User’s, Programming, and Measurement Guide

Agilent Technologies
ESA-E Series Spectrum Analyzers
Modulation Analysis Measurement Personality

This manual provides documentation for the following instruments:

ESA-E Series

E4402B (9 kHz - 3.0 GHz)
E4404B (9 kHz - 6.7 GHz)
E4405B (9 kHz - 13.2 GHz)
E4407B (9 kHz - 26.5 GHz)

Agilent Technologies

Manufacturing Part Number: E4402-90037

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WARNING **Warning denotes a hazard. It calls attention to a procedure which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a warning note until the indicated conditions are fully understood and met.**

CAUTION Caution denotes a hazard. It calls attention to a procedure that, if not correctly performed or adhered to, could result in damage to or destruction of the instrument. Do not proceed beyond a caution sign until the indicated conditions are fully understood and met.

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WARNING **No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers.**

CAUTION Always use the three-prong AC power cord supplied with this product. Failure to ensure adequate grounding may cause product damage.

Contents

Contents

1 Using This Document

This chapter describes the organization of this reference guide.

Book Organization

This book includes both user and programmer information. The first 5 chapters cover user information such as how to set up and use the instrument. Chapter 7 covers the SCPI remote programming commands.

The following table gives a brief overview of each chapter.

Table 1-1 Book Organization

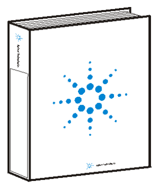
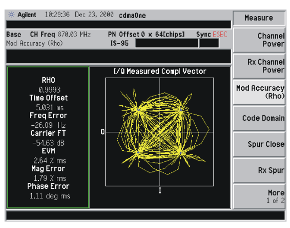
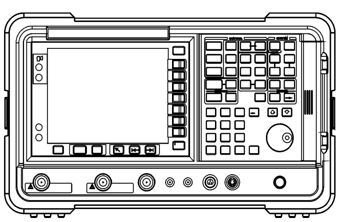
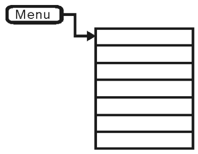
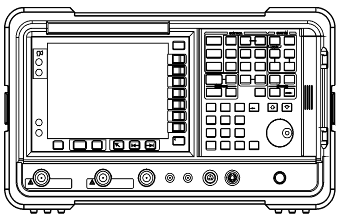
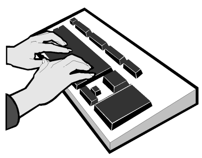
	**1. Using this Document** This chapter.	This chapter describes the organization of this book.
	**2. Understanding Modulation Analysis** See page 5.	This chapter defines modulation analysis and describes its characteristics
	**3. Setting up the Instrument in Modulation Analysis Mode** See page 17.	This chapter describes how to set the instrument up to perform modulation analysis measurements.
	4. Making Modulation Analysis Measurements See page 21.	This chapter describes how to make standard and custom measurements and interpret the results.

Table 1-1 Book Organization

	**5. Menu Maps** See page 59.	This chapter illustrates the menu structure of the front-panel and lower-level keys. Refer to this chapter to identify the lower-level softkeys associated with the front-panel keys.
	**6. Front Panel Key Reference** See page 75.	This chapter describes the instrument front-panel and menu keys. The front-panel keys are arranged alphabetically, and the menu keys are arranged as they appear on the instrument menus.
	**7. Programming Language Reference** See page 97.	These are the SCPI commands available in EVM mode.
	**8. If You Have a Problem** See page 143.	This chapter includes information on basic troubleshooting and contacting Agilent.

2 Understanding Modulation Analysis

The modulation analysis personality will support base-band modulation analysis for several industry standards. This chapter introduces you to the basics of some of the most common formats and the general functionality of the ESA with the modulation analysis measurement personality installed. Sources for additional information on digital communications are also listed.

Digital Communication Systems Standards Overview

The W-CDMA Communication System

Wideband code division multiple access (W-CDMA) is the first of the most popular air interface technologies for the third generation RF cellular communication systems. In this system, the cells operate asynchronously. Hence, it makes the mobile synchronization more complex, but offers the advantage of flexibility in placement of the base stations. Both reverse and forward transmitter power controls are implemented with 0.625 ms intervals. W-CDMA is a direct sequence spread spectrum digital communications technique that supports a wider RF bandwidth at 5 MHz.

The CDMA2000 Communication System

Code division multiple access 2000 (cdma2000) is the second of the two most popular wideband air interface technologies for the third generation RF cellular communication systems. This system relies on the Global Positioning System (GPS) for intercell synchronization. Both reverse and forward transmitter power controls are implemented with 1.25 ms intervals. cdma2000 is a direct sequence spread-spectrum digital communications technique that supports a wider RF bandwidth at 1.25 MHz.

W-CDMA and cdma2000 Advantages

The main advantages of cdma2000 and W-CDMA over other types of communication schemes are:

- Greater capacity
- Immunity to signal loss and degradation due to high-level broadband interference, multipath scattering and fading
- Power consumption of mobile stations is strictly minimized by base station and mobile controls
- Supports variable data rates up to 144 kbits/second for mobile (vehicular) data rate, up to 384 kbits/second for portable (pedestrian) data rate, and up to 2 Mbits/second for fixed installations
- Provides increased security

W-CDMA and cdma2000 uses correlative codes to distinguish one user from another. Frequency division is still used, as is done with Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA). Frequency division is used in a much larger bandwidth such as 1.25 MHz or greater (for cdma 2000) and 5 MHz or greater (for W-CDMA). For W-CDMA, an initial baseband data rate is spread to a transmitted data rate of 3.840 Mcps, which is also called chip rate or spread data rate. W-CDMA and cdma2000 both realize increased capacity from 1:1 frequency reuse and sectored cells. The capacity limit is soft. That is, capacity can be increased with some degradation of the error rate or voice quality.

In W-CDMA and cdma2000, a single user's channel consists of a specific frequency combined with a unique code. Correlative codes allow each user to operate in the presence of substantial interference. The interference is the sum of all other users on the same W-CDMA or cdma2000 frequency, both from within and outside of the home cell, and from delayed versions of these signals. It also includes the usual thermal noise and atmospheric disturbances. Delayed signals caused by multipath are separately received and combined in these systems. One of the major differences in access is that any frequency can be used in all sectors of all cells. This is possible because the W-CDMA and cdma2000 systems are designed to decode the proper signal in the presence of high interference.

Additionally, cdma2000 offers a number of RF structures to accommodate almost any conceivable application. These options include direct spreading to support those applications where clear spectrum is available and multicarrier arrangements using 1.25 MHz wide channels to allow overlays with TIA/EIA-95-B systems.

TIA/EIA/IS-2000 Mobile Station - Base Station Compatibility Standard for Dual-Mode Wideband Spread Spectrum Cellular System

W-CDMA (3GPP) is defined in the following documents:

TS 25.XX series 3rd Generation Partnership Project Technical Specification; Radio Performance aspects. These documents define complex multipart measurements used to maintain an interference free environment.

There are many other formats supported by the modulation analysis personality that can be referenced by the appropriate standards documents.

cdma2000 is defined in the following Telecommunications Industry Association(TIA) and Electronics Industry Alliance (EIA) document:

cdmaOne Standards

The cdmaOne communication system personality is defined in the following standard bodies: Electronics Industry Association (EIA), Telecommunications Industry Association (TIA), American National Standards Institute (ANSI), Association of Radio Industries and Businesses (ARIB) (Japan), and Korean standards documents:

IS-95-A:

TIA/EIA-IS-95-A	Mobile Station-Base Station Compatibility Standard for Dual-Mode Wideband Spread Spectrum Cellular System. May 1995
TIA/EIA-IS-97-A	Recommended Minimum Performance Standards for Base Stations Supporting Dual-Mode Wideband Spread Spectrum Cellular Mobile Stations. July 1996
TIA/EIA-IS-98-A	Recommended Minimum Performance Standards for Dual-Mode Wideband Spread Spectrum Cellular Mobile Stations. July 1996

TIA/EIA-95-B Cell and TIA/EIA-95-B PCS:

TIA/EIA-95-B	Mobile Station-Base Station Compatibility Standard for Dual-Mode Spread Spectrum Systems. (SP-3693-1) July 17, 1998
TIA/EIA-97-B	Recommended Minimum Performance Standards for Base Stations Supporting Dual-Mode Spread Spectrum Cellular Mobile Stations. August 1998
TIA/EIA-98-B	Recommended Minimum Performance Standards for Dual-Mode Spread Spectrum Cellular Mobile Stations. August 1998

95-C Cell and 95-C PCS:

TIA/EIA-95-B	Mobile Station-Base Station Compatibility Standard for Dual-Mode Spread Spectrum Systems. (SP-3693-1) July 17, 1998
TIA/EIA-97-C	Recommended Minimum Performance Standards for Base Stations Supporting Dual-Mode Spread Spectrum Mobile Stations. (SP-4384) Ballot Version: Nov. 20, 1998
TIA/EIA-98-C	Recommended Minimum Performance Standards for Dual-Mode Spread Spectrum Mobile Stations. (SP-4383) Ballot Version: March. 19, 1999

ANSI J-STD-008:

ANSI J-STD-008	Personal Station-Base Station Compatibility Requirements for 1.8 to 2.0 GHz Code Division Multiple Access (CDMA) Personal Communications Systems. August 29, 1995.
ANSI J-STD-018	Recommended Minimum Performance Requirements for 1.8 to 2.0 GHz Code Division Multiple Access (CDMA) Personal Stations. (SP-3385) January 16, 1996
ANSI J-STD-019	Recommended Minimum Performance Requirements for Base Stations Supporting 1.8 to 2.0 GHz Code Division Multiple Access (CDMA) Personal Stations. (SP-3383) January 12, 1996

The NADC Communications System

The North American Dual-Mode Cellular (NADC) is one of the cellular communications systems. NADC is also referred to as North American Digital Cellular, or American Digital Cellular (ADC). Occasionally, it is also referred to as Digital Advanced Mobile Phone Service (D-AMPS) or -NADC-TDMA. The NADC communications system is defined in the Electronics Industry Alliance (EIA) and Telecommunication Industry Association (TIA) standard documents. The following is a list of all relevant and applicable standard documents:

TIA/EIA IS-136.1	TDMA Cellular/PCS - Radio Interface - Mobile Station - Base Station Compatibility - Digital Control Channel
TIA/EIA IS-136.2	TDMA Cellular/PCS - Radio Interface - Mobile Station - Base Station Compatibility - Traffic Channels and FSK Control Channel
TIA/EIA IS-137	TDMA Cellular/PCS - Radio Interface - Minimum Performance Standards for Mobile Stations
TIA/EIA IS-138	TDMA Cellular/PCS - Radio Interface - Minimum Performance Standards for Base Stations
TIA/EIA-627	800 MHz Cellular System, TDMA Radio Interface, Dual-Mode Mobile Station - Base Station Compatibility Standard (ANSI/TIA/EIA-627-96), which replaced IS-54-B
TIA/EIA-628	800 MHz Cellular System, TDMA Radio Interface, Dual-Mode Mobile Station - Base Station Compatibility Standard (ANSI/TIA/EIA-627-96), which replaced IS-54-B
TIA/EIA-629	800 MHz Cellular System, TDMA Radio Interface, Minimum Performance Standards for Base Stations Supporting Dual-Mode Mobile Stations (ANSI/TIA/EIA-629-96), which replaced IS-56-A

The EDGE Standard

What is EDGE with GSM?

The Global System for Mobile communication (GSM) digital communications standard defines a voice and data over-air interface between a mobile radio and the system infrastructure. This standard was designed as the basis for a radio communications system. A base station control center (BSC) is linked to multiple base transceiver station (BTS) sites which provide the required coverage.

EDGE (Enhanced Data Rates for GSM Evolution) enhances the GSM standard with a new modulation format (3p/8 8PSK) and filtering designed to provide higher data rates in the same spectrum. EDGE allows more bits to be sent in each burst. This increasing the number of bits per symbol, and provides a 3-fold increase in data rate over GSM’s GMSK (Gaussian Minimum Shift Keying) modulation format. EDGE has also been adopted as the basis for IS-136HS (NADC).

GSM 900, GSM 450, GSM 480, GSM 850, DCS 1800, and PCS 1900 are GSM-defined frequency bands. The term GSM 900 is used for any EDGE (with

GSM) system operating in the 900 MHz band, which includes P-GSM, E-GSM, and R-GSM. Primary, or standard, GSM 900 band (P-GSM) is the original GSM band. Extended GSM 900 band (E-GSM) includes all the P-GSM band plus an additional 50 channels. Railway GSM 900 band (R-GSM) includes all the E-GSM band plus additional channels. DCS 1800 is an adaptation of GSM 900, created to allow for smaller cell sizes for higher system capacity. PCS 1900 is intended to be identical to DCS 1800 except for frequency allocation and power levels. The term GSM 1800 is sometimes used for DCS 1800, and the term GSM 1900 is sometimes used for PCS 1900.

The GSM digital communications standard employs an 8:1 Time Division Multiple Access (TDMA) allowing eight channels to use one carrier frequency simultaneously. The 270.833 kbits/second raw bit rate is modulated on the RF carrier using Gaussian Minimum Shift Keying (GMSK).The standard includes multiple traffic channels (TCH), a control channel (CCH), and a broadcast control channel (BCCH). The GSM specification defines a channel spacing of 200 kHz.

EDGE employs the same symbol rate and frame structure as GSM. EDGE and GSM signals can be transmitted on the same frequency, occupying different timeslots, and both use existing GSM equipment. Due to the similarity between the formats, the transmitter measurements are the same, with the addition of only a few EDGE-specific measurements. One of them is:

EDGE EVM — It provides a measure of modulation accuracy. EDGE 8PSK modulation pattern uses a rotation of 3p/8 radians to avoid zero crossing, thus affording some margin of linearity relief for amplifier performance. It is substantially more demanding than GSM modulation (GMSK), and EDGE EVM testing is necessary to reveal performance shortcomings.

The EDGE format is defined in the following standards documents:
GSM 05.04, 05.05, 11.10, 11.21, and ANSI J-STD-007 specifications. These documents define complex, multi-part measurements used to maintain an interference-free environment. For example, the documents include measuring the power of a carrier.

The PDC Standard

Personal Digital Cellular (PDC) is one of the cellular communications systems in Japan. The digital modulation format used in the PDC system is the pi/4 differential quadrature phase shift keying (pi/4 DQPSK). The pi/4 DQPSK modulation causes both phase and amplitude variations on the RF signal. The quadrature nature of this modulation allows 2 bits to be transmitted at the same time on orthogonal carriers. These 2 bits make one PDC symbol.The PDC communications system is defined in the Association of Radio Industries and Business (ARIB) document, RCR STD-27, Personal Digital Cellular Telecommunication System Standard.

The TETRA Standard

TErrestrial Trunked RAdio (TETRA) is the modern digital Private Mobile Radio (PMR) and Public Access Mobile Radio (PAMR) technology for police, ambulance and fire services, security services, utilities, military, public access, fleet management, transport services, closed user groups, factory site services, mining. TETRA uses Time Division Multiple Access (TDMA) technology with 4 user channels on one radio carrier and 25 kHz spacing between carriers. This makes it inherently efficient in the way that it uses the frequency spectrum.

What the Modulation Analysis Measurement Personality and Hardware Does

The Agilent ESA-E Series Spectrum Analyzer with the modulation analysis measurement personality and hardware can help identify common impairments to digitally modulated signals for all the major communication formats.

There are two ways to configure the analyzer for digital demodulation measurements. You can manually enter values for all demodulation parameters, or you can specify the standard of your digital communications system and let the analyzer automatically set the parameters.

The analyzer lets you select from several standards. When you select a standard, the analyzer automatically sets the parameters shown in the following table.

