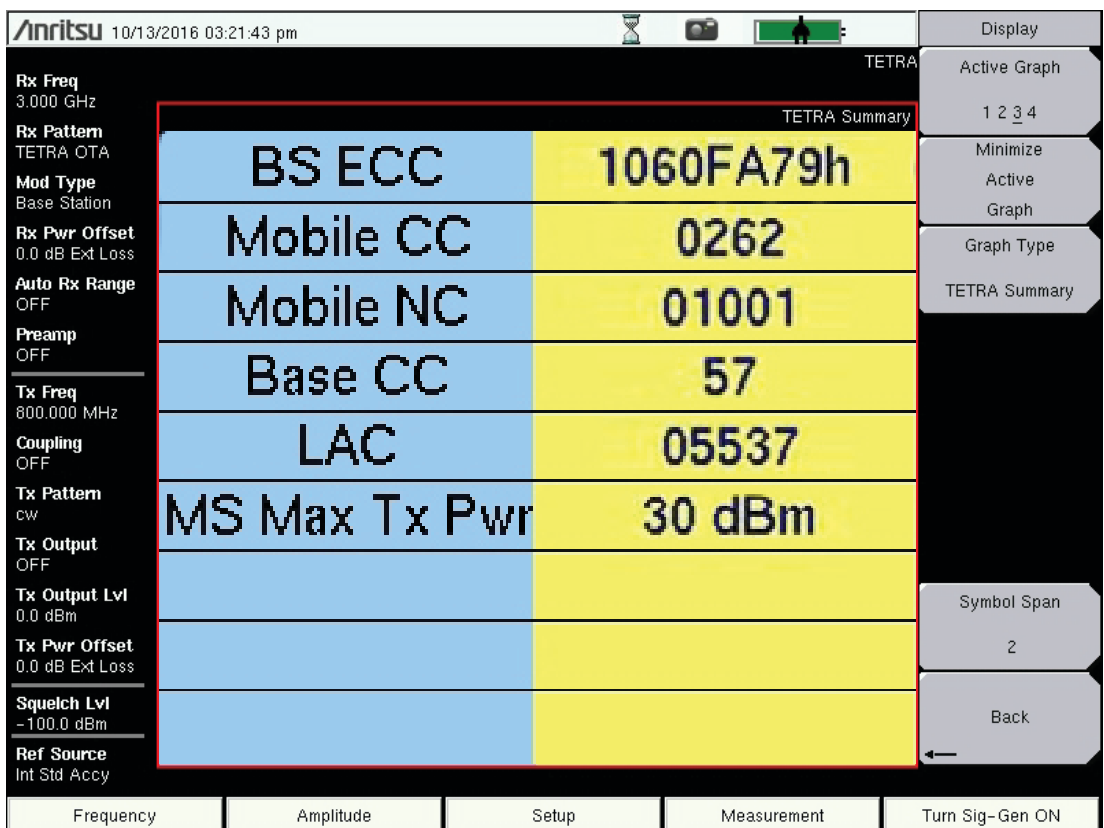


Figure 7-5. TETRA Summary Graph (with Received Power Above the Squelch Level)

Note that BS ECC in the Summary graph is provided in 8 hexadecimal digits so that the least significant 30 bits of this value may be used for verification of corresponding bits of initial state of scramblers and descramblers of encoders and decoders, respectively, of any TETRA channel other than the Broadcast Synchronization Channel.

Note

In the Summary graph, the “h” in BS ECC 1060FA79h indicates that 1060FA79 is a hexadecimal number.

7-4 TETRA IQ Data

Note This measurement is captured on an external USB flash drive. The captured data file cannot be recalled and displayed on the instrument screen.

The LMR Master can capture and log TETRA IQ data to a USB flash drive.

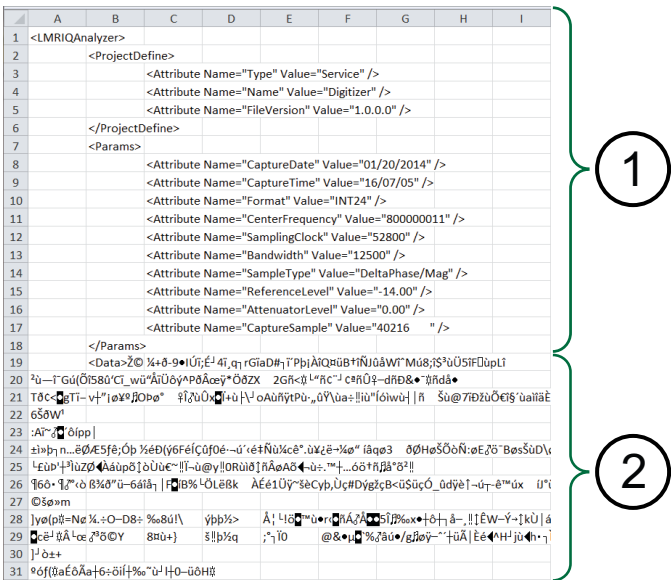
- 1. From the **Frequency** main menu, set the receiver frequency (Rx Freq).
- 2. Insert a formatted USB flash drive into the LMR Master, and from the **Measurement** main menu, press the **TETRA IQ Capture** submenu key. After approximately 10 seconds, the instrument displays a message that the capture is complete.

The IQ data is sampled at 4,800 x 11 samples per second. The saved file has an ASCII header and binary data (see [Figure 7-6 on page 7-8](#) for an example). The data is written in 24-bit two's complement integer format. Interleaved Delta Phase (I) data then Magnitude (Q) data is captured. The file is intended for post-processing in MATLAB or other data analysis software.

The file will be written to a data stamped folder inside the /usr folder on the root level of the USB flash drive. The file is named:

IQ_CAPTUREyearmonthdaytime.TETRA

Note There is no display menu for TETRA IQ Capture. The LMR Master will continue to display the previous measurement screen during IQ Capture.



- 1. ASCII header listing parametric information
- 2. Binary data in 24-bit two's complement integer format

Figure 7-6. IQ Capture

7-5 TETRA Base Station Receiver Sensitivity Testing

The receiver testing/verification procedure consist of sending a known test signal to the base station (BS) radio to verify the receive path. It provides commands and responses to verify proper operation of the base station radio receiver path. The quality metric referred to is the bit error rate (BER) value measured during the testing procedure and is specified by the manufacturer (or a network operator). Manufacturers have different requirements for receiver sensitivity, so check with the appropriate manufacturer for their specification.

Caution	To minimizes or eliminates disruption of service to system users, take the base station radio out of service or perform these procedures during off-peak hours.
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This section outlines a basic test setup and measurement procedure for testing the following base station radios:

- [Airbus TB3 TETRA Station \(Single Rx/Tx Port\)](#)
- [Airbus TB3 TETRA Station \(Separate Rx/Tx Ports\)](#)
- [Hytera TETRA Station](#)
- [Motorola TETRA Station](#)
- [ETELM TETRA Station](#)

Airbus TB3 TETRA Station (Single Rx/Tx Port)

Hardware Setup

1. Connect the TB3 Base Station and S412E to the MA25200A Input Protection Module as shown below:

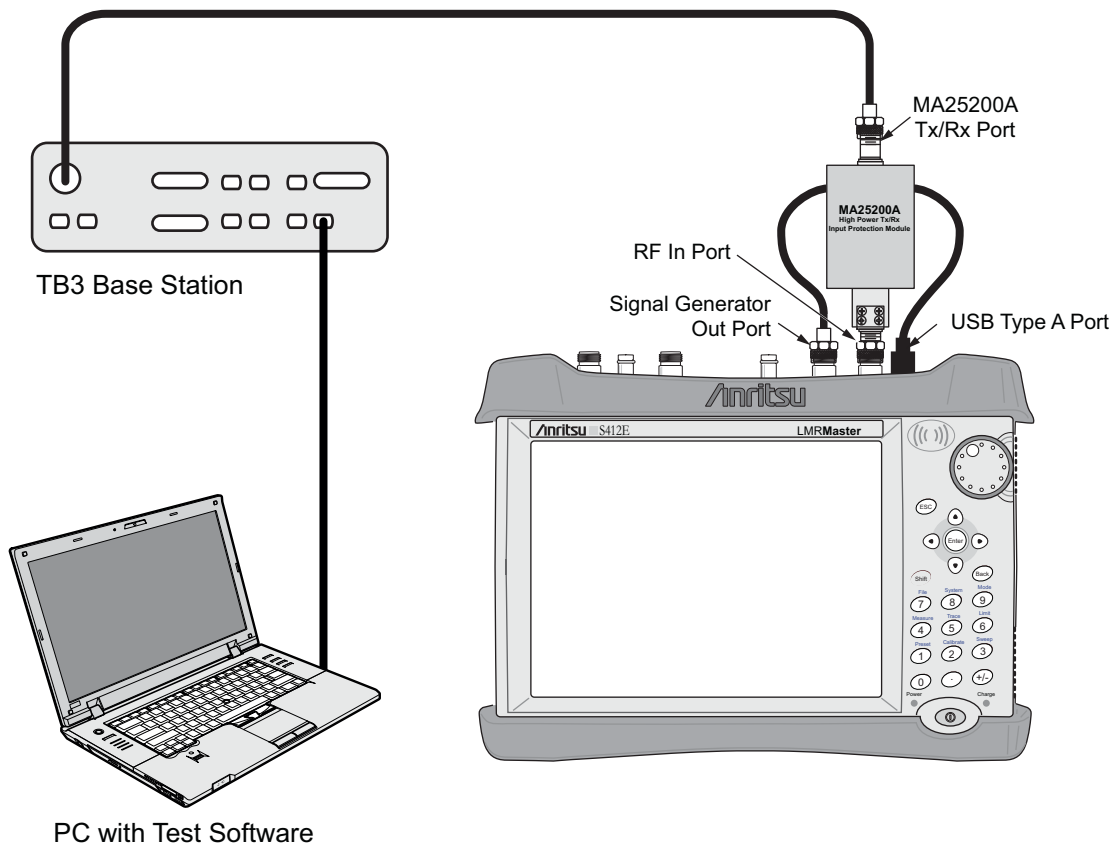


Figure 7-7. Airbus TB3 Base Station Setup

2. Connect the TB3 base station to a PC with the test software.

S412E Setup

1. Set S412E to TETRA Analyzer Mode.
2. Ensure that the Modulation Type is set to “Base Station”

Setup -> Mod Type = Base Station

3. Set S412E Frequencies:
 - Set Rx frequency to Tx frequency of TB3
 - Set Tx frequency to Rx frequency of TB3
4. Set the S412E Amplitude:

- Set Input and Output Offset to 40 dB Loss.
This will compensate for the loss through the MA25200A. Both Input and Output ports will have the same loss of 40 dB.
 - Set the Reference Level to +50 dBm. This is to avoid overdriving the ADC.
 - Set the Output Level to your desired test level – Note that the 40 dB loss is already taken into account. For example, if you want –110 dBm output, set the Output Level to –110 dBm.
5. Set up TETRA Base Station Receiver Sensitivity Mode:

Measurement -> TETRA BS Sensitivity ->
Base Station = Airbus TB3 0 or 1

- Airbus TB3 0 will set the ECC to 0
- Airbus TB3 1 will set the ECC to Airbus Recommended Test Default

Set Up Airbus Test Software

6. Make sure the Airbus BS is transmitting and verify that the ECC displayed on the S412E is what is expected.
7. Do not start measuring the BER until the S412E signal generator starts transmitting.
8. Start the S412E BS Sensitivity test by selecting the “Start Test” button in the TETRA BS Sensitivity menu.
9. WAIT for the “Start Test” button to change to “Stop Test” – this lets you know that the signal generator has synchronized to the BS frame structure and is playing the TCH/7.2 signal.
10. Start the BER measurement on the TB3 BS.
 - The signal from the S412E will restart every 60 seconds, so make sure that the BER measurement is made within this time interval.
11. You can now go to the Amplitude menu and change the Amplitude to your desired level.

Measurements	BS Sensitivity
TETRA 	Base Station
Analyzer →	Airbus TB3 0
TETRA 	BCC = 0 MCC = 0 MNC = 0
Coverage →	Trigger Type External <u>Internal</u>
TETRA	Trigger Edge <u>Rising</u> Falling
IQ Capture	Delay Adjustment 85.200 ms
TETRA	Start Test 
BS Sensitivity →	Back ←

Note

If you go back to the BS Sensitivity menu, the test will stop and you can restart it by following the same procedure.

12. Stop the test on the S412E:

Measurement -> TETRA BS Sensitivity -> Stop Test.

13. Disconnect the equipment.

Airbus TB3 TETRA Station (Separate Rx/Tx Ports)

Hardware Setup

1. Connect the TB3 to the S412E as shown below:
 - TB3 Tx port to the S412E RF In Port (use attenuator as needed)
 - TB3 Rx port to the S412E Signal Generator Output Port

Warning

The maximum input power the S412E can handle is +33 dBm. Care must be taken not to exceed this power level as it may damage the RF Input of the S412E. It is highly recommended that an attenuator be used if the Tx power output of the TB3 base station is greater than +30 dBm.

An optional attenuator may be used on the signal generator output if very low output signal levels are desired at the TB3 Rx port.

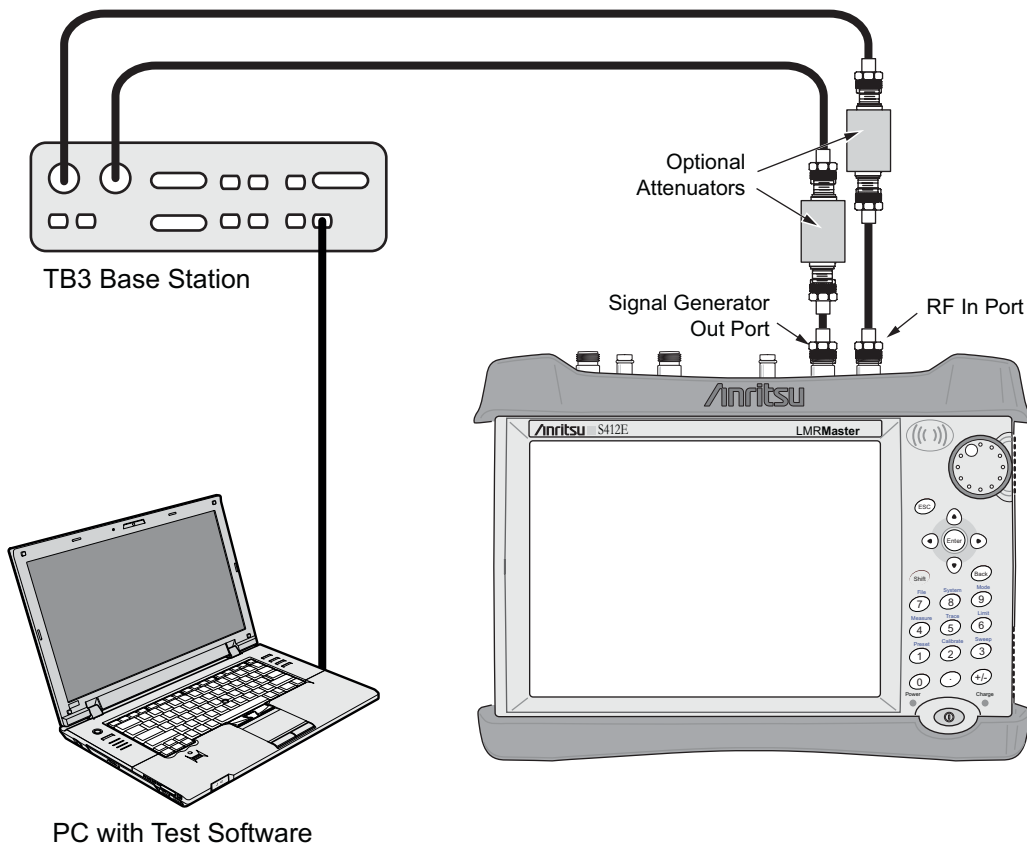


Figure 7-8. Airbus TB3 Base Station Setup

2. Connect the TB3 base station to a PC with the test software.

S412E Setup

3. Set S412E to TETRA Analyzer Mode.
4. Ensure that the Modulation Type is set to “Base Station”

Setup -> Mod Type = Base Station

5. Set S412E Frequency:
 - Set Rx frequency to Tx frequency of TB3
 - Set Tx frequency to Rx frequency of TB3
6. Set the S412E Amplitude:
 - Set Input and Output Offset to the appropriate Loss. This also compensates for the loss through the attenuators, if external attenuators are used. Both Input and Output port offset levels must be set properly.
 - Set the Reference Level to an appropriate setting (a few dB higher than the expected TB3 Tx output level). This is to avoid overdriving the ADC.
 - Set the Output Level to your desired test level.
Note that losses and external attenuation will be taken into account by the offset setting used earlier. If you want -110 dBm output, set the Output Level to -110 dBm.
7. Set up TETRA Base Station Receiver Sensitivity Mode:

Measurement -> TETRA BS Sensitivity ->
Base Station = Airbus TB3 0 or 1

- Airbus TB3 0 will set the ECC to 0
- Airbus TB3 1 will set the ECC to Airbus Recommended Test Default

Measurements	BS Sensitivity
TETRA ●	Base Station
Analyzer →	Airbus TB3 0
TETRA ○	BCC = 0
Coverage →	MCC = 0
	MNC = 0
	Trigger Type
	External <u>Internal</u>
TETRA	Trigger Edge
IQ Capture	<u>Rising</u> Falling
TETRA	Delay Adjustment
BS Sensitivity →	85.200 ms
	Start Test ●
	Back
	←

Set Up Airbus Test Software

8. Make sure the Airbus BS is transmitting and verify that the ECC displayed on the S412E is what is expected.
9. Do not start measuring the BER until the S412E signal generator starts transmitting.
10. Start the S412E BS Sensitivity test by selecting the “Start Test” button in the TETRA BS Sensitivity menu.
11. WAIT for the “Start Test” button to change to “Stop Test” – this lets you know that the signal generator has synchronized to the BS frame structure and is playing the TCH/7.2 signal.
12. Start the BER measurement on the TB3 BS.
 - The signal from the S412E will restart every 60 seconds, so make sure that the BER measurement is made within this time interval.
 - You can now go to the Amplitude menu and change the Amplitude to your desired level.

Note

If you go back to the BS Sensitivity menu, the test will stop and you can restart it by following the same procedure.

13. Stop the test on the S412E:

Measurement -> TETRA BS Sensitivity -> Stop Test.

14. Disconnect the equipment.

Hytera TETRA Station

Hardware Setup

1. Connect the MA25200A Input Protection Module to the Hytera base station and to the S412E as shown below:

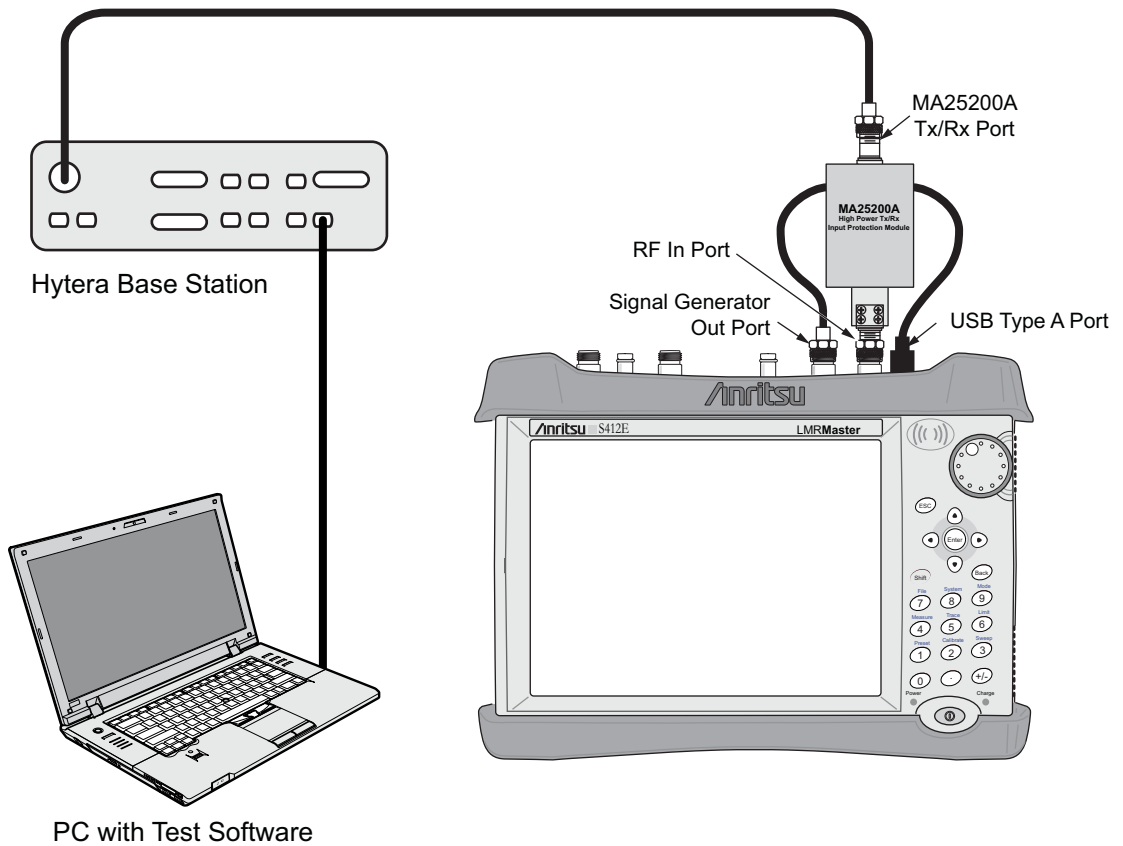


Figure 7-9. Hytera Base Station Setup

2. Connect the TB3 base station to a PC with the test software.

S412E Setup

3. Set S412E to TETRA Analyzer Mode.
4. Ensure that the Modulation Type is set to “Base Station”

Setup -> Mod Type = Base Station

5. Set S412E Frequency:
 - Set Rx frequency to Tx frequency of the BS
 - Set Tx frequency to Rx frequency of the BS
6. Set the S412E Amplitude:
 - Set Input and Output Offset to the appropriate Loss. This also compensates for the loss through the attenuators, if external attenuators are used. Both Input and Output port offset levels must be set properly.
 - Set the Reference Level to an appropriate setting (a few dB higher than the expected TB3 Tx output level). This is to avoid overdriving the ADC.
 - Set the Output Level to your desired test level.
Note that losses and external attenuation will be taken into account by the offset setting used earlier. If you want –110 dBm output, set the Output Level to –110 dBm.

7. Set up TETRA Base Station Receiver Sensitivity Mode:

Measurement -> TETRA BS Sensitivity ->
Base Station = Hytera

The TCH/7.2 Test Pattern ECC will be set with the following:

- BCC = 1
- MCC = 0
- MNC = 0

8. Set up the Hytera Test Software for Sensitivity Measurement.
9. Verify that the Hytera BS is transmitting and that the ECC displayed on the S412E is what is expected.
10. Do not start measuring the BER until the S412E signal generator starts transmitting.
11. Start the S412E BS Sensitivity test by selecting the “Start Test” button in the TETRA BS Sensitivity menu.
12. WAIT for the “Start Test” button to change to “Stop Test” – this lets you know that the signal generator has synchronized to the BS frame structure and is playing the TCH/7.2 signal.

Measurements	BS Sensitivity
TETRA ●	Base Station
Analyzer →	Hytera
TETRA ○	BCC = 1
Coverage →	MCC = 0
	MNC = 0
TETRA	Trigger Type
IQ Capture	External <u>Internal</u>
TETRA	Trigger Edge
BS Sensitivity →	<u>Rising</u> Falling
	Delay Adjustment
	85.200 ms
	Start Test ●
	Back
	←

13. Ensure that the BS under test has its ECC set to the following:

- BCC = 1
- MCC = 0
- MNC = 0

14. Start the BER measurement on the TB3 BS.

- The signal from the S412E will restart every 60 seconds, so make sure that the BER measurement is made within this time interval. If a measurement occurs between these 60 second bursts, the BER measurement will result in errors as the Hytera BS will no longer be synchronized to the S412E bit pattern. If this happens, the measurement must be restarted.
- You can now go to the Amplitude menu and change the Amplitude to your desired level.

Note	If you go back to the BS Sensitivity menu, the test will stop and you can restart it by following the same procedure.
-------------	---

15. Stop the test on the S412E:

Measurement -> TETRA BS Sensitivity -> Stop Test.

16. Disconnect the equipment.

Motorola TETRA Station

Hardware Setup

A test PC with HyperTerminal (or similar) is required for this test (Man-Machine Interface (MMI) commands are used to control the BTS using this connection). A special BTS Test/Service Cable (“Service Connector Box”, available from the BTS manufacturer) is used for connecting a PC (RS232 connector) to the Base Radio (RJ45 connector on a service port) and to the S412E test equipment (External Trigger and External Reference BNC connectors). The cable has additional functionality for measuring receiver sensitivity and it is necessary to use the sync pulses from the base radio for the test set timing/synchronization.

Note

The LMR Master S412E supports Motorola MTS and Motorola EBTS Tx patterns. The setup pictured below is for a Motorola MTS base station. Your particular test configuration may be different. Refer to your Motorola Base Station documentation.

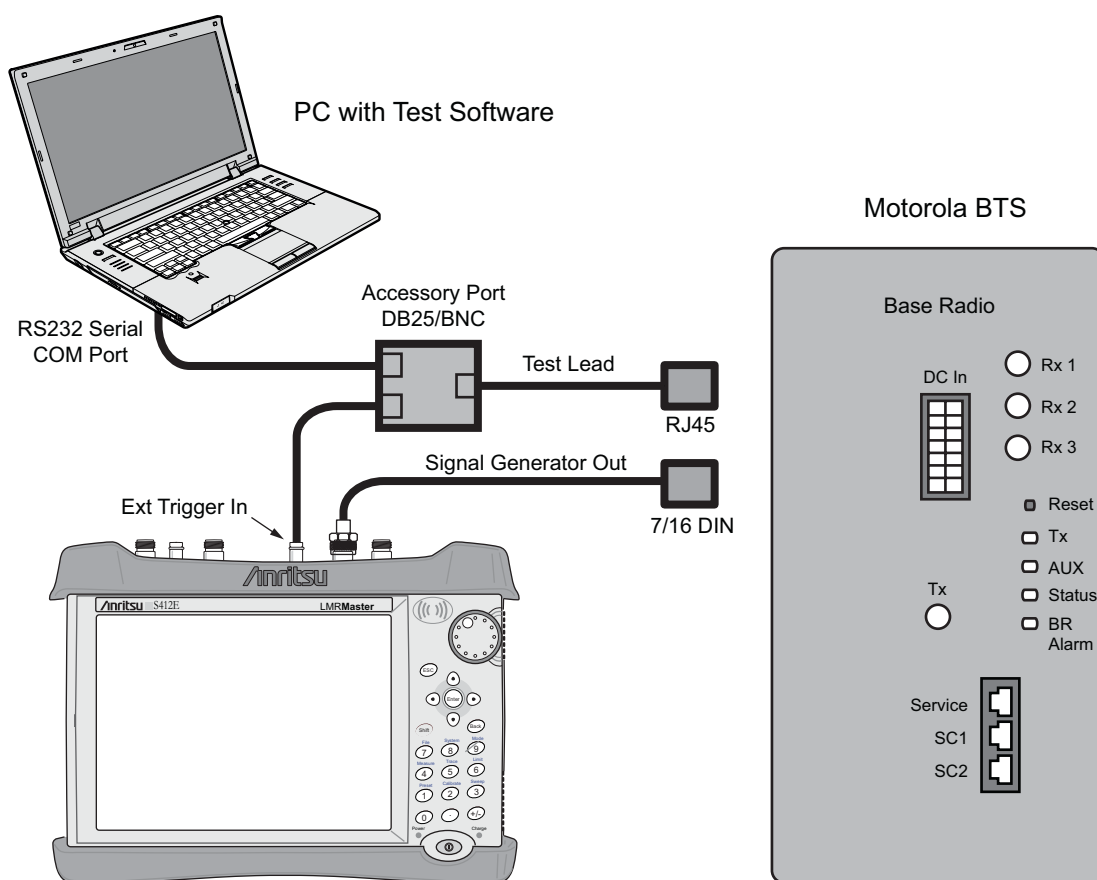


Figure 7-10. Motorola MTS Base Station Setup

1. Connect one end of the service cable to the service computer (RS232 port).
2. Connect the other end of the service cable to the base radio front panel **Service** access port (RJ45 port).

3. Disconnect the existing cables from the base radio Tx and Rx connectors (or the connector corresponding to the receiver under test).
4. Connect a coaxial test cable to the Tx/Rx antenna port connector (or to the connector corresponding to the receiver under test: Rx 1, Rx 2, Rx 3).
5. Connect the other end of the coaxial test cable to the RF output on a S412E TETRA “Signal Generator Out” (N-female). The S412E should be powered on in a TETRA Analyzer mode and warmed-up according to the operation manual.
6. Connect the Trigger Output connector on the service port cable to the “External Trigger In” on the S412E.
7. Switch on the power of the base radio and enter the test application mode. On the test PC, start the BTS Service Software application, select the proper MTS type and log on (refer to the BTS Service Manual for more details and MMI commands).

S412E Setup

8. On the S412E, set up TETRA Base Station Receiver Sensitivity Mode:

Measurement -> TETRA BS Sensitivity ->
Base Station = Motorola MTS or EBTS

The TCH/7.2 Test Pattern ECC will be set with the following: BCC = 1; MCC = 0; MNC = 0.

- Motorola MTS:
Trigger Type = External
Trigger Edge = Rising
Delay Adjustment = 28.064 ms
- Motorola EBTS:
Trigger Type = External
Trigger Edge = Falling
Delay Adjustment = 85.113 ms

9. Set the S412E TETRA signal generator to the receive frequency of the base radio under test:

Frequency -> Tx Freq

All receivers within a single base radio have the same receive frequency.

10. Set the S412E TETRA signal generator to generate the test signal at an output level of -117.5 dBm (or according to particular test requirements):

Amplitude -> Tx Output Lvl.

Use Tx Power Offset menu to compensate losses due to the test cable and adapters in use.

Measurements	BS Sensitivity
TETRA ●	Base Station
Analyzer →	Motorola MTS
TETRA ○	BCC = 1
Coverage →	MCC = 0
	MNC = 0
	Trigger Type
	<u>External</u> Internal
TETRA	Trigger Edge
IQ Capture	<u>Rising</u> Falling
TETRA	Delay Adjustment
BS Sensitivity →	28.064 ms
	Start Test ●
	Back
	←

11. Start the test on S412E:

Measurement -> TETRA BS Sensitivity -> Start Test.

12. WAIT for the “Start Test” button to change to “Stop Test” – this lets you know that the signal generator has synchronized to the BS frame structure and is playing the TCH/7.2 signal.
13. Type the corresponding MMI command (refer to the BTS Service Manual for more details) on a service computer test application to analyze the received RF signal quality of the base radio.
14. A performance report is returned including Received Signal Strengths Indicator (RSSI) for each receive path and bit error rate (BER). Verify that these parameters are within specification.
15. Record the results in a test results sheet.

Step example:

Receiver Number	=	1	2	3
SGC Attenuation (dB)	=	0	0	0
Sync. Location (1/10 us)	=	1058	1058	1058
Sync. Amplitude (dB)	=	-81	-81	-81
Total Bits/Msqs	=	86400	86400	86400
Bits/Msqs in Error	=	2186	2214	2251
BER/MER (%)	=	2.530092	2.562500	2.605324
RSSI (dBm)	=	-118	-118	-119

16. Stop the test on the S412E:

Measurement -> TETRA BS Sensitivity -> Stop Test.

17. Repeat [Step 11](#) through [Step 15](#) for all receiver branches.
18. Disconnect the equipment.

ETELM TETRA Station

Controlling the Base Station

1. Connect the Serial Cable from one of the two ports on the Base Station to the computer (if unsure of which to use, try both). If your PC does not have a serial port, you need a Serial to USB adapter.
2. Run the TTCI software application and load the included Anritsu's setup file Anritsu.ttc.
3. Select the proper COM Port for your computer.
4. Press the connect button. The connection indicator on the bottom left should turn green.

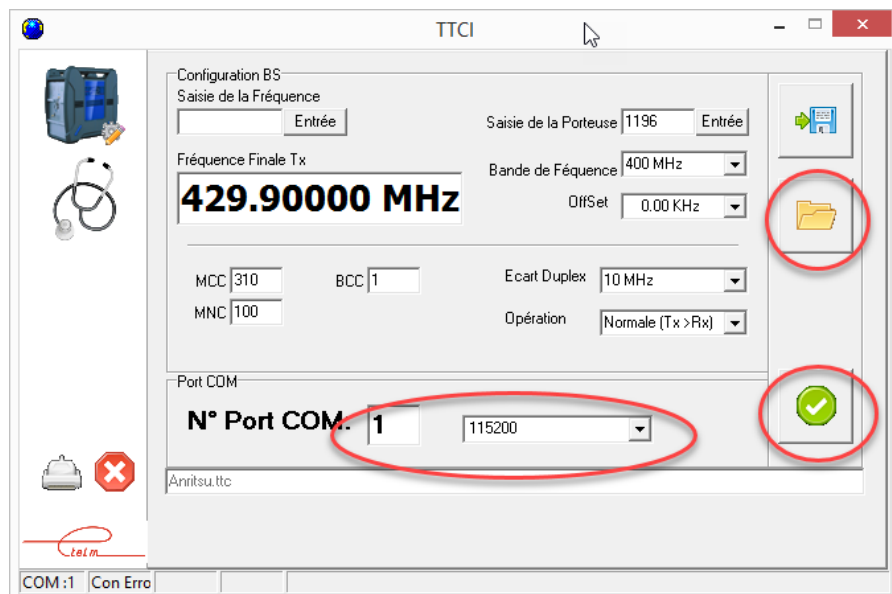


Figure 7-11. TCI Software Configuration

7-5 TETRA Base Station Receiver Sensitivity TestingTETRA Analyzer (Option 581)

- 5. Once connected, press the Stethoscope button to access the test screen, and then start the test by pressing the “play” button.

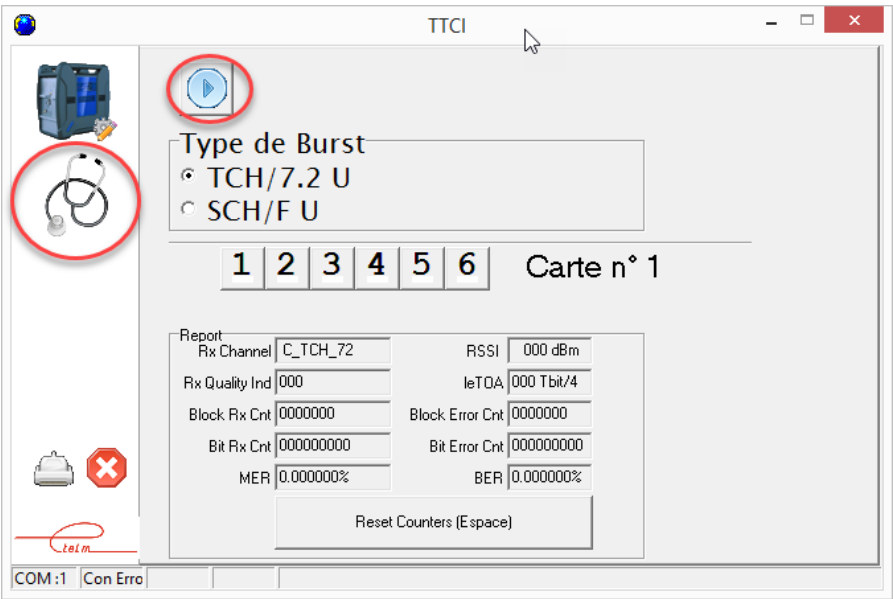


Figure 7-12. Running TTCI Software

Hardware Setup

6. Connect the ETELM base station and the S412E to the MA25200A High Power Input Protection Module as shown below:

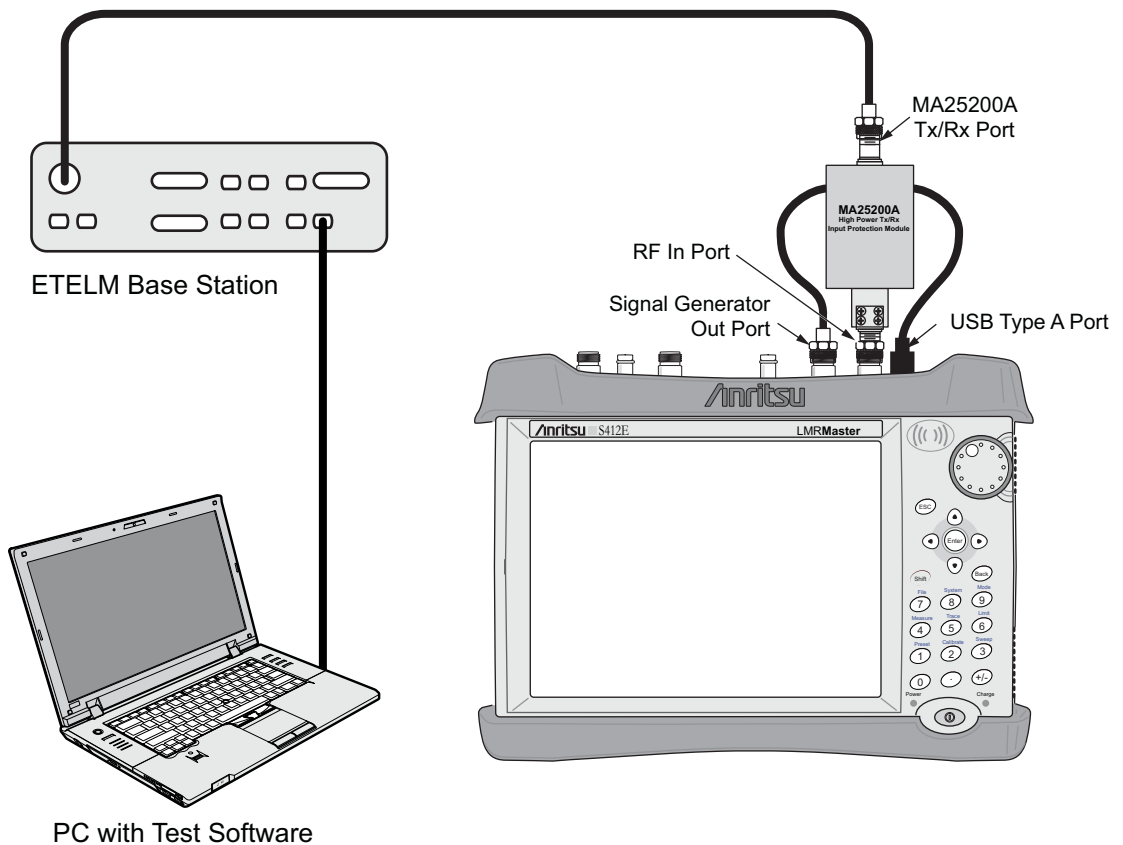


Figure 7-13. ETELM Base Station Setup

S412E Setup

7. Set S412E to TETRA Analyzer Mode.
8. Ensure that the Modulation Type is set to “Base Station”

Setup -> Mod Type = Base Station

9. Set S412E Frequency:
 - Set Rx frequency to Tx frequency of the BS
 - Set Tx frequency to Rx frequency of the BS
10. Set the S412E Amplitude:
 - Set Input and Output Offset to the appropriate Loss. This also compensates for the loss through the attenuators, if external attenuators are used. Both Input and Output port offset levels must be set properly.