Radio Format	Device	Demod Format	Symbol Rate	Meas Filter	Ref Filter	Alpha/BT	Points/Symbol[a]	Measurement Interval or Result Length	Frequency Span	Burst Search Threshold	Burst Search Length	Burst Sync (Under EVM MeasSetup)	I/Q Invert
cdmaOne	BTS	QPSK	1.2288 MS/s	cdma BS Ph EQ	Chebyshev	n/a	5	200	3 MHz	–20 dB	1 s	None	Off
cdmaOne	MS	Offset QPSK	1.2288 MS/s	Off	Chebyshev	n/a	4	200	3 MHz	–20 dB	1 s	None	Off
cdma2000 SR1	BTS	QPSK	1.2288 MS/s	cdma BS Ph EQ	Chebyshev	n/a	5	256	3 MHz	–20 dB	1 s	None	Off
cdma2000 SR1	MS	QPSK	1.2288 MS/s	Off	Chebyshev	n/a	5	256	3 MHz	–20 dB	1 s	None	Off
W-CDMA 3GPP	BTS & MS	QPSK	3.84 MS/s	Root Nyquist	Nyquist	0.22	5	256	6 MHz	–20 dB	1 s	None	Off
NADC	BTS	Pi/4 DQPSK	24.3 kS/s	Root Nyquist	Nyquist	0.35	5	162	100 kHz	–20 dB	49 ms	None	Off
NADC	MS	Pi/4 DQPSK	24.3 kS/s	Root Nyquist	Nyquist	0.35	5	157	100 kHz	–20 dB	49 ms	RF Amptd	Off
EDGE (8PSK)	BTS	PSK EDGE	270.833 kS/s	Edge Tx	Edge Meas	0.25	1	142	600 kHz	–20 dB	3.655 ms	Training Seq	Off
EDGE (8PSK)	MS	PSK EDGE	270.833 kS/s	Edge Tx	Edge Meas	0.25	1	142	600 kHz	–20 dB	3.655 ms	None	Off
PDC	BTS	Pi/4 DQPSK	21.0 kS/s	Root Nyquist	Nyquist	0.5	5	138	100 kHz	–20 dB	48 ms	RF Amptd	Off
PDC	MS	Pi/4 DQPSK	21.0 kS/s	Root Nyquist	Nyquist	0.5	5	135	100 kHz	–20 dB	48 ms	RF Amptd	Off
TETRA	BTS	Pi/4 DQPSK	18.0 kS/s	Root Nyquist	Nyquist	0.35	5	246	100 kHz	–20 dB	73 ms	None	Off
TETRA	MS	Pi/4 DQPSK	18.0 kS/s	Root Nyquist	Nyquist	0.35	5	231	100 kHz	–20 dB	73 ms	RF Amptd	Off

a. To convert symbols to seconds, divide by the symbol rate.

The ESA spectrum analyzer with modulation analysis measurement personality is capable of making the following measurements:

- Peak and RMS EVM
- Peak and RMS magnitude error
- Peak and RMS phase error
- Frequency Error
- Phase error/symbol display
- Magnitude error versus symbol display
- Polar vector display
- Polar constellation display
- I and Q eye display
- I/Q Offset
- Amplitude Droop error

In addition to the measurements listed above, the modulation analysis personality provides or uses the following supplemental functions:

- Wideband Calibration which allows the user to effectively perform a factory calibration on the analyzer's front end.
- Automatic signal level detection and analyzer setup.
- External reference configuration and control.
- Save and recall mode state (Mode is the operation mode of the instrument. *For example: SA = Spectrum Analyzer or MAN = Modulation Analysis Measurement personality*)
- Storing/printing of results internally or directly to a floppy disk in spreadsheet (.csv) format.

Other Sources of Measurement Information

Additional measurement application information is available through your local Agilent Technologies sales and service office. The following application notes provide more detail on digital communications and measurements.

- Application Note 1298
  Digital Modulation in Communications Systems - An Introduction HP/Agilent part number 5965-7160E
- Application Note 1311
  Understanding CDMA Measurements for Base Stations and Their Components HP/Agilent part number 5968-0953E
- Application Note 1313
  Testing and Troubleshooting Digital RF Communications Transmitter Designs HP/Agilent part number 5968-3578E
- Application Note 1314
  Testing and Troubleshooting Digital RF Communications Receiver Designs HP/Agilent part number 5968-3579E
- Application Note 150
  Spectrum Analyzer Basics
  HP/Agilent part number 5952-0292

3 Setting Up the Modulation Analysis Mode

This chapter introduces you to the basic measurement process.

Preparing to Make Measurements

At initial power up, the analyzer will be in spectrum analyzer (SA) mode and the **FREQUENCY Channel** menu displayed. To access the Modulation Analysis measurement personality, press the **Mode** key and select the **Modulation Analysis** key.

Initial Settings

If you have already been into Modulation Analysis mode since the instrument was powered up, then the screen displayed and the settings in force will be exactly as they were when you last switched out of Modulation Analysis mode.

When you put the instrument into Modulation Analysis mode for the first time after a power up, the Monitor Spectrum screen will be displayed with a center frequency setting of 1.0 GHz and a span of 3 MHz. This Monitor Spectrum function allows you to check that there is a signal to be measured.

The center frequency can be changed by pressing **Frequency** and then entering the required frequency using the numeric keys. The span can be altered by pressing **Span** and entering the required span using the numeric keys.

Before making a measurement, make sure the mode setup and radio standard parameters are set to the desired settings. Refer to Chapter 5 , “Menu Maps,” and Chapter 6 , “Front-Panel Key Reference,” for additional information to guide you in changing parameter settings.

If you want to set the instrument (including the Error Vector Magnitude (EVM) mode settings) to a known, factory default state, press **Preset**. This will preset the mode setup and all of the measurement setup parameters to the factory default parameters. Note that **Preset** will switch modes, returning the ESA to the SA mode. You must re-access the EVM mode after the preset operation is completed.

You can set the instrument to use **User** preset or **Factory** preset under the **System** front panel key. If you set the preset to **User**, the instrument displays a **Preset** menu when you press **Preset**. The **Preset** menu allows you to select the **User** defaults or the **Factory** defaults. For more information on setting, saving, and using user defaults, refer to the *ESA Spectrum Analyzers User's Guide*.

If you want to set only the EVM mode to a known, factory default state, press **Mode Setup** and **Restore Mode Defaults**. This will reset only the EVM parameters to the factory defaults without affecting the SA mode, and the instrument will not exit the EVM mode.

To preset only the settings that are specific to the selected measurement, press **Restore Meas Defaults** under **Meas Setup**. This will set the measurement setup parameters, for the currently selected measurement only, to the factory defaults.

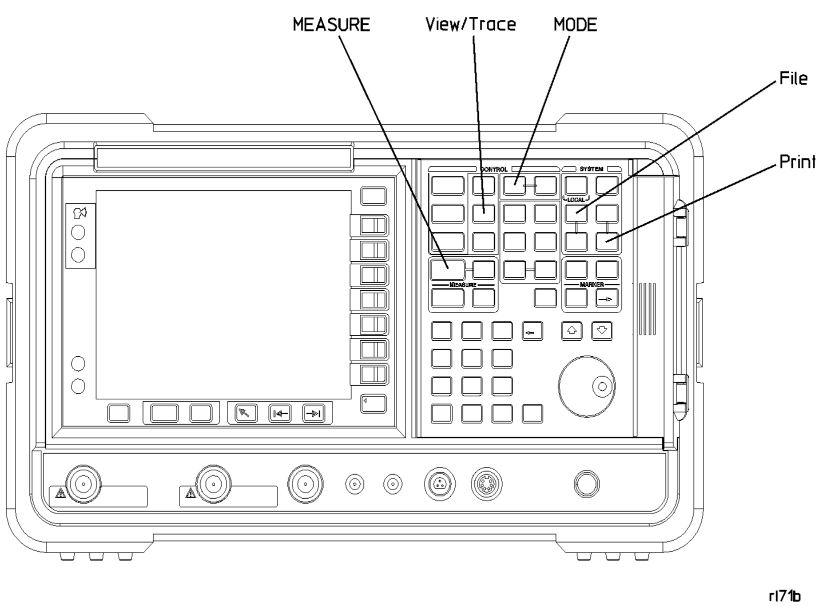
How to Make an EVM (Error Vector Magnitude) Measurement

The EVM (Error Vector Magnitude) measurement is set up and is intended to be used as a “one-button” measurement. After you have properly connected the instrument to the digital communications system equipment and selected the EVM measurement, the measurement is made using the default parameters defined by the selected standard.

Even though the measurement is designed as one-button measurement, you may change the default settings using various setup keys. However, changing the default settings may produce measurement results that are outside of the parameters of the selected standard.

Most measurements can be performed using the simple four-step procedure outlined in the table below. Most measurements are performed using only the primary keys listed in conjunction with a minimum of setup keys. Measurement setup keys (**Meas Setup**) can be used for non-standards compliant testing. For more information see “Initial Settings”.

Step	Primary Key	Setup Keys	Related Keys
1. Select and setup mode	**MODE**	**Mode Setup**	**System**
2. Select and setup measurement	**MEASURE**	**Meas Setup**, **Restore Meas Defaults,** **FREQUENCY Channel**	**Meas Control**, **Restart**
3. Select and setup view	**View/Trace**	**Span X Scale**, **Amplitude Y Scale**, **Display**	**Marker**, **Search**
4. Saving and printing results	**File** **Print**	**Print Setup**	**Save**



How to Save Measurement Results

To save measurement results follow the process shown below. For additional information on file management in the spectrum analyzer, refer to the *ESA Spectrum Analyzers User's Guide*.

1. Press **File**, **Save**, **Type**, **More**, **Measurement Results**.
2. If you want to change the file name, press **Name**, and use the Alpha Editor the enter the new name. For more information on using the Alpha Editor, refer to the *ESA Spectrum Analyzers User's Guide*.
3. The default directory is the C: drive. If you want to change the file directory, press **Dir Up** (or **Dir Select)** and use the up or down arrows to select the desired directory and then press **Dir Select**.
4. Press **Save Now** to complete the file saving process.
5. If you have used the default file name and wish to save additional measurement results, press **Save**. The current measurement result will be saved with the next default file name.
6. If you have not used the default file name and wish to save additional measurement results, repeat steps 1 through 3.

4 Making Modulation Analysis Measurements

This chapter shows how to make modulation analysis measurements and how to interpret them. Various radio signals having different problems are shown and compared against results of acceptable signals.

What You Will Find in This Chapter

The Modulation Analysis Personality

Purpose

A thorough analysis of EVM (error vector magnitude) in a digital communication system is invaluable for troubleshooting common errors such as:

I/Q error
Symbol rate errors
Wrong filter coefficients
Wrong interpolation, IF filter tilt, or ripple
LO instability
Tone interference
AM/PM conversion errors

The Agilent Modulation Analysis Measurement Personality provides this analysis of digitally-modulated signals for the following major cellular standards:

cdmaOne (IS-95 and J-STD-008)
cdma2000 SR1
W-CDMA (3GPP)
NADC
EDGE
PDC
TETRA

In addition, the personality allows you to alter the filters and symbol rates defined by the communication standards if the signal you are analyzing differs from a defined radio standard.

This guide shows you how to set up the Agilent ESA to measure and display the results of EVM using eye, constellation, and vector diagrams, as well as tabular data. The key results provided are:

Peak and RMS EVM
Peak and RMS Magnitude error
Peak and RMS Phase error
Frequency error
I/Q offset
Droop error
EVM versus symbol display
Magnitude error versus symbol display
Phase error versus symbol display
Polar vector display
Polar constellation display
I and Q eye display

Measurement Method for a CDMA System

Consider making an EVM measurement on a CDMA system.

You can only make an EVM measurement intrusively. When you perform the measurement, a carrier channel with a single pilot channel are the only allowed active channels. No other traffic channels or paging channels may be present.

The intrusive method takes the measurement directly from the RF output port of the transceiver, as shown in Figure 4-1.

CAUTION If you take the measurement directly from the RF output port of the transceiver, ensure that the power level at the RF input of the spectrum analyzer does not exceed the damage level of 30 dBm.

Because you disconnect the antenna from the transceiver and disrupt the transmission signal, this cannot be considered a non-intrusive test. The transceiver will not be able to communicate with users on the system.

You may also make a less intrusive test by connecting a directional coupler to the RF output with the main arm connected to the antenna and the coupled port connected to the spectrum analyzer, as shown in Figure 4-2. You must ensure that only the pilot Walsh channel is active. Because only a pilot channel will be observed, the transceiver will not be able to communicate with users on the system.

NOTE The time bases of the base station and the spectrum analyzer should be locked together. These are referred to as “10 MHz Ref In” or “Ext Ref In” throughout the remainder of this document.

Making a Wideband CDMA Measurement

NOTE Use the **Help** key to get a quick explanation of any Modulation Analysis Personality key, as well as any equivalent SCPI command that performs the function of that key.

1. Install the Modulation Analysis Measurements Personality as described in the “Getting Started” chapter of this guide.
2. Make sure that the base transceiver station is in service with only the pilot Walsh channel active.
3. Connect the device being measured and the spectrum analyzer input as shown in Figure 4-1 or Figure 4-2.

Figure 4-1 Measurement Setup

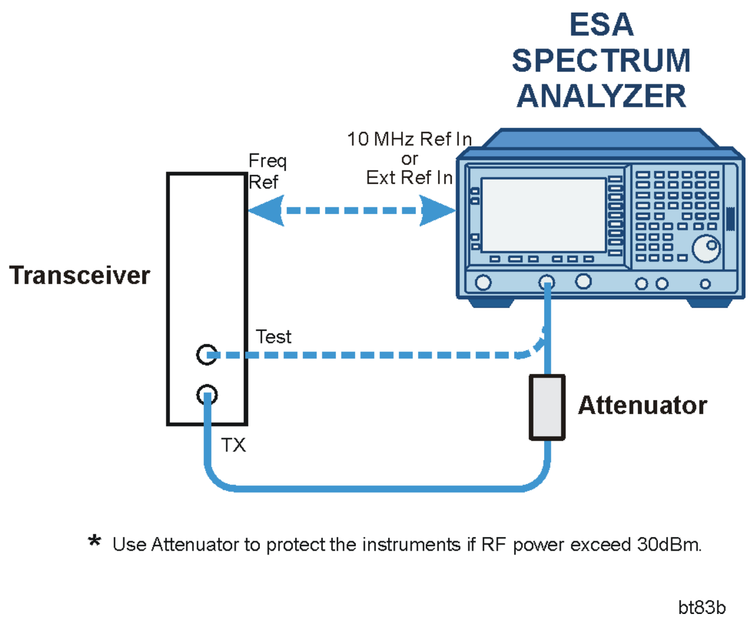
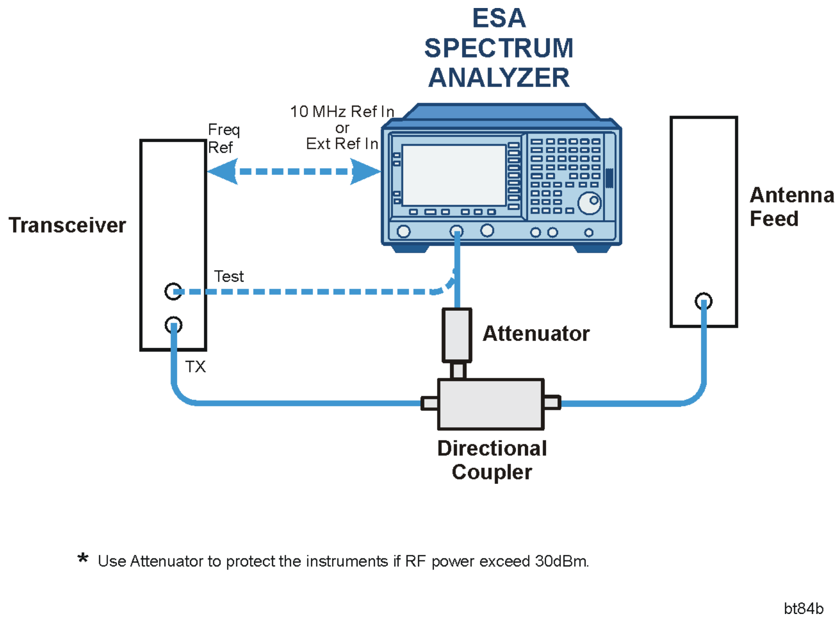
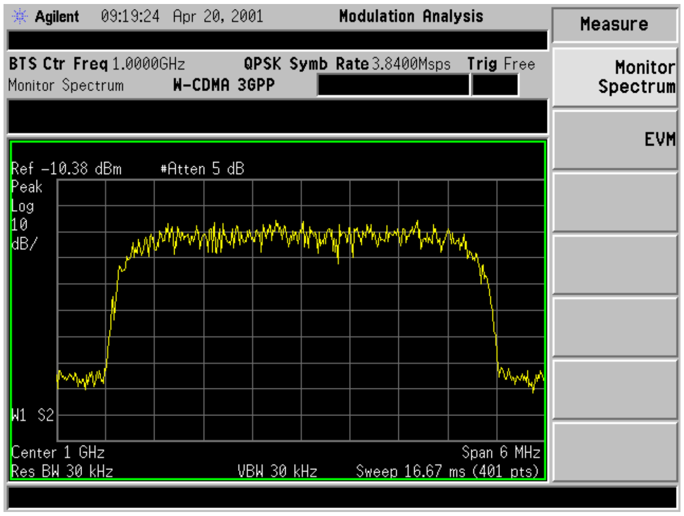


Figure 4-2 Alternative Measurement Setup



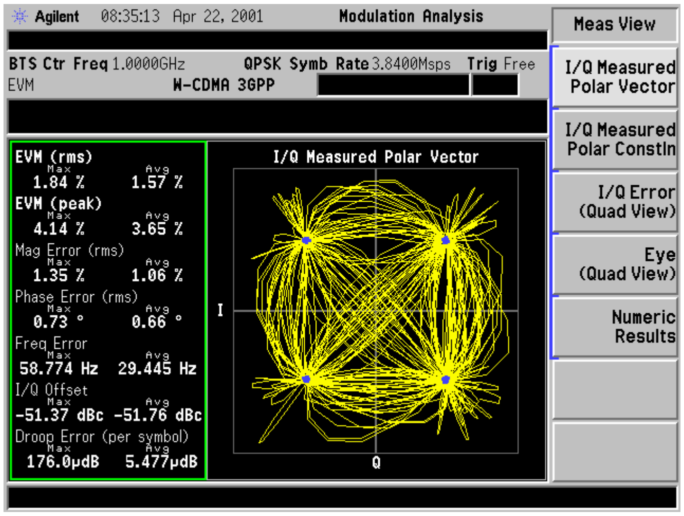
4. Press **Mode, Modulation Analysis**, **Mode Setup**, **Radio Std** and choose the radio standard being used.
5. Press **FREQUENCY** and set the center frequency to the transmit frequency of the radio.
6. Press **MEASURE, Monitor Spectrum** and check to see that the spectrum looks reasonable. It should be centered on the display with modulation present, as shown in Figure 4-3 (Wideband CDMA signal shown). If not, then refer to "Problems Obtaining a Measurement" later in this chapter.