7-5 TETRA Base Station Receiver Sensitivity TestingTETRA Analyzer (Option 581)

- Set the Reference Level to an appropriate setting (a few dB higher than the expected TB3 Tx output level). This is to avoid overdriving the ADC.
- Set the Output Level to your desired test level.
Note that losses and external attenuation will be taken into account by the offset setting used earlier. If you want -110 dBm output, set the Output Level to -110 dBm.

11. Set up TETRA Base Station Receiver Sensitivity Mode:

Measurement -> TETRA BS Sensitivity -> Base Station = ETELM NeTIS

This will set the ECC to ETELM recommended test default; do not change any other settings.

12. Make sure the BS is transmitting and verify that the ECC displayed on the S412E is what is expected.
13. Start the S412E BS Sensitivity test by selecting the “Start Test” button in the TETRA BS Sensitivity menu.
14. WAIT for the “Start Test” button to change to “Stop Test” – this lets you know that the signal generator has synchronized to the BS frame structure and is playing the TCH/7.2 signal.
15. Read the BER Results from the ETELM Software.
16. Stop the test on the S412E:

Measurement -> TETRA BS Sensitivity -> Stop Test.

17. Disconnect the equipment.

Measurements	BS Sensitivity
TETRA 	Base Station
Analyzer →	ETELM NeTIS
TETRA 	BCC = 1
Coverage →	MCC = 310
	MNC = 100
	Trigger Type
	External <u>Internal</u>
TETRA	Trigger Edge
IQ Capture	<u>Rising</u> Falling
TETRA	Delay Adjustment
BS Sensitivity →	113.568 ms
	Start Test 
	Back
	←

7-6 TETRA Analyzer Menus

Menu maps typically display all possible submenu keys, although some keys are displayed on the instruments only under special circumstances (refer to menu descriptions on the following pages).

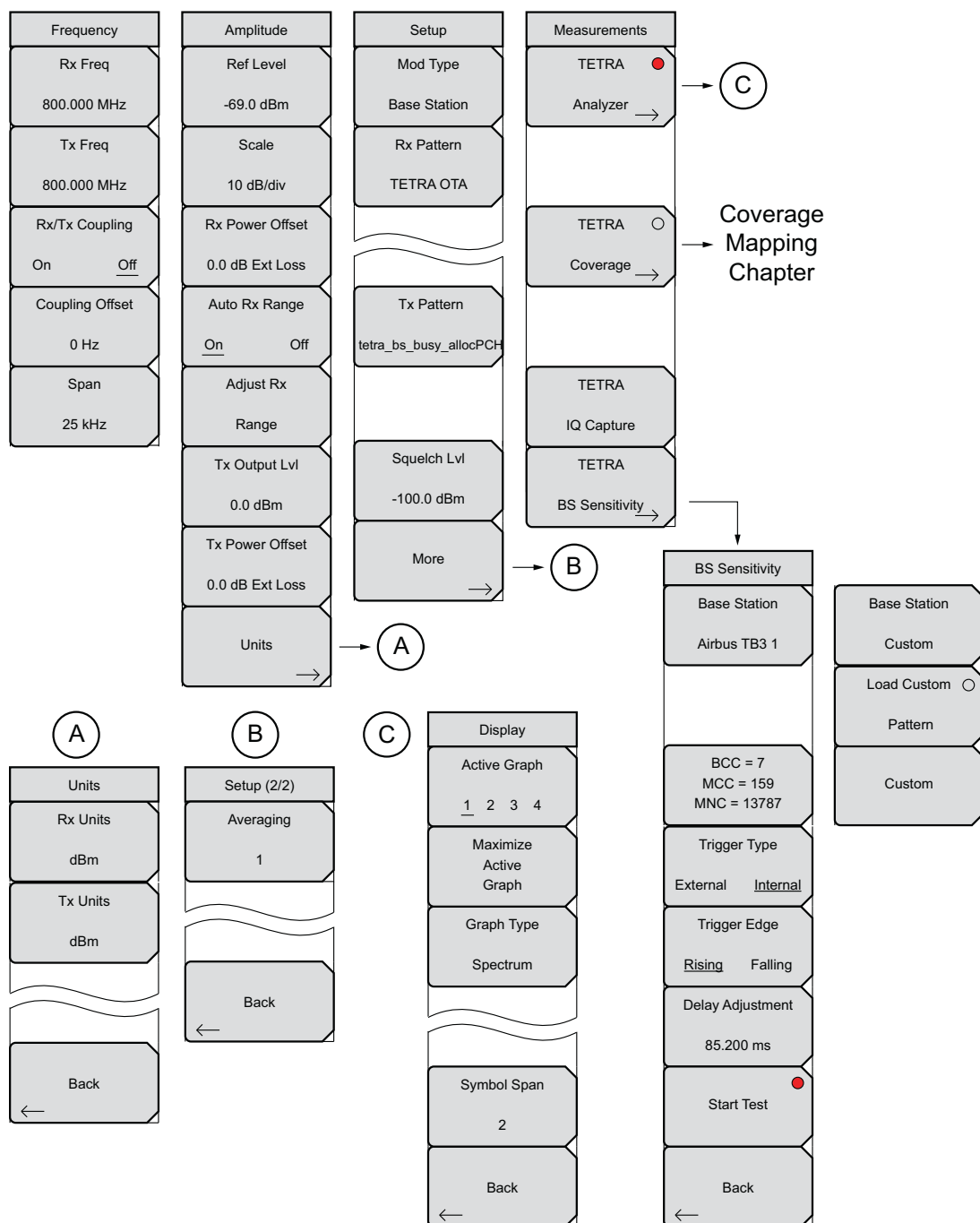


Figure 7-14. TETRA Analyzer Menu Layout

7-7 Frequency Menu

Key Sequence: **Frequency**

Frequency	Rx Freq: Sets the receiver frequency. Press the Rx Freq key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the submenu key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the Enter key has the same effect as pressing the MHz submenu key.
Rx Freq 800.000 MHz	
Tx Freq 800.000 MHz	Tx Freq: Sets the signal generator frequency. Press Tx Rx Freq key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the submenu key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the Enter key has the same effect as pressing the MHz submenu key.
Rx/Tx Coupling On Off	Rx/Tx Coupling: Couples the signal generator to the receiver frequency. When set to On the Tx Freq key is disabled.
Coupling Offset 0 Hz	Coupling Offset: Sets the Offset of the signal generator frequency and the receiver frequency. Only functional when Rx/Tx Coupling is set to On.
Span 25 kHz	Span: Sets the span of the Spectrum Graph. Span selections are 25 kHz, 50 kHz, 100 kHz, 500 kHz, 1 MHz, and 5 MHz.

Figure 7-15. TETRA Analyzer Frequency Menu

7-8 Amplitude Menu

Key Sequence: **Amplitude**

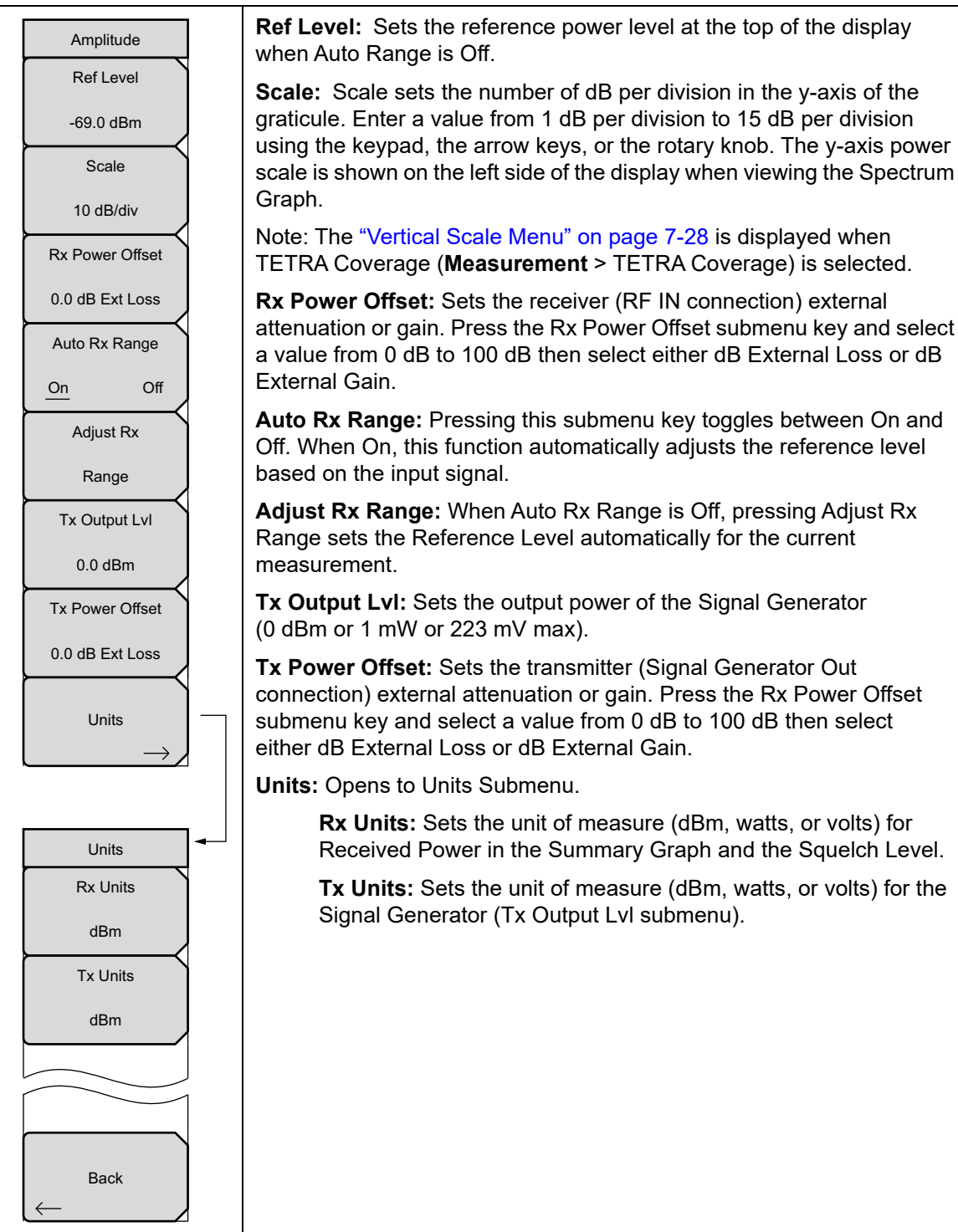


Figure 7-16. TETRA Analyzer Amplitude Menu

Vertical Scale Menu

Key Sequence: **Amplitude** > Vertical Scale

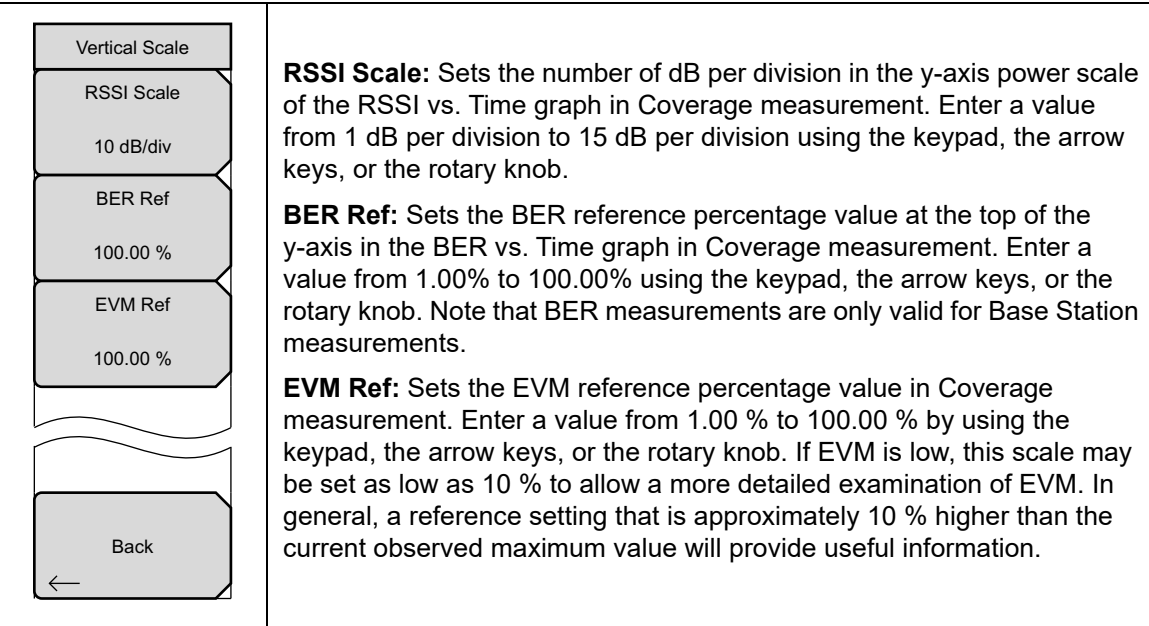


Figure 7-17. Vertical Scale Menu

Refer to 10580-00425B-TETRA- Patterns Quick Start Guide to learn how to load custom DL Patterns.

7-9 Setup Menu

Key Sequence: **Setup**

Setup	
Mod Type	Mod Type: Sets the type of modulation. The options are Mobile Station or Base Station.
Base Station	
Rx Pattern	Rx Pattern: The setting of this key is locked to "TETRA OTA".
TETRA OTA	
Tx Pattern	Tx Pattern: Selects the transmitter pattern to send when the
tetra_bs_busy_allocPCH	Turn Sig-Gen ON main menu key is selected. Select a pattern from the list box with the arrow keys or rotary knob and press Enter .
Squelch Lvl	Squelch Lvl: Sets the squelch power level. When the Received Power is
-100.0 dBm	lower than the set squelch level, all summary graph measurements except for Received Pwr will be blanked out (--).
More	More: Opens the "Setup (2/2) Menu" on page 7-31.

Figure 7-18. TETRA Analyzer Setup Menu

Setup	
Mod Type Base Station	Mod Type: Sets the type of modulation. The options are Mobile Station or Base Station.
Rx Pattern TETRA OTA	Rx Pattern: The setting of this key is locked to “TETRA OTA”.
Load Custom DL Pattern	Load Custom: Loads the custom DL pattern generated using TETRA signal generator application. Copy the custom DL pattern file (.txt) into a USB memory device, and recall the file to load the custom pattern.
Custom Pattern Info (None)	Custom Pattern Info: Displays the custom DL pattern information such as center frequency, MCC, BCC, MNC and LAC.
Tx Pattern tetra_bs_busy_allocPCH	Note: Load Custom and Custom Pattern Info soft keys are available in the instruments which signal generator flash size greater than or equal to 2 .Giga bits. Press Shift > System> Application Self Test, to check the signal generator flash size.
	Tx Pattern: Selects the transmitter pattern to send when the Turn Sig-Gen ON main menu key is selected. Select a pattern from the list box with the arrow keys or rotary knob and press Enter .
Squelch Lvl -100.0 dBm	Squelch Lvl: Sets the squelch power level. When the Received Power is lower than the set squelch level, all summary graph measurements except for Received Pwr will be blanked out (--).
More →	More: Opens the “ Setup (2/2) Menu ” on page 7-31.

Figure 7-19. TETRA Analyzer Setup Menu- Custom DL Pattern

Setup (2/2) Menu

Key Sequence: **Setup** > More

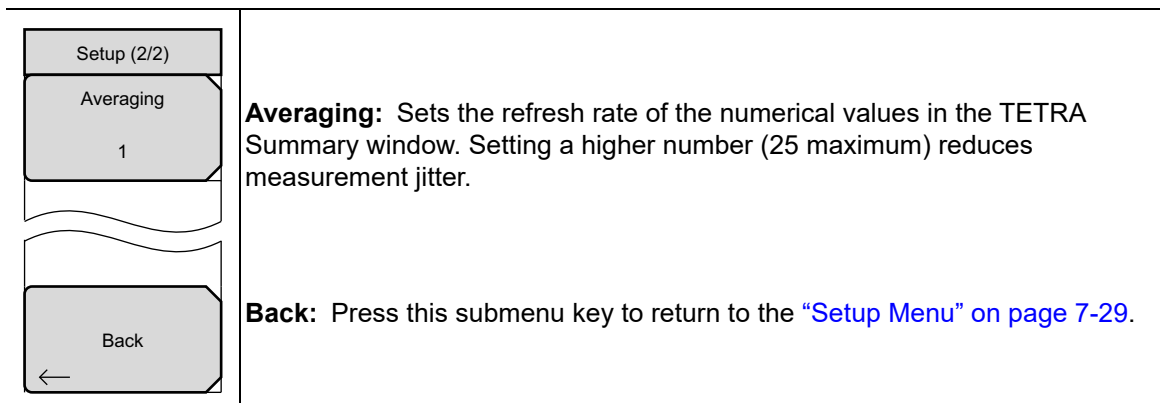


Figure 7-20. TETRA Analyzer Setup Menu

7-10 Measurement Menu

Key Sequence: **Measurement**

<div>Measurements</div> <div>TETRA </div> <div>Analyzer →</div>	TETRA Analyzer: Opens the “ Display Menu ” on page 7-33.
<div>TETRA </div> <div>Coverage →</div>	TETRA Coverage (Option 582 required): Opens the TETRA Coverage menu. Refer to Chapter 11, “LMR Coverage Mapping” .
<div>TETRA</div> <div>IQ Capture</div>	TETRA IQ Capture: Pressing this key starts the IQ data capture. Make sure that a formatted USB flash drive is attached to the instrument before starting IQ Capture. When the capture is complete, a message is displayed. This may take a few seconds.
<div>TETRA</div> <div>BS Sensitivity →</div>	TETRA BS Sensitivity: Opens the “ BS Sensitivity Menu ” on page 7-34.

Figure 7-21. TETRA Analyzer Measurement Menu

Display Menu

Key Sequence: **Measurement** > TETRA Analyzer

<div><div>Display</div><div>Active Graph</div><div>1 2 3 4</div><div>Maximize Active Graph</div><div>Graph Type</div><div>Constellation</div><div>Symbol Span</div><div>2</div><div>Back</div></div>	<p>Active Graph 1 2 3 4: In Four Screen view use this menu to select which of the four graphs is active. The current active graph is underlined (1 2 3 4) and has a red perimeter line. Any of the four graphs can also be made active by tapping once on the touch screen. Repeatedly pressing the Active Graph submenu key will cycle the active graph, 1 through 4.</p> <p>In Standard view (one graph displayed on the screen) the Active Graphic key will rotate between the four graphs displayed in the Four Screen view.</p> <p>Maximize/Minimize Active Graph: The submenu key toggles between displaying the Four Screen (4 graphs) view and the Standard view (1 graph). Tapping twice on a selected graph also toggles between the two display options.</p> <p>Graph Type: The label on the bottom of this button displays the current active graph type. Pressing the button will open a list box of the graph types available for TETRA Analyzer measurements. Select the desired graph type with the arrow keys or rotatory knob and press Enter. The current active graph will be replaced with the new selection.</p> <p>Available graphs include:</p> <ul style="list-style-type: none">ConstellationSpectrumEye DiagramSummaryTETRA Summary <p>Refer to “TETRA Analyzer Graphs” on page 7-3 for additional information.</p> <p>Symbol Span: Use this menu to adjust the number of symbols viewed across the screen in the Eye Diagram graph. Adjust from 2 through 5 using the keypad, the arrow keys, or the rotary knob. Keypad values entered outside of this range are ignored.</p> <p>Back: Returns to the “Measurement Menu” on page 7-32.</p>
--	---

Figure 7-22. TETRA Analyzer Display Menu

BS Sensitivity Menu

Key Sequence: **Measurement** > TETRA BS Sensitivity

BS Sensitivity

Base Station

Motorola MTS

BCC = 1

MCC = 0

MNC = 0

Trigger Type

External Internal

Trigger Edge

Rising Falling

Delay Adjustment

28.064 ms

Start Test

Back

BS Sensitivity

Base Station

Custom

Load Custom

Pattern

Custom

Base Station: Pressing this button displays a Manufacturer Selector list where you can select a preloaded base station manufacturer (Airbus, Hytera, Sepura, Motorola, ETELM NeTIS) or choose to load a custom pattern. When Custom is selected, the **Load Custom Pattern** button becomes available (shown below, left) to load a custom pattern from memory or a USB device. Once a pattern is loaded, the button indicator turns red.

BCC/MCC/MNC: This button indicates the number of MultiFrames (#MF) of the currently loaded signal pattern: Base Color Code (BCC), Mobile Country Code (MCC), and Mobile Network Code (MNC). **No Pattern Loaded** is displayed when a valid pattern is not loaded.

Trigger Type: Toggles between External and Internal trigger.

Trigger Edge: Toggles between Rising and Falling trigger edge.

Delay Adjustment: Sets the playback delay. Press the Delay Adjustment key and enter the desired playback delay using the keypad, the arrow keys, or the rotary knob. If entering a delay time using the keypad, the submenu key labels change to ms or μs. Press the appropriate units key. Note that changing the delay will change the selected Base Station to Custom or to another manufacturer.

Start/Stop Test: This button is active (red indicator) once a valid TCH/7.2 test pattern has been loaded into signal memory and is ready to start a test. When this button is pressed, the test signal starts playing back continuously (clear indicator) and button text changes to **Stop Test**. Pressing the button again, changing a setting or leaving the BS Sensitivity menu will stop the test. The button may also display **Waiting for Trigger**.

Back: Returns to the [“Measurement Menu” on page 7-32](#).

Figure 7-23. TETRA BS Sensitivity Menu

7-11 Sweep Menu

Key Sequence: **Shift** > **Sweep (3)** key

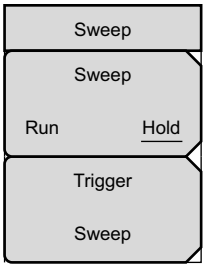
	<p>Sweep Run/Hold: This submenu key toggles between continuous (run) sweep and hold sweep. In Run sweep mode, sweeps are continuous and one starts immediately after the previous sweep is completed. In Hold sweep mode, the results of the last sweep are displayed on the screen while the instrument waits for a trigger event to start a new sweep. HOLD is displayed on the right side of the screen in this mode.</p> <p>Trigger Sweep: Pressing this submenu key causes the instrument to make a single sweep when the instrument is in Hold sweep mode. This key has no function when the instrument is in Run sweep mode.</p>
---	--

Figure 7-24. TETRA Analyzer Sweep Menu

7-12 Measure Menu

Key Sequence: **Shift** > **Measure (4)** key

Display the [“Measurement Menu” on page 7-32.](#)

7-13 Trace Menu

This menu is not available in TETRA Analyzer measurement mode.

7-14 Limit Menu

This menu is not available in TETRA Analyzer measurement mode.

7-15 Other Menus

Preset, **Calibrate**, **File**, **System** and **Mode** are described in the User Guide.

Chapter 8 — DMR Analyzer (Option 591)

8-1 Introduction

The DMR Analyzer option provides a method to verify the operation of Digital Mobile Radio (DMR) compliant equipment. DMR is an open digital radio standard specified in the European Telecommunications Standards Institute (ETSI) Standards TS 102 361.

Option 591 includes the ability to display constellation, spectrum, histogram, and eye diagram graphs. In addition, a summary graph displays numeric values of received power, frequency error, modulation fidelity (Mod Fid), bit error rate (BER), symbol deviation, Color Code (CC), and symbol rate error of the input signal. BER comparisons can be made to the 1031 Hz Standard Tone or the Standard Transmitter Test (O.153) pattern, regular voice traffic using a proprietary algorithm.

8-2 Setup Procedure

Direct Connect to the Transmitter

1. Press the **Menu** key then select the DMR Signal Analyzer icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight DMR Analyzer and press **Enter**.

Caution

The maximum input power without damage is 2 watts (+33 dBm) to the RF In 50 ohm connector. To prevent damage, use a coupler or attenuator to reduce the input power to below this level when measuring high output power devices. Refer to [Chapter 12, "High Power Input Protection"](#)

2. Connect the transmitter to the RF In 50 Ohm connector on the LMR Master using a coupler or attenuator.
3. Press the **Frequency** main menu key to set the receiver center frequency (Rx Freq) of the measurement. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.
4. Press the **Setup** main menu key to select the receiver modulation type. Select **Base Station** or **Mobile Station** using the RX Mod Type key. Press the Rx Pattern key to choose the pattern against which to measure error rates. 1031 Hz and O.153 (V.52) will measure BER directly against the selected pattern. **Voice** uses a proprietary method to estimate BER from regular voice traffic. **Silence** and **Idle** are two additional patterns in DMR that can be used to measure BER.
5. For Base Station modulation type, select the TDMA slot (1 or 2) using the Rx Slot submenu key.
6. Press the **Amplitude** main menu key, then the Rx Power Offset submenu key to set the receiver attenuation (or gain). Use the arrow keys, rotary knob or the numeric keypad to enter the adjustment value, up to 100 dB, and then press either the **Loss** or **Gain**

submenu key. For instance, if the transmitter under test is emitting 50 watts (+47 dBm) of power, and the External Attenuation value is 40 dB (such as from a 40 dB directional coupler), then the Received Power displayed will be +7 dBm.

7. Press the **Measurement** key, then the DMR Analyzer submenu key. Select the Graph types to view with the **Graph Type** submenu key. The **Symbol Span** submenu is used to adjust the number of “eyes” displayed across the screen in the Eye Diagram graph. Refer to [“DMR Analyzer Graphs” on page 8-4](#) on the available graph types.

Over-the-Air (OTA) Analysis Setup

1. Press the **Menu** key then select the DMR Signal Analyzer icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight DMR Analyzer and press **Enter**.

Caution

The damage input power level is 2 watts (+33 dBm) to the RF In 50 Ohm connector. To prevent damage, use a coupler or attenuator to reduce the input power to below this level when measuring high output power devices.

2. Connect an antenna with the appropriate frequency range to the RF In 50 Ohm connector on the LMR Master.
3. Press the **Frequency** main menu key to set the center frequency of the measurement using the **Rx Freq** key. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.
4. Press the **Setup** main menu key to select the modulation type. Select **Base Station** or **Mobile Station** using the **Mod Type** key. Press the **Rx Pattern** key to choose the pattern against which to measure error rates. 1031 Hz and O.153 (V.52) will measure BER directly against the selected pattern. Voice uses a proprietary method to estimate BER from regular voice traffic. **Silence** and **Idle** are two additional patterns in DMR that can be used to measure BER. Refer to [“DMR Analyzer Graphs” on page 8-4](#) on the available graph types.
5. Select the TDMA slot (1 or 2) using the **Rx Slot** submenu key.

Using the Signal Generator for Receiver or OTA Analysis

1. Press the **Menu** key then select the DMR Signal Analyzer icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight DMR Analyzer and press **Enter**.

Caution	The maximum output power from the Signal Generator Out connector is 1 mW (0 dBm) and the frequency range is 500 kHz to 1.6 GHz.
----------------	---

2. Direct connect the LMR Master Signal Generator Out 50 Ohm connector to the repeater/receiver or connect an antenna with the appropriate frequency range to the connector.
3. Press the **Frequency** main menu key to set the transmit frequency using the Tx Freq key. Use the arrow key, rotary knob, or the numeric keypad. When using the keypad, press the appropriate terminator submenu key to set the center frequency.

If testing a DMR repeater, then you can bind the transmit frequency to the receive frequency by setting Rx/Tx Coupling to On and entering the Coupling Offset.

Note	When Rx/Tx Coupling is on, the Tx Freq submenu key is disabled.
-------------	---

4. Press the **Amplitude** main menu key, then the Tx Output Lvl submenu key to set the output power. Enter any output attenuation or gain using the Tx Power Offset key.
5. Set the transmit pattern by pressing the **Setup** main menu key then the Tx Pattern submenu key. Available patterns are listed on the display and additional patterns can be downloaded via the **System** > Application Options menu.
6. For Base Station testing, select the TDMA slot (1 or 2) using the Rx Slot submenu key.
7. Press the **Turn Sig-Gen ON** main menu key to start the signal generator. Press the key again to turn Off the signal generator.

8-3 DMR Analyzer Graphs

The following DMR Analyzer measurements are available on the LMR Master. From the **Measurements** main menu press DMR Analyzer twice. Press the Graph Type submenu key to select the measurement type.

Constellation and Linear Constellation

Constellation view displays the demodulation information in an IQ format (Figure 8-1). The chart shows the relationship between the location of a constellation data point, its deviation frequency, and the information it carries.

Symbol: +3	Symbol: +1
Bit Information: 01	Bit Information: 00
Dev.: +1944 Hz	Dev.: +648 Hz
Symbol: -3	Symbol: -1
Bit Information: 11	Bit Information: 10
Dev.: -1944 Hz	Dev.: -648 Hz

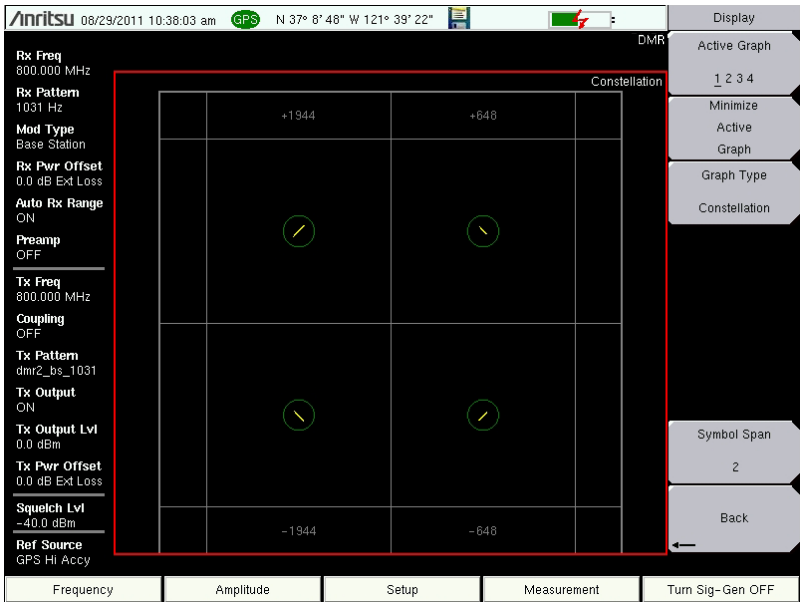


Figure 8-1. Constellation Diagram

Figure 8-2 shows the same information in the Linear Constellation View.

Symbol: -3	Symbol: -1	Symbol: +1	Symbol: +3
Bit Information: 11	Bit Information: 10	Bit Information: 00	Bit Information: 01
Dev.: -1944 Hz	Dev.: -648 Hz	Dev.: +648 Hz	Dev.: +1944 Hz

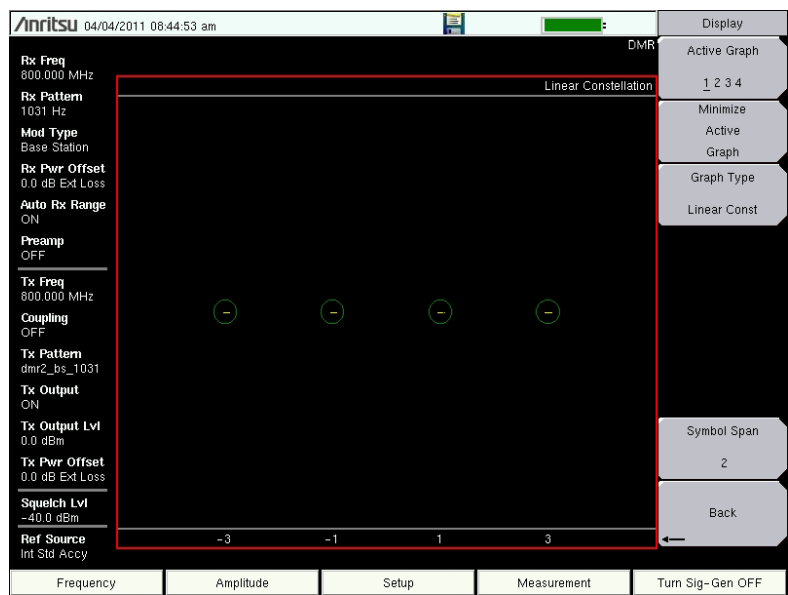


Figure 8-2. Linear Constellation Diagram

For input signals that are not DMR encoded, the LMR Master will still try to decode it and fit it to a symbol. This may cause some measurement results that are unexpected.

Histogram Graph

The Histogram graph displays a graphical representation of the symbols that are being received. The graph for each symbol represents the relative percentage that symbol was identified out of all the received symbols.

Each update of the screen is a separate representation of the latest data, rather than a cumulative total. The vertical scale is fixed at 0 % to 100 %, with each horizontal grid line representing 10 % of the total symbols received.

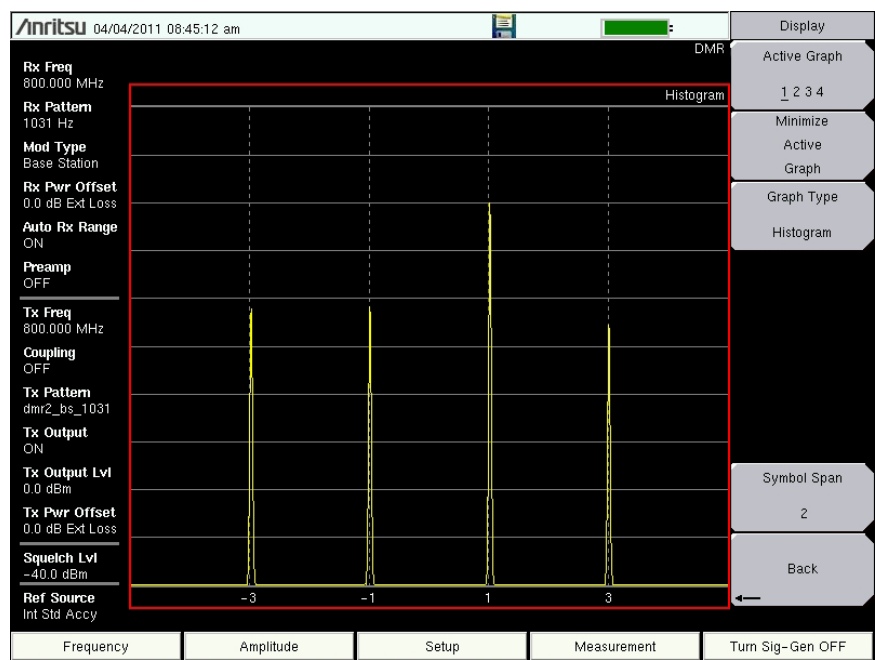


Figure 8-3. DMR Histogram

Spectrum Graph

The spectrum view displays a graphical representation of power (dBm) vs. frequency. The spectrum display gives an indication if there are interferers present that may degrade the bit error rate of the DMR signal. The frequency span is adjustable under the **Frequency** menu. The reference level is adjusted with the **Amplitude** menu. Refer to [“Amplitude Menu” on page 8-18](#) for details. [Figure 8-4](#) displays the same signal using a 25 kHz span and a 500 kHz span.