Figure 4-3 Monitor Spectrum Display



7. Press **EVM**. You should see an I/Q polar vector display of the signal, similar to that shown in Figure 4-4. Results are listed in a table left of the vector display.

Figure 4-4 Polar Vector Display



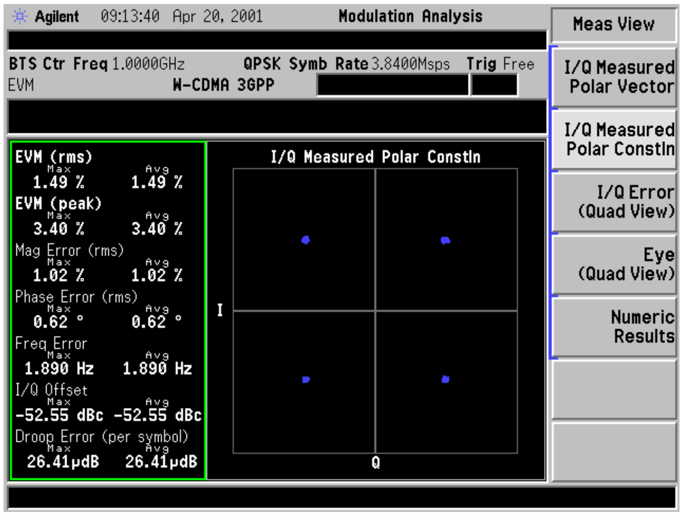
8. Press **View/Trace, I/Q Measured Polar Constln**. You should see an I/Q polar constellation display of the signal and the table of critical parameter values, similar to that shown in Figure 4-5.

NOTE As a trouble shooting tool, you can manually build the polar constellation or step through the trace with a short line segment using the **I/Q Points** and **I/Q Points Offset** keys.

When you make a single measurement (press the **Single** key on the front panel), the data for that single measurement is held within instrument memory. If you then set the **I/Q Points Offset** to 0, you can see how the measurement is built up by slowly increasing the **I/Q Points** figure from zero using the RPG knob.

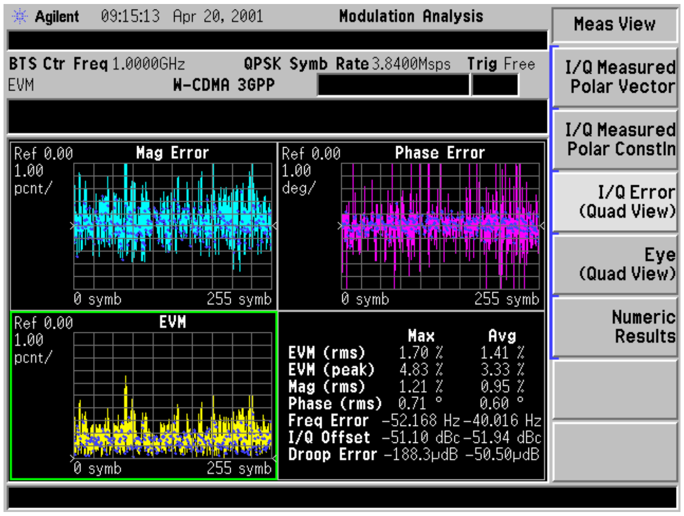
Similarly you can set the **I/Q Points** figure to a low number (say, 5 or 10) and vary the **I/Q Points Offset** figure using the RPG knob. Now you will see a 'snake' marking out the signal's trace on the display.

Figure 4-5 Polar Constellation Display



9. Press I/Q Error (Quad View) and refer to Figure 4-6. You should see graphical displays of magnitude error versus time, phase error versus time, EVM versus time, and tabular results.

Figure 4-6 I/Q Errors Showing Magnitude, Phase, and EVM



10. Press **Next Window** (a key located below the display). Each of the four individual windows are “highlighted” by a colored border as you press this key. Press **Next Window** again and then press **Zoom.** The size of the selected window expands for easier viewing.

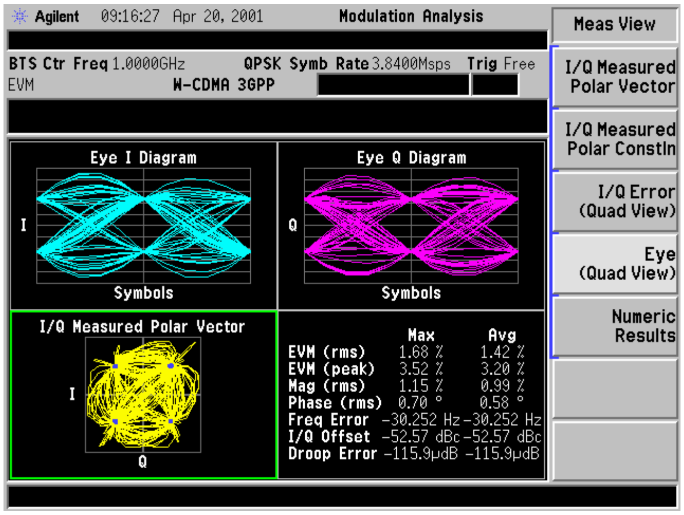
11. Press **Next Window** to select one of the time graphs and then press **Zoom.** Change the x-axis scaling (number of symbols) to 2/division by pressing **SPAN, Scale/Div, 2, Sym.** This menu also allows you to change the x-axis reference value and position.

12. Change the y-axis scaling (% for EVM, Magnitude, and ° for Phase Error graphs) to 0.5/division by pressing **AMPLITUDE, Scale/Div, .5, %** (or °.) This menu also allows you to change the y-axis reference value and position.

13. The blue data points shown along the traces are the symbol decision point locations. To turn these off, press **Display, Symbol Dots Quad View, Off**. This menu also allows you to change I/Q points and points/symbol. Press **Zoom** to return to normal viewing.

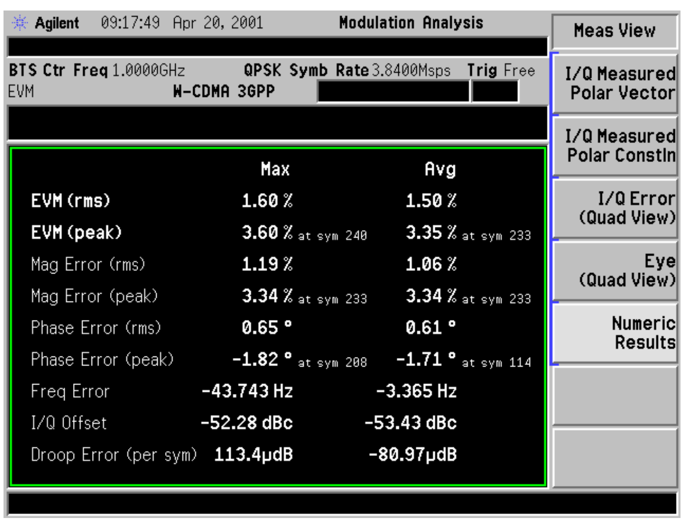
14. Press **View/Trace, Eye (Quad View)** and refer to Figure 4-7. You should see individual eye diagrams for I and Q, along with a polar vector display, and tabular results of critical parameter values.

Figure 4-7 Eye Diagrams with Polar Vector Constellation



15. Press **Numeric Results** and refer to Figure 4-8. You should see a tabular display of the critical parameter values similar to the tables in the previous views. This table differs in that it also includes peak values for magnitude error and phase error. The specific symbols are identified with each of these values.

Figure 4-8 Numeric Results View



Interpreting Measurement Results

The power of the Modulation Analysis Personality is its ability to characterize the radio signal for transmitter troubleshooting. This section illustrates how to interpret the data to indicate symptoms of problems in radio signals.

The following radio signal errors are investigated in this section:

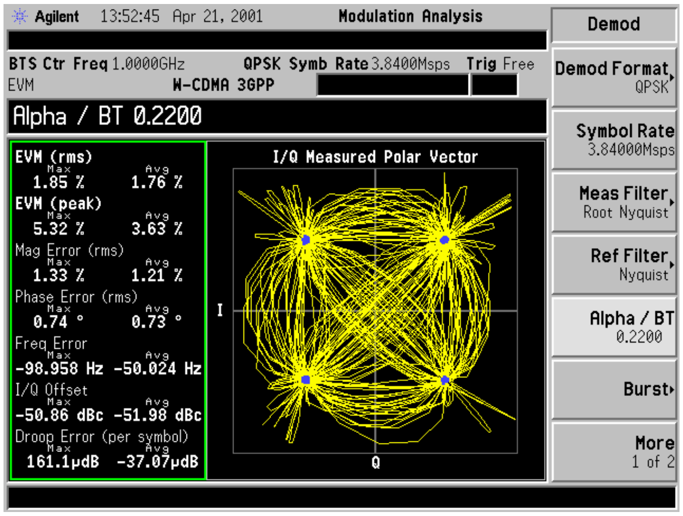
Baseband Filtering Errors
I/Q Gain Imbalance
I/Q Quadrature (Skew) Error
I/Q DC Offset Error
Symbol Rate Error
I/Q DC Offset Error
In-Channel Phase Modulation Interference
In-Channel Amplitude Modulation Interference
In-Channel Spurious Signal Interference

Baseband Filtering Errors

Filtering errors are among the most common in digital communication design. Typical filter errors can be due to errors in filter alpha, wrong filter shape, or incorrect filter coefficients. The result is increased intersymbol interference. Lower peak overshoot is also caused by signal compression, which can indicate that an amplifier stage is being overdriven.

1. The vector diagram gives the first indication of baseband filtering errors. Press **I/Q Measured Polar Vector**. The display should look similar to that shown in Figure 4-9. This is a normal Wideband CDMA signal shown with a filter α of 0.22.

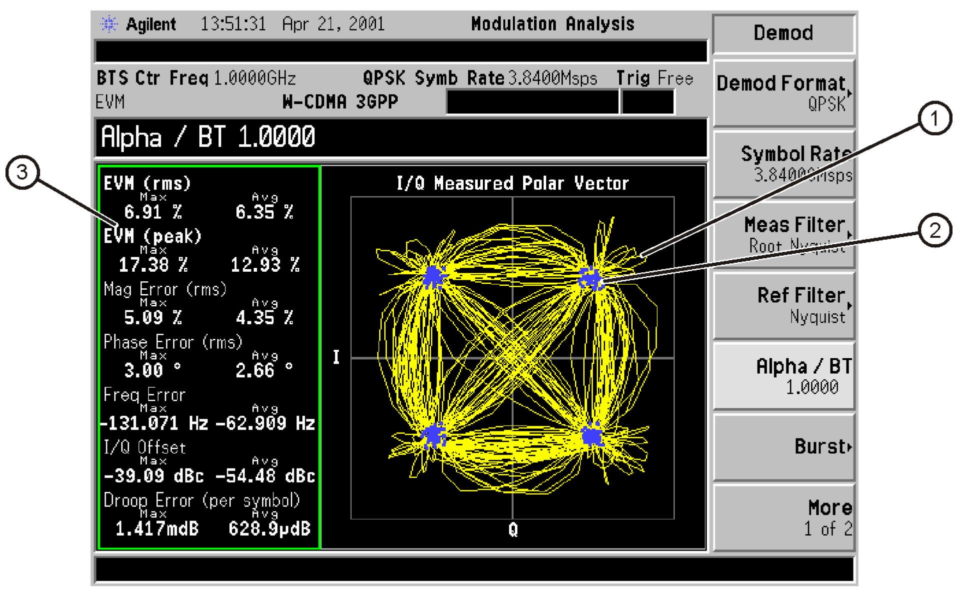
Figure 4-9 Polar Vector of Signal Using a 0.22 Filter α



2. In contrast, refer to Figure 4-10. A Wideband CDMA signal is shown with a filter α of 1. Observe that there are smaller overshoots in the trajectories between the symbol points (item 1) due to the increased alpha. This limits the required peak power and reduces the transmitter power requirements. Item 2 shows spreading of the decision points due to the increased EVM (item 3.)

NOTE To change the filter α of the analyzer, press **Det/Demod, Alpha/BT.**

Figure 4-10 Polar Vector of Signal Using a 1.0 Filter α



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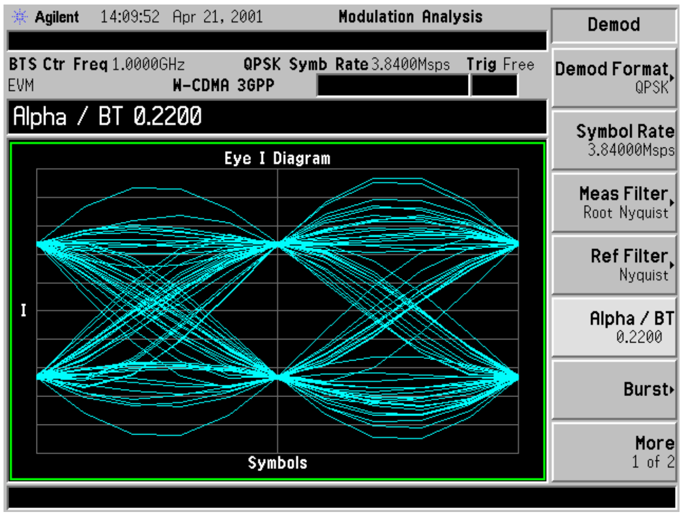
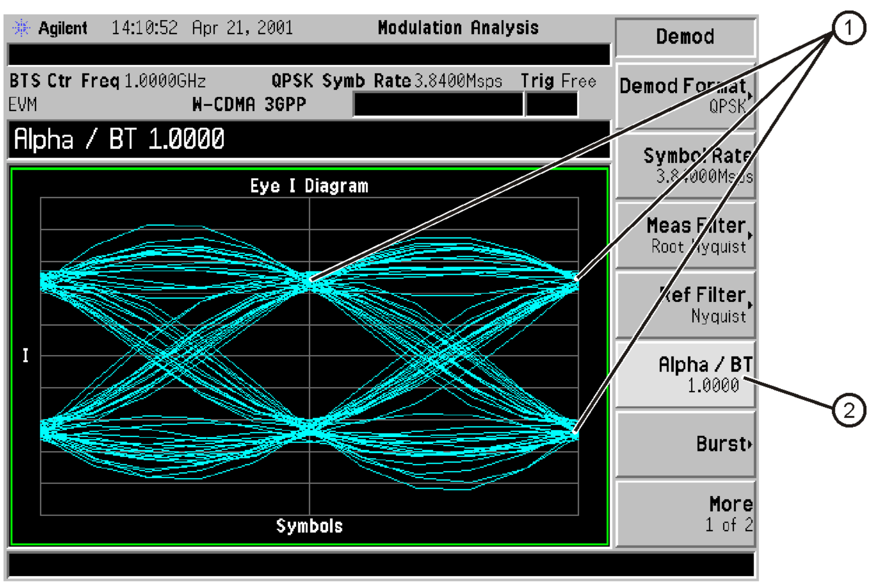
3. Press **View/Trace, Eye (Quad View), Next Window, Next Window, Next Window, Zoom**. The display should look similar to that shown in Figure 4-11 (W-CDMA signal shown with filter α = 0.22.)