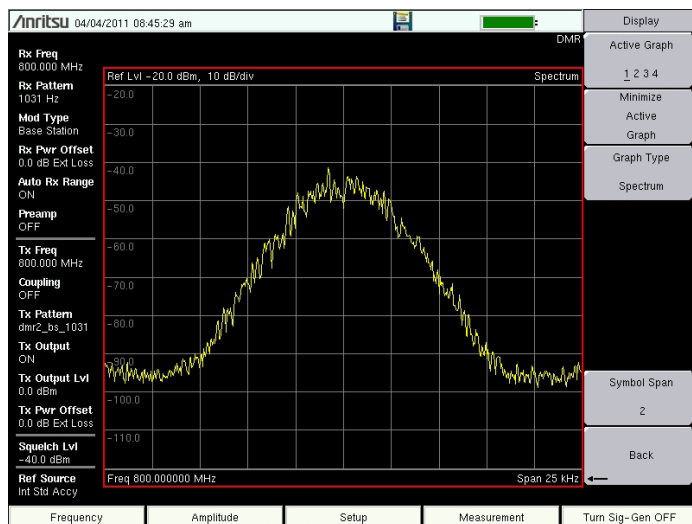
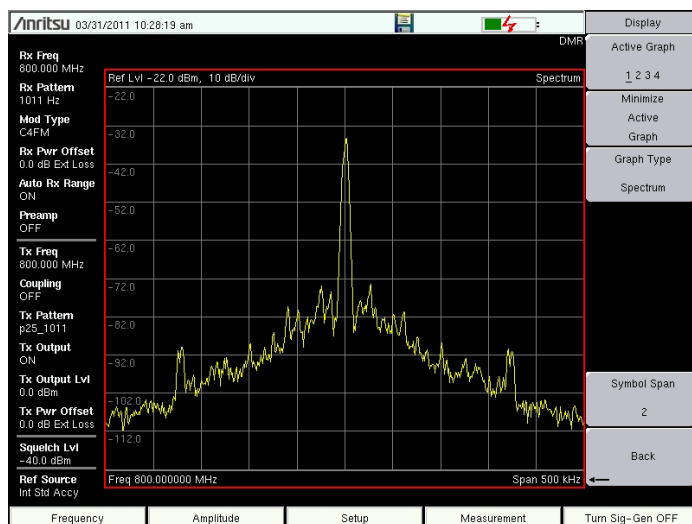


Figure 8-4. DMR Spectrum Graph (25 kHz Span and 500 kHz Span)

Eye Diagram

The eye diagram is an oscilloscope view of the DMR signal displaying the voltage of the signal vs. time. The diagram provides an indication of baseband fidelity of a DMR transmitter. With Over-the-air measurements the Eye Diagram can indicate phase distortion from multipath. The number of “eyes” displayed is set with the Symbol Span key under the “Display Menu” on page 8-22.

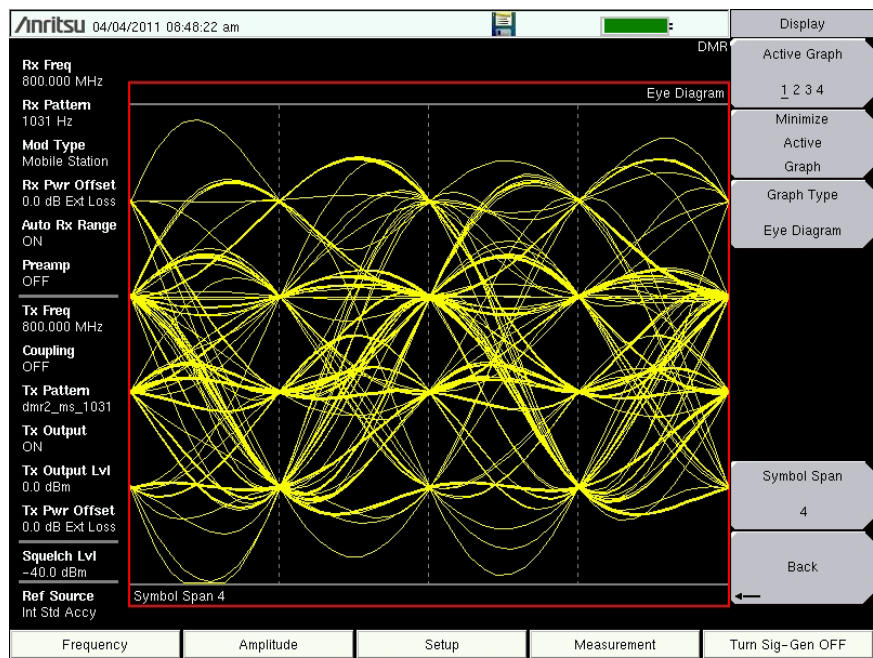


Figure 8-5. DMR Eye Diagram

Summary Graph and DMR Summary Graph

These two summary displays provide measured and decoded values in a table format.

Summary Graph

The summary graph provides an overview of a DMR transmitter. The graph displays numeric values of received power, frequency error, modulation fidelity (Mod Fid), bit error rate (BER), symbol deviation, Color Code (CC), and symbol rate error of the input signal.

The Received Power value in the summary graph can be toggled to dBm, watts, or volts by using the **Amplitude** > Units > Rx Units keys. This setting also applies to the squelch level setting.

The **Setup** > Squelch Lvl submenu key sets the squelch power level. When the Received Power is lower than the set squelch level, all summary graph measurements except for Received Pwr will be blanked out (--). When the Received Power is above the squelch level, the measurements will display as shown in [Figure 8-6](#).

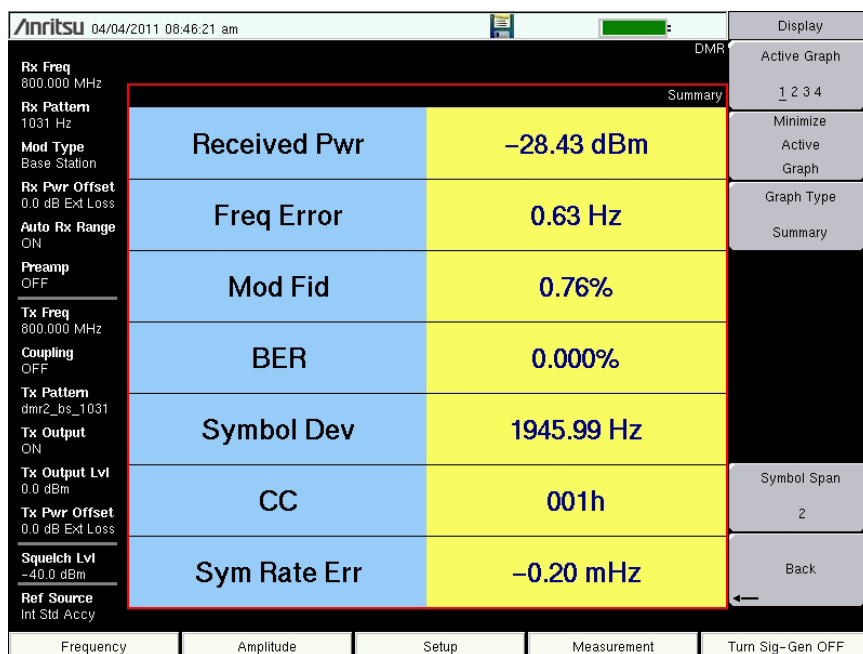


Figure 8-6. Summary Table with Received Pwr Above the Squelch Level

Received Pwr in the Summary table is the integrated power of all the energy in the receiver bandwidth. Any peak amplitude reduction seen in the Spectrum display when compared to Received Pwr is a function of the instruments RBW setting. The reduction is specified as: $10 \cdot \log(\text{Signal Bandwidth} / \text{Resolution Bandwidth})$.

DMR Summary Graph

The DMR Summary graph reports the MS ID, Target ID, Talk Group ID, FID, Call Type, Base Station ID permitted on a channel from the DMR transmitter.

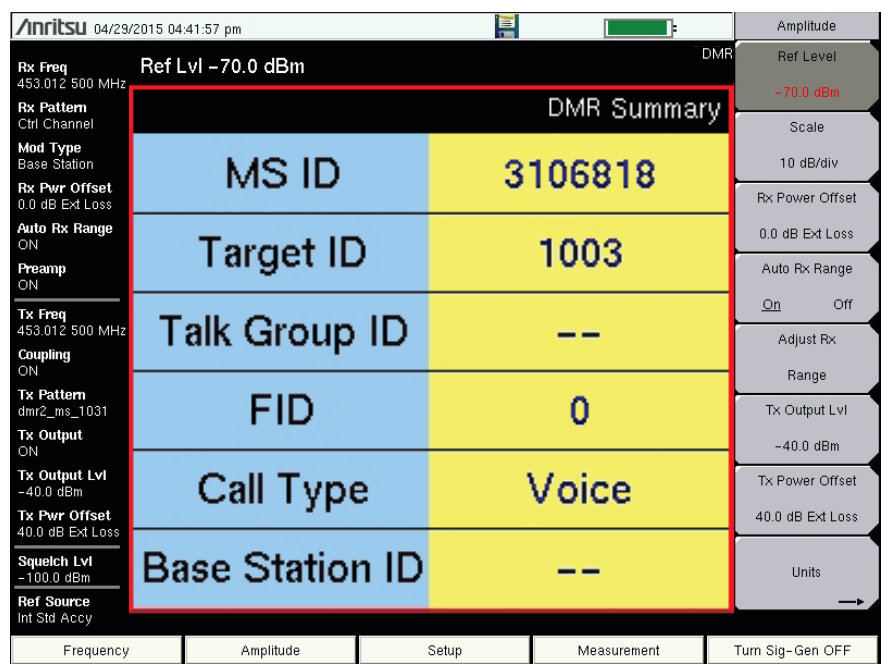


Figure 8-7. DMR Summary

Power Profile

The power profile graph is used with Mobile Station Rx Mod Type to display a zero-span view of power vs. time of the selected Rx Slot.

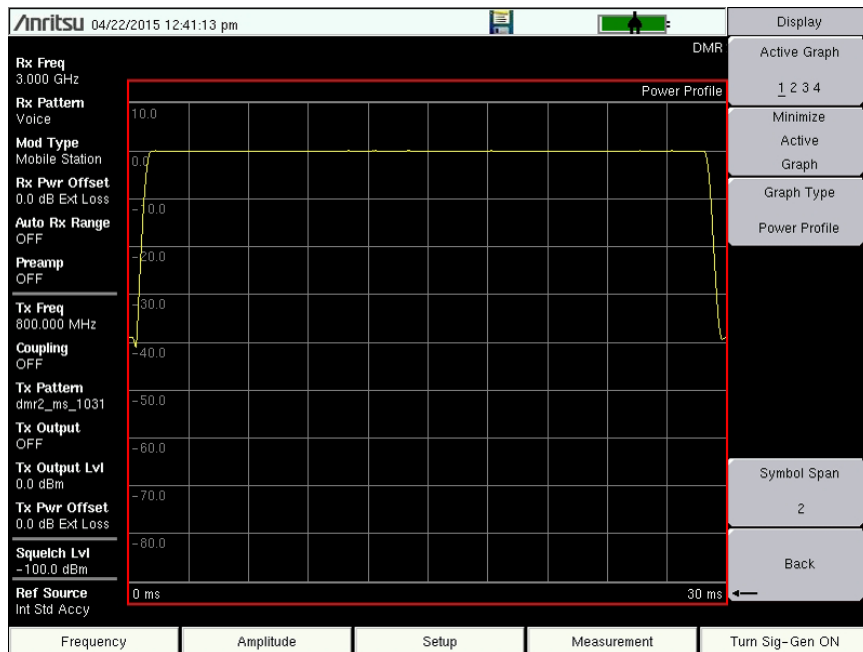


Figure 8-8. DMR Power Profile

8-4 DMR Bit Capture

Note

This measurement is captured on an external USB flash drive. The captured data file can not be recalled and displayed on the instrument screen.

The LMR Master can provide and log raw bits (pre Forward Error Correction) when the Rx Pattern is set to Voice.

1. From the **Frequency** main menu, set the receiver frequency (Rx Freq).
2. From the **Setup** main menu, choose Voice as the Rx Pattern.
3. From the **Measurement** main menu press the DMR Bit Capture submenu key twice.
4. To log data, insert a formatted USB flash drive in the LMR Master and set Log Data to On. The bit capture information will be written to a data stamped folder inside the /usr folder on the root level of the USB flash drive. The tab delimited text file contains the header and table information shown in Figure 8-9. The files are named:

BIT_CAP_LOGyearmonthdaytime.dmr

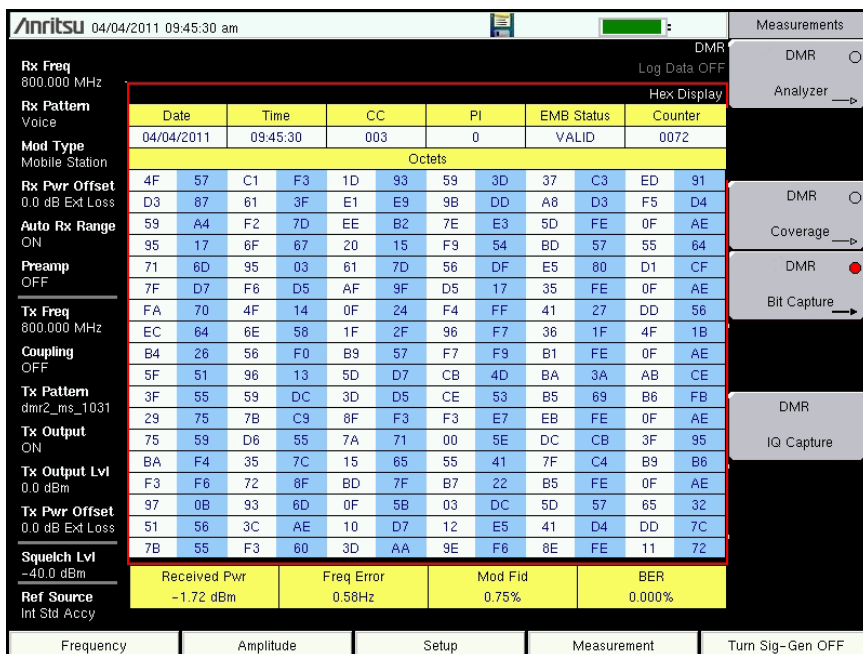


Figure 8-9. DMR Bit Capture Display

CC = Color Code

PI = Privacy Indicator

EMB Status = The EMB field contains CC, PI, and parity bits

Counter = Frame Count

Note This measurement is captured on an external USB flash drive. The captured data file can not be recalled and displayed on the instrument screen.

The LMR Master can capture and log DMR IQ data to a USB flash drive.

1. From the **Frequency** main menu, set the receiver frequency (Rx Freq).
2. Insert a formatted USB flash drive into the LMR Master and from the **Measurement** main menu, press the **DRM IQ Capture** submenu key. After approximately 10 seconds the instrument will display a message that the capture is complete.

The IQ data is sampled at 4,800 x 11 symbols per second. The saved file has an ASCII header and binary data (Figure 8-10). The data is written in 24-bit two's complement integers format. Interleaved Delta Phase (I) data then Magnitude (Q) data are captured. The file is intended for post-processing in MATLAB or other data analysis software.

The file will be written to a data stamped folder inside the `/usr` folder on the root level of the USB flash drive. The file is named:

IQ_CAPTUREyearmonthdaytime.dmr

Note There is no display menu for DMR IQ Capture. The LMR Master will continue to display the previous measurement screen during IQ Capture.

	A	B	C	D	E	F	G	H
1	LMRIQAnalyzer>							
2		<ProjectDefine>						
3			<Attribute Name="Type" Value="Service" />					
4			<Attribute Name="Name" Value="Digitizer" />					
5			<Attribute Name="FileVersion" Value="1.0.0.0" />					
6		</ProjectDefine>						
7		<Params>						
8			<Attribute Name="CaptureDate" Value="04/26/2011" />					
9			<Attribute Name="CaptureTime" Value="12/31/24" />					
10			<Attribute Name="Format" Value="INT24" />					
11			<Attribute Name="CenterFrequency" Value="800000000" />					
12			<Attribute Name="SamplingClock" Value="52800" />					
13			<Attribute Name="Bandwidth" Value="12500" />					
14			<Attribute Name="SampleType" Value="DeltaPhaseMag" />					
15			<Attribute Name="ReferenceLevel" Value="15.00" />					
16			<Attribute Name="AttenuatorLevel" Value="0.00" />					
17			<Attribute Name="CaptureSample" Value="40216" />					
18		</Params>						
19		<Data> m t A + xv t. m N T D Æ S bL ö g						
20		+Ä Äm H Ät t +s -s- B						
21		zE ÖæRUE æYAJ lÖl-t h Äk -t æY e ÖX t -g- t-ä s S n' æYÉ BÉ g2 ä&-y /						
22		ÜoçBÈ B-ÈSE æ'E pJZÄE' ö'E baöUE jNuOE ÆNUOE is æ'E Ö'stäE dq-Æ CÖ						
23		%æE slæE æ' äll						
24		*Y9 Øt gU-u æ+K -ÆS Öä Y'Ö 6Ua ÜBY Çj -Æ æ2-y set Ec kC d ... Ö! æH äH						
25		æZöl YE-Ä G'H y zä y æ'yÆ üx -Eöil Ec-ö ç i ö-ä æ i.- æ ÄÖæ@ ææ Bä ö-ä						
26		æZöl æ-äc æ'äU bæH t-æ-ä -ÜaP YæqæÖE nfæcE						
27		'æKE dR E æ'ROË BZGæ æ-s'Æ YæUR E fYSE						
28		ØU E Y-Æ' æ'SE l2 Eæ æ%Ø æH ØH Z æ i-æ i-æ Xz-i Ötæ æY						
29		bHj B-æ æØ æÄ E L+-d ch H æ'-ch D-						
30		l ö-ä						
31		NC-æ c'Zf æÖY r.- u' pUÄ ÖÖä EæY						
1845	(= zæ "æAP æ&E) ~ææ' YæBQ EöÄä æuæ YtÄl QjÄl oÖÄ-l YætäB *ü-c Data>							
1846	<LMRIQAnalyzer>							
1847								

- ASCII header lists the parametric information.

- Binary data in 24-bit two's complement integer format.

Figure 8-10. IQ Capture

8-6 DMR Repeater Receiver Sensitivity

The LMR Master can analyze the modulation quality and receiver sensitivity of a DMR repeater without needing to remove the repeater from service or to enable a special test mode.

Note

This example procedure illustrates one approach to making a repeater receiver sensitivity measurement. Different configurations may be used depending on accepted test procedures. Refer to [Chapter 12, “High Power Input Protection”](#) for an alternate connection method, especially if a direct connection to the repeater RF output is necessary.

Measuring Receiver Sensitivity Example

1. Connect the equipment as shown in [Figure 8-11](#):

- Connect the S412E **RF In** port to an antenna.
- Connect the DMR repeater **Rx** port to the S412E **Signal Generator Out** port and to an antenna via a splitter or directional coupler.

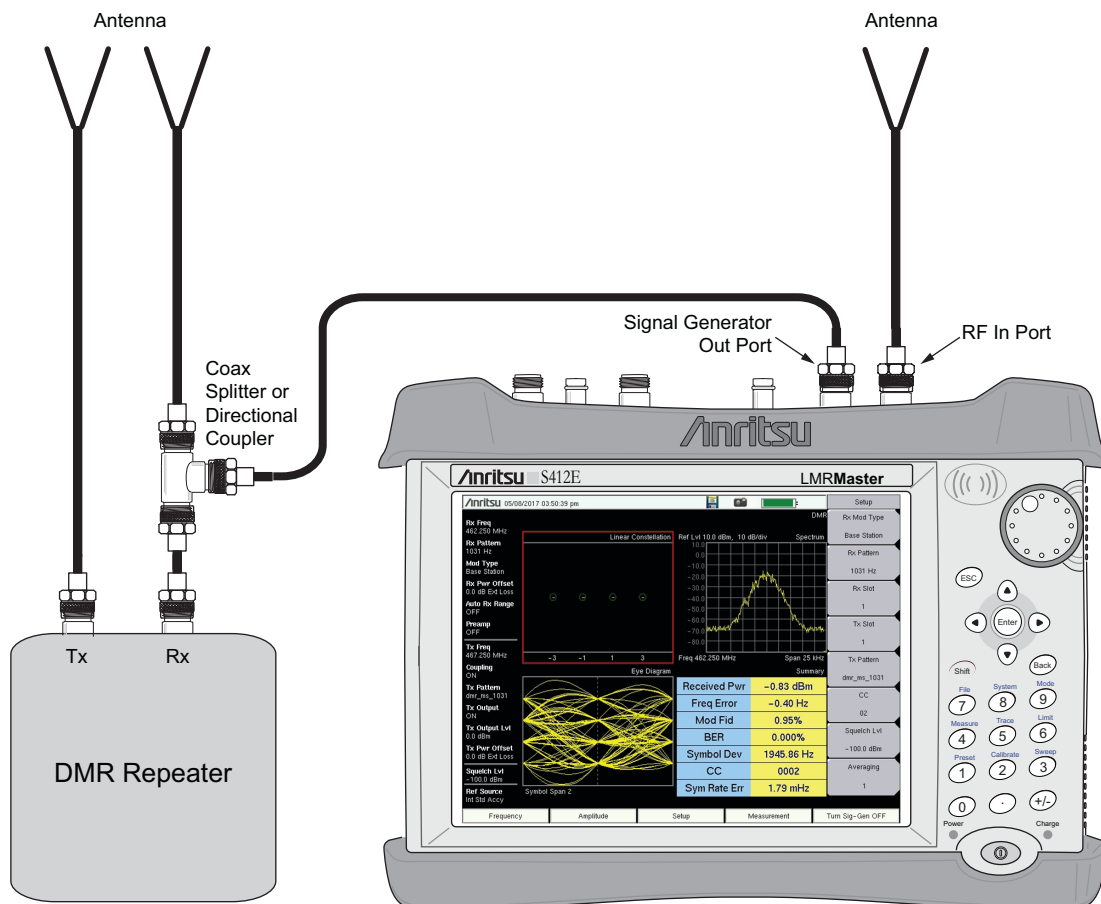


Figure 8-11. DMR Repeater Sensitivity Measurement Setup Example

2. From the S412E **Frequency** menu, set the following:
 - Rx Freq: DMR repeater transmit frequency
 - Tx Freq: DMR repeater receive frequency
 - Rx/Tx Coupling: Off
 - Coupling Offset: 0 Hz
 - Span: 25 kHz
3. From the S412E **Amplitude** menu, set the following:
 - Ref Level: Greater than expected receive signal level
 - Scale: 10 dB/div
 - Rx Power Offset: 0 dB External Loss
 - Auto Rx Range: On
 - Tx Power Offset: 3 dB External Loss for splitter (add any additional cable loss)
 - Tx Output Level: -60 dBm (initial setting)
4. From the S412E **Setup** menu, set the following:
 - Rx Mod Type: Base Station
 - Rx Pattern: 1031 Hz
 - RX and Tx Slot: Desired time slot to be measured
 - Tx Pattern: dmr_ms_1031
5. Turn the S412E Signal Generator On.
6. Toggle CC to the desired CC for testing. Toggling the CC field is used to send out a “wake-up” signal to the repeater.
7. On a DMR mobile station, listen for a tone. This indicates that the repeater is receiving and retransmitting the test signal from the LMR Master.
8. To determine if the repeater meets the sensitivity level, adjust the LMR Master signal generator output level (**Amplitude** -> Tx Output Lvl) to the specified sensitivity level.
9. Listen for a steady tone from the mobile station and note the BER measurement on the LMR Master DMR Summary screen (see [Figure 8-11](#)). The BER% should be within specification.
10. To determine the “absolute” sensitivity level, adjust the signal generator output level down until either one or both of:
 - the audible tone from the mobile station just starts to degrade
 - the BER % measurement shown on the LMR Master Summary screen is above specification.
11. Note the Tx Output Level is the absolute receiver sensitivity value.

8-7 DMR Analyzer Menus

Menu maps typically display all possible submenu keys, although some keys are displayed on the instruments only under special circumstances (refer to menu descriptions on the following pages).

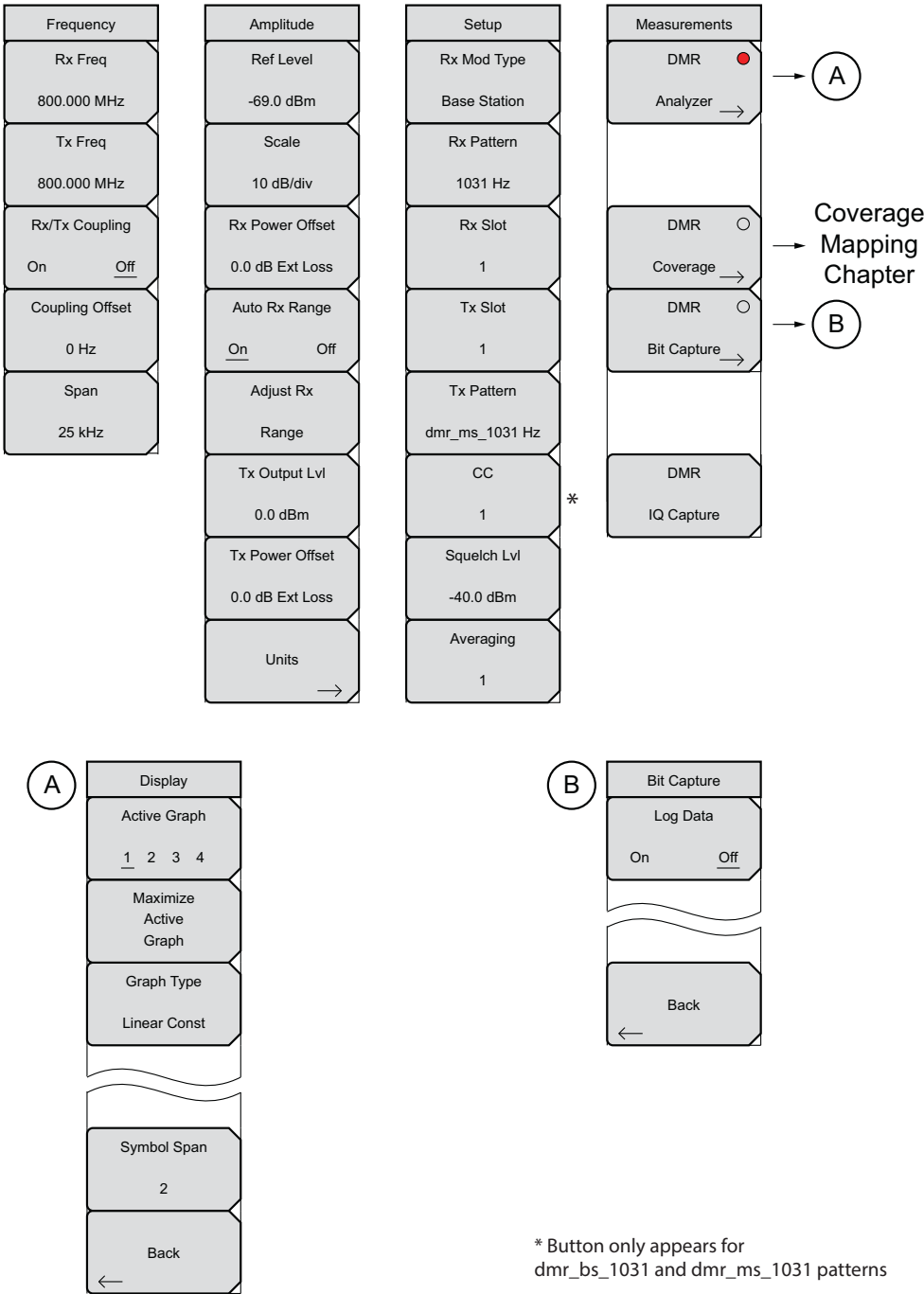


Figure 8-12. DMR Analyzer Menu Layout

8-8 Frequency Menu

Key Sequence: **Frequency**

Frequency	Rx Freq: Sets the receiver frequency. Press the Rx Freq key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the submenu key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the Enter key has the same effect as pressing the MHz submenu key.
Rx Freq 800.000 MHz	
Tx Freq 800.000 MHz	Tx Freq: Sets the signal generator frequency. Press Tx Rx Freq key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the submenu key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the Enter key has the same effect as pressing the MHz submenu key.
Rx/Tx Coupling On Off	Rx/Tx Coupling: Couples the signal generator to the receiver frequency. When set to On the Tx Freq key is disabled.
Coupling Offset 0 Hz	Coupling Offset: Sets the Offset of the signal generator frequency and the receiver frequency. Only functional when Rx/Tx Coupling is set to On.
Span 25 kHz	Span: Sets the span of the Spectrum Graph. Span selections are 25 kHz, 50 kHz, 100 kHz, 500 kHz, 1 MHz, and 5 MHz.

Figure 8-13. DMR Analyzer Frequency Menu

8-9 Amplitude Menu

Key Sequence: **Amplitude**

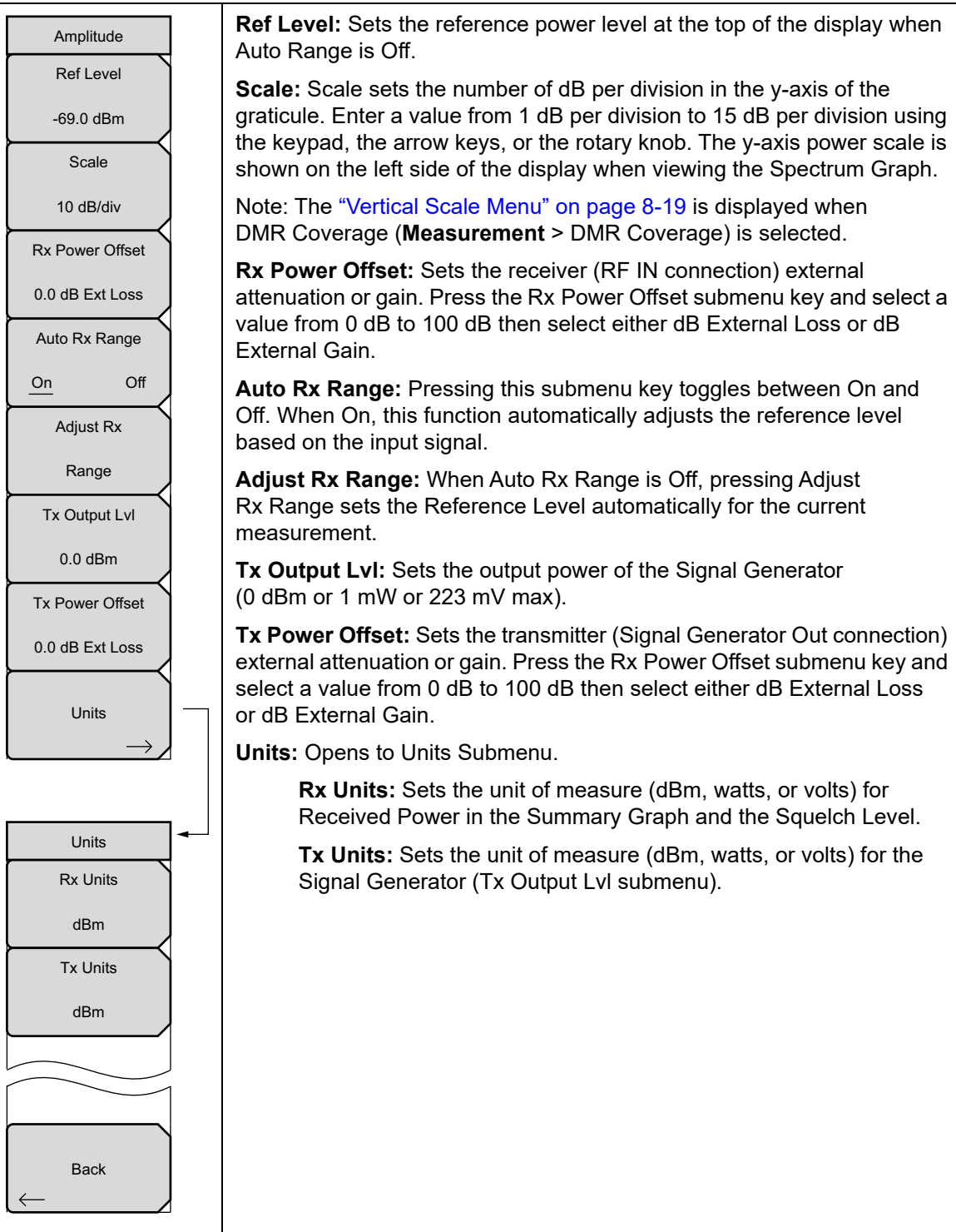


Figure 8-14. DMR Analyzer Amplitude Menu

Vertical Scale Menu

Key Sequence: **Amplitude** > Vertical Scale

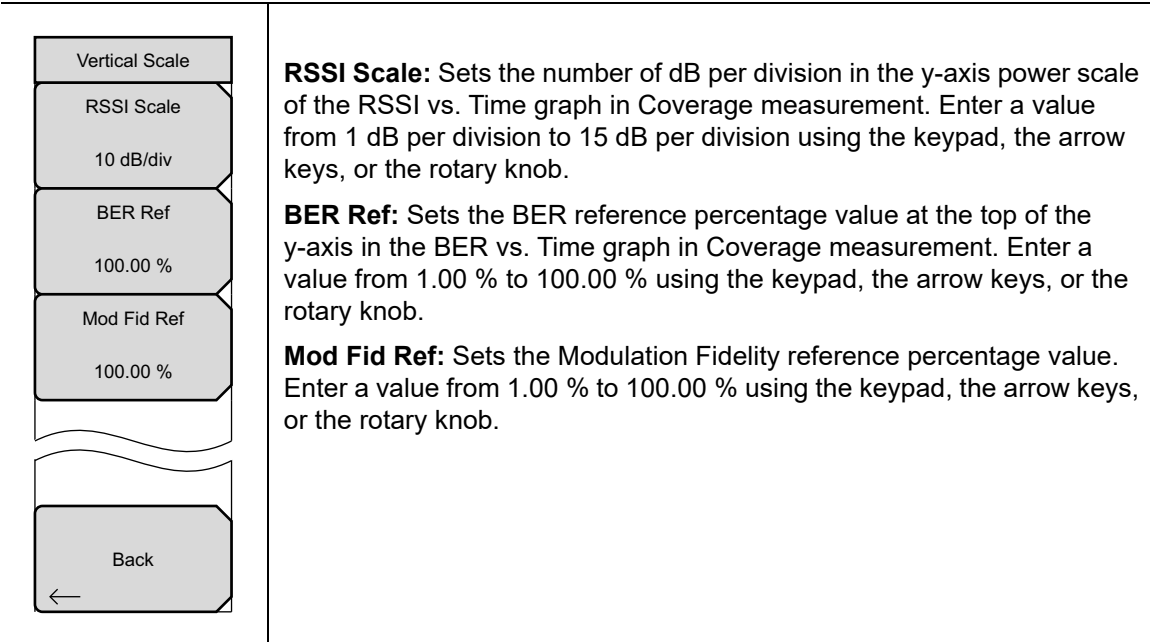


Figure 8-15. Vertical Scale Menu

8-10 Setup Menu

Key Sequence: Setup

Setup	Rx Mod Type: Sets the type of modulation. The options are Mobile Station or Base Station.
Rx Mod Type Base Station	Rx Pattern: Selects the receiver Bit Error Rate pattern. Select a pattern from the list box with the arrow keys or rotary knob and press Enter . There are four available patterns:
Rx Pattern 1031 Hz	Automatic Frequency Control (1031 Hz) Standard Transmitter Test (O.153 or V.52) Voice Silence (mobile station only)
Rx Slot 1	Rx Slot: Selects the receiver time slot: 1 or 2 (Base Station Mod Type only).
Tx Slot 1	Tx Slot: Selects the signal generator time slot: Both, 1, or, 2. (Note that selecting a time slot other than “Both” will automatically change the Tx pattern to “ms_1031” in anticipation of a receiver sensitivity test.
Tx Pattern dmr_ms_1031 Hz	Tx Pattern: Selects the transmitter pattern to send when the Turn Sig-Gen ON main menu key is selected. Select a pattern from the list box with the arrow keys or rotary knob and press Enter .
CC 1	CC: Sets the Color Code (CC) that is sent on the standard DMR 1031 Hz Tx Patterns. This setting is used when testing receivers and the button only appears when <i>dmr_bs_1031</i> or <i>dmr_ms_1031</i> patterns are selected.
Squelch Lvl -40.0 dBm	Squelch Lvl: Sets the squelch power level. When the Received Power is lower than the set squelch level, all summary graph measurements except for Received Pwr will be blanked out (--).
Averaging 1	Averaging: Sets the refresh rate of the numerical values in the DMR Summary window. Setting a higher number (25 maximum) reduces measurement jitter.