Figure 4-11 I Eye Diagram of Signal Using a 0.22 Filter α



4. In contrast, refer to Figure 4-12. This shows a Wideband CDMA signal with a filter α of 1 (item 2). An incorrect filter alpha is indicated when the center diamond shape is distorted with rounding and widened crossover points at the top and bottom corners (item 1.) The eye diagram tends to “spread out” in this case.

Figure 4-12 I Eye Diagram of Signal Using a 1.0 Filter α



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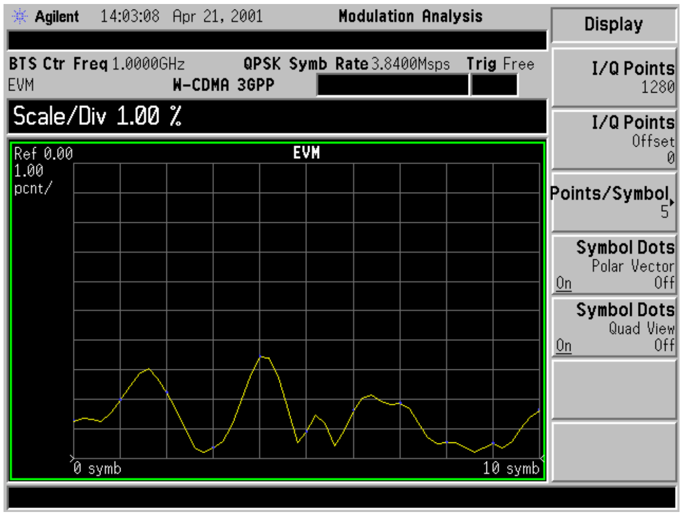
5. Press **View/Trace, I/Q Error (Quad View).** Press **Next Window** until the EVM graph is highlighted. Press **Zoom, Amplitude, Scale/Div, 6, %** to expand the y-axis scale. Press **SPAN, Scale/Div, 1, Sym** to expand the x-axis scale. The result of a “normal” signal is shown in Figure 4-13 (W-CDMA signal shown with filter $\alpha = 0.22$.)

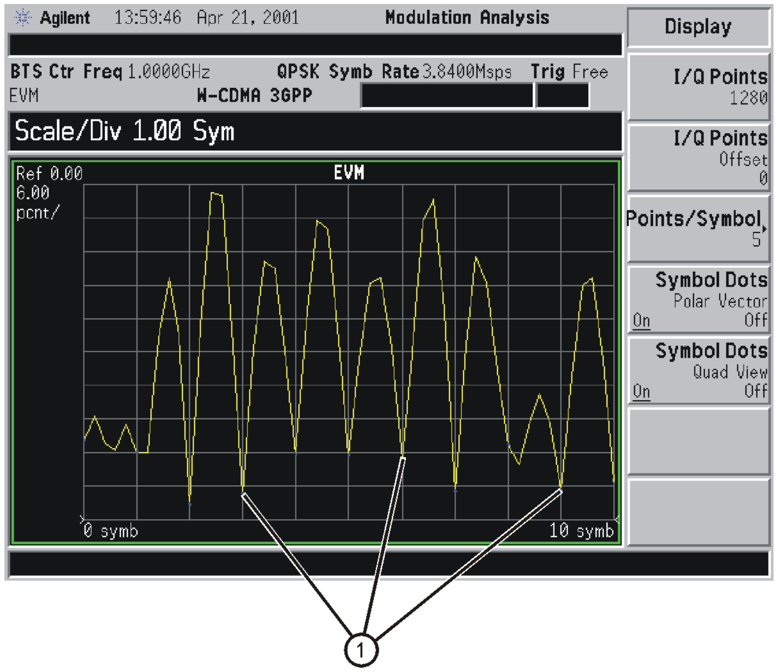
Figure 4-13 Zoomed EVM Display of Signal Using a 0.22 Filter α



6. In contrast, refer to Figure 4-14 (W-CDMA signal shown with filter $\alpha = 1$.)

   Differing filter alphas between the transmitter and receiver do not significantly affect the symbol locations. However, differing alphas do cause incorrect transitions. As a result, the error vector is large between symbol points and relatively small at the symbol locations (item 1.)

Figure 4-14 Zoomed EVM Display of Signal Using a 1.0 Filter α



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I/Q Gain Imbalance

I/Q gain imbalance is a result of non-equal gains in the I and Q parts of the network. This can be caused by differences in components such as filters, amplifiers, and DACs. For non-scrambled or spread QPSK signals, the symptom of this imbalance is indicated by rectangular-shaped groupings of symbol decision points in each quadrant.

Press **Meas Control, Pause** to view a single time record.

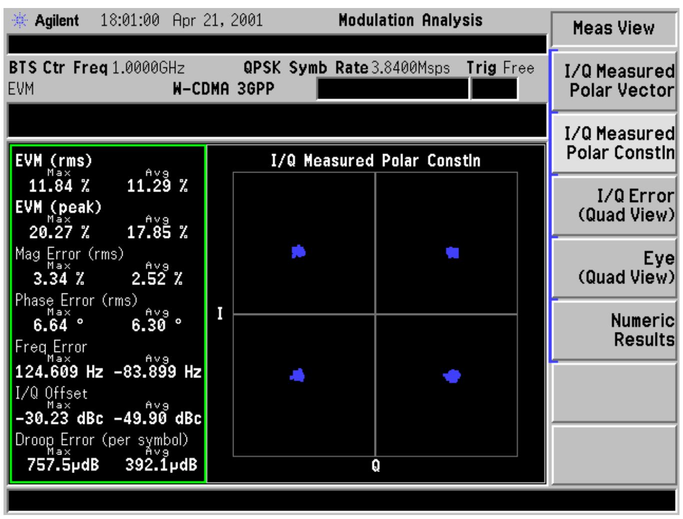
1. Use the I/Q polar constellation diagram first to identify this problem. Press **View/Trace, I/Q Measured Polar Constln**. A signal with an I/Q gain imbalance is shown in Figure 4-15. A rectangular shape is indicated with the symbol decision points at the rectangle corners, instead of the square shape you would normally see with a properly balanced signal. A gain imbalance of 2 dB was used to obtain this result.

NOTE The long side of the rectangle appears along the I axis, but this will shift 90° along the Q axis and back again in random fashion. This is normal.

The analyzer arbitrarily assigns the demodulated symbols to the I and Q channels for each new time record; the analyzer acts as an asynchronous receiver. For this reason, it is not possible to determine the correct carrier phase reference.

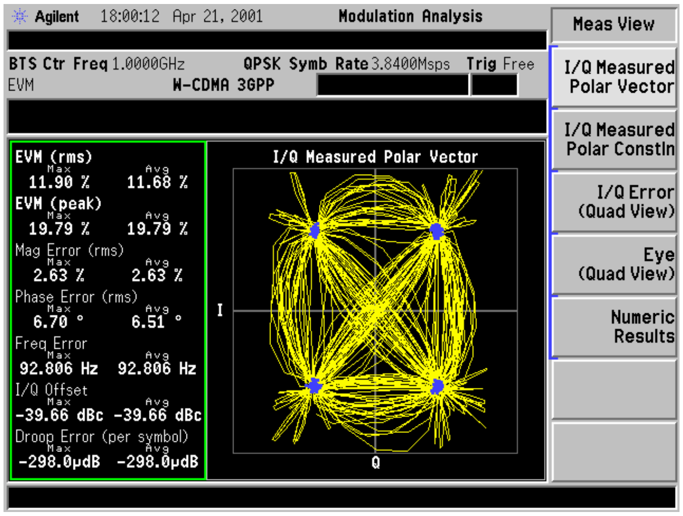
Although the display indicates a Wideband CDMA format, the signal shown is a non-scrambled or spread QPSK signal.

Figure 4-15 Polar Constellation Showing an I/Q Gain Imbalance



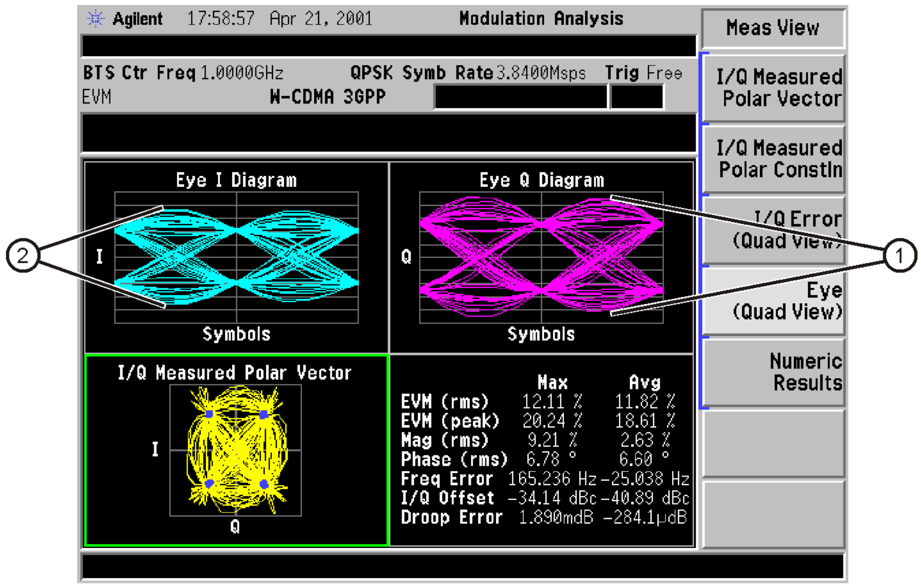
2. The polar vector diagram is shown in Figure 4-16. Observe that the rectangular shape has shifted by 90°, with the longer side of the rectangle along the Q axis. As stated earlier, this is normal, and will arbitrarily shift back and forth.

Figure 4-16 Polar Vector Showing an I/Q Gain Imbalance



3. Figure 4-17 shows the same signal using the eye diagram. Observe that with a gain imbalance, the I and Q eye diagrams will not be similar in shape, and these shapes will be swapped back and forth between each other. In this figure, the Q eye diagram vertical amplitude (item 1) is greater than that of the I eye diagram (item 2.)

Figure 4-17 Eye Diagram Showing an I/Q Gain Imbalance



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I/Q Quadrature (Skew) Error

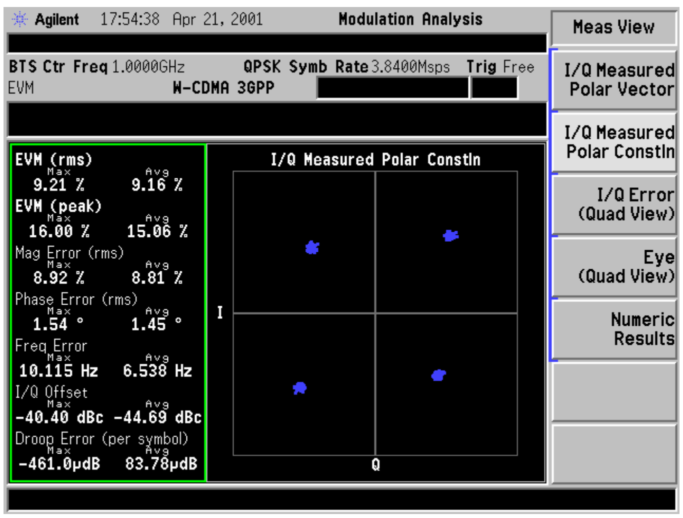
Quadrature error is due to lack of a 90 degree phase shift between the I and Q channels of a transmitter.

For non-scrambled or spread QPSK signals, the symptom of quadrature error is indicated by parallelogram-shaped groupings of symbol decision points in each quadrant.

Press **Meas Control, Pause** to view a single time record.

1. Use the I/Q polar constellation diagram first to identify this problem. Press **I/Q Measured Polar Constln**. A signal with an I/Q quadrature error is shown in Figure 4-18. A parallelogram shape is indicated with the symbol decision points at the rectangle corners. A quadrature difference of 10° was used to obtain this result.

Figure 4-18 Polar Constellation Showing I/Q Quadrature Error



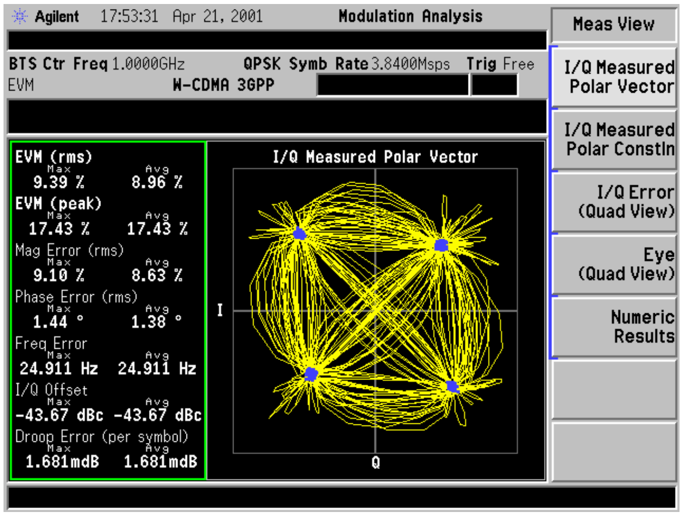
NOTE The shape of the parallelogram will shift 90° along the two axes and back again in random fashion. This is normal.

The analyzer arbitrarily assigns the demodulated symbols to the I and Q channels for each new time record; the analyzer acts as an asynchronous receiver. For this reason, it is not possible to determine the correct carrier phase reference.

Although the display indicates a Wideband CDMA format, the signal shown is a non-scrambled or spread QPSK signal.

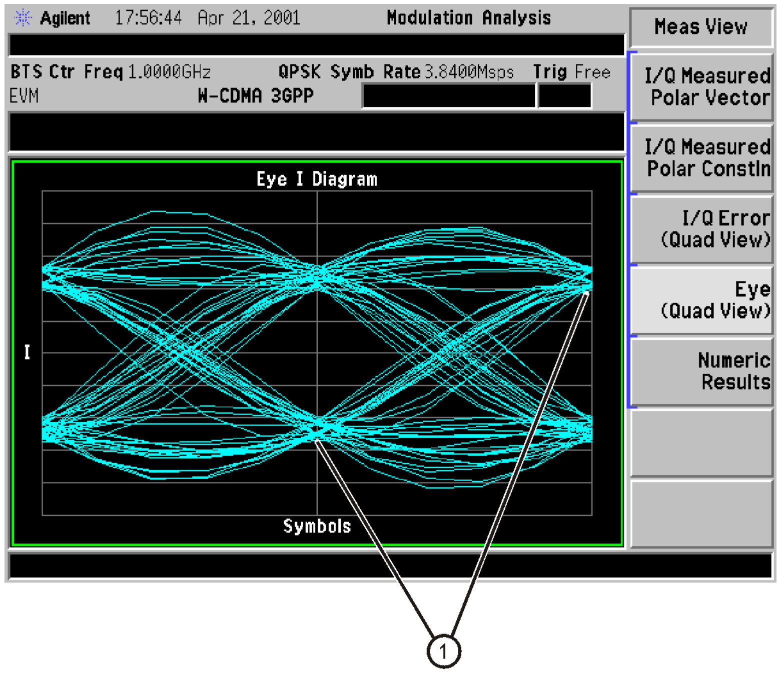
2. The polar vector diagram is shown in Figure 4-19. Observe that the parallelogram shape has shifted by 90°. As stated earlier, this is normal, and will arbitrarily shift back and forth.

Figure 4-19 Polar Vector Showing I/Q Quadrature Error



3. The zoomed I eye diagram is shown in Figure 4-20. Observe that with a quadrature error, the crossover points alternately shift between time records. Because of this, an open triangle pattern begins to take shape at the decision points (item 1.)

Figure 4-20 Zoomed I Eye Diagram Showing I/Q Quadrature Error



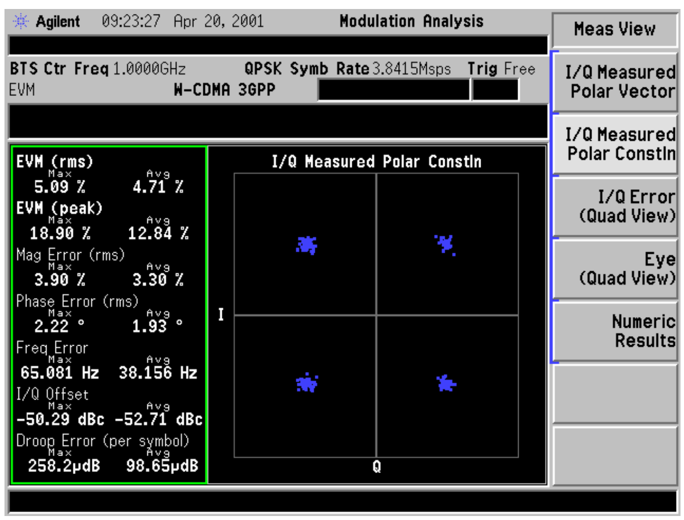
Symbol Rate Error

Small deviations in the symbol clock can result in significant modulation errors. Even a small error in symbol rate causes a large increase in peak EVM, and is indicated by a spreading of the symbol decision points.

Large symbol rate errors will result in the receiver not being able to demodulate the signal. The Modulation Analysis Personality is most useful in troubleshooting small symbol rate errors. To troubleshoot circuits with large symbol rate errors, try using the ESA occupied bandwidth measurement function to view the signal channel bandwidth. You can roughly approximate the symbol rate using this method.

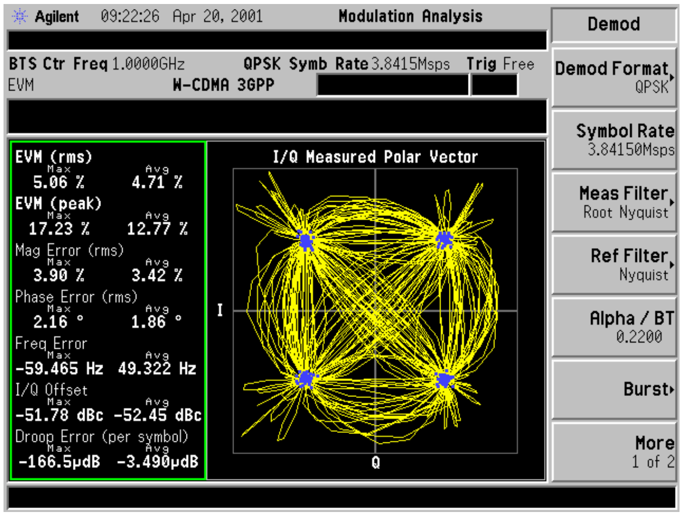
1. Use the I/Q polar constellation diagram first to identify symbol rate errors. Press **I/Q Measured Polar Constln**. A signal with symbol rate errors is shown in Figure 4-21. Note the spreading of the symbol decision points and large values of EVM. A symbol rate error of 0.0015 Msps over the actual symbol rate was used to obtain this result.

Figure 4-21 Polar Constellation Showing Symbol Rate Error



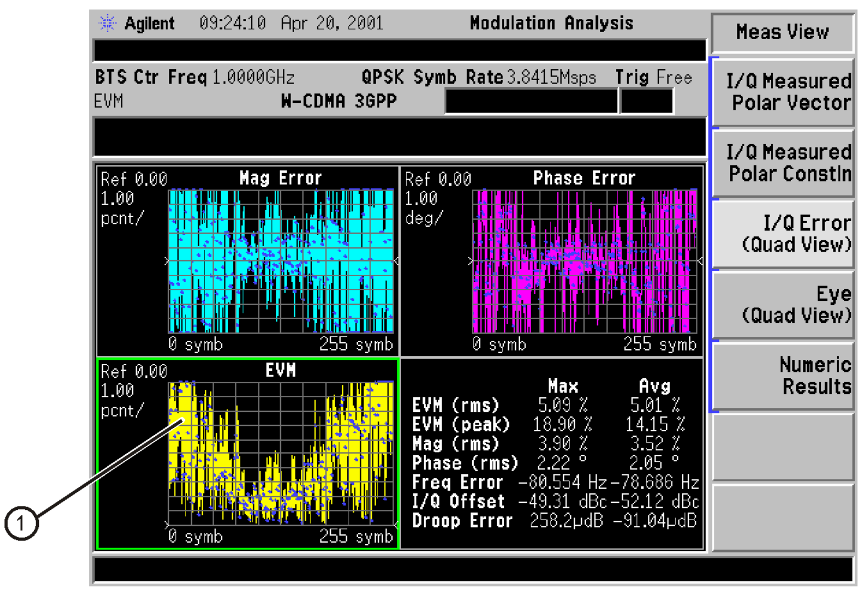
2. Figure 4-22 shows the polar vector diagram of this signal, with a received symbol rate of 3.84150 Msps (this symbol rate can be seen above the vector diagram in the figure.) The transmitted symbol rate is 3.840 Msps.

Figure 4-22 Polar Vector Showing Symbol Rate Error



3. Figure 4-23 shows the I/Q error views of this signal. Observe at item 1 that with a symbol rate error, the EVM versus time graph shows a "V" shape.

Figure 4-23 I/Q Error Diagram Showing Symbol Rate Error



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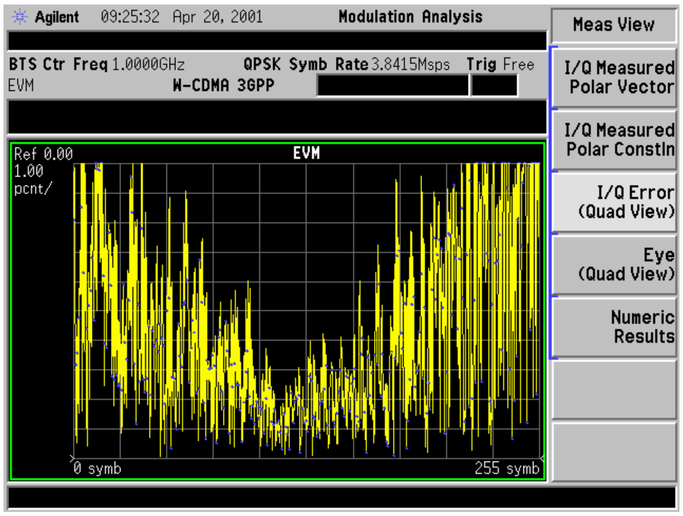
4. Figure 4-24 shows the EVM versus time graph in zoom mode. The characteristic "V" shape is caused by the demodulator aligning the expected symbol clock rate with the clock rate of the signal, for best fit at the midpoint of the trace. The differences in the two clocks show increasing "slip," or deviation further from the trace center. At one arbitrary reference sample, the signal is sampled correctly. But since the symbol rate is skewed, any other sample in the positive or negative direction is slightly off in time. This causes an error which increases linearly in time.

Figure 4-24 Zoomed EVM Versus Symbol Display Showing Symbol Rate Error

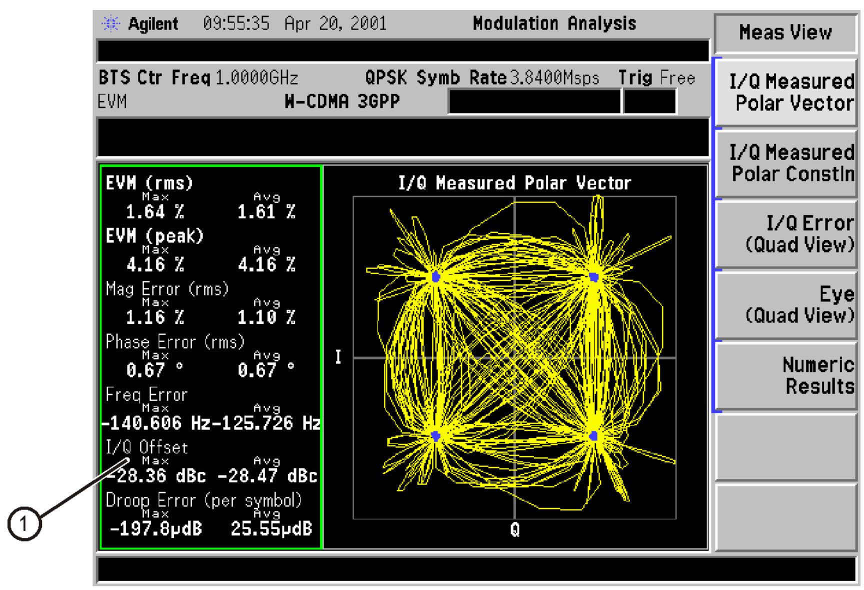


I/Q DC Offset Error

DC offset is characteristic of an improperly adjusted balanced modulator. Typically, these offsets are added in the amplifier in the I and Q paths. This type of error should be indicated in a displaced constellation from the origin of the I/Q plane. However, any DC offset is reported in the summary/symbol table only, since the analyzer measures and removes this offset during demodulation.

1. Use the I/Q polar constellation diagram to identify I/Q DC offset errors. Press **I/Q Measured Polar Vector**. A signal with an I/Q DC offset error is shown in Figure 4-25. Observe that there are no noticeable errors shown in the vector diagram itself. However, the I/Q offset value in the table is about –28 dBc (item 1), and should be closer to –52 dBc for a Wideband CDMA signal.

Figure 4-25 Polar Vector Showing I/Q DC Offset Error



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In-Channel Phase Modulating Interference

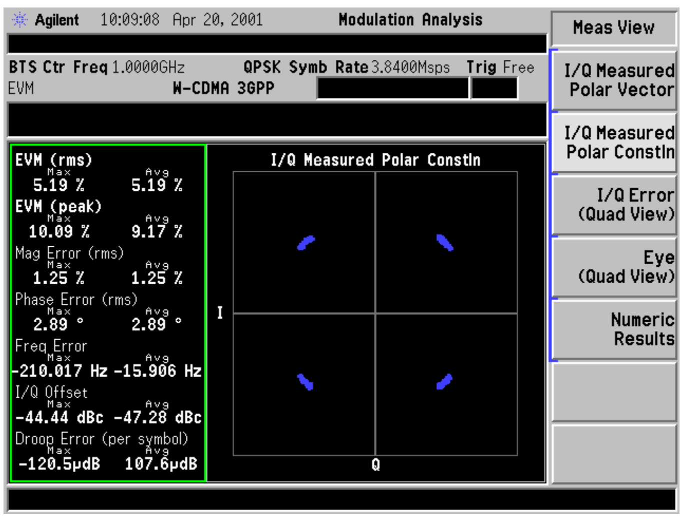
Many signals are present in an integrated communications system. Examples may include digital, baseband, IF, and RF signals. Crosstalk between adjacent components and stages often leads to unwanted signals in the output. The Modulation Analysis Personality can help identify these signals, including in-channel phase modulating signals.

For a Wideband CDMA signal, PM interference appears as an aligning of the symbol decision points in the center of each quadrant, forming "lines" of dots. This line extends farther outward as the magnitude of the PM increases.

1. Use the I/Q polar constellation diagram first to identify this problem. Press **I/Q Measured Polar Constln**. Figure 4-26 shows an example of a Wideband CDMA signal with in-channel phase modulation interference. Note the variation of phase around the ideal symbol reference points. Also observe how much larger the phase error values are compared to those for magnitude error in the table.

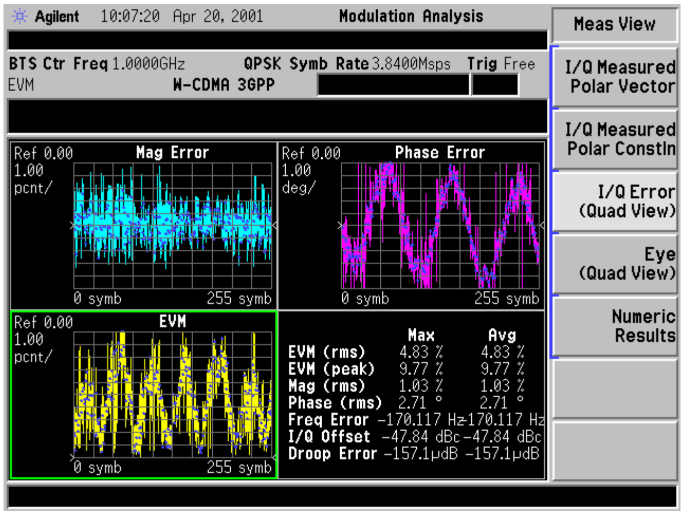
   The results shown were created with a phase modulation deviation of 0.03 pi radians (about 5.5°) and a modulating frequency of 45 kHz.

Figure 4-26 Polar Constellation Showing PM Interference



2. The I/Q error views are shown in Figure 4-27. Observe that the sinusoidal modulating waveform of the interfering PM signal is shown in the phase error versus time graph. If the graphical result was random, it would have indicated phase noise and not a PM interfering signal.

Figure 4-27 I/Q Error Display Showing PM Interference



3. The zoomed phase error graph is shown in Figure 4-28. If the number of cycles can be accurately determined, the phase modulating signal frequency can be calculated. Use the **Span** and **Amplitude** keys to adjust the scaling, if necessary, to make this determination. It may also be helpful to pause the trace using the **Meas Control** key.

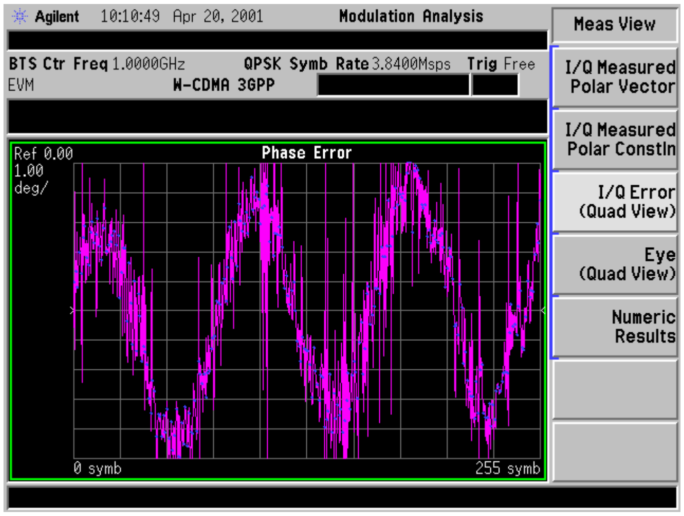
   PM_f = Phase Error freq. / number of symbols x symbol rate

   In this example, Phase Error freq. = 3 cycles, number of symbols = 256, and symbol rate is 3.84×10^6

   $PM_f = 3/256 \times 3.84 \times 10^6$, or 45 kHz

4. Peak deviation of the phase modulating signal is easily determined from Figure 4-28. There are about 5 divisions of peak phase modulation at 1 degree per division. This approximates the actual 5.5° of phase modulation applied to create this signal.