Figure 8-16. DMR Analyzer Setup Menu

8-11 Measurement Menu

Key Sequence: **Measurement**

<div>Measurements</div> <div><div>DMR</div><div>Analyzer →</div></div> <div><div>DMR</div><div>Coverage →</div></div> <div><div>DMR</div><div>Bit Capture →</div></div> <div><div>DMR</div><div>IQ Capture</div></div>	<p>DMR Analyzer: Opens the “Display Menu” on page 8-22.</p> <p>DMR Coverage (Option 592 required): Opens the DMR Coverage menu. Refer to Chapter 11, “LMR Coverage Mapping”.</p> <p>DMR Bit Capture: This submenu key is valid only when Rx Pattern is set to Voice. Pressing this key opens a submenu for data logging. Make sure that a formatted USB flash drive is attached to the instrument before starting bit capture. Set Log Data to On to start the bit capture. Bit capture will continue until Log Data is set to Off or the USB flash drive is filled.</p> <p>The files are saved in a time-stamped folder under the usr folder on the USB flash drive.</p> <p>If Log Data is On, any of the following functions will stop the logging:</p> <ul style="list-style-type: none">Rx Frequency changeSetup changeStarting another measurement <p>DMR IQ Capture: Pressing this key starts the IQ data capture. Make sure that a formatted USB flash drive is attached to the instrument before starting IQ Capture. When the capture is complete, a message is displayed. This may take a few seconds.</p>
--	---

Figure 8-17. DMR Analyzer Measurement Menu

Display Menu

Key Sequence: **Measurement** > DMR Analyzer

Display

Active Graph

1 2 3 4

Maximize
Active
Graph

Graph Type

Spectrum

Symbol Span

2

Back

Active Graph 1 2 3 4: In Four Screen view, use this menu to select which of the four graphs is active. The current active graph is underlined (1 2 3 4) and has a red perimeter line. Any of the four graphs can also be made active by tapping once on the touch screen. Repeatedly pressing the Active Graph submenu key cycles the active graph, 1 through 4.

In Standard view (one graph displayed on the screen) the Active Graphic key rotates between the four graphs displayed in the Four Screen view.

Maximize/Minimize Active Graph: The submenu key toggles between displaying the Four Screen (4 graphs) view and the Standard view (1 graph). Tapping twice on a selected graph also toggles between the two display options.

Graph Type: The label on the bottom of this button displays the current active graph type. Pressing the button will open a list box of the graphs types available for DMR Analyzer measurements. Select the desired graph type with the arrow keys or rotatory knob and press **Enter**. The current active graph will be replaced with the new selection.

Available graphs include:

- Constellation
- Spectrum
- Histogram
- Eye Diagram
- Linear Constellation
- Summary and DMR Summary
- Power Profile

Refer to [“DMR Analyzer Graphs” on page 8-4](#) for additional information.

Symbol Span: Use this menu to adjust the number of symbols viewed across the screen in the Eye Diagram graph. Adjust from 2 to 5 by using the keypad, the arrow keys, or the rotary knob. Keypad values entered outside of this range are ignored.

Back: Returns to the [“Measurement Menu” on page 8-21](#).

Figure 8-18. DMR Analyzer Display Menu

8-12 Sweep Menu

Key Sequence: **Shift** > **Sweep (3)** key

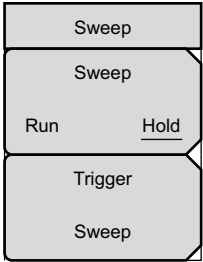
	<p>Sweep Run/Hold: This submenu key toggles between continuous (run) sweep and hold sweep. In Run sweep mode, sweeps are continuous and one starts immediately after the previous sweep is completed. In Hold sweep mode, the results of the last sweep are displayed on the screen while the instrument waits for a trigger event to start a new sweep. HOLD is displayed on the right side of the screen in this mode.</p> <p>Trigger Sweep: Pressing this submenu key causes the instrument to make a single sweep when the instrument is in Hold sweep mode. This key has no function when the instrument is in Run sweep mode.</p> <p>Trigger Sweep is not available in DMR Bit Capture measurements.</p>
---	---

Figure 8-19. DMR Analyzer Sweep Menu

8-13 Measure Menu

Key Sequence: **Shift** > **Measure (4)** key

Display the [“Measurement Menu” on page 8-21.](#)

8-14 Trace Menu

This menu is not available in DMR Analyzer measurement mode.

8-15 Limit Menu

This menu is not available in DMR Analyzer measurement mode.

8-16 Other Menus

Preset, **Calibrate**, **File**, **System** and **Mode** are described in the User Guide.

Chapter 9 — PTC-ITCR Analyzer (Option 721)

9-1 Introduction

The PTC-ITCR Analyzer option provides a method to verify the operation of ITCR Positive Train Control (PTC) systems (PTC-ITCR). PTC-ITCR is an integrated communication and information system for controlling train movements. Option 721 includes the ability to display constellation, spectrum, histogram, and eye diagram graphs. In addition, a summary table displays numeric values of received power or burst power, PEP (Peak Envelope Power), frequency error, EVM (Error Vector Magnitude), bit error rate (BER), IQ (In phase and Quadrature) offset, phase and magnitude error, and symbol rate error.

EVM is a measure of how far the constellation points are from the ideal locations. BER is a comparison against standard PTC-ITCR test patterns – either O.153 or PN9. The available Symbol Rates are Half Rate (8 ksps) and Full Rate (16 ksps). IQ Offset is a combination of phase imbalance (the measured phase between I and Q arms versus an ideal 90° phase difference) and amplitude variation between the two arms.

The LMR Master will analyze input signal strengths from +33 dBm (2.0 watts) down to levels approaching the sensitivity of PTC radios, automatically adjusting the input sensitivity based on input levels.

For information on coverage, see [Chapter 11, “LMR Coverage Mapping”](#).

9-2 Setup Procedure

Direct Connect to the Transmitter

1. Press the **Menu** key then select the PTC-ITCR Analyzer icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight PTC-ITCR Analyzer and press **Enter**.

Caution

The maximum input power without damage is 2 watts (+33 dBm) to the RF In 50 Ohm connector. To prevent damage, use a coupler or attenuator to reduce the input power to below this level when measuring high output power devices.

2. Connect the transmitter to the RF In 50 Ohm connector on the LMR Master using a coupler or attenuator.
3. Press the **Frequency** main menu key to set the receiver center frequency (Rx Freq) of the measurement. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.
4. Press the **Setup** main menu key to choose the Rx and Tx patterns and set the Symbol Rate, Squelch Lvl, and Averaging.

5. Press the **Amplitude** main menu key, then the Rx Power Offset submenu key to set the receiver attenuation (or gain). Use the arrow keys, rotary knob or the numeric keypad to enter the adjustment value, up to 100 dB and select either the Loss or Gain submenu key. The offset will be applied to the Receiver Power value in the Summary graph. For instance, if the transmitter under test is emitting 50 watts (+47 dBm) of power, and the External Attenuation value is 40 dB (such as from a 40 dB directional coupler) the Received Power displayed will be +7 dBm.
6. Press the **Measurement** key, then the PTC-ITCR Analyzer submenu key. Select the Graph types to view with the Graph Type submenu key. The Symbol Span submenu is used to adjust the number of “eyes” displayed across the screen in the Eye Diagram graph. Refer to [“PTC-ITCR Analyzer Graphs” on page 9-4](#) for information on the available graph types.

Over-the-Air (OTA) Analysis Setup

1. Press the **Menu** key then select the PTC-ITCR Signal Analyzer icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight PTC-ITCR Analyzer and press **Enter**.

Caution	The maximum input power without damage is 2 watts (+33 dBm) to the RF In 50 Ohm connector. To prevent damage, use a coupler or attenuator to reduce the input power to below this level when measuring high output power devices.
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2. Connect an antenna with the appropriate frequency range to the RF In 50 Ohm connector on the LMR Master.
3. Press the **Frequency** main menu key to set the center frequency of the measurement using the Rx Freq key. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.
4. Press the **Setup** main menu key, then select the symbol rate of either Half Rate (8 ksps) or Full Rate (16 ksps) by using the Symbol Rate key.
5. Refer to [“PTC-ITCR Analyzer Graphs” on page 9-4](#) for information on the available graph types.

Using the Signal Generator for Receiver or OTA Analysis

1. Press the **Menu** key then select the PTC-ITCR Signal Analyzer icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight PTC-ITCR Analyzer and press **Enter**.

Caution	The maximum output power from the Signal Generator Out connector is 1 mW (0 dBm) and the frequency range is 500 kHz to 1.6 GHz.
----------------	---

2. Directly connect the LMR Master Signal Generator Out 50 Ohm connector to the repeater/receiver or connect an antenna with the appropriate frequency range to the connector.
3. Press the **Frequency** main menu key to set the transmit frequency using the Tx Freq key. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.

If testing a PTC repeater, you can bind the transmit frequency to the receive frequency by setting Rx/Tx Coupling to On and entering the Coupling Offset.

Note	When Rx/Tx Coupling is On, the Tx Freq submenu key is disabled.
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4. Press the **Amplitude** main menu key, then the Tx Output Lvl submenu key to set the output power. Enter any output attenuation or gain using the Tx Power Offset key.
5. Set the transmit pattern. Press the **Setup** main menu and select the Tx Pattern submenu key. The **Symbol Rate** settings apply to the standard PTC patterns (8 ksp/s or 16 ksp/s patterns will be shown, depending on the **Symbol Rate** setting). Available patterns are listed on the display and additional patterns can be downloaded via the **System** > Application Options menu.
6. Press the **Turn Sig-Gen ON** main menu key to start the signal generator. Press the key again to turn off the signal generator.

9-3 PTC-ITCR Analyzer Graphs

To select the measurement type:

- 1. From the Measurements main menu press PTC-ACSES Analyzer:
 - a. once if the selected indicator is red (see [Figure 9-7 on page 9-10](#))
 - b. twice if the selected indicator is gray (the PTC-ACSES Coverage indicator is red)

The Active Graph menu displays. These PTC-ITCR Analyzer measurements are available on the LMR Master:

- [Constellation and Linear Constellation](#)
 - [Spectrum Graph](#)
 - [Histogram Graph](#)
 - [Eye Diagram](#)
 - [Summary Table](#)
- 2. The Graph Type submenu key shows the graph type of the active window. Press this key to display the Graph Type Selector and change the type.

Constellation and Linear Constellation

Constellation view displays the demodulation information in an IQ format ([Figure 9-1](#)). The chart shows the relationship between the location of a constellation data point, its deviation frequency, and the information it carries.

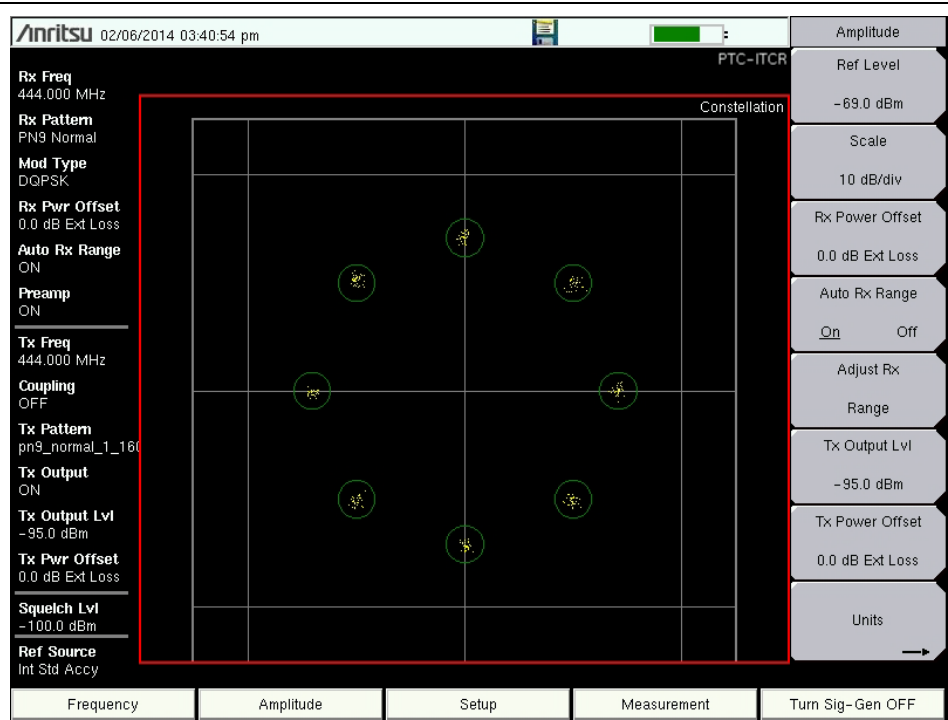


Figure 9-1. Constellation Diagram

Figure 9-2 shows the same information is the Linear Constellation View.

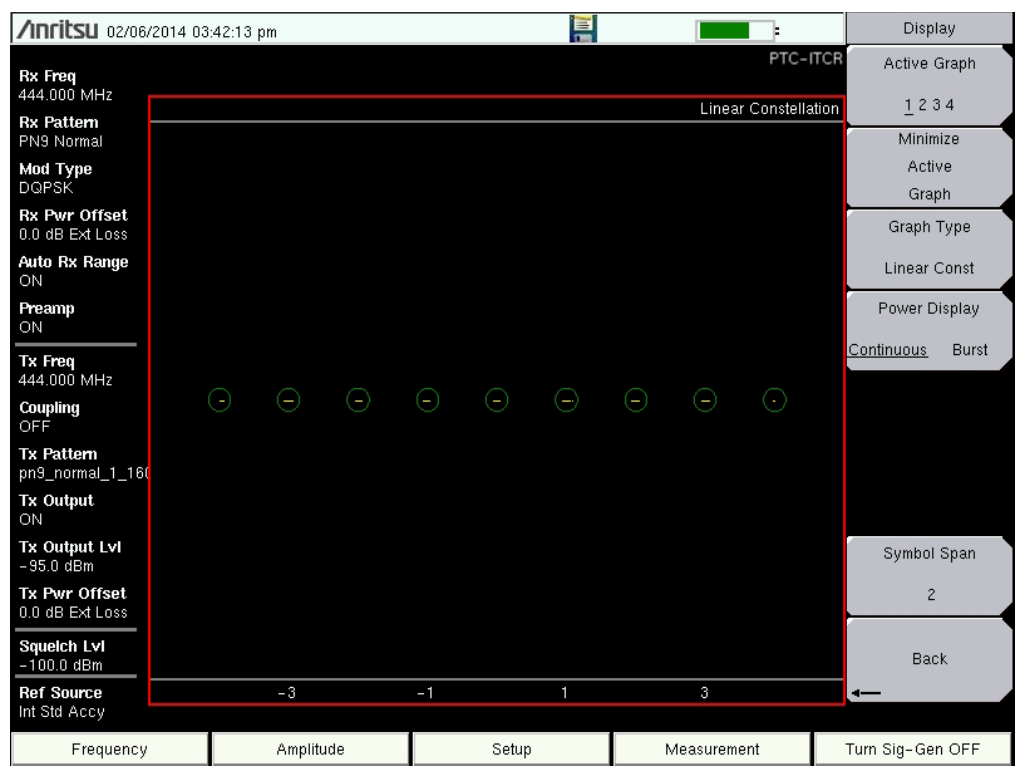


Figure 9-2. Linear Constellation Diagram

For input signals that are not PTC encoded, the LMR Master will still try to decode them and fit them to a symbol. This may cause some unexpected measurement results.

Spectrum Graph

The Spectrum view displays a graphical representation of power (dBm) vs. frequency. The Spectrum display gives an indication if there are interfering entities present that may degrade the bit error rate of the PTC signal. The frequency span is adjustable under the **Frequency** menu. The reference level is adjusted with the **Amplitude** menu. Refer to [“Amplitude Menu” on page 9-16](#) for details. [Figure 9-3](#) displays the same signal using a 25 kHz span and a 500 kHz span.

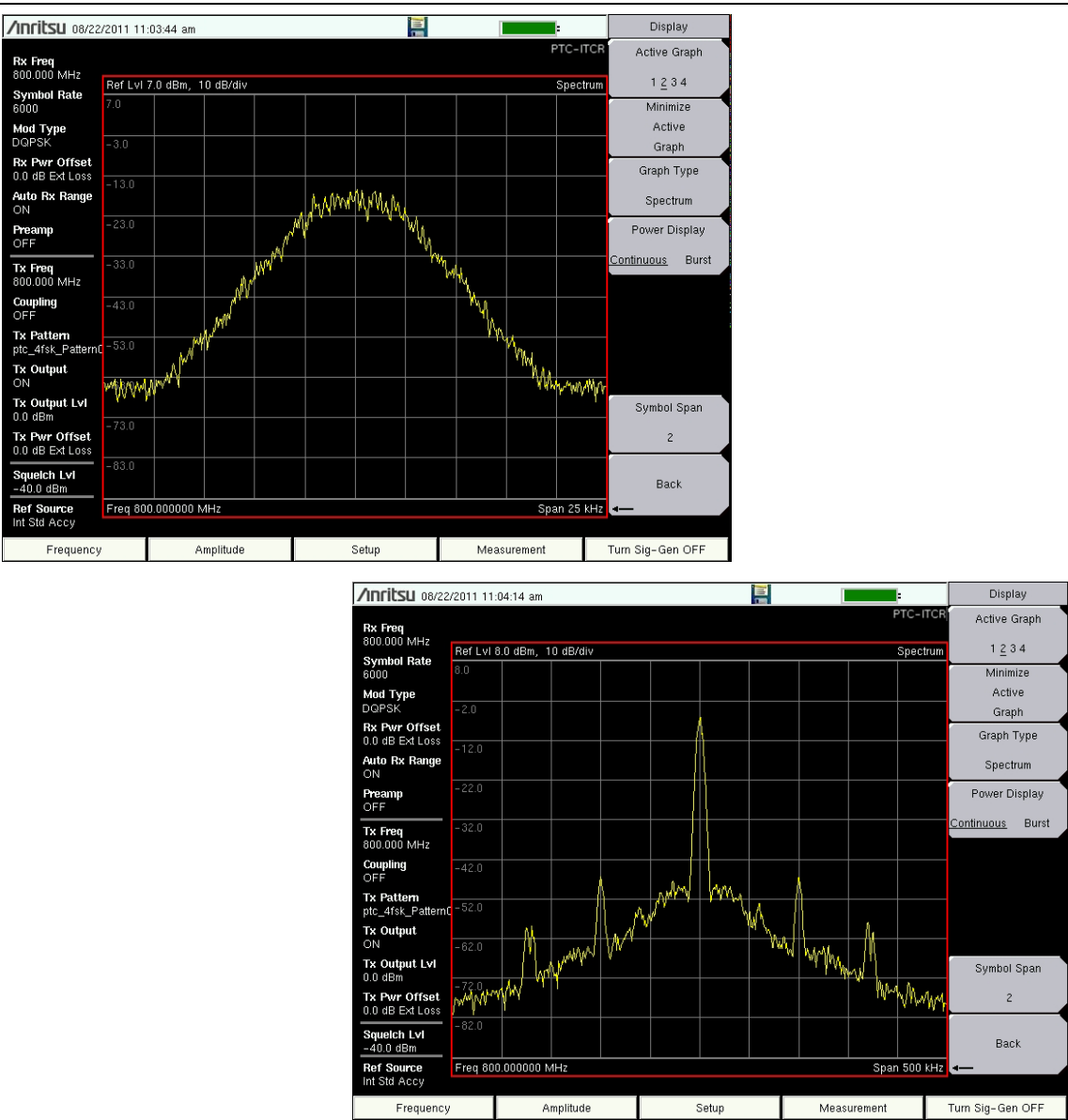


Figure 9-3. PTC-ITCR Spectrum Graph (25 kHz Span and 500 kHz Span)

Histogram Graph

The Histogram graph displays a graphical representation of the symbols that are being received. The graph for each symbol represents the relative percentage that symbol was identified out of all the received symbols.

Each update of the screen is a separate representation of the latest data, rather than a cumulative total. The vertical scale is fixed at 0 to 100 %, with each horizontal grid line representing 10 % of the total symbols received.

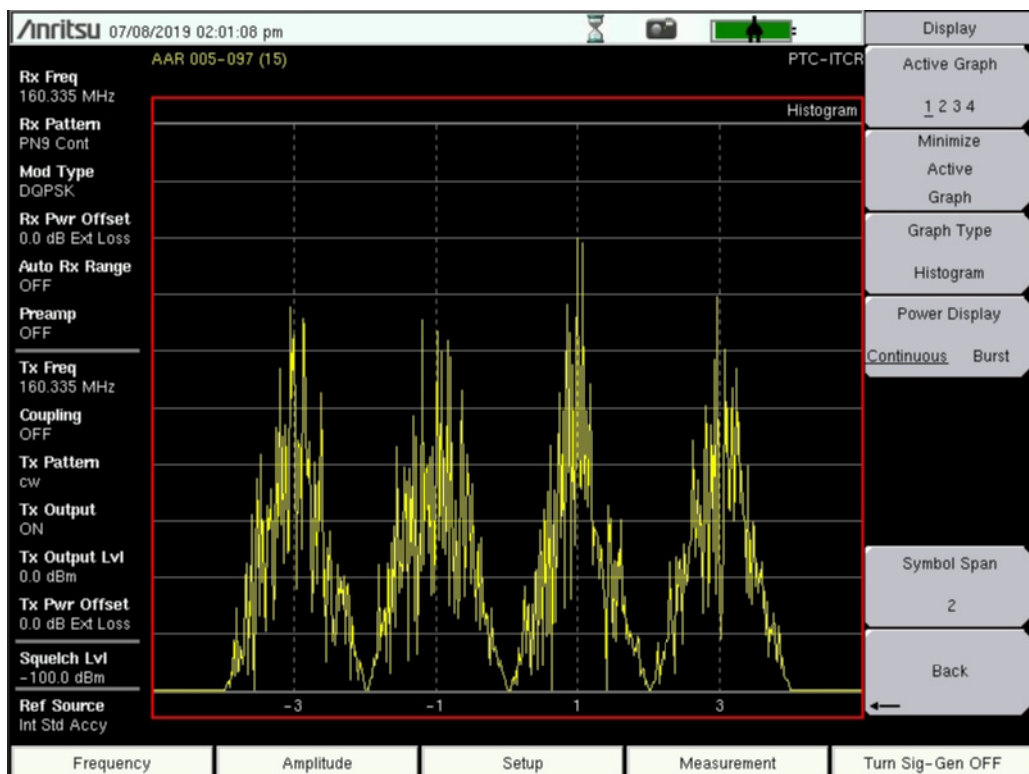


Figure 9-4. PTC-ITCR Histogram

Eye Diagram

The eye diagram is an oscilloscope view of the PTC-ITCR signal displaying the voltage of the signal vs. time. The diagram provides an indication of baseband fidelity of a PTC transmitter. With Over-the-air measurements the Eye Diagram can indicate phase distortion from multipath. The number of “eyes” displayed is set with the Symbol Span key under the “Display Menu” on page 9-21.

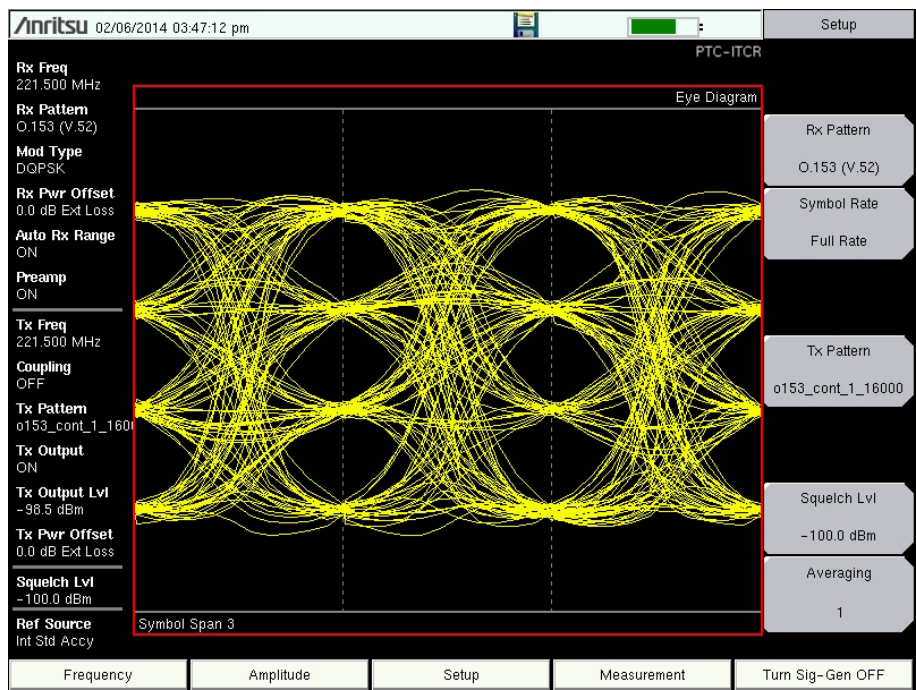


Figure 9-5. PTC-ITCR Eye Diagram

Summary Table

The Summary Table provides an overview of a PTC transmitter. The table displays received power or burst power, peak envelope power (PEP), frequency error, error vector magnitude (EVM), bit error rate (BER), IQ offset, phase error, magnitude error, and symbol rate error of the input signal.

The received power and PEP values in the Summary Table can be changed between dBm, watts, and volts using the **Amplitude** > Units > Rx Units submenu key. This setting also applies to the burst power and squelch level setting. Press the Power Display key to toggle between displaying the received power (continuous) or the burst power.

The **Setup** > Squelch Lvl submenu key sets the received power level below which Summary Table results are not displayed. When the received power is lower than the set squelch level, all measurement values except for received/burst power will be blanked out (--) in the summary table. When the received power is above the squelch level, the measurements will display as shown in Figure 9-6.

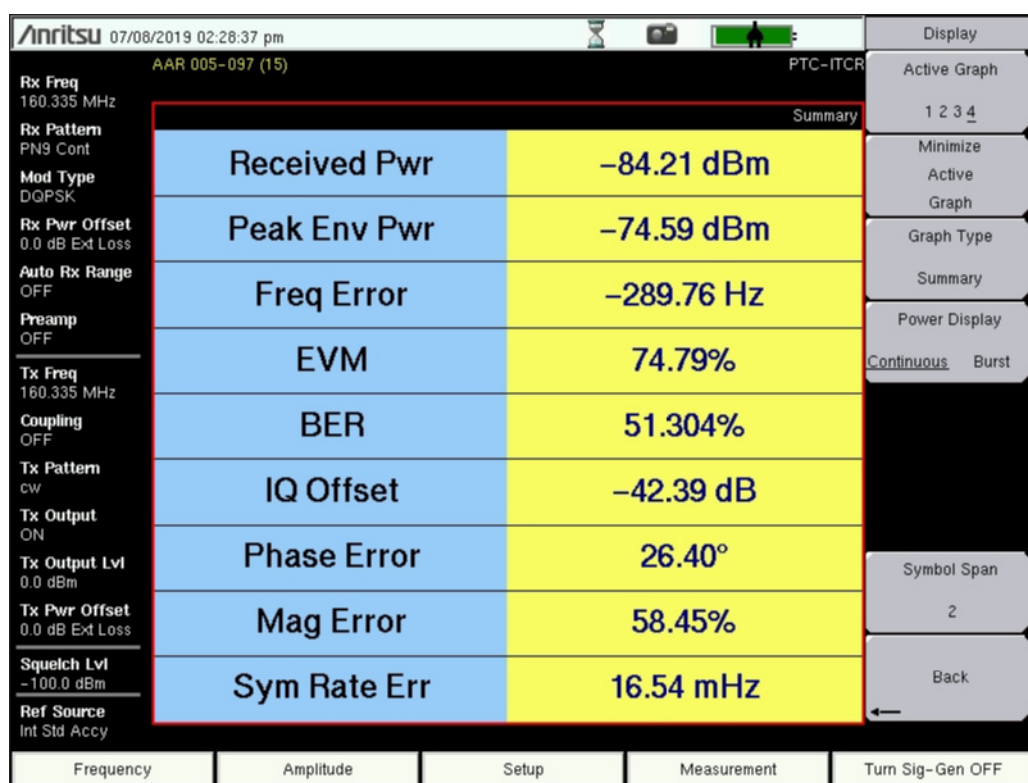


Figure 9-6. PTC-ITCR Summary Graph

Received power in the Summary Table is the integrated power of all the energy in the receiver bandwidth. Any peak amplitude reduction seen in the Spectrum display when compared to Received Pwr is a function of the RBW setting of the instrument. The reduction is specified as: $10 \cdot \log(\text{Signal Bandwidth} / \text{Resolution Bandwidth})$. Burst power in the Summary Table is calculated only when the data stream contains packets.

9-4 PTC-ITCR Analyzer Main Menu Map

Menu maps typically display all possible submenu keys, although some keys are displayed on the instruments only under special circumstances (refer to menu descriptions on the following pages).

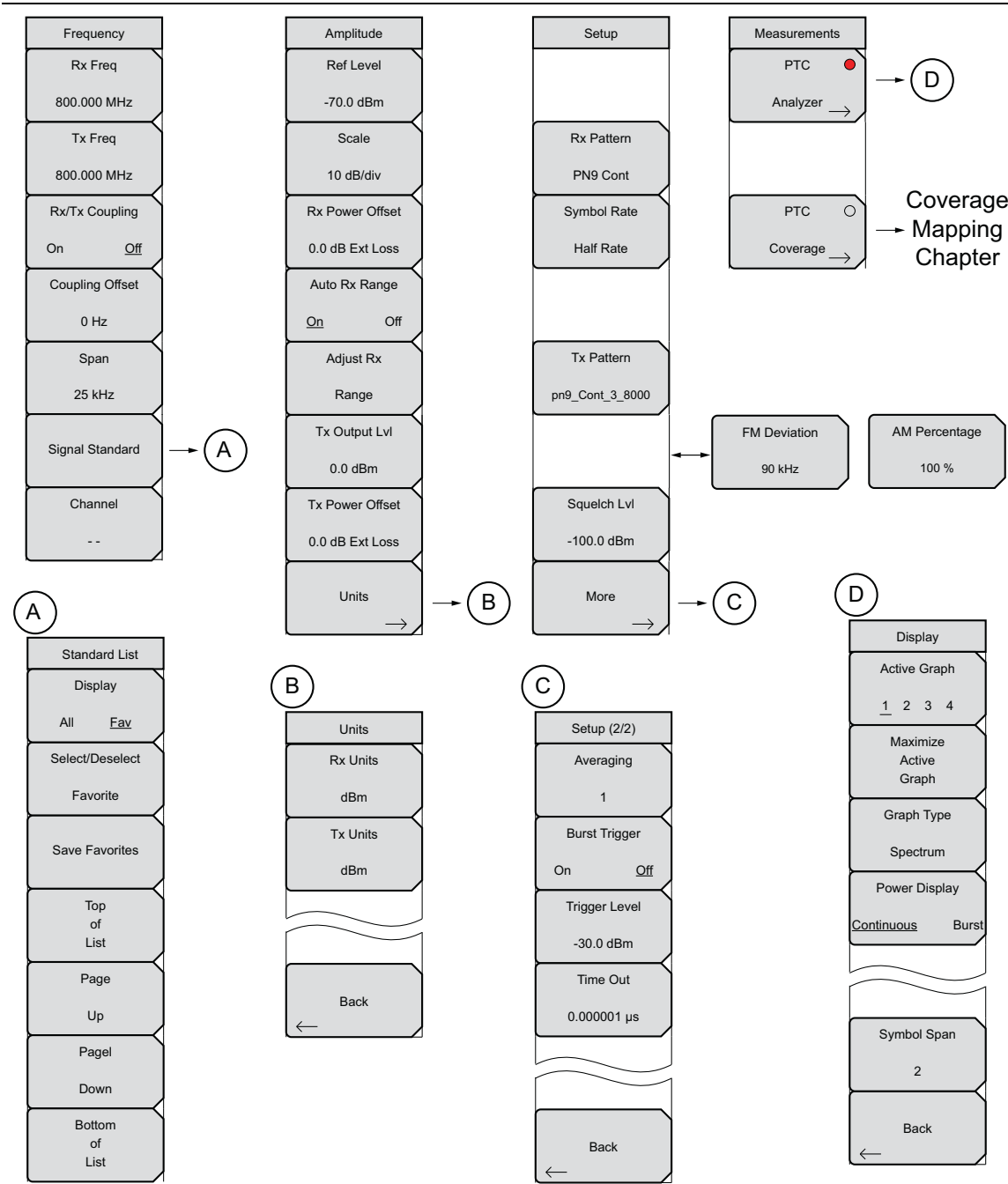


Figure 9-7. PTC-ITCR Analyzer Menu Layout

9-5 Frequency Menu

Key Sequence: **Frequency**

Frequency	Rx Freq: Sets the receiver frequency. Press the Rx Freq key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the submenu key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the Enter key has the same effect as pressing the MHz submenu key.
Rx Freq 800.000 MHz	
Tx Freq 800.000 MHz	Tx Freq: Sets the signal generator frequency. Press the Tx Freq key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the submenu key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the Enter key has the same effect as pressing the MHz submenu key.
Rx/Tx Coupling On Off	
Coupling Offset 0 Hz	Rx/Tx Coupling: Couples the signal generator to the receiver frequency. When set to On, the Tx Freq key is disabled.
Span 25 kHz	Coupling Offset: Sets the offset of the signal generator frequency and the receiver frequency.
Signal Standard	Span: Sets the span of the Spectrum Graph. Span selections are 25 kHz, 50 kHz, 100 kHz, 500 kHz, 1 MHz, and 5 MHz.
Channel --	Signal Standard: Opens the Signal Standards selection box, see Figure 9-9 and the softkey menu, see Figure 9-12 . Use the touch screen, rotary knob, menu keys, or the arrow keys to select from the list of available AAR (Association of American Railroads) channels and ranges. For signal standards that are associated with a channel range, such as AAR 005-097, press the Channel key to open the Channel Editor window, where you can select the AAR channel number. Channel: Opens the Channel Editor window. See Figure 9-10 . Use the rotary knob or the Up/Down arrow keys to select the AAR channel number. The channel is fixed and cannot be changed if the selected signal standard is a single channel and not a range.

Figure 9-8. PTC-ITCR Analyzer Frequency Menu

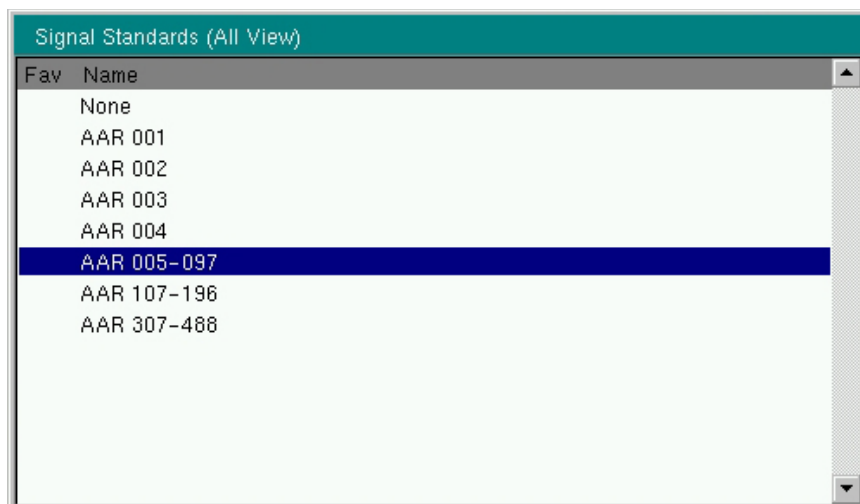


Figure 9-9. PTC-ITCR Signal Standards

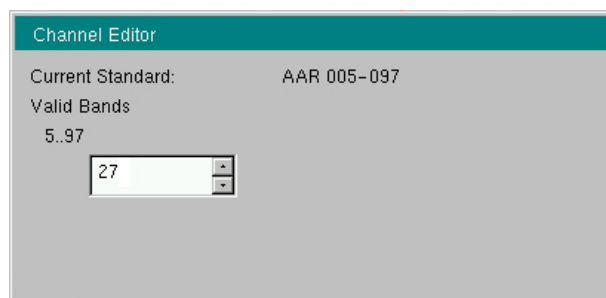


Figure 9-10. PTC-ITCR Channel Editor

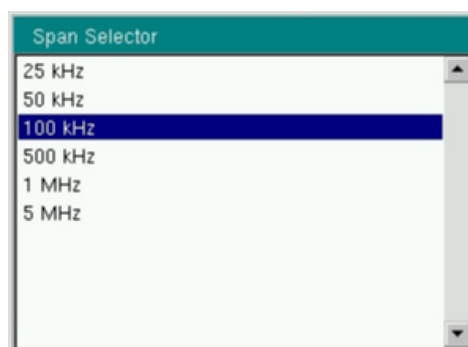


Figure 9-11. PTC-ITCR Span Selector

9-6 Signal Standard Menu

This menu provides navigation aids to the Signal Standard List.

Standard List	
Display	Display: Displays All or the favorites.
All Fav	
Select/Deselect	Select/Deselect: Selects or deselects the favorites.
Favorite	
Save Favorites	Save Favorites: Saves the favorites.
Top of List	Top of List: Positions cursor at the top of the list.
Page Up	Page up/Page down: Positions the list at the previous or next page.
Page Down	
Bottom of List	Bottom of List: Positions the cursor at the bottom of the list.

Figure 9-12. PTC-ACSES Signal Standard Menu

To select or deselect favorites:

1. Move the cursor to the standard you want to select or deselect as a favorite.

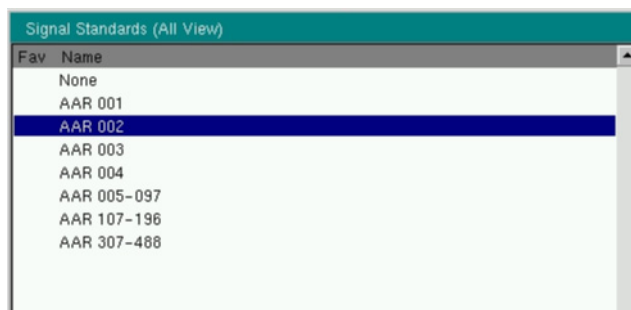


Figure 9-13. PTC-ITCR Signal Standard List

9-6 Signal Standard MenuPTC-ITCR Analyzer (Option 721)

- 2. Press Select/Deselect button. This image shows a single selection.



Figure 9-14. PTC-ITCR Select First Favorite

- 3. Perform steps 1 and 2 for as many standards as needed.

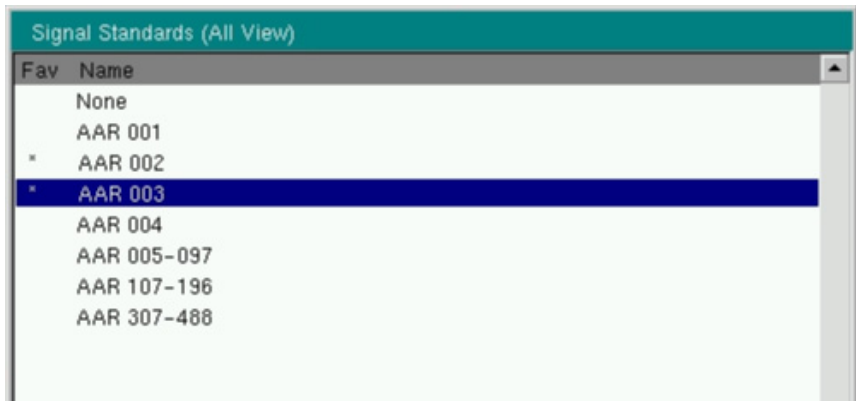


Figure 9-15. PTC-ITCR Select More Favorites

- 4. Press Save Favorites.

5. Press Display to toggle to the Favorites View.
-

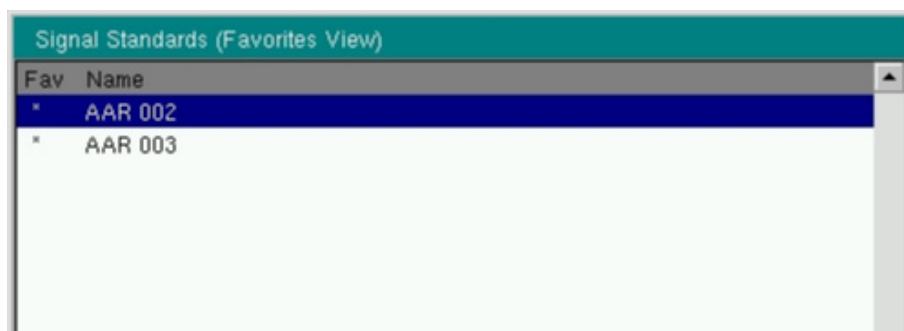


Figure 9-16. PTC-ITCR View Favorites

9-7
Amplitude Menu

Key Sequence:
Amplitude

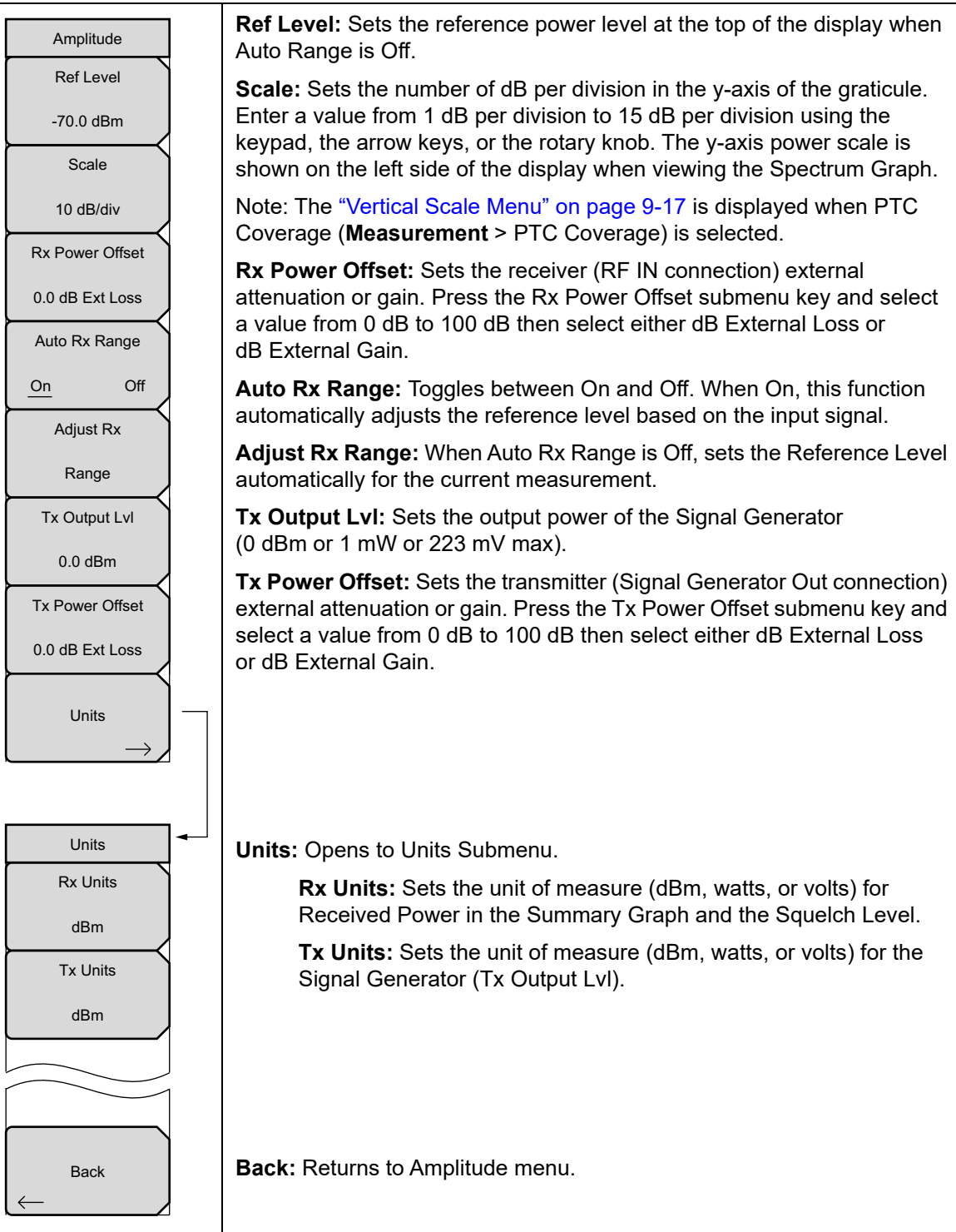


Figure 9-17. PTC-ITCR Analyzer Amplitude Menu

9-8 Vertical Scale Menu

Key Sequence: **Amplitude** > Vertical Scale

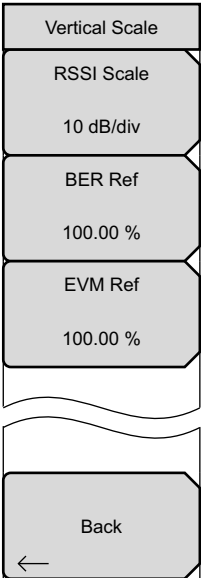
	<p>Note: This menu displayed when PTC-ACSES Coverage is selected from the Measurement menu. Then select Amplitude > Vertical Scale.</p> <p>RSSI Scale: Sets the number of dB per division in the y-axis power scale of the RSSI vs. Time graph in Coverage measurement. Enter a value from 1 dB per division to 15 dB per division using the keypad, the arrow keys, or the rotary knob.</p> <p>BER Ref: Sets the BER reference percentage value at the top of the y-axis in the BER vs. Time graph in Coverage measurement. Enter a value from 1.00 % to 100.00 % using the keypad, the arrow keys, or the rotary knob.</p> <p>EVM Ref: Sets the EVM reference percentage value. Enter a value from 1.00 % to 100.00 % using the keypad, the arrow keys, or the rotary knob.</p> <p>Back: Returns to Amplitude menu.</p>
---	--

Figure 9-18. PTC-ITCR Vertical Scale Menu

9-9 Setup Menu

Key Sequence: Setup

Setup	Rx Pattern: Selects the receiver Bit Error Rate pattern. Select a pattern from the list box with the arrow keys or rotary knob and press Enter. There are two available patterns: PN9 Cont PN9 Burst
Rx Pattern PN9 Cont	Symbol Rate: Selects the symbol rate for the signal generator when using the standard PTC patterns. Options are Half Rate (8 ksps) or Full Rate (16 ksps).
Symbol Rate Half Rate	Also sets the receiver IQ pattern deviation.
Tx Pattern pn9_cont_3_8000	Tx Pattern: Selects the transmitter pattern to send when the Turn Sig-Gen ON main menu key is pressed. Select a pattern from the list box with the Arrow keys or rotary knob, and then press Enter . Patterns include PN9 continuous and burst (with repeating or sequential payloads) at Half Rate or Full Rate, CW, AM 1 kHz audio, and FM 1 kHz audio.
AM Percentage 100 %	Two submenu keys appear only with specific Tx Pattern settings: AM Percentage: When am_1khx_audio is selected as the TX pattern, this submenu key displays to allow the setting of the percentage of the Amplitude modulation. The range is 0 % to 100 %.
Squelch Lvl -100.0 dBm	FM Deviation: When fm_1khx_audio is selected as the TX pattern, this submenu key displays to allow the setting of the cycle count of the frequency deviation. The range is 0 Hz to 100 kHz.
More →	Squelch Lvl: Sets the squelch power level. When the Received Power is lower than the set squelch level, all summary graph measurements except for Received Pwr will be blanked out (--). More: Opens the “Setup (2/2) Menu” on page 9-19.

Figure 9-19. PTC-ITCR Analyzer Setup Menu

Setup (2/2) Menu

Key Sequence: Setup > More

Setup (2/2)	
Averaging 1	Averaging: Sets the refresh rate of the numerical values in the Summary Table. Setting a higher number (25 maximum) will reduce measurement jitter.
Burst Trigger On Off	Burst Trigger: Turns the Burst Trigger On or Off. When turned ON, the PTC analyzer will wait for the input signal to cross the Trigger Level signal threshold (set below) before capturing and analyzing the data. When turned Off, the PTC-ITCR analyzer captures and analyzes the signals continuously.
Trigger Level -30.0 dBm	Trigger Level: Sets the minimum power level of the signal required to activate the burst trigger when Burst Trigger is On.
Time Out 100 ms	Time Out: Sets the trigger time out value. The display will not update while waiting for a trigger. When the “time out” duration elapses, the display is updated even if there is no trigger detected. The instrument provides an audible sound and displays a message to adjust the trigger level.
<hr/>	
Back ←	Back: Returns to the “Setup Menu” on page 9-18.

Figure 9-20. PTC-ITCR Analyzer Setup (2/2) Menu

9-10 Measurement Menu

Key Sequence: **Measurement**

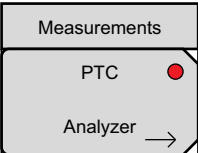
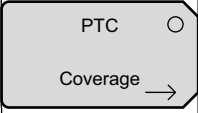
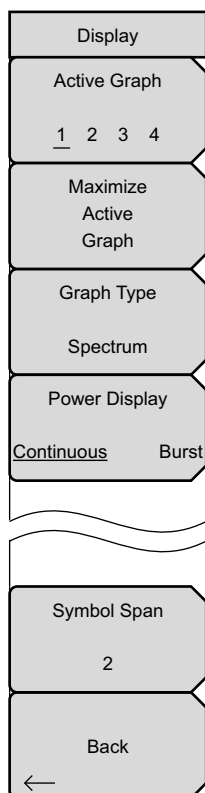
 <p>The icon shows a menu structure. At the top is a box labeled 'Measurements'. Below it is a box labeled 'PTC' with a red dot in the top right corner. Below that is a box labeled 'Analyzer' with a right-pointing arrow.</p>	<p>PTC Analyzer: Opens the “Display Menu” on page 9-21.</p>
 <p>The icon shows a menu structure. At the top is a box labeled 'PTC' with an open circle in the top right corner. Below it is a box labeled 'Coverage' with a right-pointing arrow.</p>	<p>PTC Coverage (Option 722 required): Opens the PTC Coverage menu. Refer to Chapter 11, “LMR Coverage Mapping”.</p>

Figure 9-21. PTC-ITCR Analyzer Measurement Menu

Display Menu

Key Sequence: **Measurement** > PTC-ITCR Analyzer



Active Graph: In Four-Screen view (maximized), use this submenu key to select which of the four graphs is active. The current active graph is underlined (1 2 3 4), and the graph has a red perimeter line in the sweep window. Any of the four graphs can also be made active by tapping once on the graph in the touch screen. Repeatedly pressing the Active Graph submenu key will cycle the active graph, 1 through 4.

In Standard view (one graph displayed on the screen – refer to Maximize Active Graph key) the Active Graphic key rotates active focus among the four graphs that are displayed in the Four-Screen view.

Maximize/Minimize Active Graph: The submenu key toggles between displaying the Four-Screen view (four graphs) and the Standard view (one graph, maximized). Tapping twice on a selected graph also toggles between the two display options.

Graph Type: The label on the bottom of this key displays the current active graph type. Pressing the key opens a list box of the graph types available for PTC Analyzer measurements. Select the desired graph type with the **Arrow** keys or rotatory knob, and then press **Enter**. The current, active graph will be replaced with the new selection.

Available graphs include:

- Constellation
- Spectrum
- Histogram
- Eye Diagram
- Linear Constellation
- Summary

Refer to “[PTC-ITCR Analyzer Graphs](#)” on page 9-4 for additional information.

Power Display

Continuous Burst: Depending on their configuration, PTC-ITCR radios emit signals as either a continuous data stream or a burst/packet stream. Pressing this submenu key toggles between Continuous or Burst power measurement mode. In Continuous mode, Received Power is calculated as the integrated power over time. In Burst mode, Received Power is calculated only when the data stream contains packets.

Note: Selection of Continuous mode when analyzing burst/packet signals produces artificially low values for Received Power. The magnitude of this error is a function of the burst/packet duty cycle.

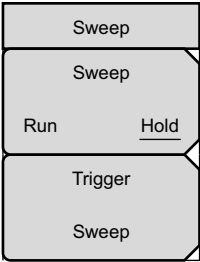
Symbol Span: Use this menu to adjust the number of symbols viewed across the screen in the Eye Diagram graph. Adjust from 2 and 5 using the keypad, the arrow keys, or the rotary knob. Keypad values entered outside of this range are ignored.

Back: Returns to the “[Measurement Menu](#)” on page 9-20.

Figure 9-22. PTC-ITCR Analyzer Display Menu

9-11 Sweep Menu

Key Sequence: **Shift > Sweep (3)** key



Sweep Run/Hold: This submenu key toggles between continuous (run) sweep and hold sweep. In Run sweep mode, sweeps are continuous and one starts immediately after the previous sweep is completed. In Hold sweep mode, the results of the last sweep are displayed on the screen while the instrument waits for a trigger event to start a new sweep. **HOLD** is displayed on the right side of the screen in this mode.

Trigger Sweep: Pressing this submenu key causes the instrument to make a single sweep when the instrument is in Hold sweep mode. This key has no function when the instrument is in Run sweep mode.

Figure 9-23. PTC-ITCR Analyzer Sweep Menu

9-12 Measure Menu

Key Sequence: **Shift > Measure (4)** key

Display the [“Measurement Menu” on page 9-20](#).

9-13 Trace Menu

This menu is not available in PTC-ITCR Analyzer measurement mode.

9-14 Limit Menu

This menu is not available in PTC-ITCR Analyzer measurement mode.

9-15 Other Menus

The **Preset**, **Calibrate**, **File**, **System**, and **Mode** menus are described in the User Guide.

Chapter 10 — PTC-ACSES Analyzer (Option 731)

10-1 Introduction

The PTC-ACSES Analyzer option provides a method to verify the operation of ACSES Positive Train Control (PTC) systems. PTC-ACSES is an integrated communication and information system for controlling train movements. Option 731 includes the ability to display constellation, spectrum, and eye-diagram graphs. In addition, a summary table displays numeric values of received power or burst power, PEP (Peak Envelope Power), frequency error, EVM (Error Vector Magnitude), BER (Bit Error Rate), and phase and magnitude error.

BER is a comparison against standard PTC test patterns and is calculated based on forward error correction (FEC).

The LMR Master will analyze input signal strengths from +33 dBm (2.0 watts) down to levels approaching the sensitivity of PTC radios, automatically adjusting the input sensitivity based on input levels.

For information on coverage, see [Chapter 11, “LMR Coverage Mapping”](#).

10-2 Setup Procedure

Start the PTC-ACSES Mode

To enter PTC-ACSES mode:

1. Press the **Menu** then select the PTC-ACSES Analyzer icon.

OR

2. Press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight PTC-ACSES Analyzer and press **Enter**.

Direct Connection to the Transmitter

1. Connect the transmitter to the RF In 50 Ohm connector on the LMR Master using a coupler or attenuator.

Caution

The maximum input power without damage is 2 watts (+33 dBm) to the RF In 50 Ohm connector. To prevent damage, use a coupler or attenuator to reduce the input power to below this level when measuring high output power devices.

2. Press the **Frequency** main menu key to set the receiver center frequency (Rx Freq) of the measurement. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.

3. Press the **Setup** main menu key to choose the Rx and Tx patterns and set the Squelch Lvl and Averaging.
4. Press the **Amplitude** main menu key, then the Rx Power Offset submenu key to set the receiver attenuation (or gain). Use the arrow keys, rotary knob or the numeric keypad to enter the adjustment value, up to 100 dB and select either the Loss or Gain submenu key. The offset will be applied to the Receiver Power value in the Summary graph. For instance, if the transmitter under test is emitting 50 watts (+47 dBm) of power, and the External Attenuation value is 40 dB (such as from a 40 dB directional coupler) the Received Power displayed will be +7 dBm.
5. Press the **Measurement** key, then the PTC ACSES Analyzer submenu key. Select the Graph types to view with the Graph Type submenu key. The Symbol Span submenu is used to adjust the number of “eyes” displayed across the screen in the Eye Diagram graph. Refer to [“PTC-ACSES Analyzer Graphs” on page 10-4](#) for information on the available graph types.

Over-the-Air (OTA) Analysis Setup

1. Connect an antenna with the appropriate frequency range to the RF In 50 Ohm connector on the LMR Master.

Caution	The maximum input power without damage is 2 watts (+33 dBm) to the RF In 50 Ohm connector. To prevent damage, use a coupler or attenuator to reduce the input power to below this level when measuring high output power devices.
----------------	---

2. For the coverage mapping or the beacon-ignore functionalities, connect the GPS antenna.
3. Press the **Frequency** main menu key to set the center frequency of the measurement using the Rx Freq key. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.
4. Press the **Setup** main menu key, then select the RF Trigger setup. Make sure the RF Trigger source is selected. Choose the right trigger level and timeout for the use case.
5. Refer to [“PTC-ACSES Analyzer Graphs” on page 10-4](#) for information on the available graph types.

Using the Signal Generator for Receiver or Repeater Analysis

1. Follow instructions in [“Start the PTC-ACSES Mode” on page 10-1](#).

Caution	The maximum output power from the Signal Generator Out connector is 1 mW (0 dBm) and the frequency range is 500 kHz to 1.6 GHz.
----------------	---

2. Directly connect the LMR Master Signal Generator Out 50 Ohm connector to the repeater/receiver or connect an antenna with the appropriate frequency range to the connector.
3. Connect the GPS antenna connector to an external antenna.
4. Press the **Frequency** main menu key to set the transmit frequency using the Tx Freq key. Use the arrow key, rotary knob or the numeric keypad. When using the keypad, select the appropriate terminator submenu key to set the center frequency.

If testing a PTC repeater, you can bind the transmit frequency to the receive frequency by setting Rx/Tx Coupling to On and entering the Coupling Offset.

Note	When Rx/Tx Coupling is On, the Tx Freq submenu key is disabled.
-------------	---

5. Press the **Amplitude** main menu key, then the Tx Output Lvl submenu key to set the output power. Enter any output attenuation or gain using the Tx Power Offset key.
6. Set the transmit pattern. Press the **Setup** main menu button and select the Tx Pattern submenu key. Available patterns are listed on the display and additional patterns can be downloaded via the **System** > Application Options menu.
7. Press the **Measurement** main menu button. The Measurements menu displays.
8. Press the PTC Receiver Tester key. The PTC Receiver Test menu displays.
9. Press the Start Test key to start the test. The key's text changes to Waiting for Trigger. When the trigger is sensed, the text changes to Stop Test. The **Turn Sig-Gen On** main menu button changes to **Turn Sig-Gen Off**.

10-3 PTC-ACSES Analyzer Graphs

To select the measurement type:

1. From the Measurements main menu press PTC-ACSES Analyzer:
 - a. once if its indicator is red (see [Figure 10-24 on page 10-24](#))
 - b. twice if its indicator is gray (the PTC-ACSES Coverage indicator is red)

The Active Graph menu displays. These PTC-ACSES Analyzer measurements are available on the LMR Master:

- [Constellation](#)
 - [Spectrum](#)
 - [Eye Diagram](#)
 - [Summary Table](#)
 - [Message Decode Table](#)
 - [Payload Table](#)
2. The Graph Type submenu key shows the graph type of the active window. Press this key to change the type.

Constellation

Constellation view displays the demodulation information in an IQ format (Figure 10-1). The chart shows the relationship between the location of a constellation data point, its deviation frequency, and the information it carries.

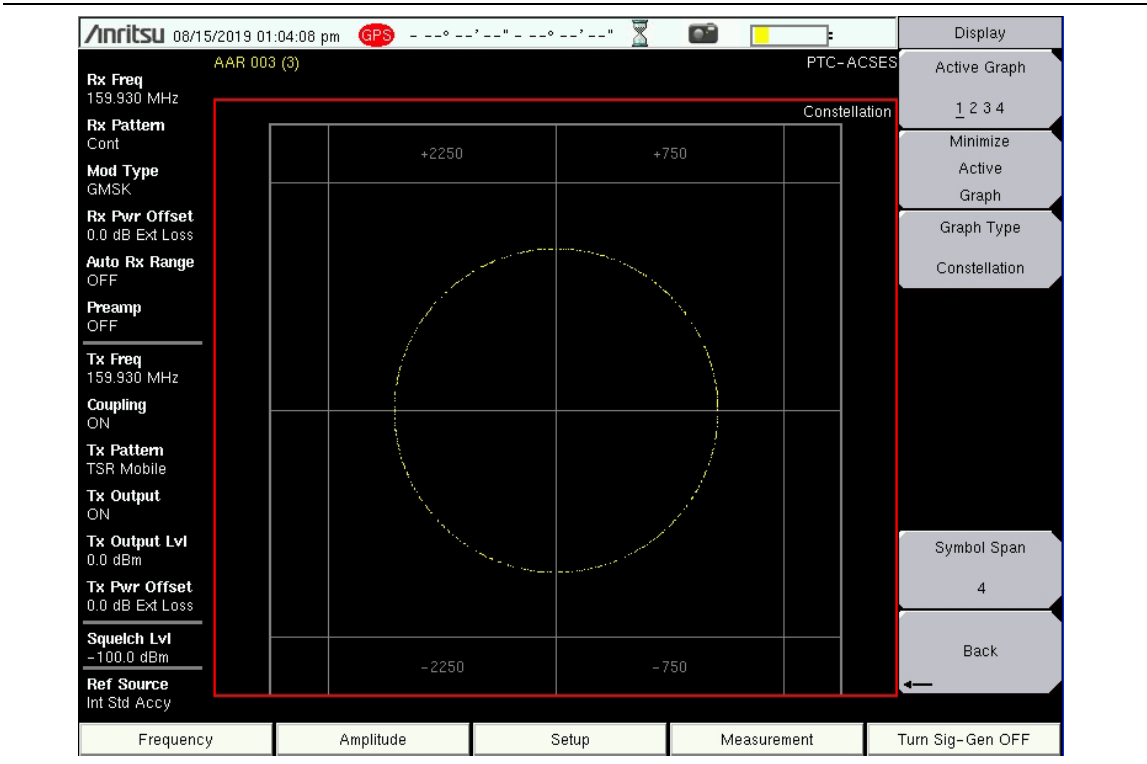


Figure 10-1. Constellation Diagram

Spectrum

The Spectrum view displays a graphical representation of power (dBm) vs. frequency. The Spectrum display gives an indication if there are interfering entities present that may degrade the bit error rate of the PTC signal. The frequency span is adjustable under the **Frequency** menu. The reference level is adjusted with the **Amplitude** menu. Refer to [“Amplitude Menu” on page 10-19](#) for details. [Figure 10-2](#) displays the same signal using a 25 kHz span and a 50 kHz span.

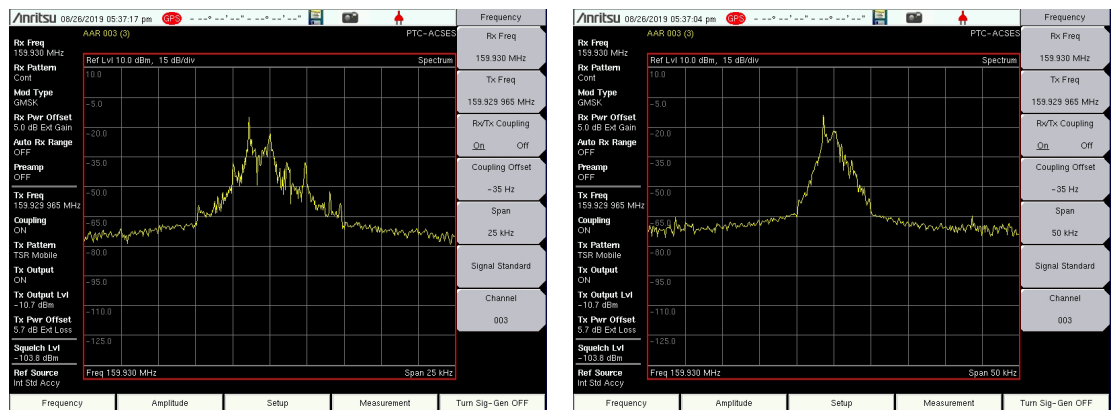


Figure 10-2. PTC-ACSES Spectrum Graph25kHz and 50kHz

Eye Diagram

The eye diagram is an oscilloscope view of the PTC signal displaying the voltage of the signal vs. time. The diagram provides an indication of baseband fidelity of a PTC transmitter. With over-the-air measurements, the Eye Diagram can indicate phase distortion from multipath. The number of “eyes” displayed is set with the Symbol Span key under the “Display Menu” on page 10-25.

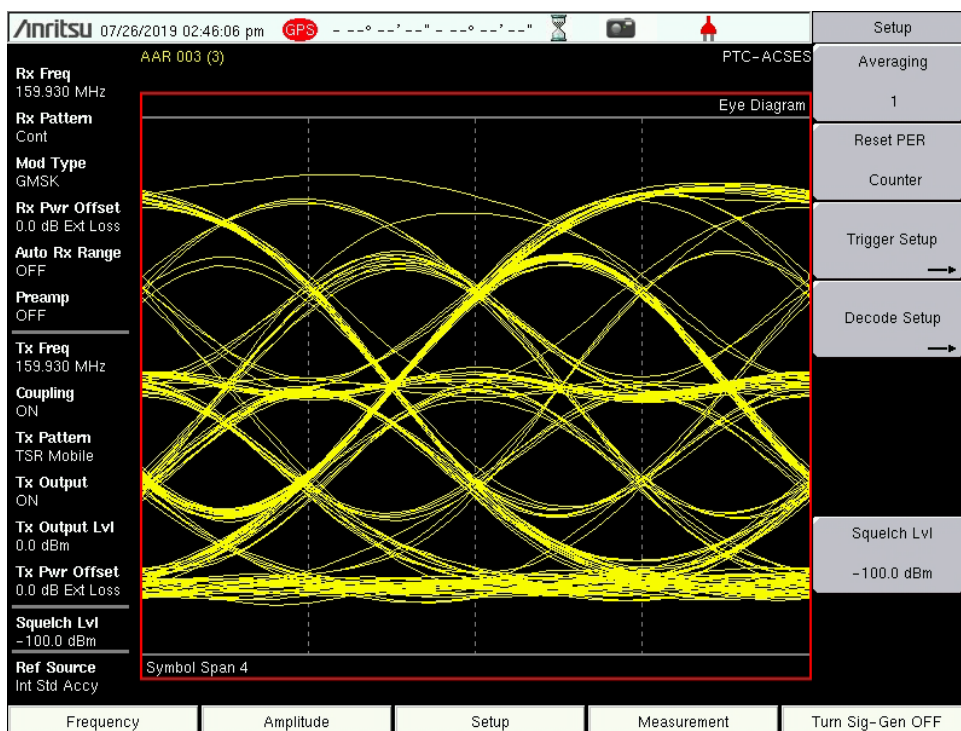


Figure 10-3. PTC-ACSES Eye Diagram

Summary Table

The Summary Table provides an overview of a PTC-ACSES transmitter. The table displays received power or burst power, peak envelope power (PEP), frequency error, error vector magnitude (EVM), bit error rate (BER), IQ offset, phase error, magnitude error, and symbol rate error of the input signal.

The received power and PEP values in the Summary Table can be changed between dBm, watts, and volts using the **Amplitude > Units > Rx Units** submenu key. This setting also applies to the burst power and squelch level setting. Press the **Power Display** key to toggle between displaying the received power (continuous) or the burst power.

The **Setup > Squelch Lvl** submenu key sets the received power level below which Summary Table results are not displayed. When the received power is lower than the set squelch level, all measurement values except for received/burst power will be blanked out (--) in the summary table. When the received power is above the squelch level, the measurements will display as shown in [Figure 10-4](#).

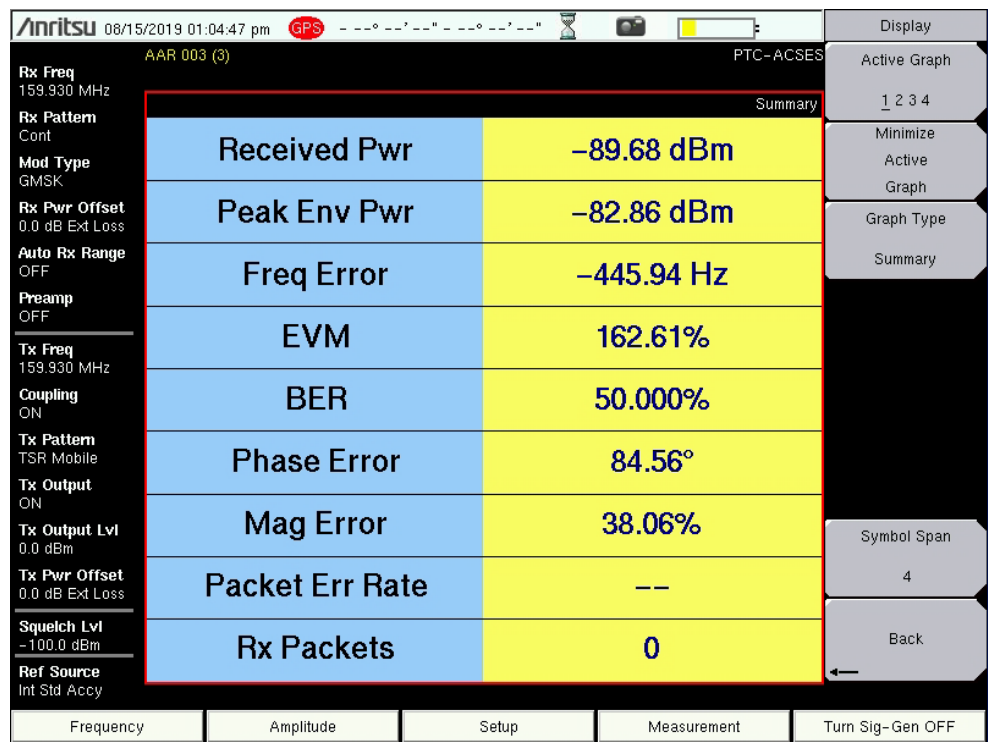


Figure 10-4. PTC-ACSES Summary Table

Received power in the Summary Table is the integrated power of all the energy in the receiver bandwidth. The reduction is specified as: 10*Log (Signal Bandwidth / Resolution Bandwidth). Burst power in the Summary Table is calculated only when the data stream contains packets and BER is calculated for each burst.

Message Decode Table

The Message Decode Table displays several items:

Source ATCS Address	x.RRR.xxxx.xx
Source Type	N/A, Wayside, Train, Office
Destination ATCS Address	x.RRR.xxx.xxx.xx.xx
Destination Type	N/A, Wayside, Train, Office
Time Slot in Frame	Value
Time Slot in Epoch	Value

Figure 10-5. PTC-ACSES Message Decode Table

Source ATCS Address:

This address is found either by parsing the payload searching for the Railroad ID (RRR) or derived from the Source Address location specified in the Setup Menu. The value displays in hex.

Source Type:

The type is decoded from the Source Address identified by RRR.

Destination ATCS Address:

This address is found either by parsing the payload searching for the Railroad ID (RRR), or derived from the Destination Address location specified in the Setup Menu. The value displays in hex.

Destination

ion	
Typ	
pe:	The type is decoded from the Source Address identified by RRR.
Time Slot in frame	This slot is the time slot (1-8) within the current 1-second frame that contains the message being displayed.
Time Slot in epoch	This slot is the time slot (1-48) within the current 6-second epoch that contains the message being displayed.

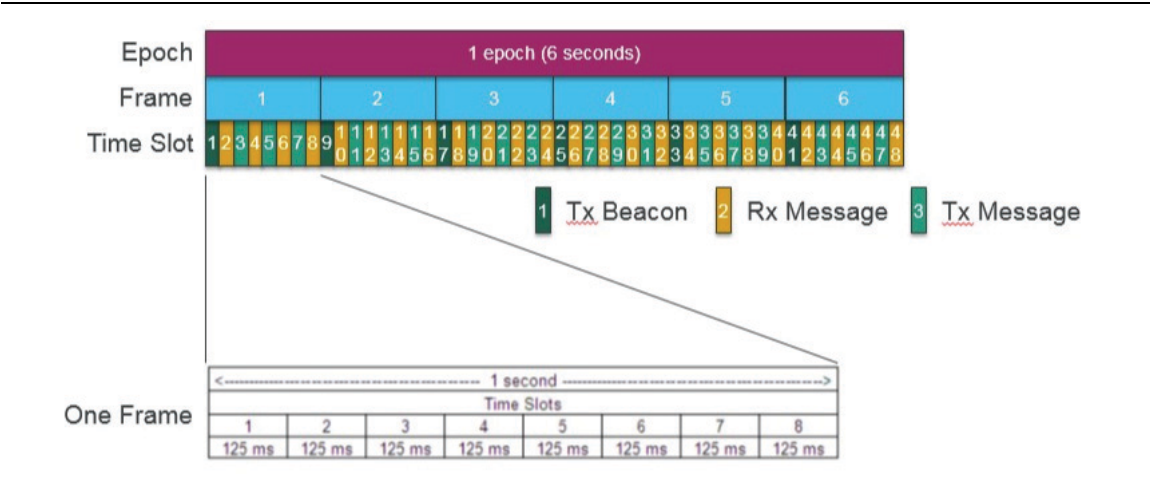


Figure 10-6. Time-slots

Payload Table

The Payload Table Payload displays the contents of the 117-byte payload in hex format. The image below is 10 rows of 12 hex values (last row only has 9 hex values).