Figure 4-28 Zoomed Phase Error Display Showing PM Interference



In-Channel Amplitude Modulation Interference

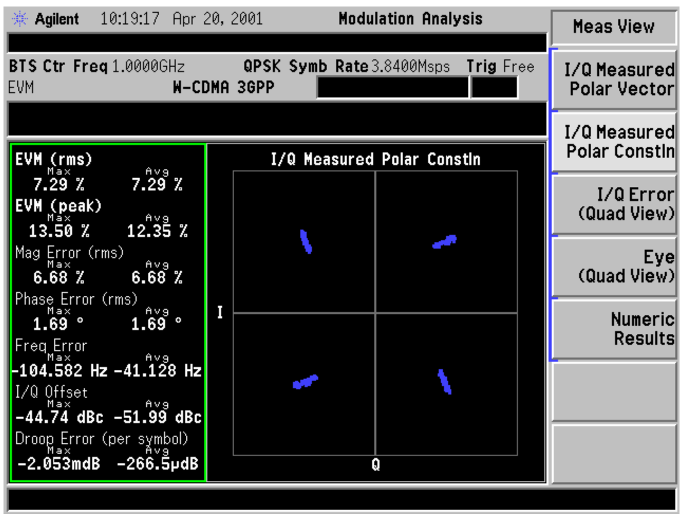
Many signals are present in an integrated communications system. Examples may include digital, baseband, IF, and RF signals. Crosstalk between adjacent components and stages often leads to unwanted signals in the output. The Modulation Analysis Personality can help identify these signals, including in-channel interfering tones that are amplitude modulated.

For a Wideband CDMA signal, AM interference appears as an aligning of the symbol decision points in the center of each quadrant, forming "lines" of dots. This line extends farther outward as the magnitude of the AM increases.

1. Use the I/Q polar constellation diagram first to identify this problem. Press **I/Q Measured Polar Constln**. Figure 4-29 shows an example of a Wideband CDMA signal with in-channel amplitude modulation interference. Note the variation of amplitude around the ideal symbol reference points. Also observe how much larger the amplitude error values are compared to those for phase error in the table.

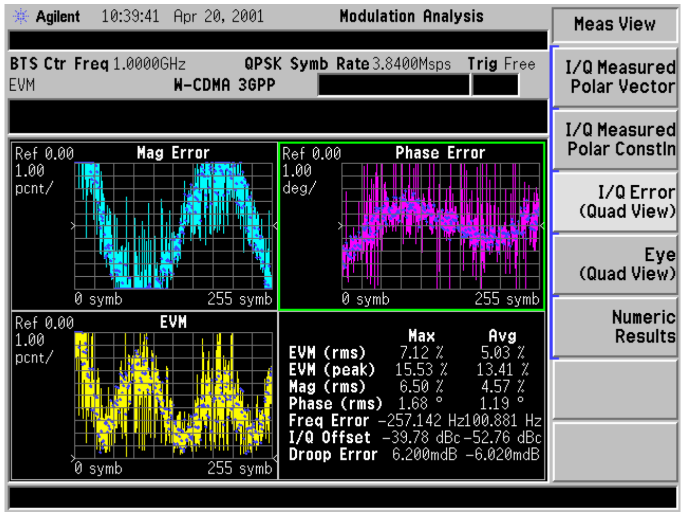
   The results shown were created with an amplitude modulation deviation of 10% and a modulating frequency of 15 kHz.

Figure 4-29 Polar Constellation Showing AM Interference



2. The I/Q error view graphs are shown in Figure 4-30.

Figure 4-30 I/Q Error Display Showing AM Interference



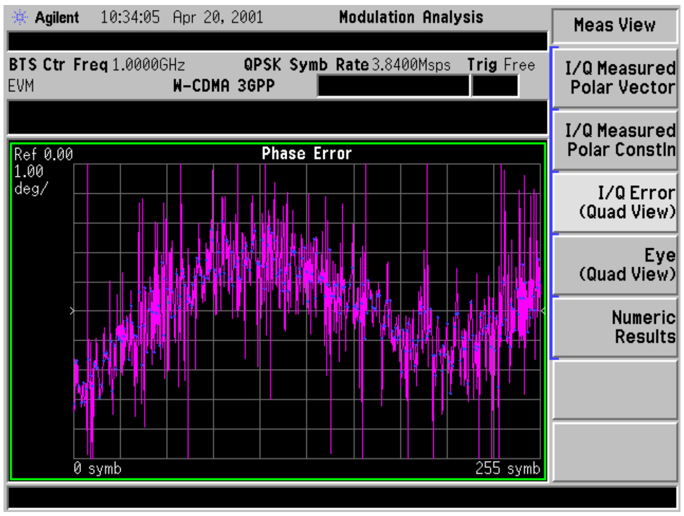
3. The zoomed phase error graph is shown in Figure 4-31. If the number of cycles can be accurately determined, the amplitude modulating signal frequency can be calculated. Use the **Span** and **Amplitude** keys to adjust the scaling, if necessary, to make this determination. It may also be helpful to pause the trace using the **Meas Control** key.

   AM_f = Phase Error freq. / number of symbols x symbol rate

   In this example, Phase Error freq. = 1.1 cycles, number of symbols = 256, and symbol rate is 3.84 x 10^6

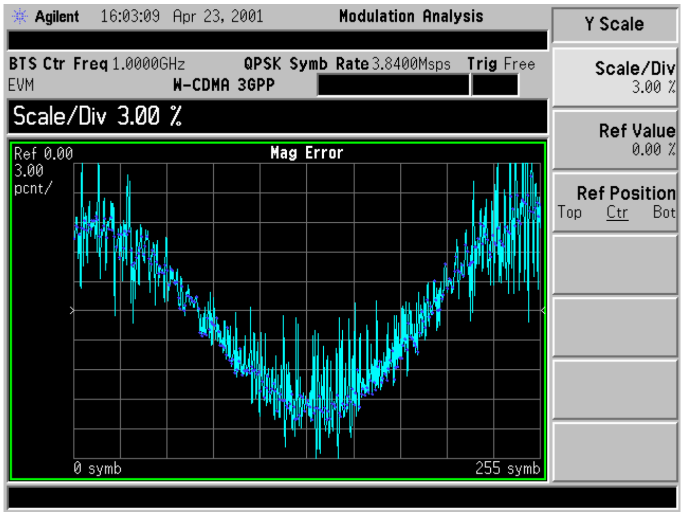
   AM_f = 1.1/256 x 3.84 x 10^6, or about 16 kHz

Figure 4-31 Zoomed Phase Error Display Showing AM Interference



4. Peak deviation of the amplitude modulating signal is easily determined from Figure 4-32, the zoomed magnitude error versus time graph. There are about 7 divisions of peak-to-peak amplitude modulation at 3% per division, yielding 10.5% peak amplitude. This approximates the actual 10% of amplitude modulation applied to create this signal.

Figure 4-32 Zoomed Magnitude Error Display Showing AM Interference



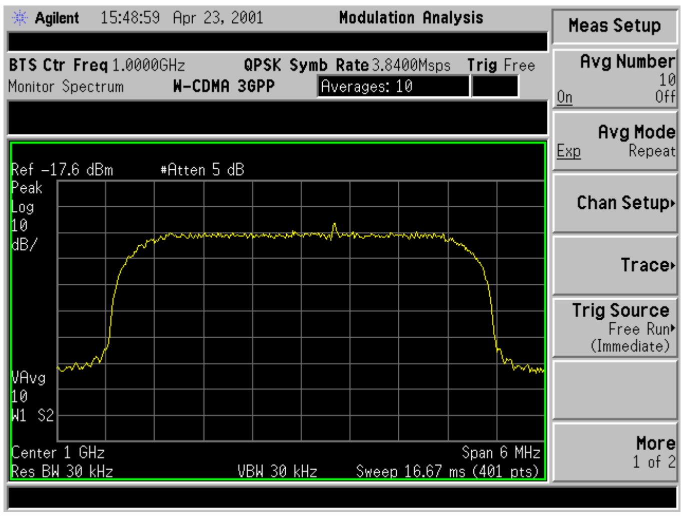
In-Channel Spurious Signal Interference

Many signals are present in an integrated communications system. Examples may include digital, baseband, IF, and RF signals. Crosstalk between adjacent components and stages often leads to unwanted signals in the output. The Modulation Analysis Personality can help identify these signals, including in-channel spurious signals.

For a Wideband CDMA signal, an in-channel spurious signal appears as circular-shaped donut groupings of symbol decision points in each of the quadrants. This is because the spur modulates both the amplitude and phase of the I and Q signals. If the signal is modulated only without spurious interference, there will be no holes in the circles; this also indicates a poor signal-to-noise ratio. The donut size diameter increases as the magnitude of the spur increases.

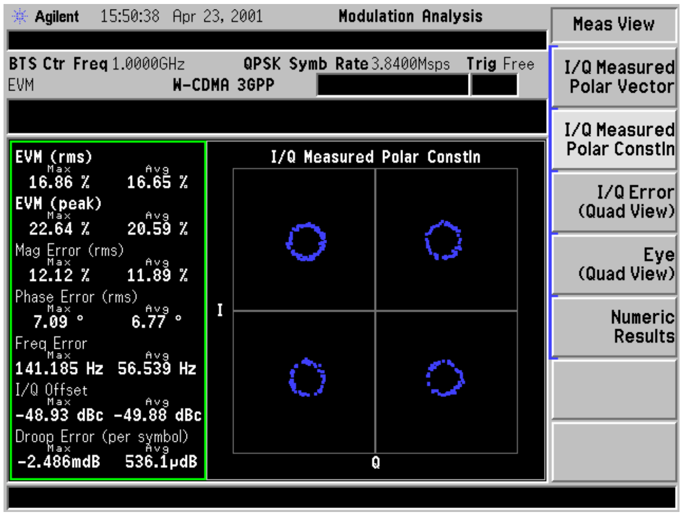
1. Figure 4-33 shows an in-channel spurious signal that is –15 dBc and + 400 kHz away from the unmodulated radio signal. Even a large interfering signal such as this is barely visible in the spectrum view, even with averaging on.

Figure 4-33 Spectrum Display Showing In-Channel Spurious Interference



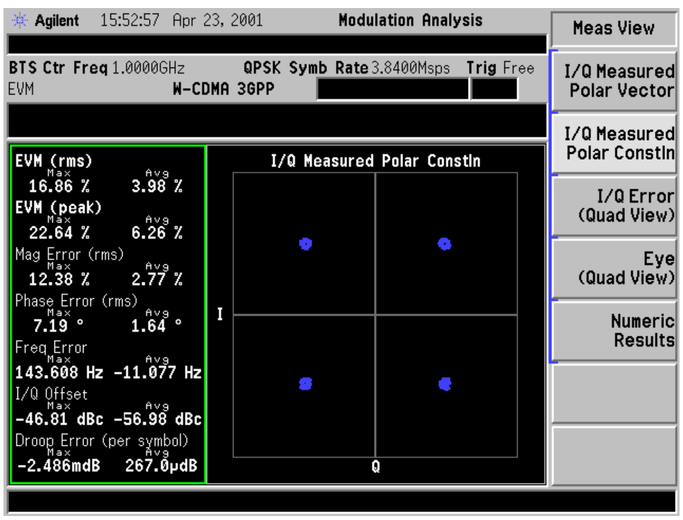
2. Use the I/Q polar constellation diagram first to identify this problem. Press **I/Q Measured Polar Constln**. Figure 4-34 shows the results created using the same interfering signal as was used in Figure 4-33.

Figure 4-34 Polar Constellation Showing Spurious Interference at –15 dBc



3. The same view of the interfering signal is shown in Figure 4-35, but at –28 dBc. The characteristic “donut” shape can still be seen.

Figure 4-35 Polar Constellation Showing Spurious Interference at –28 dBc



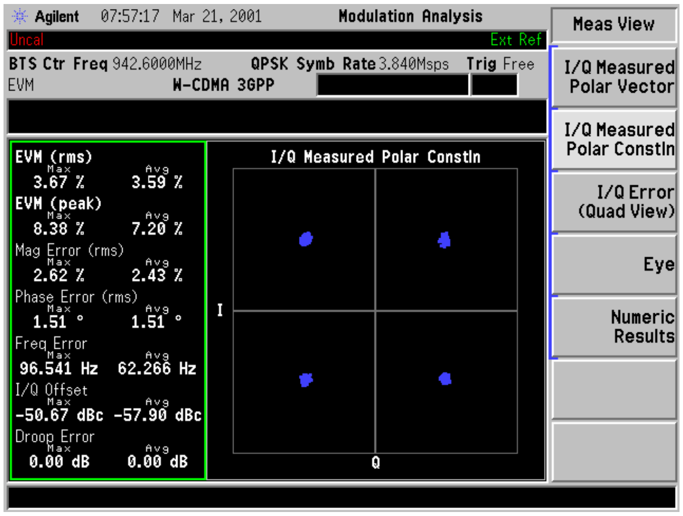
Measuring a Custom QPSK Format Signal

The Modulation Analysis Personality allows you to demodulate a QPSK modulation formatted signal using your own custom parameters. This section provides an example of how to set up the analyzer to measure such a signal. The signal parameters are: type QPSK modulation, symbol rate 3.84 Msps, Root Nyquist filtering using Alpha/BT of 0.35.

1. Press **Demod Format**, **QPSK** to select the correct demodulation format.
2. Press **Symbol Rate**, **3.84 Msps** to enter the correct symbol rate.
3. Press **Meas Filter, Root Nyquist** to select the correct measurement filter.
4. Press **Ref Filter, Nyquist** to select the correct reference filter.
5. Press **Det/Demod, Alpha/BT, 0.35, Enter** to enter the correct alpha value.
6. Press **View/Trace**, **I/Q Measured Polar Constln** to select the correct constellation view.

You should see the classic four symmetric decision regions (symbol points) of a QPSK constellation, as shown in Figure 4-36.

Figure 4-36 Polar Constellation of a QPSK Signal



Other Customized Changes You Can Make

1. Press Display to vary the number of I/Q points, I/Q points offset, and turn on or off the symbol dots for polar vector or quad views.
2. Press **Det/Demod** to access a menu to allow you to vary the type of measurement and reference filters.
3. Set the measurement parameters to the default values by pressing **Meas Setup**, **More**, **Restore Meas Defaults**.

NOTE If the desired RF channel or channel frequency has been set for a previous measurement, it is used for all subsequent measurements, and it does not need to be set again.

4. Set the mode parameters to the default values by pressing **Mode Setup**, **Restore Mode Setup Defaults**.
5. To change any of the measurement parameters from the factory default values, press the **Meas Setup**, **Mode Setup**, or **Det/Demod** keys to access menus that allow you to modify the parameters for this measurement. For additional information on keys to access measurement parameters, refer to the *Front-Panel Key Reference* section in this User's Guide, or use the on-screen help.

Problems Obtaining a Measurement

The following list of common problems and their solutions may help if you are having trouble obtaining a proper measurement using the Modulation Analysis Personality.

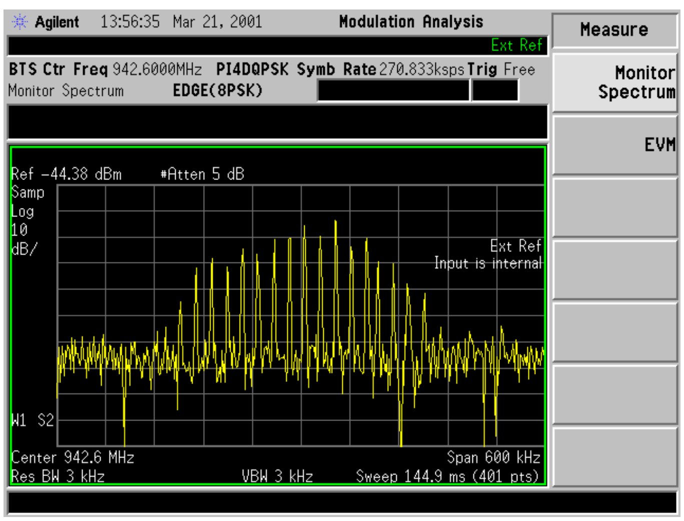
In Monitor Spectrum mode, the signal is missing, or does not look correct.

The analyzer may be tuned to a frequency other than the radio signal frequency. While the analyzer is in Modulation Analysis mode, press **FREQUENCY Channel** and then set the analyzer frequency. If the analyzer frequency was set while in SA mode, the Modulation Analysis mode frequency was unaffected.

When using the EDGE standard, the spectrum looks valid, but all EVM measurements are invalid.

If you are using a signal generator, the data format must be “framed” and not “patterned,” unlike the other TDMA modes. For example, the signal needs to be bursted with the correct midamble training sequence code as is defined in the EDGE standard. The spectrum should look like Figure 4-37 for an EDGE signal with only one active timeslot.

Figure 4-37 Spectrum Display of an EDGE Signal with One Active Timeslot



An NADC, TETRA, or PDC signal looks incorrect.

Make sure that BTS/MS is correctly selected. BTS assumes a continuous, non-burst signal with all timeslots active.

A “Wideband Cal Required” error message appears.