18 91 0A FF 16 79 D4 F8 19 52 7B 1A
18 91 0A FF 16 79 D4 F8 19 52 7B 1A
18 91 0A FF 16 79 D4 F8 19 52 7B 1A
18 91 0A FF 16 79 D4 F8 19 52 7B 1A
18 91 0A FF 16 79 D4 F8 19 52 7B 1A
18 91 0A FF 16 79 D4 F8 19 52 7B 1A
18 91 0A FF 16 79 D4 F8 19 52 7B 1A
18 91 0A FF 16 79 D4 F8 19 52 7B 1A
18 91 0A FF 16 79 D4 F8 19 52 7B 1A
18 91 0A FF 16 79 D4 F8 19

Figure 10-7. PTC-ACSES Payload Table

The number of rows and hex values within each row are flexible, allowing for font size and available space.

Message payload is also sent over the Ethernet, accessible by TeraTerm.

10-4 PTC-ACSES Analyzer Main Menu

Menu maps typically display all possible submenu keys, although some keys are displayed on the instruments only under special circumstances (refer to menu descriptions on the following pages).

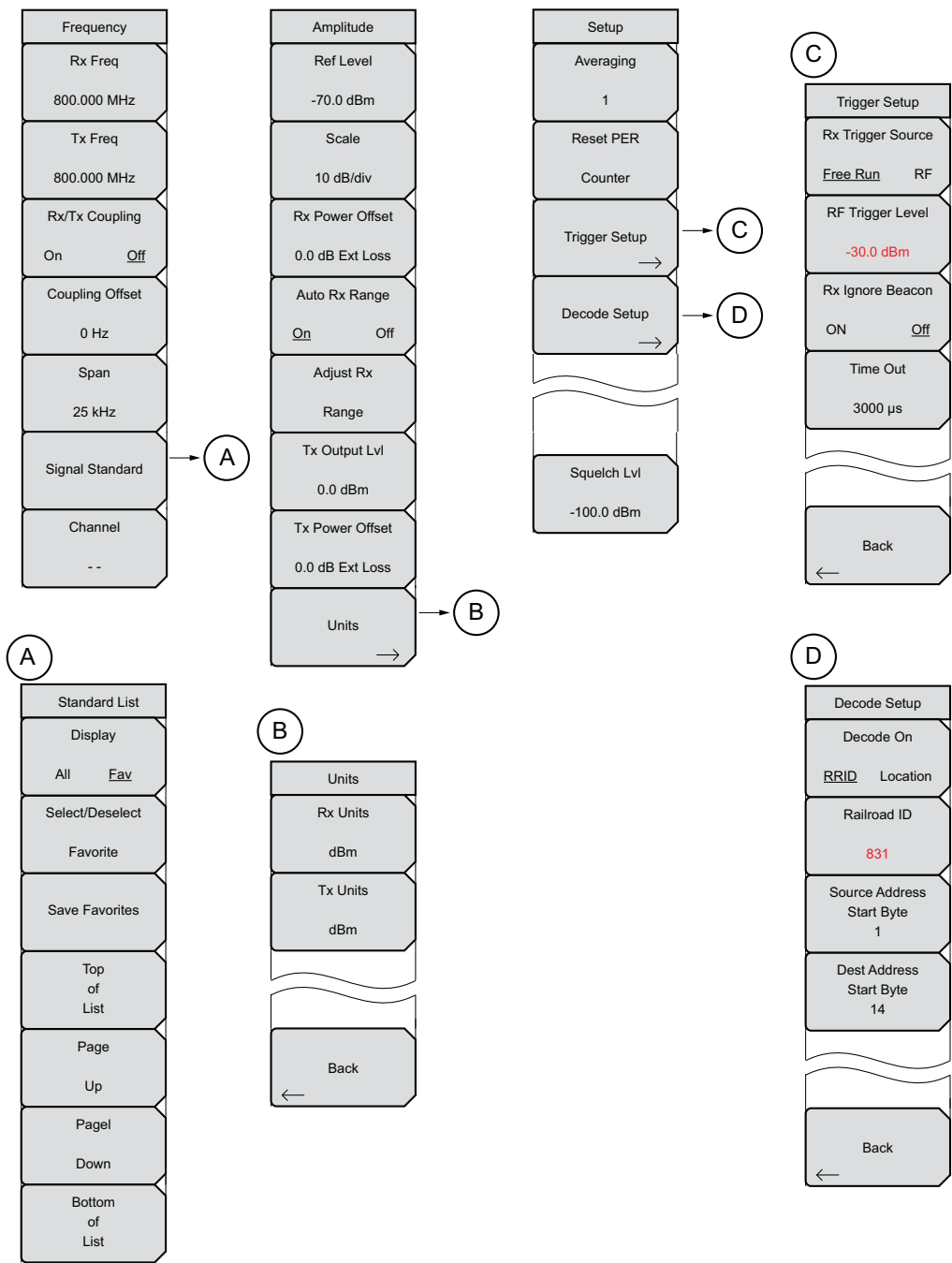


Figure 10-8. PTC-ACSES Analyzer Main Menu Layout

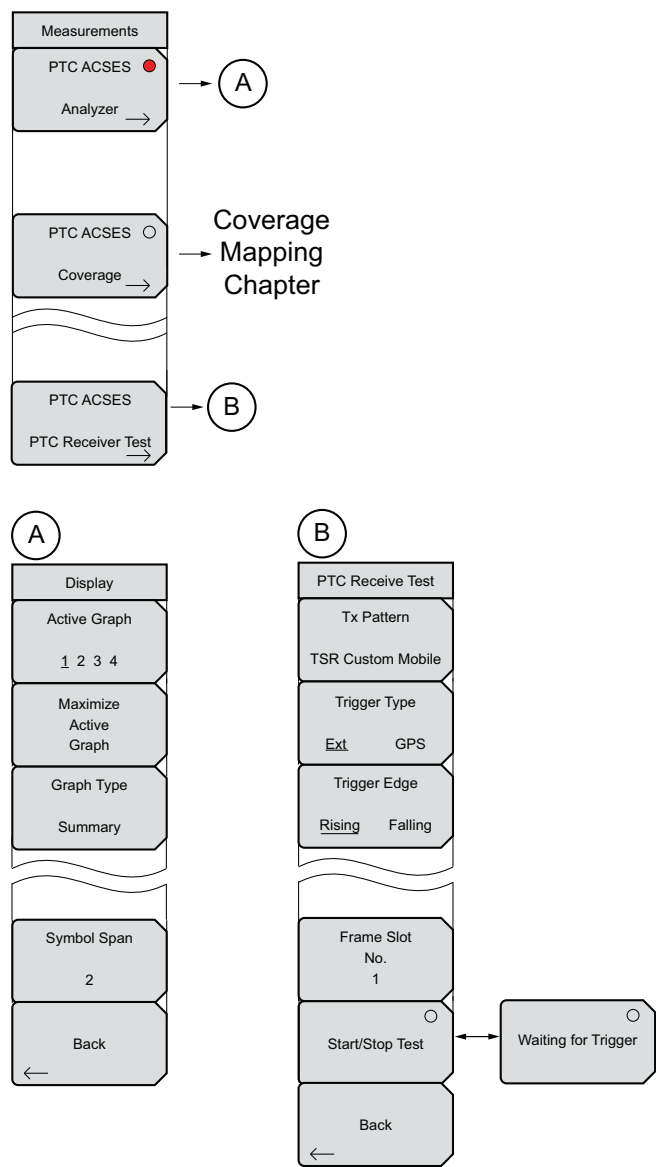


Figure 10-9. PTC-ACSES Analyzer Main Menu: Measurement Layout

10-5 Frequency Menu

Key Sequence: **Frequency**

Frequency	Rx Freq: Sets the receiver frequency. Press the Rx Freq key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the submenu key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the Enter key has the same effect as pressing the MHz submenu key.
Rx Freq 800.000 MHz	
Tx Freq 800.000 MHz	Tx Freq: Sets the signal generator frequency. Press the Tx Freq key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the submenu key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the Enter key has the same effect as pressing the MHz submenu key.
Rx/Tx Coupling On Off	
Coupling Offset 0 Hz	Rx/Tx Coupling: Couples the signal generator to the receiver frequency. When set to On, the Tx Freq key is disabled.
Span 25 kHz	Coupling Offset: Sets the offset of the signal generator frequency and the receiver frequency.
Signal Standard	Span: Sets the span of the Spectrum Graph. Span selections are 25 kHz, 50 kHz, 100 kHz, 500 kHz, 1 MHz, and 5 MHz.
Channel --	Signal Standard: Opens the Signal Standards selection box see Figure 10-11 and the softkey menu, see Figure 10-14 . Use the touch screen, rotary knob, the softkey menu, or the arrow keys to select from the list of available AAR (Association of American Railroads) channels and ranges. For signal standards that are associated with a channel range, such as AAR 005-097, press the Channel key to open the Channel Editor window, where you can select the AAR channel number. Channel: Opens the Channel Editor window. See Figure 10-12 . Use the rotary knob or the Up/Down arrow keys to select the AAR channel number. The channel is fixed and cannot be changed if the selected signal standard is a single channel and not a range.

Figure 10-10. PTC-ACSES Analyzer Frequency Menu

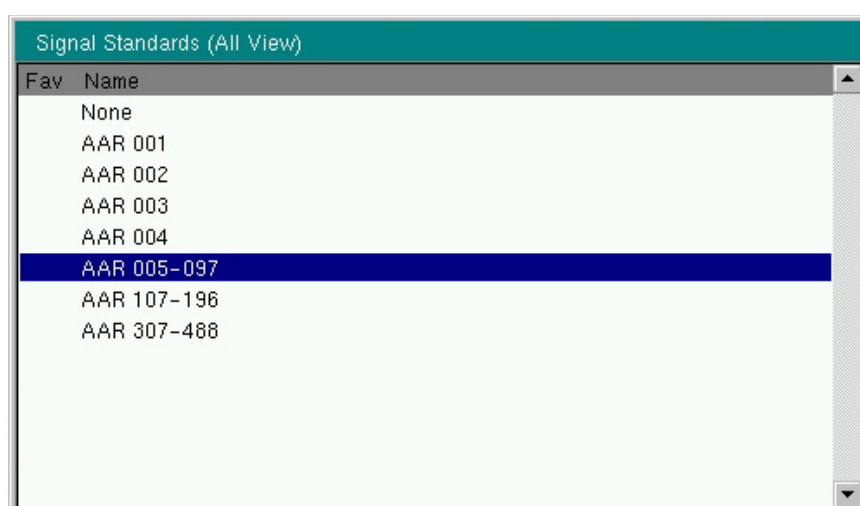


Figure 10-11. PTC-ACSES Signal Standards

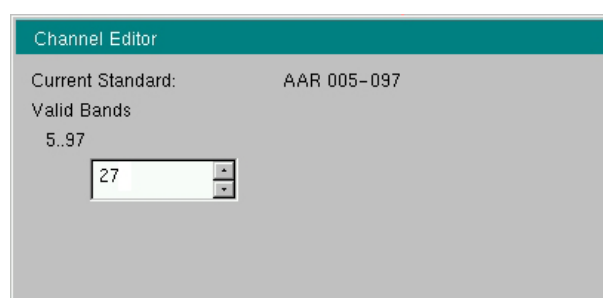


Figure 10-12. PTC-ACSES Channel Editor

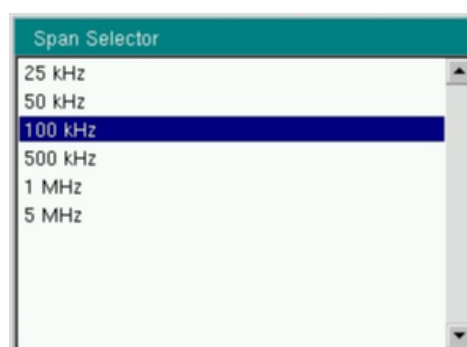


Figure 10-13. PTC-ACSES Span Selector

Signal Standard Menu

This menu provides navigation aids to the Signal Standard List.

Standard List

Display

All Fav

Select/Deselect

Favorite

Save Favorites

Top of List

Page Up

Page Down

Bottom of List

Display: Displays All or the favorites.

Select/Deselect: Selects or deselects the favorites.

Save Favorites: Saves the favorites.

Top of List: Positions cursor at the top of the list.

Page up/Page down: Positions the list at the previous or next page.

Bottom of List: Positions the cursor at the bottom of the list.

Figure 10-14.PTC-ACSES Signal Standard Menu

To select or deselect favorites:

- 1. Move the cursor to the standard you want to select or deselect as a favorite.



Figure 10-15.PTC-ACSES Signal Standard List

2. Press Select/Deselect button. This image shows a single selection.

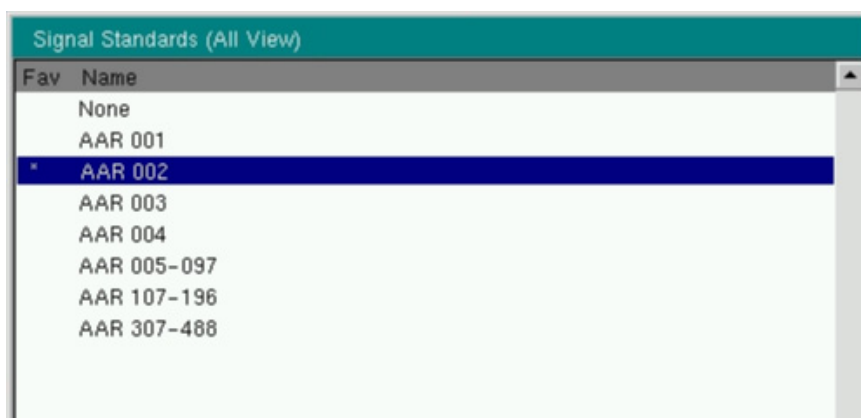


Figure 10-16.PTC-ACSES Select First Favorite

3. Perform steps 1 and 2 for as many standards as needed.

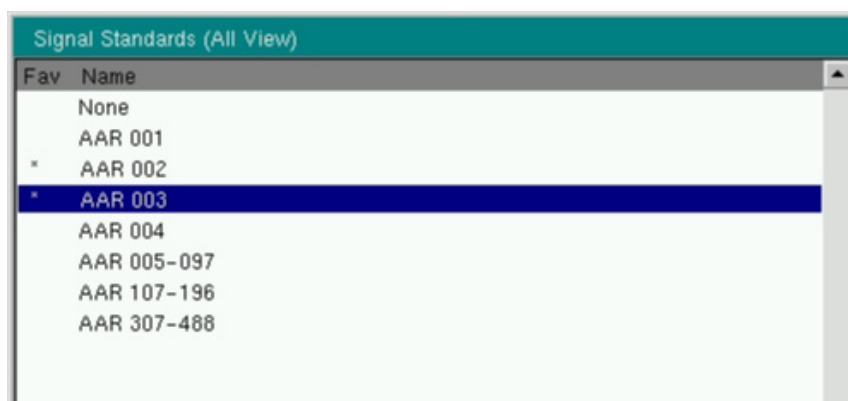


Figure 10-17.PTC-ACSES Select More Favorites

4. Press Save Favorites.

- 5. Press Display to toggle to the Favorites View.
-



Figure 10-18.PTC-ACSES View Favorites

10-6 Amplitude Menu

Key Sequence: **Amplitude**

Amplitude	Ref Level: Sets the reference power level at the top of the display when Auto Range is Off.
Ref Level	
-70.0 dBm	
Scale	Scale: Scale sets the number of dB per division in the y-axis of the graticule. Enter a value from 1 dB per division to 15 dB per division using the keypad, the arrow keys, or the rotary knob. The y-axis power scale is shown on the left side of the display when viewing the Spectrum Graph.
10 dB/div	Note: The "Scale Menu" on page 10-20 is displayed when PTC-ACSES Coverage (Measurement > PTC-ACSES Coverage) is selected.
Rx Power Offset	Rx Power Offset: Sets the receiver (RF IN connection) external attenuation or gain. Press the Rx Power Offset submenu key and select a value from 0 dB to 100 dB then select either dB External Loss or dB External Gain.
0.0 dB Ext Loss	
Auto Rx Range	Auto Rx Range: Pressing this submenu key toggles between On and Off. When On, this function automatically adjusts the pre-amplifier based on the input signal. This only has 3 unique settings:
On Off	<ul style="list-style-type: none"> • Ref level -4 with Preamp Off • Ref level -41 with Preamp Off • Ref level -41 with Preamp ON
Adjust Rx	Adjust Rx Range: When Auto Rx Range is Off, pressing Adjust Rx Range sets the Reference Level automatically for the current measurement.
Range	
Tx Output Lvl	Tx Output Lvl: Sets the output power of the Signal Generator (0 dBm or 1 mW or 223 mV max).
0.0 dBm	Tx Power Offset: Sets the transmitter (Signal Generator Out connection) external attenuation or gain. Press the Tx Power Offset submenu key and select a value from 0 dB to 100 dB then select either dB External Loss or dB External Gain.
Tx Power Offset	
0.0 dB Ext Loss	
Units	Units: Opens to Units Submenu.
→	
Units	Rx Units: Sets the unit of measure (dBm, watts, or volts) for Received Power in the Summary Graph and the Squelch Level.
Rx Units	
dBm	Tx Units: Sets the unit of measure (dBm, watts, or volts) for the Signal Generator (Tx Output Lvl submenu).
Tx Units	
dBm	
Back	Back: Returns to Amplitude menu.
←	

Figure 10-19. PTC-ACSES Analyzer Amplitude Menu

Scale Menu

Key Sequence: **Amplitude** > Scale

Vertical Scale

RSSI Scale

10 dB/div

BER Ref

100.00 %

Mod Fid Ref

100.00 %

Back

←

Note: This menu displayed when PTC-ACSES Coverage (**Measurement** > PTC-ACSES Coverage) is selected.

RSSI Scale: Sets the number of dB per division in the y-axis power scale of the RSSI vs. Time graph in Coverage measurement. Enter a value from 1 dB per division to 15 dB per division using the keypad, the arrow keys, or the rotary knob.

BER Ref: Sets the BER reference percentage value at the top of the y-axis in the BER vs. Time graph in Coverage measurement. Enter a value from 1.00 % to 100.00 % using the keypad, the arrow keys, or the rotary knob.

EVM Ref: Sets the EVM reference percentage value. Enter a value from 1.00 % to 100.00 % using the keypad, the arrow keys, or the rotary knob.

Back: Returns to Amplitude menu.

Figure 10-20. PTC-ACSES Vertical Scale Menu

10-7 Setup Menu

Key Sequence: **Setup**

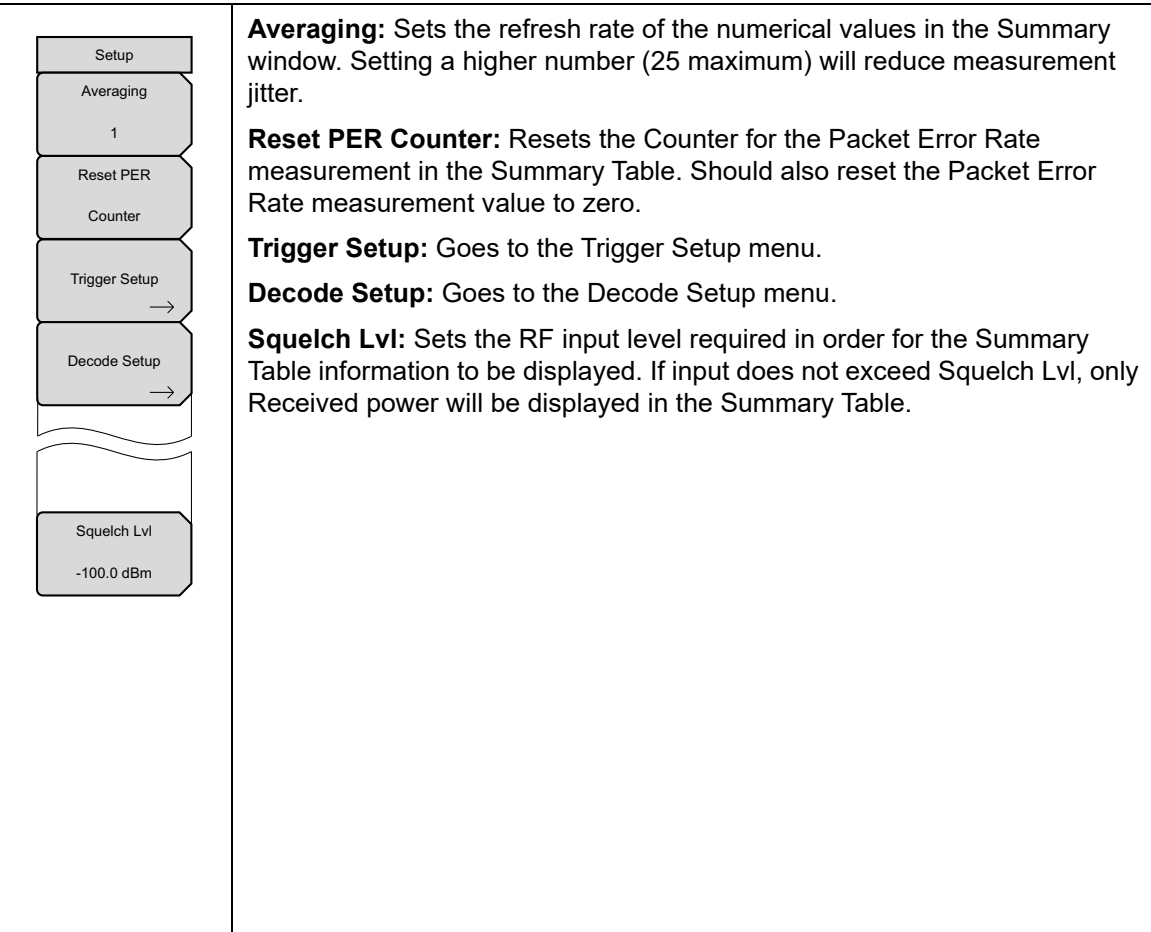


Figure 10-21.PTC-ACSES Analyzer Setup Menu

Trigger Menu

Key Sequence: Setup > Trigger Setup

Trigger Setup

Rx Trigger Source

Free Run RF

RF Trigger Level

-30.0 dBm

Rx Ignore Beacon

ON Off

Time Out

3000 μs

Back

RxTrigger Source: Selects whether the LMR SPA receiver is free-running to capture and analyze whatever happens to be at its input, or is triggered to capture by an incoming RF signal level. Selecting RF is level-triggered (rather than edge-triggered), and as long as the incoming RF signal level is above the RF trigger level, a capture will be initiated. Must be using RF Trigger with an appropriate Trigger threshold for data to be accurately decoded without the Beacon interfering.

RF Trigger Level: Sets the RF level above which a capture and analyze is initiated in the SPA receiver. Only applies when the Rx Trigger Source is set to RF. Default value is Rx.

Rx Ignore Beacon: Only applies when Rx Trigger Source is RF. When set to ON, allows the unit to ignore the Wayside beacon for analysis and only trigger on message content between wayside and train radios. When OFF, the unit will analyze the first RF signal to exceed the trigger level, whether it is beacon or message. Default value is OFF. This setting requires that the GPS antenna be in a locked state.

Time Out: Only applies when Rx Trigger Source is RF. Sets the amount of time that the LMR Master will wait for valid RF trigger before timing out and displaying “- -” in the demod Summary and Payload tables as indicators that no valid RF burst was detected. Default value is 3000 ms.

Back: Returns to the “Setup Menu” on page 10-21.

Figure 10-22.PTC-ACSES Trigger Setup Menu

Decode Menu

Key Sequence: **Setup > Decode Setup**

Decode Setup	
Decode On	
RRID Location	
Railroad ID	
831	
Source Address Start Byte	
1	
Dest Address Start Byte	
1	
<hr/>	
Back	
←	

Decode On: Tells LMR Master to search for message source/destination information based on Railroad ID number or physical location within the payload section of the message. Default selection is Railroad ID.

Railroad ID: When decoding on Railroad ID, LMR Master will combine the 1,2,7 designator with the RR ID to search the payload for source and destination address information. Values should be entered and displayed in hexadecimal format, and be three digits Default value is 891 (hex).

Source Address Start Byte: Provides the location within the message payload of the first byte of the Source Address. Valid entries are 1 through 110, inclusive. Default value is 1.

Dest Address Start Byte: provides the location within the message payload of the first byte of the Destination Address. Valid entries are 1 through 110, inclusive. Default value is 14.

Back: Returns to the ["Setup Menu" on page 10-21](#).

Figure 10-23. PTC-ACSES Analyzer Setup (2/2) Menu

10-8 Measurement Menu

Key Sequence: **Measurement**

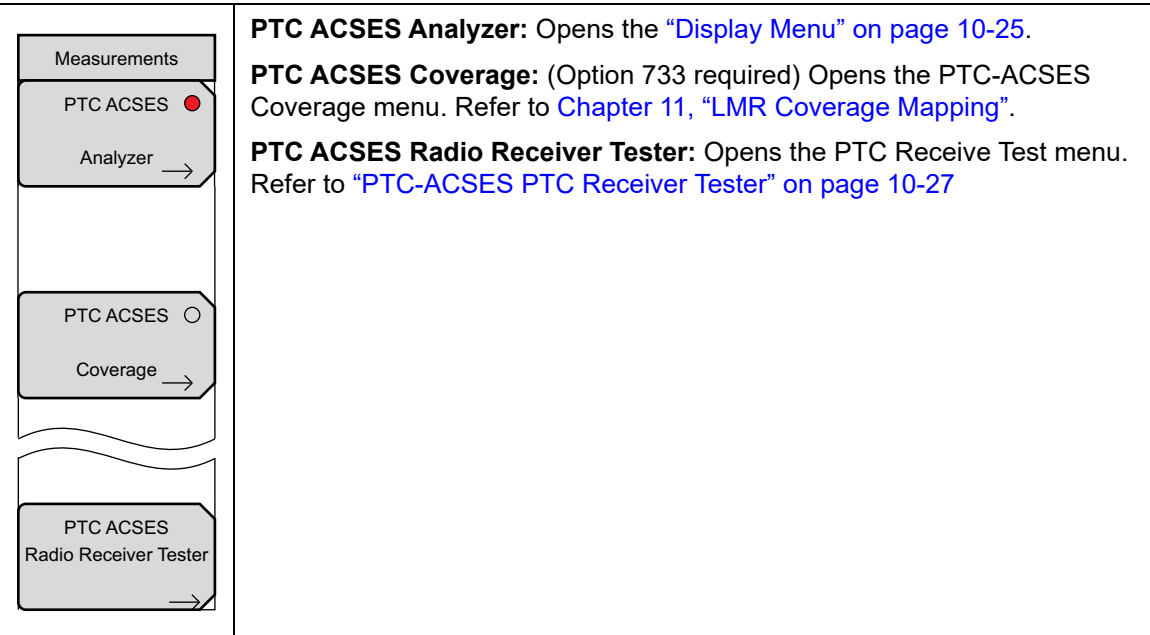


Figure 10-24.PTC-ACSES Analyzer Measurement Menu

Alternatively use Shift + 4 on the key pad.

PTC-ACSES Analyzer

Display Menu

Key Sequence: **Measurement** > PTC-ACSES Analyzer

<div><div>Display</div><div>Active Graph</div><div><div><div><div>1</div><div>2</div><div>3</div><div>4</div></div></div></div><div>Maximize Active Graph</div><div>Graph Type</div><div>Spectrum</div><div></div><div></div><div>Symbol Span</div><div>2</div><div>Back</div><div></div></div>	<p>Active Graph: In Four-Screen view (maximized), use this submenu key to select which of the four graphs is active. The current active graph is underlined (<u>1</u> 2 3 4), and the graph has a red perimeter line in the sweep window. Any of the four graphs can also be made active by tapping once on the graph in the touch screen. Repeatedly pressing the Active Graph submenu key will cycle the active graph, 1 through 4.</p> <p>In Standard view (one graph displayed on the screen – refer to Maximize Active Graph key) the Active Graph key rotates active focus among the four graphs that are displayed in the Four-Screen view.</p> <p>Maximize/Minimize Active Graph: The submenu key toggles between displaying the Four-Screen view (4 graphs) and the Standard view (1 graph). Tapping twice on a selected graph also toggles between the two display options.</p> <p>Graph Type: The label on the bottom of this key displays the current active graph type. Pressing the key opens a list box of the graph types available for PTC-ACSES Analyzer measurements. Select the desired graph type with the Arrow keys or rotatory knob, and then press Enter. The current, active graph will be replaced with the new selection.</p> <p>Refer to “PTC-ACSES Analyzer Graphs” on page 10-4 for additional information.</p> <p>Symbol Span: Use this menu to adjust the number of symbols viewed across the screen in the Eye Diagram graph. Adjust from 2 and 5 using the keypad, the arrow keys, or the rotary knob. Keypad values entered outside of this range are ignored.</p> <p>Back: Returns to the “Measurement Menu” on page 10-24.</p>
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Figure 10-25.PTC-ACSES Analyzer Display Menu

PTC-ACSES Coverage

Key Sequence: **Measurement** > Coverage Mapping

Coverage Mapping

Save/Recall

Points/Map →

Mapping Type

RSSI

Legend

Setup →

Display Type

Map Graph

Point Distance/Time Setup →

Back

←

For an extensive treatment of the options and operations of Coverage Mapping, refer to [“LMR Coverage Mapping” on page 11-1](#).

Back: Returns to the [“Measurement Menu” on page 10-24](#).

Figure 10-26.PTC-ACSES Analyzer Display Menu

PTC-ACSES PTC Receiver Tester

<div data-bbox="175 266 371 311">PTC Receive Test</div> <div data-bbox="175 311 371 355">Tx Pattern</div> <div data-bbox="175 355 371 399">TSR Mobile</div> <div data-bbox="175 399 371 444">Trigger Type</div> <div data-bbox="175 444 371 488">Ext <u>GPS</u></div> <div data-bbox="175 488 371 533">Trigger Edge</div> <div data-bbox="175 533 371 577">Rising <u>Falling</u></div> <div data-bbox="175 672 371 826"> <div data-bbox="175 672 371 826">Frame Slot No. 2</div> </div> <div data-bbox="175 826 371 929"> <div data-bbox="175 826 371 929">Start Test</div> </div> <div data-bbox="175 929 371 1039"> <div data-bbox="175 929 371 1039">Back</div> </div>	<p>Tx Pattern: Displays the Pattern Type Selector dialog so that a pattern may be selected.</p> <div data-bbox="541 320 1136 755"> </div> <p>Trigger Type: Press this button to switch between External and GPS trigger type.</p> <p>Trigger Edge: Press this button to switch between rising and falling trigger type.</p> <p>Frame Slot No: Press this key and use the keypad or the rotary switch to adjust the Frame Slot.</p> <p>Start Test: Press the button to start the test (the Back button is displayed with this button). For Wayside with beacon pattern, the Frame slot number must be set to 1.</p> <p>Stop Test: Press the button to stop the test and turn off the generator. Use this button only to sync up the GPS/Ext trigger.</p> <p>Waiting for Trigger: When displayed, the GPS/Ext was not detected and output is not synced.</p> <p>Back: Returns to the “Measurement Menu” on page 10-24 (this button is only visible with the Start Test button).</p>
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Figure 10-27.PTC-ACSES Receiver Tester Menu

10-9 Sweep Menu

Key Sequence: **Shift > Sweep (3)** key

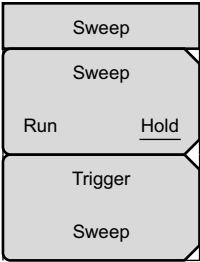
	<p>Sweep Run/Hold: This submenu key toggles between continuous (run) sweep and hold sweep. In Run sweep mode, sweeps are continuous and one starts immediately after the previous sweep is completed. In Hold sweep mode, the results of the last sweep are displayed on the screen while the instrument waits for a trigger event to start a new sweep. HOLD is displayed on the right side of the screen in this mode.</p> <p>Trigger Sweep: Pressing this submenu key causes the instrument to make a single sweep when the instrument is in Hold sweep mode. This key has no function when the instrument is in Run sweep mode.</p>
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Figure 10-28.PTC-ACSES Analyzer Sweep Menu

10-10 Trace Menu

This menu is not available in PTC ACSES Analyzer measurement mode.

10-11 Limit Menu

This menu is not available in PTC ACSES Analyzer measurement mode.

10-12 Other Menus

Preset, Calibrate, File, System, and **Mode** are described in the User Guide.

Chapter 11 — LMR Coverage Mapping

To perform indoor and outdoor coverage mapping measurements Option 31, compatible GPS Antenna (outdoor coverage mapping) are required. Coverage mapping also requires one or more of the following options installed on the LMR Master:

Note

- NBFM Coverage (Standard)
- P25/P25p2 Coverage (Option 522)
- NXDN Coverage (Option 532)
- dPMR Coverage (Option 572)
- TETRA Coverage (Option 582)
- DMR Coverage (Option 592)
- PTC-ITCR and PTC ACSES Coverage (Option 722 and 733)

11-1 Introduction

The LMR Master Coverage Mapping feature measures map signal strength, modulation fidelity, error vector magnitude, or bit error rate of a single channel as a function of time and location. These options are not to be confused with Option 431 Coverage Mapping, which is a legacy option that applies only to the Spectrum Analyzer mode.

The LMR Master combines the received signal information with time and location information from the internal GPS module (Option 31 required) to store data that can then be turned into coverage maps using third party software.

The easyMap Tools™ program creates single panel maps (.map) that are compatible with Anritsu's handheld instruments. The software also creates pan and zoom maps (.azm) that are compatible with supported Anritsu instruments. The software imports maps from OpenStreetMap and Google Maps and creates files with or without GPS information. Anritsu easyMap Tools is available from the Anritsu Web site: www.anritsu.com.

- .azm map files allow Pan and Zoom on the instrument.
- .map map files are in a legacy format that is compatible with older firmware.

When **Start Data Collection** is turned On, OTA measurements are attached to the GPS location and time data, and the measurements are saved to a file. Captured data can be saved as a tab delimited text file (.mtd) for viewing coverage data in a spreadsheet, text editor, or third-party coverage prediction software. The measurements can also be saved in .kml format for direct viewing with mapping software, such as Google Earth.

For P25/P25p2, NXDN, dPMR, TETRA, DMR, and PTC Coverage (both ITCR and ACSES), the measurement information that is collected includes Received Signal Strength Indication (RSSI), Bit/Message Error Rate (BER/MER), and Modulation Fidelity (in TETRA and PTC, RMS Vector Err (EVM) replaces Modulation Fidelity). NBFM Coverage includes RSSI, Total Harmonic Distortion (THD), Signal-to-Noise and Distortion ratio (SINAD), and External SINAD.

11-2 General Measurement Setups

Refer to the setup procedures in this Measurement Guide for the specific measurement mode used in Coverage Mapping:

- NBFM, [“Transmitter Analysis Setup” on page 2-2](#)
- P25, [“Over-the-Air \(OTA\) Analysis Setup” on page 3-2](#)
- P25p2, [“Over-the-Air \(OTA\) Analysis Setup” on page 4-2](#)
- NXDN, [“Over-the-Air \(OTA\) Analysis Setup” on page 5-2](#)
- dPMR, [“Over-the-Air \(OTA\) Analysis Setup” on page 6-2](#)
- TETRA, [“Over-the-Air \(OTA\) Analysis Setup” on page 7-1](#)
- DMR, [“Over-the-Air \(OTA\) Analysis Setup” on page 8-2](#)
- PTC-ITCR, [“Over-the-Air \(OTA\) Analysis Setup” on page 9-2](#)
- PTC-ACSES, [“Over-the-Air \(OTA\) Analysis Setup” on page 10-2](#)

11-3 Coverage Mapping Introduction

Note Outdoor coverage mapping requires Option 31 (GPS) and a GPS antenna. Indoor coverage mapping utilizes the instrument touch screen to log points, and thus does not require Option 31.

Two screen display options are available for Indoor and Outdoor mapping:

- **Map Display Type:** Displays an imported map or the default grid. After starting data collection, values for the mapping parameters are recorded for each data point.

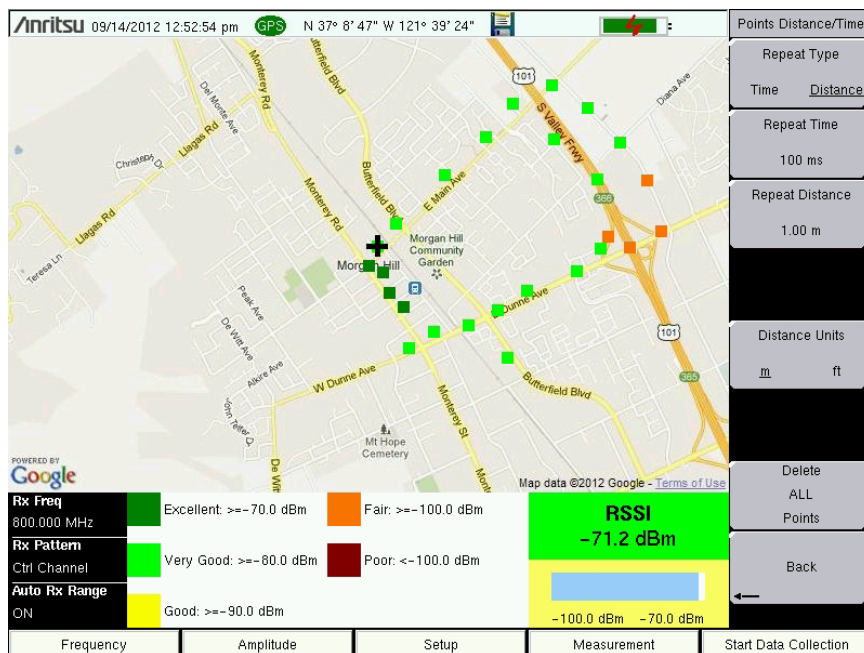


Figure 11-1. Coverage Mapping Using the Map Display

- **Graph Display Type:** Displays line graphs for 2 of the 3 measurement values for the selected frequency over time. Change the displayed graph type by using the Mapping Type button. Graph points are displayed in yellow when GPS is On and in red when GPS is Off.

The graph display can show the most recent 551 measured points, covering approximately 30 minutes of measurement. The most recent data appears at the right edge of the display. These two measurements with the third measurement type (not displayed in a graph) are shown in three fields with a yellow background at the bottom of the screen.

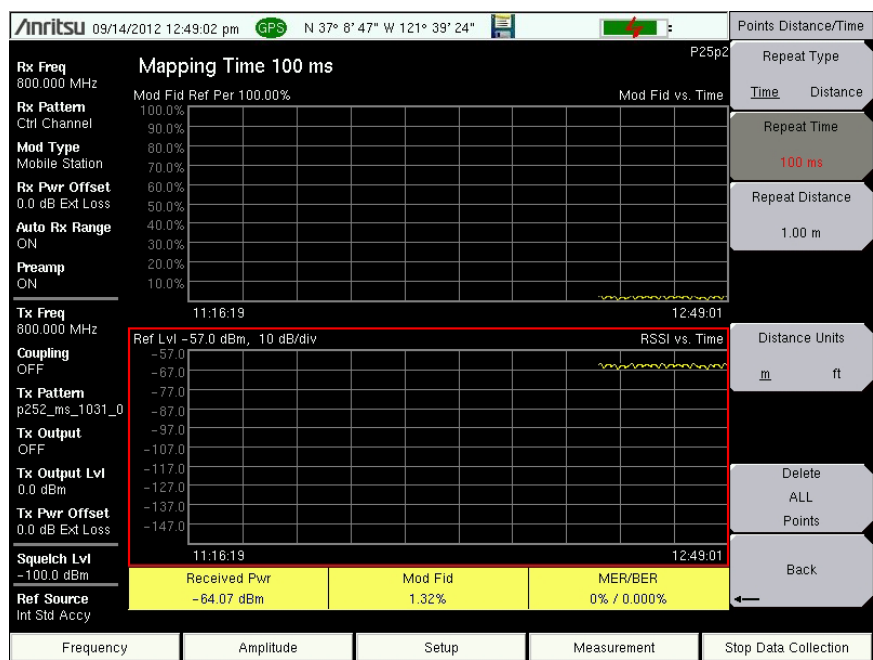


Figure 11-2. Coverage Mapping Using the Graph Display

The Coverage Mapping option allows for both indoor (no GPS signal) and outdoor (GPS signal required) mapping.

- **Indoor Mapping:** Using a start-walk-stop approach, the instrument provides in-building coverage mapping by overlaying data directly onto the downloaded map. Data is captured at user-defined time intervals or user-defined map locations by tapping the touchscreen.
- **Outdoor Mapping:** The instrument logs data automatically based on either time or distance interval. If no map is available when making the measurements, then you can still save all the data to a KML file and later combine the data file with a map. Refer to [“Recall the Default Grid” on page 11-15](#).

Outdoor Coverage Mapping

With a valid GPS signal, the instrument identifies the current location on the displayed GeoEmbedded map with a cross. Previously saved locations are displayed as squares.

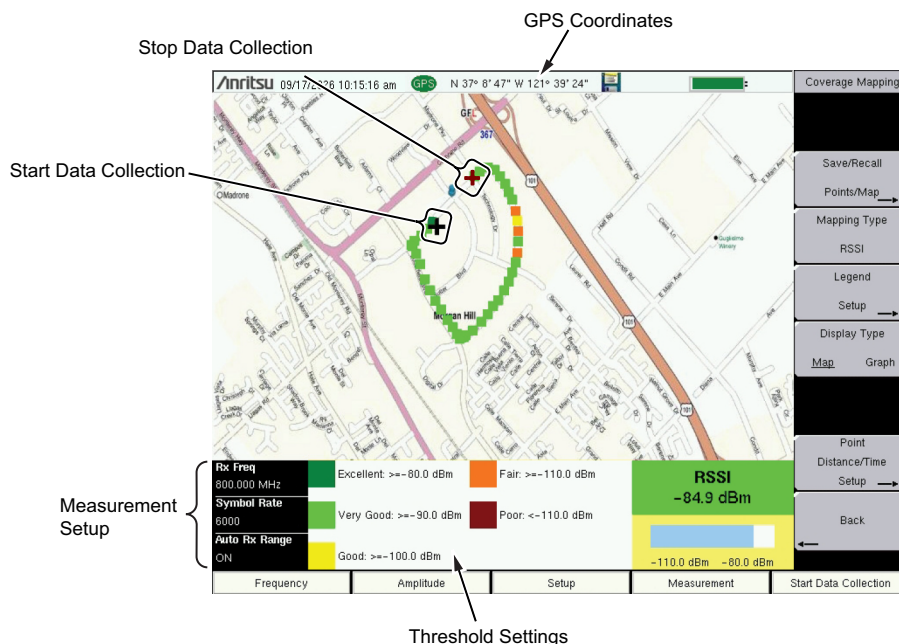


Figure 11-3. Outdoor Coverage Mapping (GPS On)

Note

The Measurement Setup and Threshold Setting boxes can be used as menu shortcuts on touch screen instruments. Use the touch screen to select the parameter to edit.

Indoor Coverage Mapping

With GPS turned Off, and with a non-GeoEmbedded map file, you indicate the current position (+) on the displayed map by using the instrument touch screen. Previously saved locations are displayed as squares.

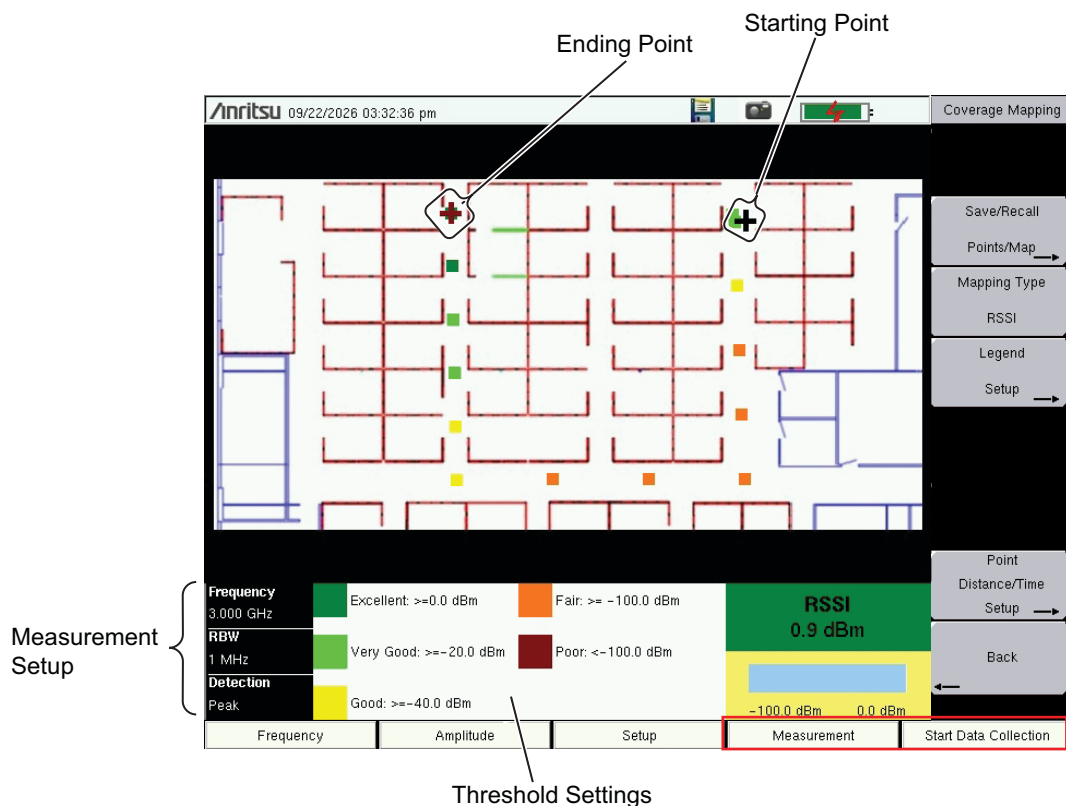


Figure 11-4. Indoor Coverage Mapping

Indoor Coverage Mapping is performed as below:

1. Press Shift + 7 to open the File > Recall.
2. Load an indoor map of the facility stored in the internal memory or an external USB device.
3. Press Measurement > Select Wireless Standard.
4. Tap on the instrument display to set the starting point indicated by the black grid point (black cross). Press Start Data Collection button located at the bottom of the instrument display. Begin moving from the starting point.
5. Tap constantly on the instrument display while in motion. Notice that each tap is marked by a red grid point (red cross). Alternately, use the left or right arrows keys on the instrument to place the red grid point.
6. Press Stop Data Collection button to stop collecting the data points after reaching the destination.
7. Select Save/Recall Points/Map button on the Coverage Mapping menu. See [Figure 11-4](#).

8. Choose from the available file formats in the Mapping Save/Recall menu to save the coverage mapping file on the instrument or an external memory device.

11-4 Anritsu easyMap Tools

Anritsu easyMap Tools allows you to capture maps of any location and to create Anritsu Map Files. These Anritsu Map Files are used for Coverage Mapping. The Help button in easyMap Tools provides details for the use of the application.

Download and install Anritsu easyMap Tools from the Anritsu Web site (www.anritsu.com).

Terminology:

AZM – Anritsu Zoomable Map, the format of a map file with pan and zoom capabilities for on-instrument maps.

Coverage Map – This defines the bounds of the AZM file. Everything contained within this map shows up in the AZM file.

Detail Map – This defines the maximum image detail that is recorded in the AZM file. Ensure that desirable street names are visible here.

Red Highlight Area – This highlighted segment of the Coverage Map represents the area that is currently covered by the Detail Map.

Example Procedure:

1. Start easyMap Tools.
2. Select your Map Type, if the current one does not meet your needs.
3. The Coverage Map is displayed on the left side, and the Detail Map is displayed on the right side.
4. Enter an address (that you want the coverage map to center upon) into the Address bar, then click “Go” or press the **Enter** key.
 - a. This can be a partial address, such as “Morgan Hill, CA” or “95037”.
 - b. This can be a full street address, such as “490 Jarvis Drive, Morgan Hill, CA.”
5. Adjust the Coverage Map by panning and zooming until the Coverage Map covers everything that needs to be in the AZM file.
6. Pan around the Detail Map to confirm that the lowest level of detail is sufficient. For example, ensure that the necessary street names are shown.
 - a. If the map is not detailed enough, zoom into the Detail Map until the desired level of detail is reached (maximum zoom level is 3 without API keys).
 - b. Maps with more detail take longer to download and also take up more disc space.
 - c. The estimated size of the map file is displayed above the Detail Map, adjacent to the Save Map button.
 - d. If the Coverage Map is covering too much, it can be zoomed in to reduce total map size.
 - e. Consider making multiple maps (if necessary), especially if the intended region has a significantly different shape than the Coverage Map (such as a long highway drive test).

7. Confirm that your easyMap settings meet your needs:

Set Map Format – This determines which type of map file is created. Only AZM files can contain multiple map tiles.

Set Color Filter – This allows the resulting AZM file to match various alternative instrument user interface color schemes.

This does not affect the appearance of the Coverage Map or the Detail Map, but the changes show up when viewing the resulting AZM file.

Register API keys – API keys (Google or MapQuest) must be registered for maps larger than approximately 5 MB estimated size (this allows for 3 zoom levels in your AZM file).

Note	MapQuest keys are generally easier to set up than Google Keys. The easyMap Help file has links to help pages for registering your own API Key.
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Configure Web Proxy – This is necessary only for users who must connect to their work network via Web Proxy.

8. Save your map (**File** > **Save Map**, with current settings).
9. When the map has finished downloading, open it (**File** > **Open Map**).

When the map has finished downloading, it can be copied to your instrument via USB flash drive.

Creating an Outdoor Map File with easyMap Tools

The easyMap Tools program allows you to create a map from map providers Google and MapQuest. Google Maps offer Road, Terrain, Satellite, and Hybrid maps. MapQuest offers OpenStreetMaps.

Two methods can be used to create outdoor maps by using easyMap Tools:

Method 1: Opening a JPEG, GIF, TIFF, or PNG file and adding GPS data.

- 1. Capture a bitmapped image of a map from a map provider and save it in one of the available file formats.
The image size should be close to 640 pixels by 420 pixels (approximately a 1.6:1 ratio).
- 2. Launch the Anritsu easyMap Tools application.
- 3. In the File pull-down menu, select Open Image File... and choose the image file to be converted to a map.
- 4. Set up the map as desired, including adding Latitude and Longitude parameters, and then save the map.
- 5. If you have GPS information only in the Degree-Minute-Second (DMS) format, then use the following relationship to convert to Decimal Degrees (DD):

$$\text{Degrees} + \frac{\text{Minutes}}{60} + \frac{\text{Seconds}}{3600} = \text{DD}$$

Note Remember to enter location information for the borders of the map, not your current location.

Figure 11-5 is an example of two overlapping maps from a mapping service with GPS data for the border of each map.

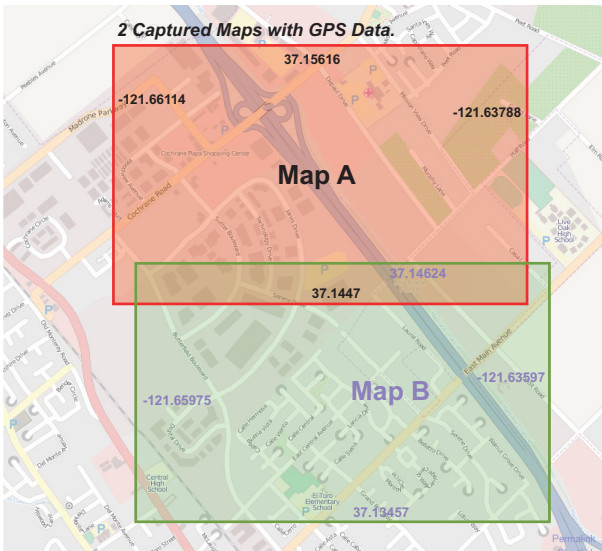


Figure 11-5. Overlapping Captured Maps with Border GPS Data

Note easyMap Tools can open and modify GPS data in existing .map files.

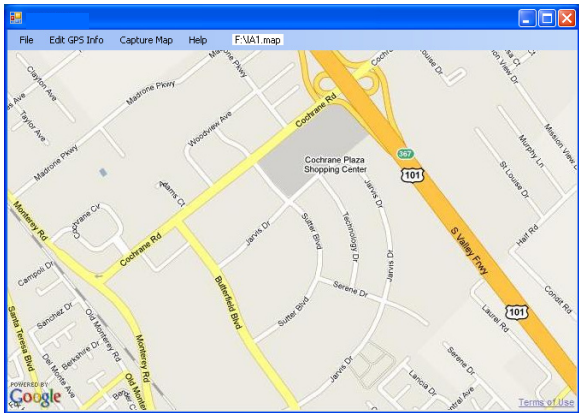
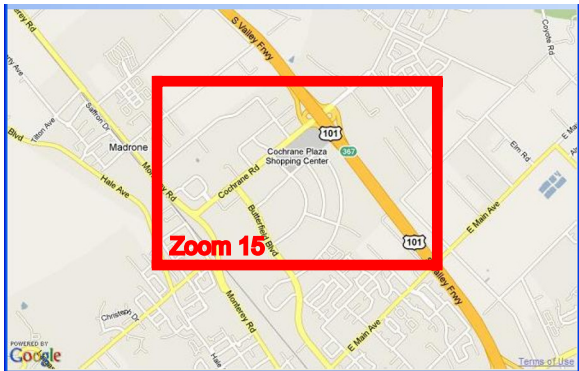
Method 2: Typing in an address in easyMap Tools and capturing a Google map with GPS data.

1. Launch the Anritsu easyMap Tools application.
2. Enter a street address in the address field.
3. Set up the map as desired, and then save the map.

Note A USB flash drive is required to transfer maps to the instrument.

Creating and saving .map files of the same address at several zoom levels can be helpful in the field when your location is off the current view, or when the vectors cross outside of the current map that is displayed on the instrument. Table 11-1 lists the map area at several zoom levels. Notice from the examples that zooming in a level with Anritsu easyMap Tools reduces the map dimensions by half, and zooming out a level doubles the map dimensions.

Table 11-1. Map Coverage at Different Zoom Levels (1 of 2)

Zoom Level	Map Dimensions	Sample Map
15	1 mile x 1.5 miles (1.5 square miles)	
14	2 miles x 3 miles (6 square miles)	

11-4 Anritsu easyMap ToolsLMR Coverage Mapping

Table 11-1. Map Coverage at Different Zoom Levels (2 of 2)

Zoom Level	Map Dimensions	Sample Map
13	4 miles x 6 miles (24 square miles)	

Creating an Indoor Map File with easyMap Tools

- 1. Capture a bitmapped image of the floor plan that is desired for indoor mapping. Save the image in one of the compatible file formats (JPEG, GIF, TIFF, or PNG). The image size must be close to 640 pixels x 420 pixels (approximately a 1.6:1 ratio) in order to display well on your handheld instrument.
- 2. Launch the Anritsu easyMap Tools application.
- 3. In the File pull-down menu, select Open Image File... and then select your indoor mapping image file.

Note A USB flash drive is required to transfer maps to the instrument.

- 4. Set up the map as desired, and then save the map.

11-5 Instrument Settings

Setup

1. Create the appropriate map with Anritsu easyMap Tools. Refer to “[Anritsu easyMap Tools](#)” on page 11-8. Outdoor mapping requires a GeoEmbedded map or the default grid.
2. Press the **Menu** key, then select the coverage Analyzer mode (P25, NXDN, dPMR, TETRA, DMR, or PTC (ITCR and ACSES)) icon or press **Shift** and then the **Mode (9)** button to open the Mode Selector dialog box. Highlight the desired mode and press **Enter**.
3. Open Coverage Mapping by pressing the **Measurement** main menu button followed by pressing the **Coverage** submenu key. The default grid or previous map is displayed.
Continue to [Step 4](#) for outdoor mapping only. GPS must be Off for indoor mapping.
4. Turn on GPS.
 - a. Press **Shift** then **System (8)**. Press the GPS submenu key.
 - b. Connect a GPS antenna to the SMA connector.
 - c. Turn on GPS. On should be underlined in the GPS submenu key.
 - d. Press the **GPS Voltage** submenu key to select the appropriate voltage for the antenna being used. Refer to the instrument Technical Data Sheet for voltage specifications of supported GPS antennas.
 - e. Press **GPS info** and verify that the information from three or more satellites is captured. Press **Esc** to close the info box.

Several minutes may be required for the GPS receiver to track at least three satellites for obtaining longitude and latitude coordinates. Tracking 4 satellites will obtain altitude information. When at least three satellites are being tracked, the GPS icon at the top of the screen turns green. Refer to the User Guide for your instrument for additional information about GPS.

Recall a Map (Indoor or Outdoor Coverage)

The instrument allows you to recall a .map file (created with Anritsu easyMap Tools). With a valid GPS signal, the current location is displayed on an outdoor map, or an arrow shows the direction of the current location if it is outside the map coverage area. With an indoor map, you position the cross at the current location by using the touch screen, or by using the **Arrow** keys, and then pressing **Enter**.

Connect the USB flash drive to the instrument. It must have the map file (or files) that you created in [“Anritsu easyMap Tools” on page 11-8](#).

1. Press the **Measurement** main menu key, then press the **Coverage** submenu key.
2. Press the **Save/Recall Points/Map** submenu key.
3. Press **Recall a Map** and select the appropriate map from the USB flash drive.
4. Use the arrow keys to scroll down to the desired map and press **Enter** to select.

Step 5 and Step 6 apply to outdoor coverage mapping only.

5. The new map file will be displayed and the current location (if within the GPS boundaries of the displayed map) is shown as a plus sign with outdoor mapping.
6. If the current location is outside the map boundaries, an arrow indicates the direction of the current location in relation to the displayed map.

If you do not see the USB drive in the Recall menu:

1. Press the **Refresh Directories** submenu key.
2. If the drive is still not visible, exit the menu, then remove and reconnect the USB drive.
3. Press **Recall a Map** again.
4. If the drive is still not visible, reformat the USB flash drive in FAT32 format, then copy the map files to the reformatted drive.

Recall the Default Grid

The instrument is able to make coverage mapping measurements even when an Anritsu easyMap Tools file of the current indoor or outdoor location is not available. In such cases, use the default grid map, save the KML points, and recall them at a later time with a map.

Figure 11-6 on page 11-15 shows a default grid in the measurement display. Refer to “Mapping Save/Recall Menu” on page 11-25 for additional information on recalling saved maps and .kml data.

Note

When using the default grid, the coverage area for outdoor coverage mapping is fixed at 10 miles by 10 miles. For indoor coverage mapping, the grid size is the default grid image size, 640 pixels by 420 pixels.

1. Press the **Measurement** main menu key, then press the Coverage submenu key.
2. In the Coverage Mapping menu, press the Save/Recall Points/Map submenu key.
3. Press the Recall Default Grid submenu key.

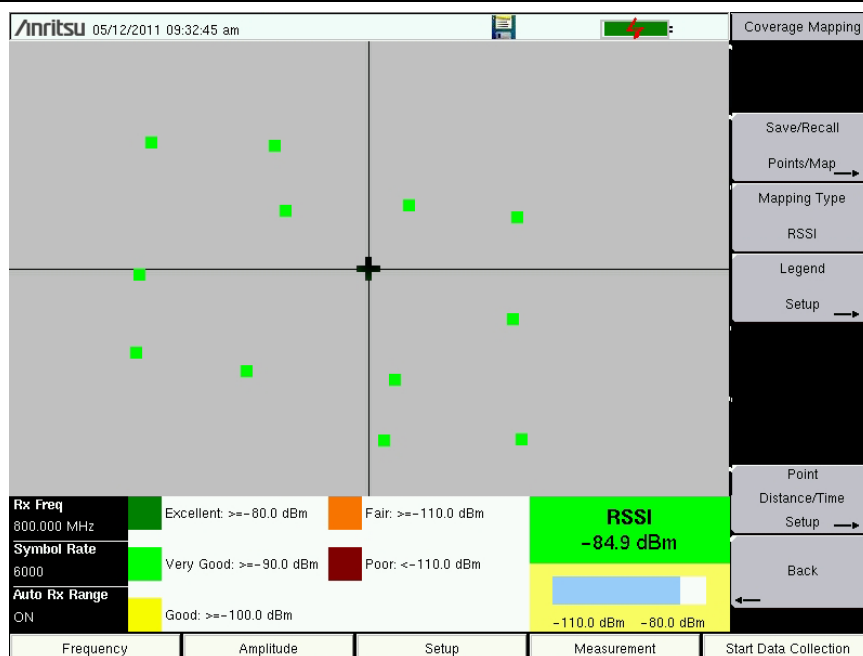


Figure 11-6. Coverage Mapping with the Default Grid.

11-6 Measurement Setup for Map Display Type

1. Refer to the appropriate chapter for frequency, amplitude, and setup parameters.
 - NBFM, “[Transmitter Analysis Setup](#)” on page 2-2
 - P25, “[Over-the-Air \(OTA\) Analysis Setup](#)” on page 3-2
 - P25p2, “[Over-the-Air \(OTA\) Analysis Setup](#)” on page 4-2
 - NXDN, “[Over-the-Air \(OTA\) Analysis Setup](#)” on page 5-2
 - dPMR, “[Over-the-Air \(OTA\) Analysis Setup](#)” on page 6-2
 - TETRA, “[Over-the-Air \(OTA\) Analysis Setup](#)” on page 7-1
 - DMR, “[Over-the-Air \(OTA\) Analysis Setup](#)” on page 8-2
 - PTC-ITCR, “[Over-the-Air \(OTA\) Analysis Setup](#)” on page 9-2
 - PTC-ACSES, “[Over-the-Air \(OTA\) Analysis Setup](#)” on page 10-2
2. Press the **Measurement** main menu key, then the **Coverage** submenu key (press the **Coverage** submenu key a second time if necessary to display the Coverage Mapping menu). The Display Type may be Map or Graph. Press the Display Type submenu key to toggle this setting.
3. Select the signal parameter to be mapped and displayed in bar graph form by pressing Mapping Type.

For P25, NXDN, and DMR, coverage, select RSSI, BER, or Mod Fid; for PTC (ITCR and ACSES) select RSSI, BER, or EVM.

RSSI displays the Received Signal Strength Indicator of the received signal.

BER displays the bit error rate of the received signal. The BER is measured against the Rx Pattern and Mod Type selected under the **Setup** main menu.

Mod Fid displays the modulation fidelity of the received signal.

SINR displays the signal-to-interference noise ratio of signal level to the noise level, in coverage mapping of control channels.

For P25p1 and P25p2 coverage, select RSSI, BER, Mod Fid, or SINR, for NXDN, DPMR and DMR coverage, select RSSI, BER, or Mod Fid, for TETRA and PTC (ITCR and ACSES) select RSSI, BER or EVM.

RSSI displays the Received Signal Strength Indicator of the received signal.

BER displays the bit error rate of the received signal. The BER is measured against the Rx Pattern and Mod Type selected under the **Setup** main menu.

Mod Fid displays the modulation fidelity of the received signal.

SINR displays the signal-to-interference noise ratio of signal level to the noise level, in coverage mapping of control channels.

When used in conjunction with BER, this feature meets the in-building coverage requirements of NFPA 1225 where SINR and BER are needed to determine Delivered Audio Quality (DAQ) in accordance with Table A.1 of TIA TSB 88.1Eal.

For dPMR coverage, select RSSI.

RSSI displays the Received Signal Strength Indicator of the received signal.

For TETRA coverage, select: RSSI, BER, or RMS Vector Err (EVM).

RSSI displays the Received Signal Strength Indicator of the received signal.

BER displays the bit error rate of the received signal. The BER is measured against the **Rx Pattern** and **Mod Type** selected under the **Setup** main menu. Note that BER measurements are only valid for Base Station measurements.

RMS and Peak Vector Err (EVM) is a measure of how far the constellation points are located from the ideal positions. EVM is measured against the **Rx Pattern** and the **Mod Type** selected from the Setup main menu.

For NBFM coverage select: **RSSI**, **THD**, **SINAD**, or **External SINAD**.

RSSI displays the Received Signal Strength Indicator of the received signal.

THD displays the total harmonic distortion.

SINAD and External SINAD display signal-to-noise and distortion ratio.

Note	RSSI values are offset by any Rx Power Offset setting (Amplitude menu).
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4. All measurement values are saved for each data point, independent of which signal parameter is chosen for mapping on the instrument screen. For example, if RSSI is selected for mapping, then the resulting .kml file also includes BER and Mod Fid values.
5. Press the **Legend Setup** submenu key to set the threshold values for the selected measurement. Set the threshold levels for **Excellent**, **Very Good**, **Good**, **Fair**, or **Poor**. Then press the **Back** button.
6. Set up the interval type and the interval parameters. Press the **Point Distance/Time Setup** submenu key to open the **Points Distance/Time** menu. If **Time** is selected for **Repeat Type**, then set the time period by pressing the **Repeat Time** submenu key. If **Distance** is selected for **Repeat Type**, then set the **Repeat Distance** and **Distance Units**. If necessary, delete any previously stored points by pressing the **Delete ALL Points** button.

Note	All files will be stored in the default save location. To change the default location, Press Shift then File (7) to enter File menu. Press Save , then press Change Save Location . Create a new folder or change the current location on the USB flash drive or in the instrument storage memory. Press Set Location to make this the new default location for saving files.
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7. Press **Back** to return to the Coverage Mapping menu.

11-7 Measurement Mapping

After completing the setups for Coverage Mapping and measurements, you are ready to make measurements.

1. Press the **Start Data Collection** main menu key. Data will be collected at the time or distance interval based on the setting in [“Point Distance/Time Setup Menu” on page 11-29](#). The color of the squares indicates the power level based on the chosen measurement and its threshold level setup.
2. Press the **Stop Data Collection** main menu key to end the measurement process. Save the collected data as a `.kml` file, a tab-delimited text file (`.mtd`), or a JPEG file. Refer to [“Save the Coverage Mapping Information” on page 11-18](#).

Note

Two options are available for interior coverage mapping because the instrument does not have location or distance information available without GPS.

Option 1: Set the Repeat Type to Time and walk the perimeter of the coverage area. Press the touchscreen at each turn, and the instrument interpolates collected data points based on the Repeat Time setting.

Option 2: Set the Repeat Type to Distance and walk the coverage area. Press the touchscreen at any time that signal power data points are required.

The saved `.kml` file in either option will not have GPS data, but it will plot on a 640 x 420 grid with measurement data for each captured point.

Save the Coverage Mapping Information

Coverage Mapping has three save options: [“Save KML Points”](#), [“Save Tab Delimited Points” on page 11-20](#), or [“Save JPG” on page 11-20](#).

Save KML Points

Press **Save/Recall Points/Map** then **Save KML Points**. In the Save dialog, change the file name and file type (KML 2D or KML 3D) as appropriate, then press **Enter**. The following information is saved for the points that are currently displayed on the screen:

- Location and time based on GPS information
- Measurements: BER, RSSI, Mod Fid (or RSSI, BER, and EVM in TETRA mode)
- Mapping type, Frequency, and Rx Pattern

The .kml file can be opened and viewed with Google Earth (Figure 11-7 on page 11-19) and can also be recalled and viewed on the instrument. Refer to “Mapping Save/Recall Menu” on page 11-25 for additional information.

Installing Google Earth

1. Go to the Web site: <http://earth.google.com/>.
2. Click **Download Google Earth** and follow the on-screen instructions.
3. After download, install Google Earth on your computer.
4. Double-click the saved .kml file to view the measurements with Google Earth.

Note

After Google Earth is opened, user instructions and several types of help are available from the Help pull-down menu.

Saved .kml files cannot be viewed directly from the instrument using Google Earth. The files need first to be copied to a USB memory stick.



Figure 11-7. Coverage Mapping KML File in Google Earth

Save Tab Delimited Points

Press Save/Recall Points/Map then Save Tab Delimited Points. At the Save menu, press **Enter**. A tab delimited text file (.mtd) is saved in the default save location for the coverage mapping data that are currently displayed on the screen.

Note

All files are stored in the default save location. To change the default location, Press **Shift** then **File (7)** to enter File menu. Press Save, then press Change Save Location. Create a new folder or change the current location on the USB flash drive (or in the instrument storage memory). Press Set Location to make this the new default location for saving files.

Save JPG

Press Save/Recall Points/Map then Save JPG. At the Save menu, press **Enter**. A .jpg file of the current screen is saved.

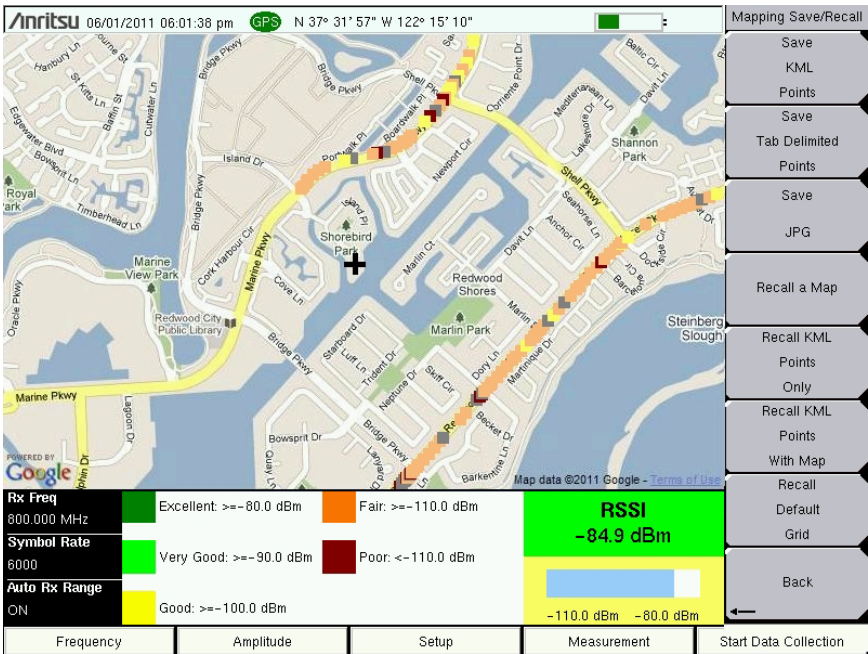


Figure 11-8. Time Interval Coverage Mapping Saved as a .jpg File

11-8 Measurements with Graph Display Type

In the Coverage Mapping menu, set the Display Type to Graph. Two graphs are displayed. Tap a graph to make it active (surrounded by a red bounding line).

Procedure to Monitor Base Station Synchronous Channel Decoding

1. Refer to the appropriate chapter for frequency, amplitude, and setup parameters.
 - NBFM, “[Transmitter Analysis Setup](#)” on page 2-2
 - P25, “[Over-the-Air \(OTA\) Analysis Setup](#)” on page 3-2
 - P25p2, “[Over-the-Air \(OTA\) Analysis Setup](#)” on page 4-2
 - NXDN, “[Over-the-Air \(OTA\) Analysis Setup](#)” on page 5-2
 - dPMR, “[Over-the-Air \(OTA\) Analysis Setup](#)” on page 6-2
 - TETRA, “[Over-the-Air \(OTA\) Analysis Setup](#)” on page 7-1
 - DMR, “[Over-the-Air \(OTA\) Analysis Setup](#)” on page 8-2
 - PTC, “[Over-the-Air \(OTA\) Analysis Setup](#)” on page 9-2
 - PTC-ACSES, “[Over-the-Air \(OTA\) Analysis Setup](#)” on page 10-2
2. Press the **Measurement** and then Coverage menu keys. You may need to press the Coverage menu key another time to display the Coverage Mapping menu.

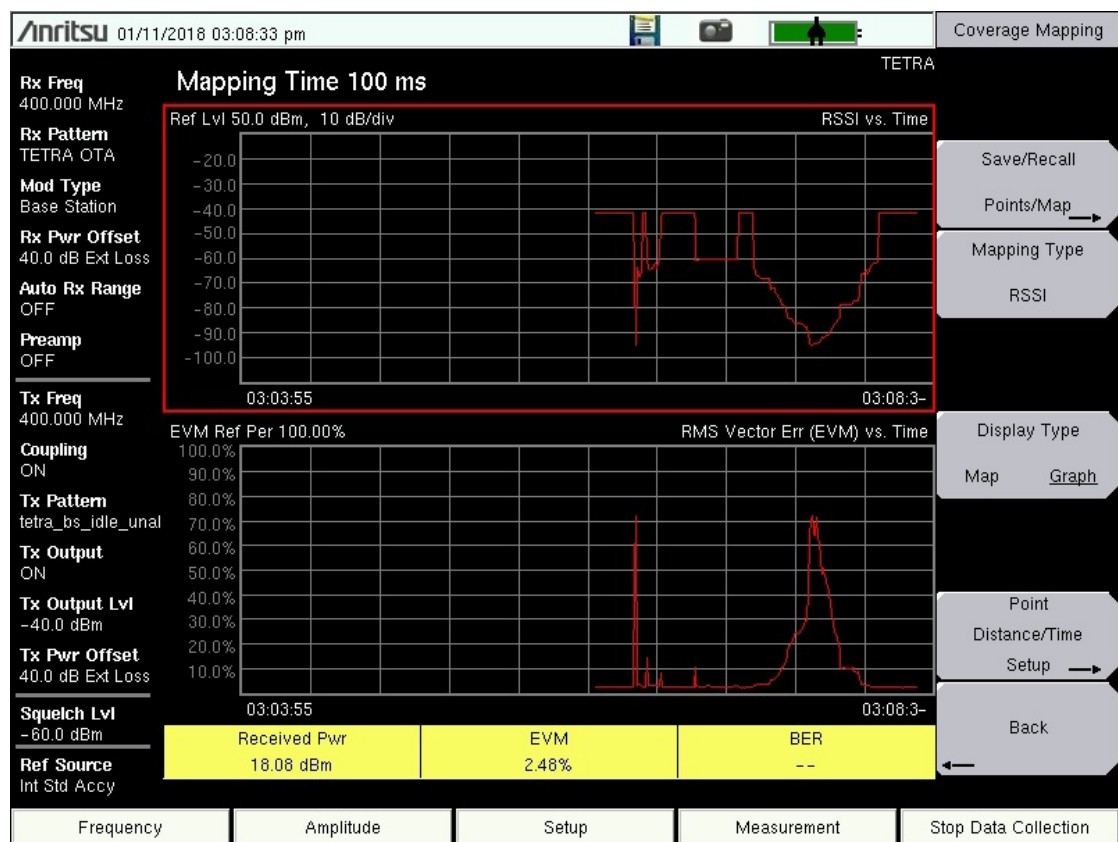


Figure 11-9. Display Type = Graph

3. If the Display Type is Map, then press the Display Type key again to toggle the setting to Graph. The display then shows two graphs. [Figure 11-9](#) shows the Graph Display Type for TETRA analyzer. The two graphs may be any two types from the Mapping Type selection list. The figure shows EVM plotted versus time.