Press **Det/Demod**, **More 1 of 2, Wideband Cal**. Follow the instructions on the display and then continue the measurement.

The results show a large EVM.

Make sure that the instrument reference is correct. Check if an external reference is being used by pressing **Det/Demod**, **More 1 of 2**. Also check to see that a cable is connected between the 10 MHz OUT port of the RF Communications Hardware (Option B7E) board to the ESA 10 MHz REF IN port.

5 Menu Maps

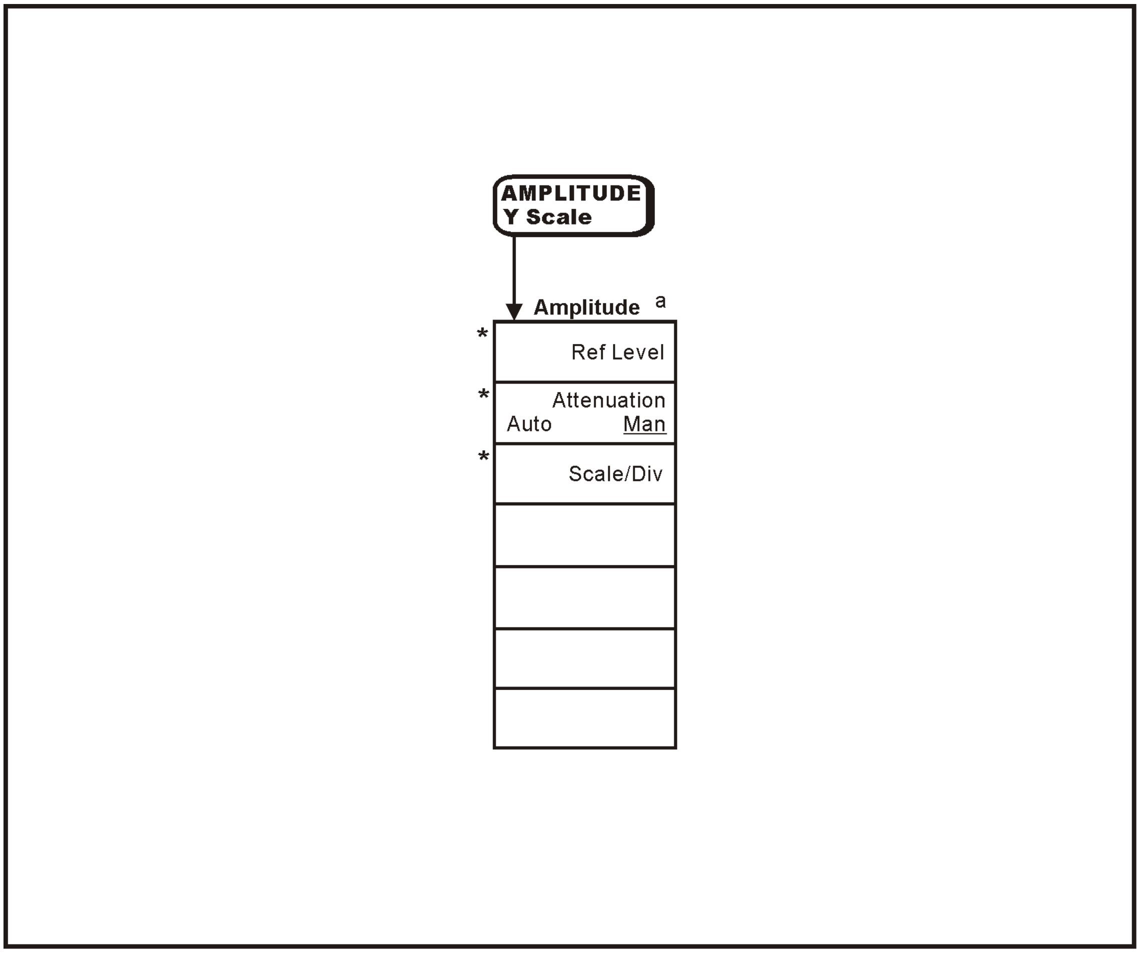
This chapter provides a visual representation of the front-panel keys and their associated menu keys. Refer to Chapter 6 , “Front-Panel Key Reference,” for key function descriptions.

What You Will Find in This Chapter

This chapter provides menu maps for the front panel keys having associated menus. The key menus appear in alphabetical order as follows:

Menus

Amplitude Menu

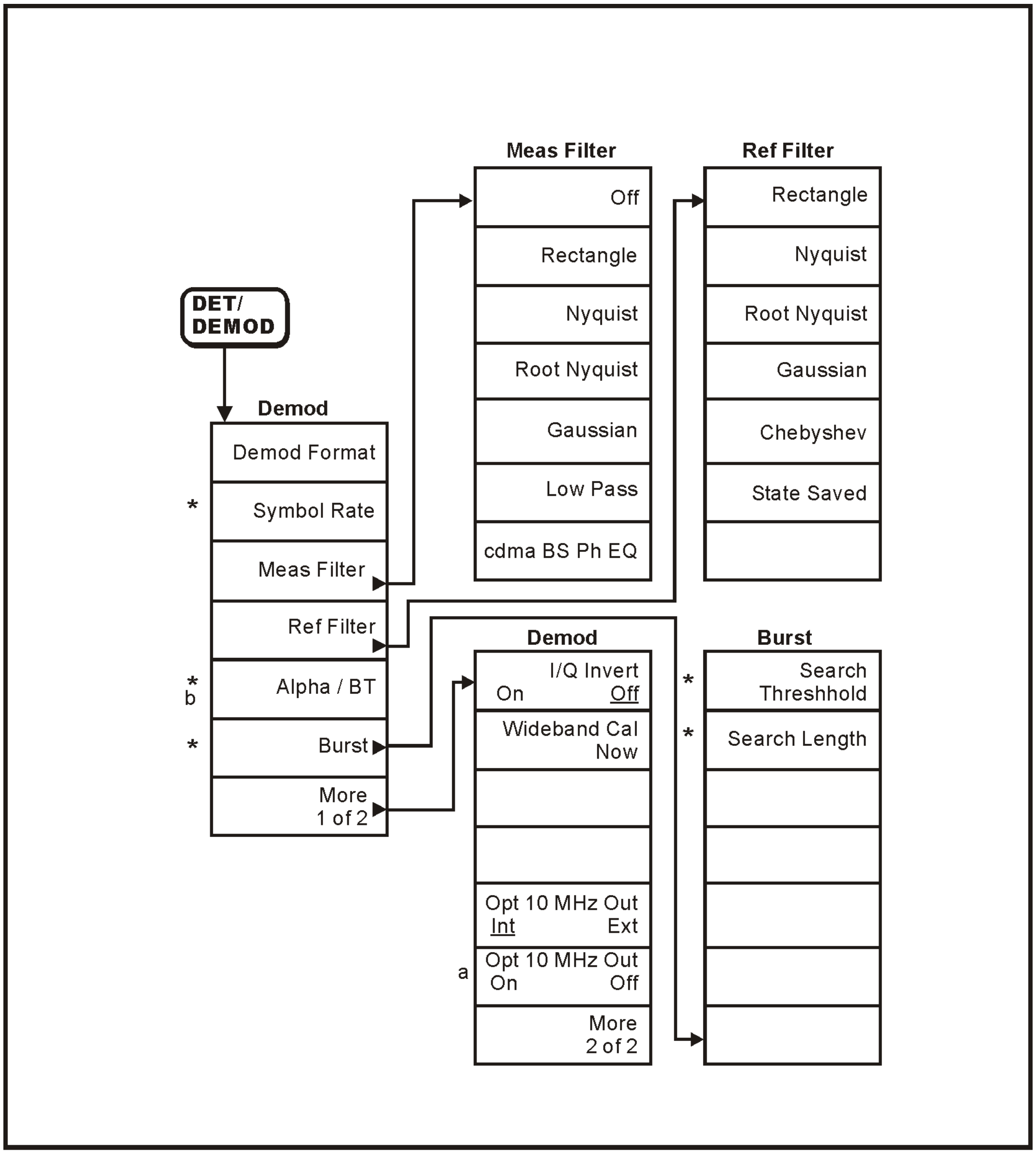


* An active function that allows data entry

a. Available only when **Monitor Spectrum** is selected under the **MEASURE** menu.

pt88a

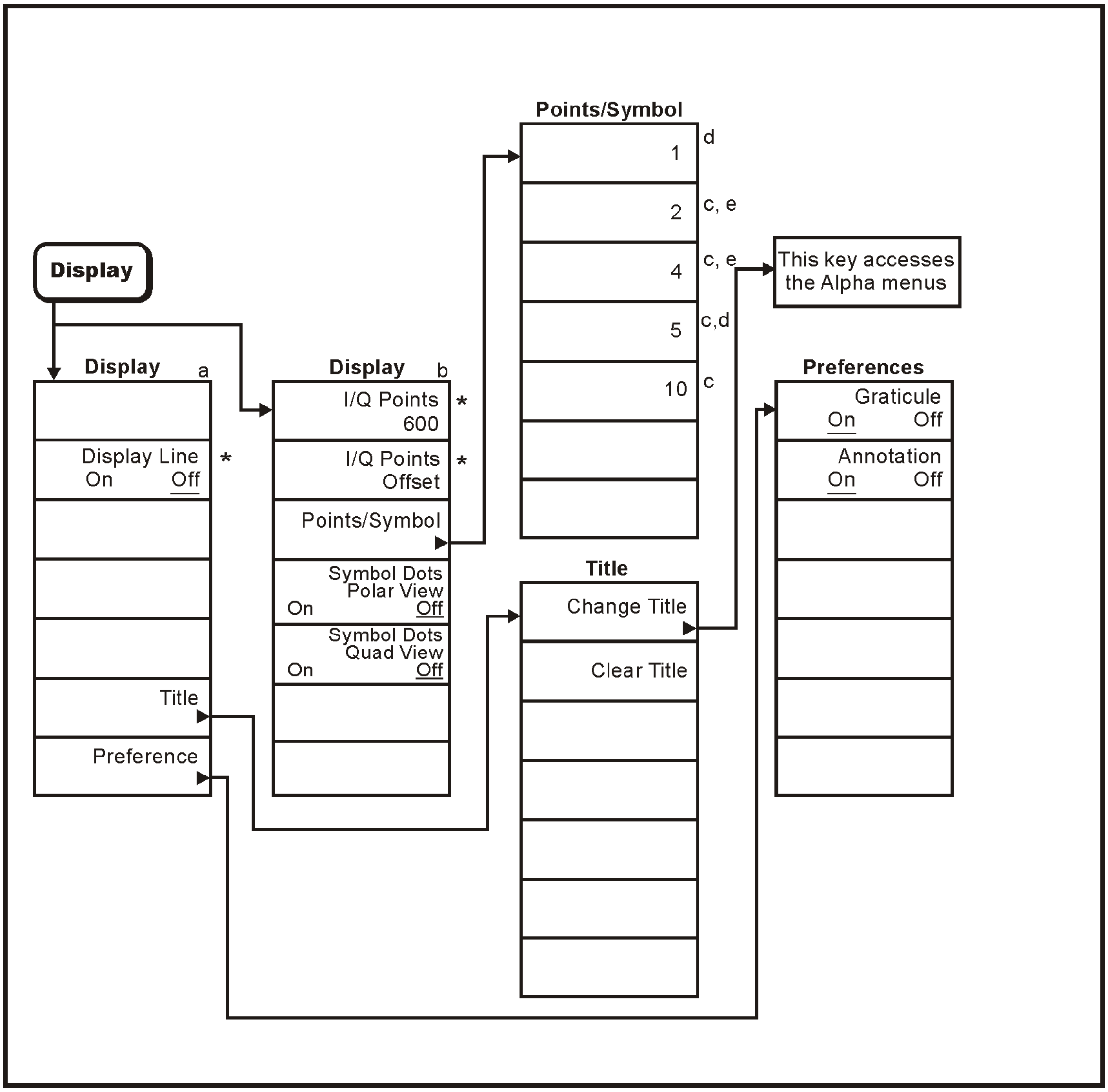
Det/Demod Menus



* An active function that allows data entry.
a. Available only when **Opt 10 MHz Out** is set to **Ext**.
b. Available only when **Ref Filter** or **Meas Filter** is set to **Gaussian**, **Nyquist**, or **Root Nyquist**.

pt84a

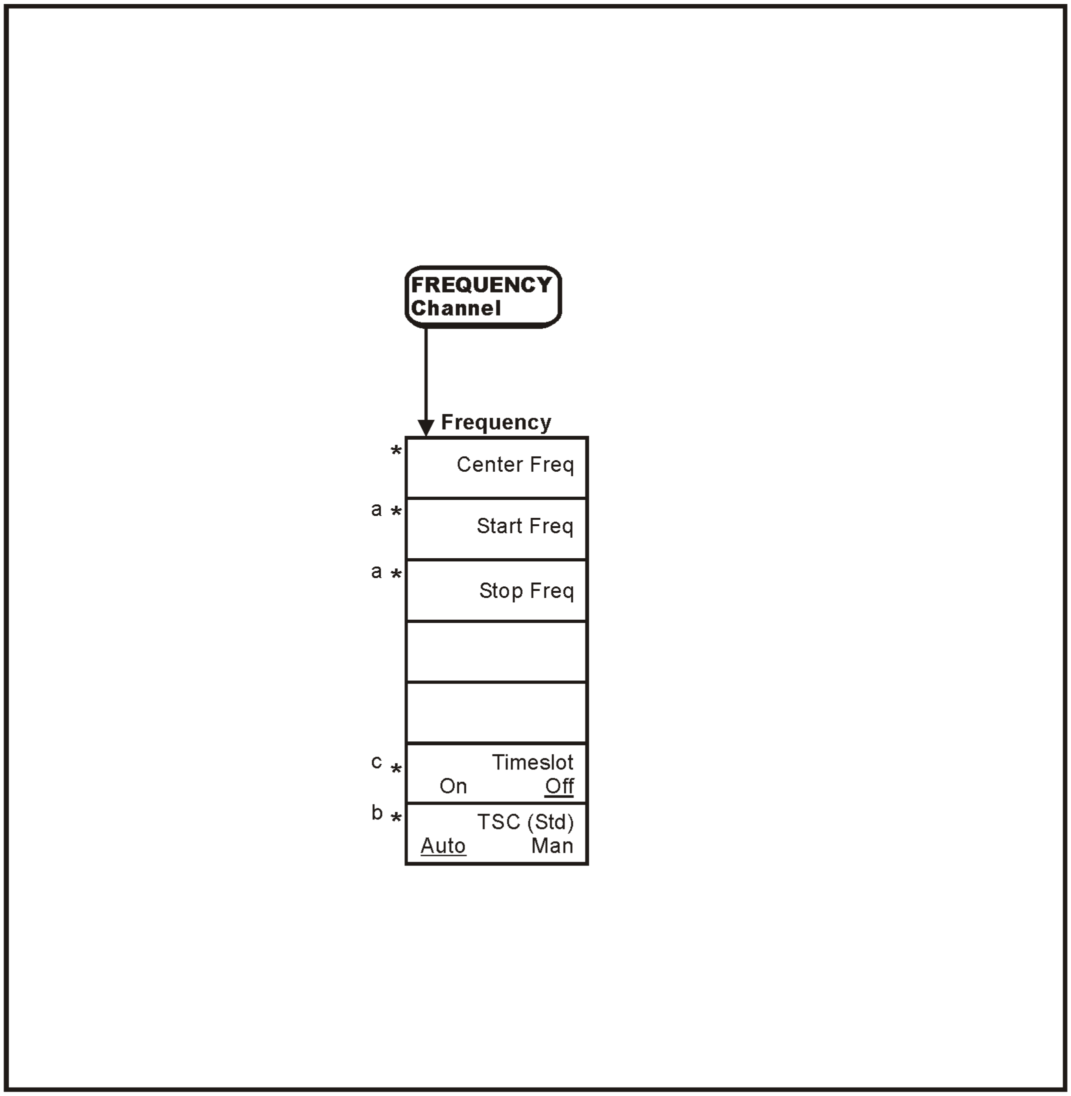
Display Menus



* An active function which allows data entry.
a. Appears only when **Monitor Spectrum** is selected in the **MEASURE** menu.
b. Appears only when **EVM** is selected in the **MEASURE** menu.
c. Unavailable and grayed out when **EDGE** (**8PSK**) is selected under the **Radio Std** menu.
d. Unavailable and grayed out when using OQPSK demode format. An example is **cdmaOne** mobile station. and **Device** is set to **MS**.
e. Unavailable and grayed out when using non-OQPSK formats.

pt89a

Frequency/Channel Menu



* An active function that allows data entry

a. Active only when **Monitor Spectrum** is selected under the **MEASURE** menu.