To change the plot in one of the graphs to a different mapping type:

- a. Select the graph by tapping anywhere on the graph to activate it. The activated graph is shown within a red rectangle.
 - b. Press the Mapping Type submenu key and make a selection from the items displayed in the Mapping Type Selector list box: RSSI or RMS Vector Err (EVM).
4. To set up the sampling time for plotting the two selected graphs, set up the parameter called Repeat Time as follows:
 - a. In the Coverage Mapping menu, press the Point Distance/Time Setup submenu key.
 - b. In the Point Distance/Time menu, press the Repeat Time submenu key, and then enter a value by using the numeric keypad. A Time menu provides submenu keys for the units, from hour to μ s. Anritsu recommends that this value be set to equal or exceed 3 seconds.
5. To start plotting the two graphs with respect to time, press the **Start Data Collection** main menu key. Note that if the previous plots need to be deleted, then press the Delete ALL Points submenu key, followed by the **Enter** key.
6. To stop the plotting of the two graphs, press the **Stop Data Collection** main menu key.

Note

Menu settings cannot be changed while data collection is in progress. You must stop the data collection before changing instrument settings. You can, however, change the active graph, and if needed, the selected graph can be made full screen by tapping the selected graph twice.

Saving Graph Data

Graph data is maintained during measurement as long as instrument memory has sufficient space to hold the data. Save data points from the graph after you press **Stop Data Collection**. The following key sequence displays the Save dialog box:

Measurement > TETRA Coverage > Save/Recall Points/Map > Save Tab Delimited Points

In the Save dialog box, enter the filename and press **Enter**.

11-9 Coverage Mapping Menus

Refer to the appropriate LMR Master Analyzer chapters for the other menus, including **Frequency**, **Amplitude**, and **Setup**. Menu maps typically display all possible submenu keys, although some keys are displayed on the instruments only under special circumstances (refer to menu descriptions on the following pages).

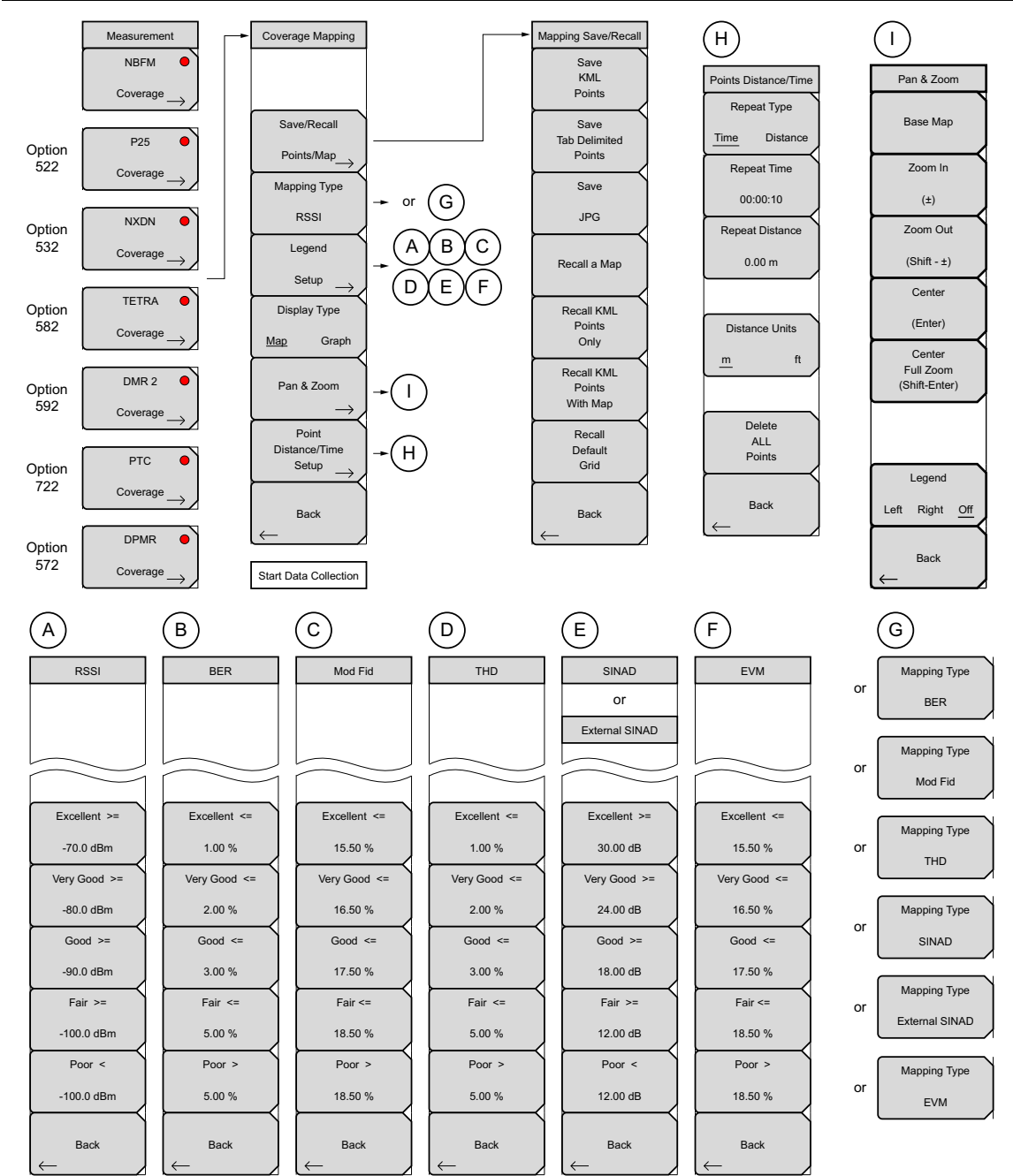


Figure 11-10. LMR Master Coverage Mapping Menu

11-10 Coverage Mapping Menu

Key Sequence: **Measurement** >... Coverage

Coverage Mapping

Save/Recall
Points/Map →

Mapping Type
RSSI

Legend
Setup →

Display Type
Map Graph

Pan & Zoom
→

Point
Distance/Time
Setup →

Back
←

Start Data Collection

Save/Recall Map Points: Opens the [“Mapping Save/Recall Menu” on page 11-25](#).

Mapping Type: Select the measurement parameter to be mapped and displayed in the bar graph. All three parameter values are saved for each data point in the saved `.kml` or `.mtd` file.

For **P25**, **NXDN**, **dPMR**, **DMR**, and **PTC** (ITCR and ACSES) measurements, the mapping options are **RSSI**, **BER**, or **Mod Fid**.

For **TETRA** measurements, the mapping options are **RSSI**, **BER**, or **EVM (RMS Vector Error)**. Note that BER measurements are only valid for Base Station measurements.

For **NBFM** measurements, the mapping options are **RSSI**, **THD**, **SINAD**, or **External SINAD**.

Legend Setup: This submenu key is present only when the Map Display Type is selected. It opens a submenu to set the legend color threshold values. This menu is based on the Mapping Type submenu selection. See [Figure 11-13 on page 11-26](#).

Display Type
Map Graph: Press to toggle the display to Map or Graph.

Pan & Zoom: Opens the [“Pan & Zoom Menu” on page 11-27](#).

Point Distance/Time Setup: Opens the [“Point Distance/Time Setup Menu” on page 11-29](#).

Back: Returns to the previous **Measurement** menu.

Start/Stop Data Collection: Press this main menu key to start coverage mapping data collection based on Measurement Setup settings and Point Distance/Time Setup settings. A running count of collected data points is displayed at the bottom of the screen. Press again to stop data collection.

Figure 11-11. Coverage Mapping Menu

Mapping Save/Recall Menu

Key Sequence: Measurement >Coverage > Save/Recall Points/Maps

Mapping Save/Recall	
Save KML Points	Save KML Points: Press this button to save the KML points. FileName.kml is stored in the selected location. From the File menu, press Save, then press Change Save Location to change default location. The Filetype setting includes: KML 2D, KML 3D, Mapping Tab Delimited, and JPEG.
Save Tab Delimited Points	Save Tab Delimited Points: Press this button to save the points in a tab delimited text file. FileName.mtd is stored in the selected location.
Save JPG	Save JPG: Press the Save JPG key to save a .jpg file of the current screen.
Recall a Map	Recall a Map: Opens the Recall menu for selecting a map created with the Anritsu easyMap Tools program to display on the screen.
Recall KML Points Only	Recall KML Point: Opens the Recall menu for selecting a .kml file. Displays the saved locations overlaid on the default grid.
Recall KML Points With Map	Recall KML Points With Map: Opens the Recall menu for selecting a .kml file. If you already have a geo-referenced map or a default grid map, then press this key to recall previously stored KML points. This feature is useful if you made measurements earlier without the appropriate maps and would like to now view the saved point locations overlaid on top of a map.
Recall Default Grid	Recall Default Grid: If you do not have a GPS embedded map, but you are out in the field making measurements, and you would like to save the KML points, then the Recall Default Grid submenu allows you to save points and the corresponding GPS coordinates to view at a later time.
Back	Back: Returns to the “Coverage Mapping Menu” on page 11-24.

Figure 11-12. Mapping Save/Recall Menu

Legend Setup Menus

Key Sequence: **Measurement** > ... Coverage > Legend Setup

RSSI	BER	Mod Fid	THD	SINAD	EVM
				or	
				External SINAD	
Excellent >= -70.0 dBm	Excellent <= 1.00 %	Excellent <= 15.50 %	Excellent <= 1.00 %	Excellent >= 30.00 dB	Excellent <= 15.50 %
Very Good >= -80.0 dBm	Very Good <= 2.00 %	Very Good <= 16.50 %	Very Good <= 2.00 %	Very Good >= 24.00 dB	Very Good <= 16.50 %
Good >= -90.0 dBm	Good <= 3.00 %	Good <= 17.50 %	Good <= 3.00 %	Good >= 18.00 dB	Good <= 17.50 %
Fair >= -100.0 dBm	Fair <= 5.00 %	Fair <= 18.50 %	Fair <= 5.00 %	Fair >= 12.00 dB	Fair <= 18.50 %
Poor < -100.0 dBm	Poor > 5.00 %	Poor > 18.50 %	Poor > 5.00 %	Poor < 12.00 dB	Poor > 18.50 %
Back ←	Back ←	Back ←	Back ←	Back ←	Back ←

Figure 11-13. Legend Setup Menu

The titles of these menus are the selections made in the Coverage Mapping menu with the Mapping Type submenu key. The choices vary depending upon the Land Mobile Radio signal type. Refer also to the [“Coverage Mapping Menu” on page 11-24](#).

Note

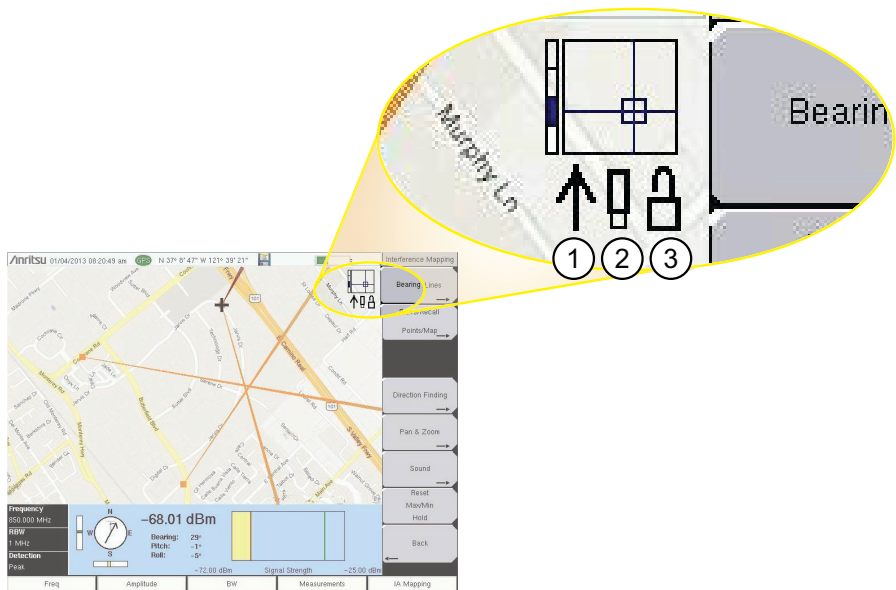
The Legend Setup submenu key is present only when the selected Display Type is Map.

Pan & Zoom Menu

Key Sequence: **Measurements** > (current LMR mode) Coverage > Pan & Zoom

Pan & Zoom	
Base Map	Base Map: Press this button to view the full map.
Zoom In	Zoom In ($\pm$): Press this button to zoom in one map panel at a time. Pressing the (+/-) keypad button does the same as long as a parameter is not being adjusted.
($\pm$)	
Zoom Out	Zoom Out (Shift - $\pm$): Press this button to zoom out one map panel at a time. Pressing the Shift and (+/-) keypad button once does the same as long as a parameter is not being adjusted.
(Shift - $\pm$)	
Center	Center (Enter): Press this button to center the panel in which the instrument is located. Pressing the Enter keypad button does the same as long as a parameter is not being adjusted.
(Enter)	
Center Full Zoom	Center Full Zoom (Shift - Enter): Brings the map panel where the instrument is currently located into the display. Pressing the Shift and Enter keypad buttons does the same as long as a parameter is not being adjusted. Note that the current location may not be exactly centered on the display.
(Shift-Enter)	
Legend	Legend Left Right Off: Press this submenu key to turn off or to display a legend at the top left or top right corner of the AZM map. The legend consists of a vertical zoom level bar, a square representing the current GPS location and base map, and three status icons (Figure 11-15). The zoom level indicator shows the number of levels of zoom in the AZM map, with the current level displayed as a dark segment on the vertical bar. Higher levels of zoom are toward the top of the indicator bar.
Left Right Off	
Back	The default square with crosshairs represents a map panel with the lowest zoom. The crosshairs are at the center of that panel. As the zoom level increases, a boundary of a panel is displayed around the crosshairs. The higher the zoom level, the smaller the square around the crosshairs. When panning the map (using the instrument's arrow keys), the crosshairs and map panel boundary display your relative location in the total mapped area.
←	When the lock is 'locked' (by pressing Enter), the map is in auto-centering mode and will update continually to keep your current position centered while you move with the instrument. If you pan (using the arrow keys), the map is taken out of auto-centering mode, or unlocked, because you have intentionally shifted the map area away from your current location. When unlocked, the map will not follow if you walk or drive around with the instrument.
	After panning, press the Enter key to re-center your GPS location on the map and lock auto-centering mode.
	Back: Returns to the "Coverage Mapping Menu" on page 11-24.

Figure 11-14. Pan & Zoom Menu



1	MA2700A USB cable is connected and recognized by the Anritsu instrument.
2	USB memory stick is available for data read/write.
3	.azm map auto-centering mode (locked/unlocked). When “locked” the instrument automatically displays the map tile at current zoom level which best centers the current GPS location. The instrument will attempt to swap map tiles as the GPS location changes to continue displaying the current location near the center of the screen.

Figure 11-15. Map Legend Status Indicators

Point Distance/Time Setup Menu

Key Sequence: **Measurement** >Coverage > Point Distance/Time Setup

Points Distance/Time	Repeat Type: Toggles between using a Time or Distance interval for capturing data.
Repeat Type	Repeat Time: Sets the time interval when the Time is selected in the Repeat Type button.
Time Distance	Repeat Distance: Sets the distance interval when the Distance is selected in the Repeat Type button.
Repeat Time	Distance Units: Toggles the unit of measure between meters and feet.
00:00:10	Delete ALL Points: Clears all displayed measurements.
Repeat Distance	Back: Returns to the “Coverage Mapping Menu” on page 11-24 .
0.00 m	
Distance Units	
m ft	
Delete ALL Points	
Back	
←	

Figure 11-16. Point Distance/Time Setup Menu

11-11 Sweep Menu

Key Sequence: **Shift > Sweep (3)** key

Sweep

Sweep

RunHold

Trigger

Sweep

Sweep Run/Hold: This submenu key toggles between continuous (run) sweep and hold sweep. In Run sweep mode, sweeps are continuous, and a sweep starts immediately after the previous sweep is completed. In Hold sweep mode, the results of the last sweep are displayed on the screen while the instrument waits for a trigger event to start a new sweep. HOLD is displayed on the right side of the screen in this mode.

Trigger Sweep: Pressing this submenu key causes the instrument to make a single sweep when the instrument is in Hold sweep mode. This key has no function when the instrument is in Run sweep mode.

Figure 11-17. DMR Coverage Sweep Menu

11-12 Measure Menu

Key Sequence: **Shift > Measure (4)** key

Displays the **Measurement** menu in the current Land Mobile Radio mode.

11-13 Trace Menu

This menu is not available in Coverage Mapping.

11-14 Limit Menu

This menu is not available in Coverage Mapping.

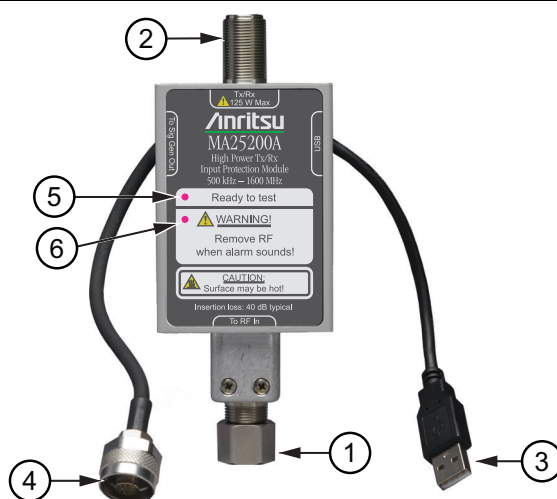
11-15 Other Menus

Preset, Calibrate, File, System and **Mode** are described in the User Guide.

Chapter 12 — High Power Input Protection

12-1 Overview

Use the MA25200A High Power Tx/Rx Input Protection Module to safeguard the S412E input ports from high power transmitters. The MA25200A attenuates RF power levels up to +51 dBm (125 W) to safe levels for measurements. The MA25200A connects directly to the RF input connector. It has an N(m) coaxial input cable that connects to the Signal Generator output. The top N(f) connector can be connected directly to portable or mobile antenna ports or base station transmit or receive ports. The nominal 40 dB insertion loss of the main input and signal generator ports can be compensated for in the S412E amplitude offset menus, enabling the displayed levels to match the RF levels at the input of the MA25200A. The insertion loss of the MA25200A is very flat over its frequency range of operation, supporting accurate amplitude measurements. Please see the *MA25200A High Power Rx/Tx Input Protection Module Technical Data Sheet* for specifications.



1. RF Output N(m) - connect to analyzer RF input connector.
2. RF Tx/Rx N(f) - connect to test device.
3. USB Type A - connect to the instrument to supply power for the cooling fan, LED indicators, and warning alarm.
4. Signal Generator Input N(m) - connect to instrument signal generator.
5. Green LED - indicates proper operation.
6. Red LED - indicates a fault or over temperature condition.

Figure 12-1. MA25200A Overview

Caution

When the internal temperature exceeds 100 °C, the red LED illuminates and an internal piezo alarm sounds continuously until the temperature returns to the proper operating range. Stop testing immediately to prevent damage to the LMR analyzer or MA25200A module.

12-2 Measuring a Handheld Transceiver

The following example uses an S412E LMR Master to analyze the modulation quality and receiver sensitivity of a P25 handheld transceiver (HT) in simplex mode.

Measuring Receiver Sensitivity

1. Connect the equipment as shown in [Figure 12-2](#):
 - Connect the MA25200A to the S412E **RF In** port, **Signal Generator Out** port, and USB port.
 - Connect the HT RF output (antenna port) to the MA25200A **Tx/Rx** port.

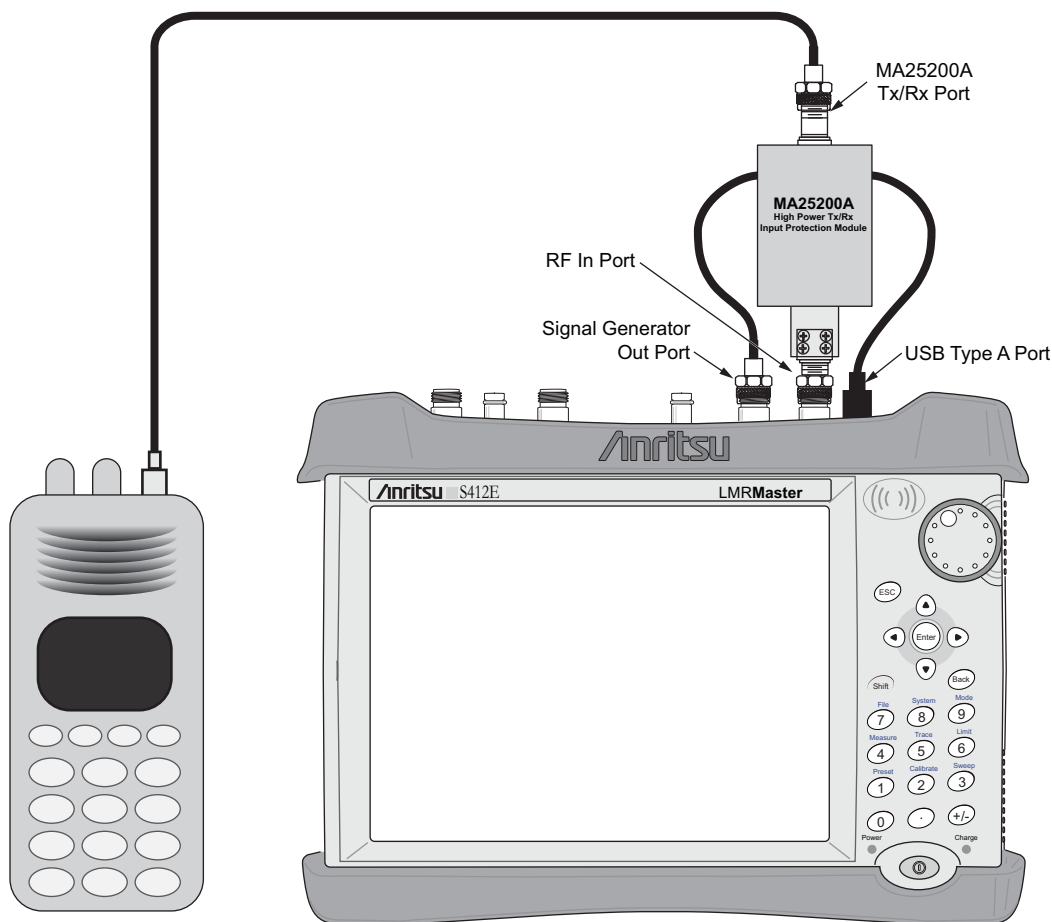


Figure 12-2. Handheld Transceiver connected to LMR Master with a MA25200A High Power Tx/Rx Input Protection Module

Note

The MA25200A combines the S412E Signal Generator Out and RF In ports to the High Power Tx/Rx port of the module.

2. Set the HT to the desired simplex mode frequency (transmit and receive frequencies set to the same values) to receive a P25 1011 Hz test pattern.
3. From the S412E Frequency menu, set the following:
 - Rx Freq: test frequency
 - Tx Freq: test frequency
 - Rx/Tx Coupling: On
 - Coupling Offset: 0 Hz
 - Span: 25 kHz
4. From the S412E Amplitude menu, set the following:
 - Ref Level: -20 dBm
 - Scale: 10 dB/div
 - Rx Power Offset: 40 dB External Loss
 - Auto Rx Range: On
 - Tx Power Offset to 40 dB External Loss
 - Tx Output Level: -120 dBm (initial setting)

From this point, the S412E signal generator and analyzer measurements are both referenced from the MA25200A Tx/Rx port.

5. Turn the S412E Signal Generator On and use the Setup menu to set the default 1011 Hz Rx Pattern and p25_1011 Tx Pattern.
6. Return to the Amplitude menu and adjust the Tx Output Level until the signal can no longer be distinguished from the measurement noise by the receiver.
7. Note the Tx Output Level is the receiver sensitivity value.

Measuring Transmitter Modulation

8. Turn off the S412E signal generator.

Note

The MA25200A has a small amount of signal leakage from the signal generator input to the analyzer output port (S412E RF In port). This leakage is mitigated by turning off the S412E signal generator.

9. Transmit the HT RF output test signal into the MA25200A Tx/Rx input and note the receiver summary data table on the S412E display.

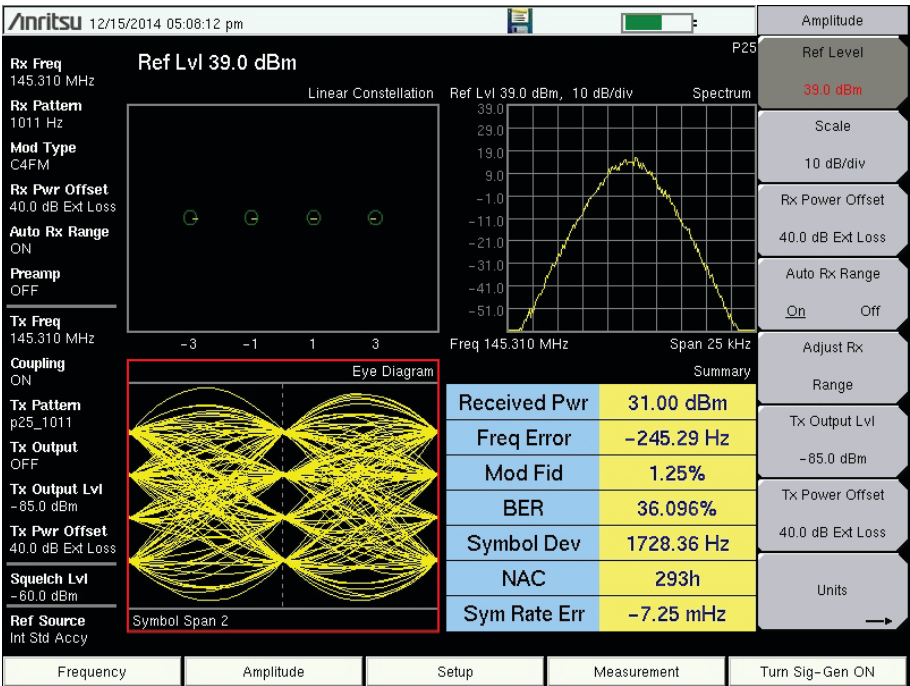


Figure 12-3. LMR Master P25 1011 Hz Analyzer Sample Display

12-3 Measuring a Base Station

The following example is using an S412E LMR Master to analyze the modulation quality and receiver sensitivity of a P25 base station transceiver.

Measuring Receiver Sensitivity

1. Connect the equipment as shown in [Figure 12-4](#):
 - Connect the MA25200A to the S412E **RF In** port and USB port.
 - Connect the base station RF output to the MA25200A **Tx/Rx** port.
 - Connect the base station signal input port to the S412E **Signal Generator Out** port.
 - Terminate the MA25200A **Sig Gen** input with a 50 Ω termination or calibration component.

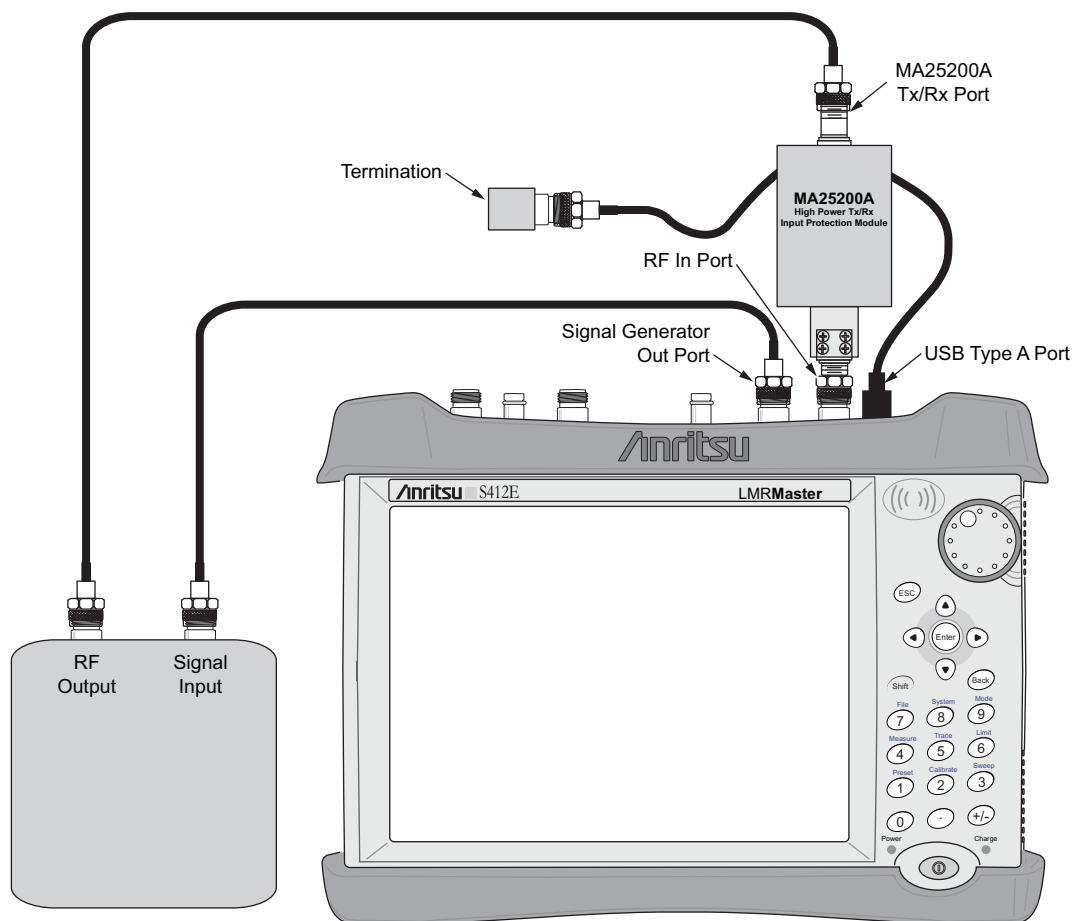


Figure 12-4. Base Station Transceiver connected to LMR Master with a MA25200A High Power Tx/Rx Input Protection Module

12-3 Measuring a Base Station High Power Input Protection

2. Set the base station to the desired simplex mode frequency (transmit and receive frequencies set to the same values) to receive a P25 1011 Hz test pattern.
3. From the S412E Frequency menu, set the following:
 - Rx Freq: test frequency
 - Tx Freq: test frequency
 - Rx/Tx Coupling: On
 - Coupling Offset: 0 Hz
 - Span: 25 kHz
4. From the S412E Amplitude menu, set the following:

- Ref Level: -20 dBm
- Scale: 10 dB/div
- Rx Power Offset: 40 dB External Loss
- Auto Rx Range: On
- Tx Power Offset to 40 dB External Loss
- Tx Output Level: -120 dBm (initial setting)

From this point, the S412E signal generator and analyzer measurements are both referenced from the MA25200A Tx/Rx port.

5. Turn the S412E Signal Generator On and use the Setup menu to set the default 1011 Hz Rx Pattern and p25_1011 Tx Pattern.
6. Return to the Amplitude menu and adjust the Tx Output Level until the signal can no longer be distinguished from the measurement noise by the receiver.
7. Note the Tx Output Level is the receiver sensitivity value.

Measuring Transmitter Modulation

8. Turn off the S412E signal generator.
9. Transmit the base station RF output test signal into the MA25200A Tx/Rx input and note the receiver summary data table on the S412E display.

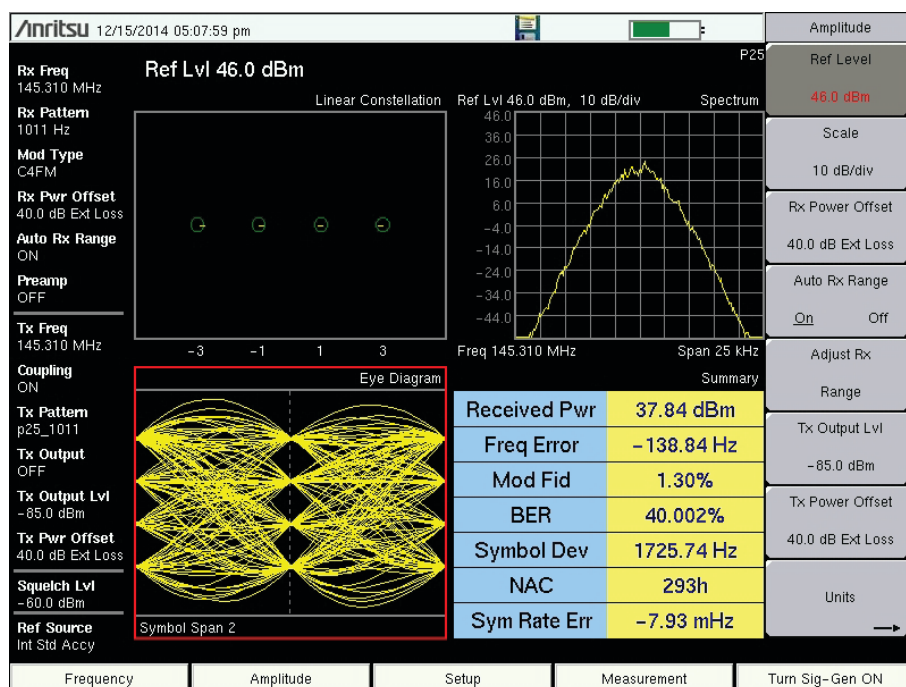


Figure 12-5. LMR Master P25 1011 Hz Analyzer Sample Display

Appendix A — Error Messages

A-1 P25/P25p2, NXDN, dPMR, TETRA, DMR, and PTC Messages

This Appendix provides a list of P25, NXDN, dPMR, TETRA, DMR, and PTC (ITCR and ACSES) error messages. Self Test and General Operation error messages are in the User Guide.

Notifications

1. External Reference not found. Internal reference Locked successfully.
This message is displayed when the instrument has detected an external reference but couldn't lock to the reference. It automatically switches to the Internal Reference.
2. External Reference Locked Successfully.

Warning Messages

- RF Over Power: Decrease input power.
- ADC over range: Adjust the ADC range.
 - a. If Auto Range is ON: Decrease input power.
 - b. If Auto Range is Off and if Atten = 65 then ADC over range: Decrease input power.
 - c. If Auto Range is Off and Atten is < 65 then ADC over range: Adjust range.
- No signal detected: Increase input power.
- Weak signal detected: Increase input power or decrease any external attenuation.
- Out of band saturation:

When the software detects that there is too much power outside the current frequency range, this message is displayed. This usually means that the instrument is currently tuned to a frequency with a very low amplitude signal or no signal and there is a strong signal at another frequency outside the current IF bandwidth.

- Lock failure %x where %x is a mix of the following in hex:

When there is a lock failure detected from any of the internal LOs, this message is displayed. The xx is usually an error code in hex that can be interpreted by a service center to obtain more information on which LO had the failure.

```
#define DSP_SAMPLER_PLL_UNLOCKED    0x000100
#define DSP_LO1_PLL_UNLOCKED        0x000200
#define DSP_LO2_PLL_UNLOCKED        0x000400
#define DSP_LO3_PLL_UNLOCKED        0x000800
```

- Not available in REVIEW Mode
 - a. Turn off Review mode

Data Logging Errors

- Error Making Directory On USB, Verify Media is Installed.

A USB flash drive is not connected to the USB port or the device is not recognized. Try to connect again, use a different USB flash drive, or reformat the USB flash drive on a PC.

Warning All data on a USB flash drive will be erased if it is reformatted.

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