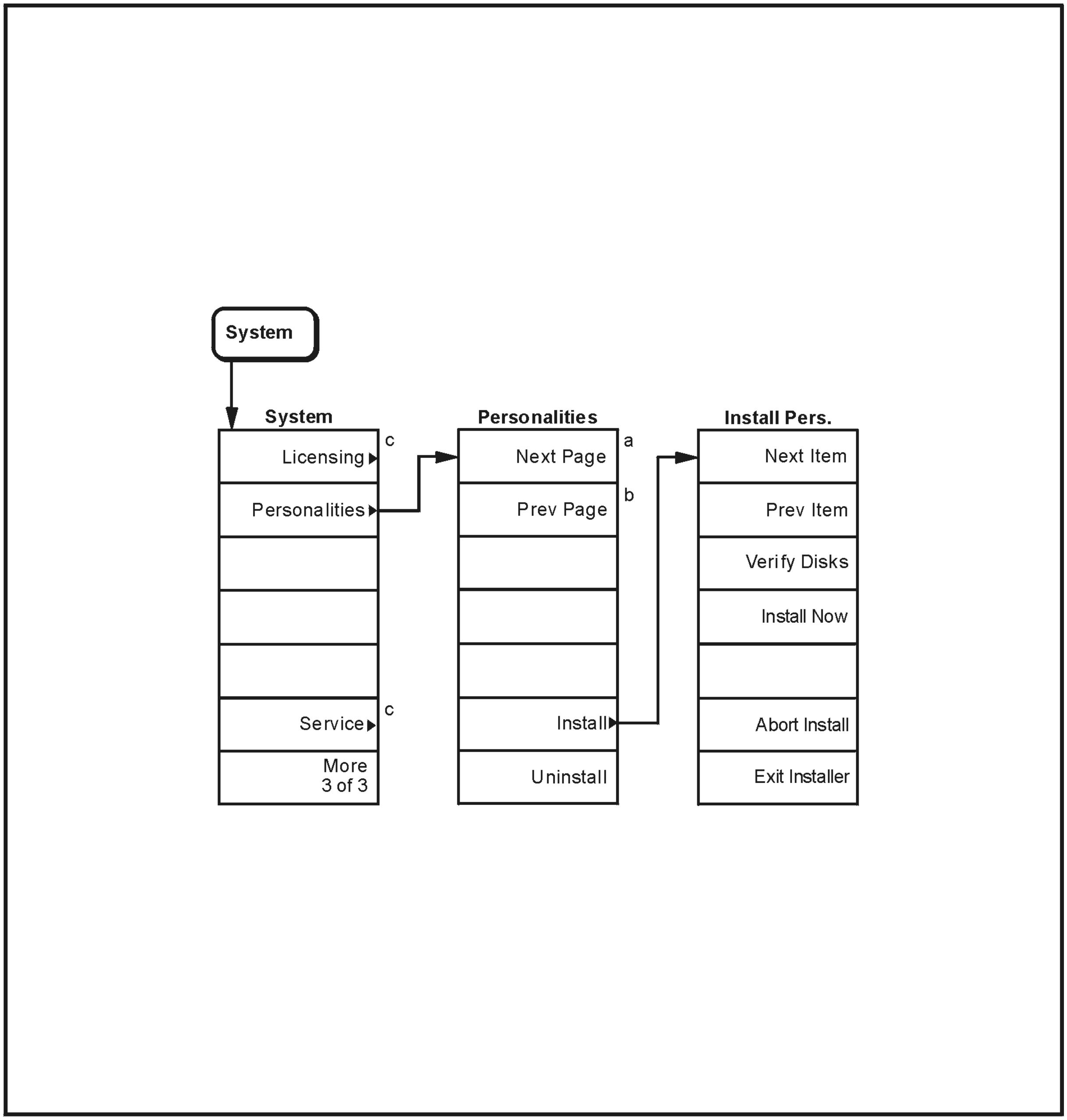
b. Active only when **EDGE (8 PSK)** is selected under the **Radio Std** menu.

c. Active only when **EDGE (8 PSK)** is selected under the **Radio Std** menu and trigger is set to external.

pt85a

Installer Menus

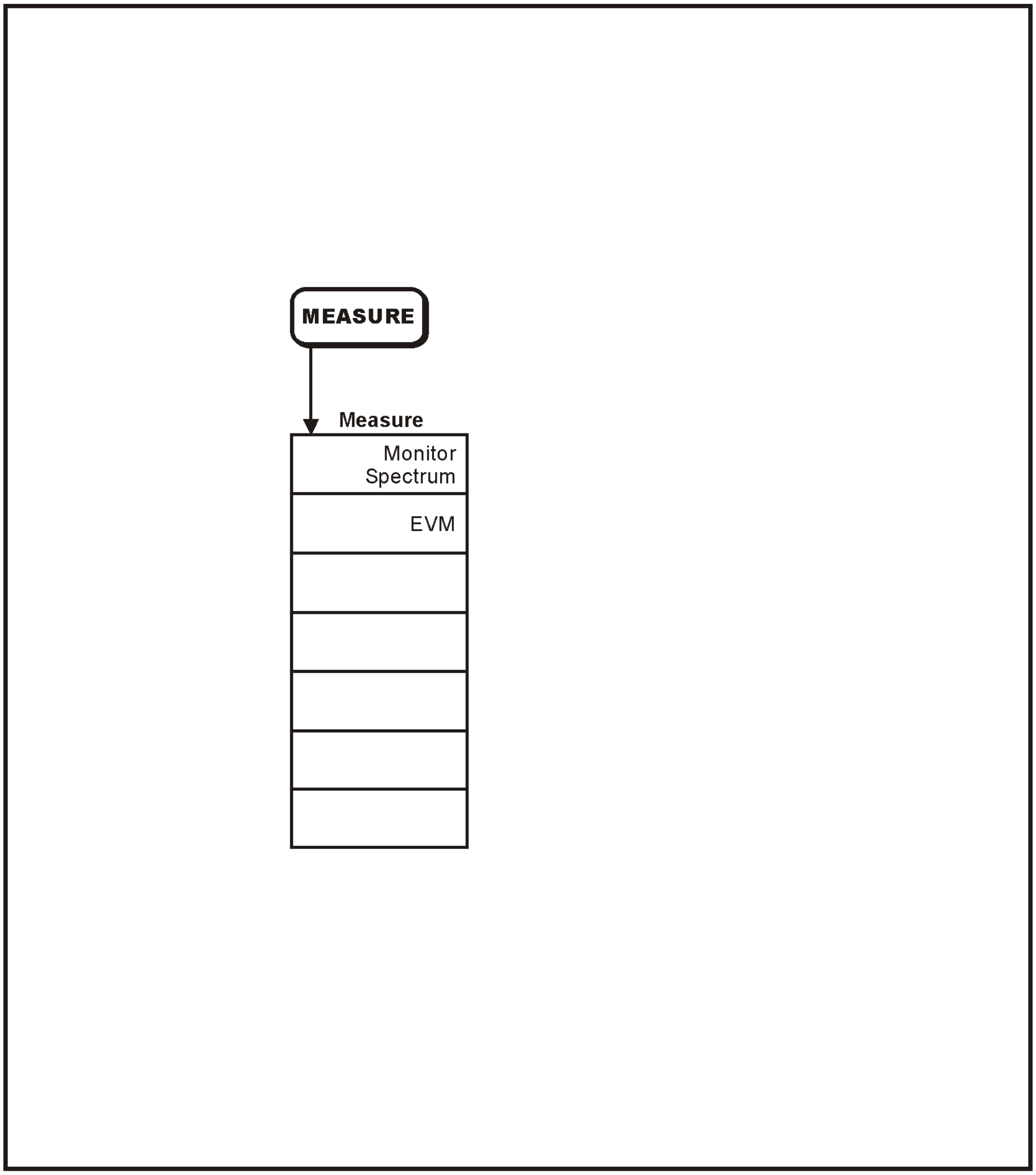
For more information on the System and Personalities menus, refer to the *ESA Spectrum Analyzers User's Guide*.



a. Grayed out when on the last page or if there is only one page
b. Grayed out when on the first page or if there is only one page
c. For information on the menu accessed by this key, refer to the ESA Spectrum Analyzers User's Guide.

pl737b

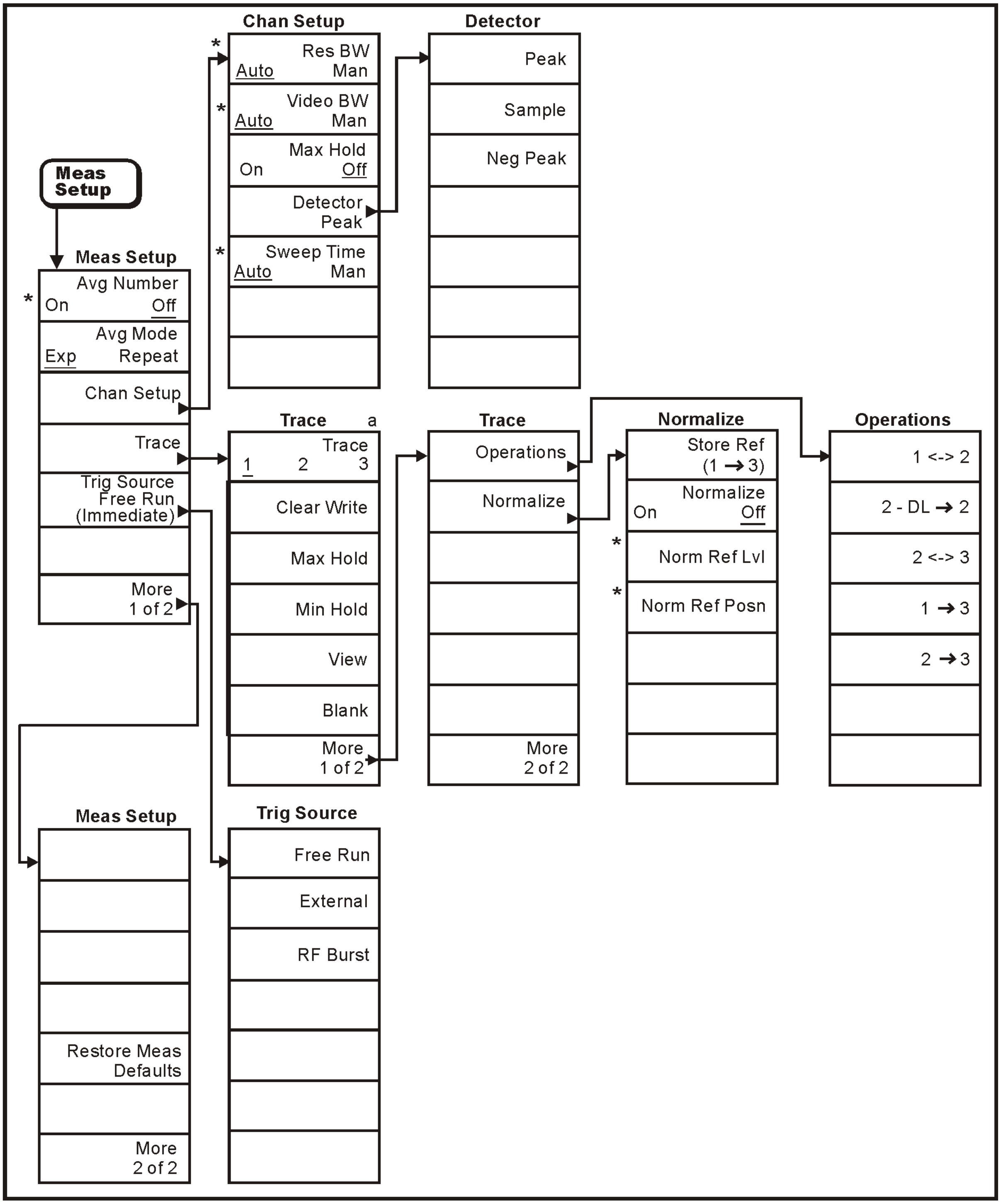
Measure Menu



pt86a

Measurement Setup Menus

Monitor Spectrum Setup Menus

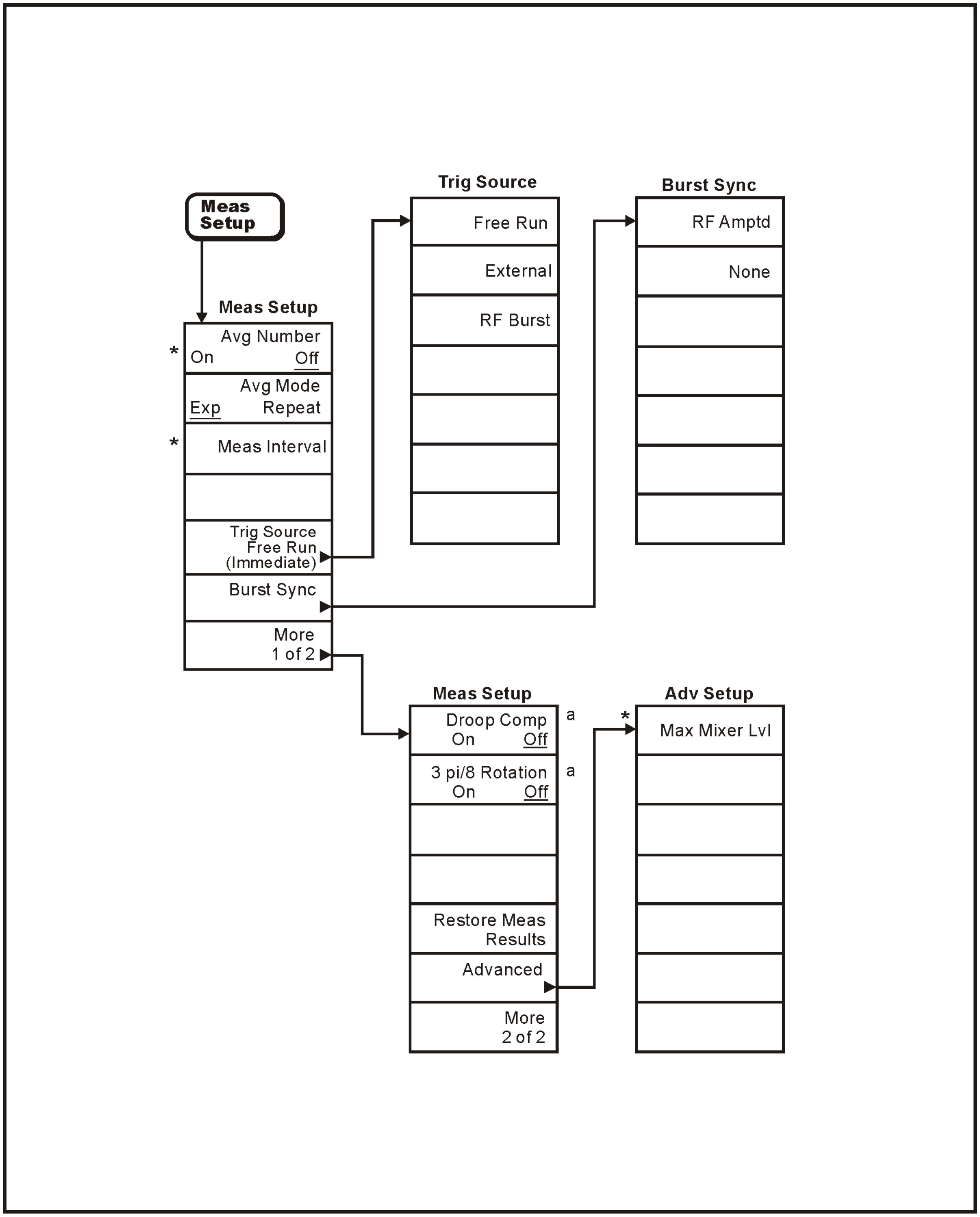


* An active function that allows data entry.

a. Appears only when **Monitor Spectrum** is selected in the **MEASURE** menu.

pt810a

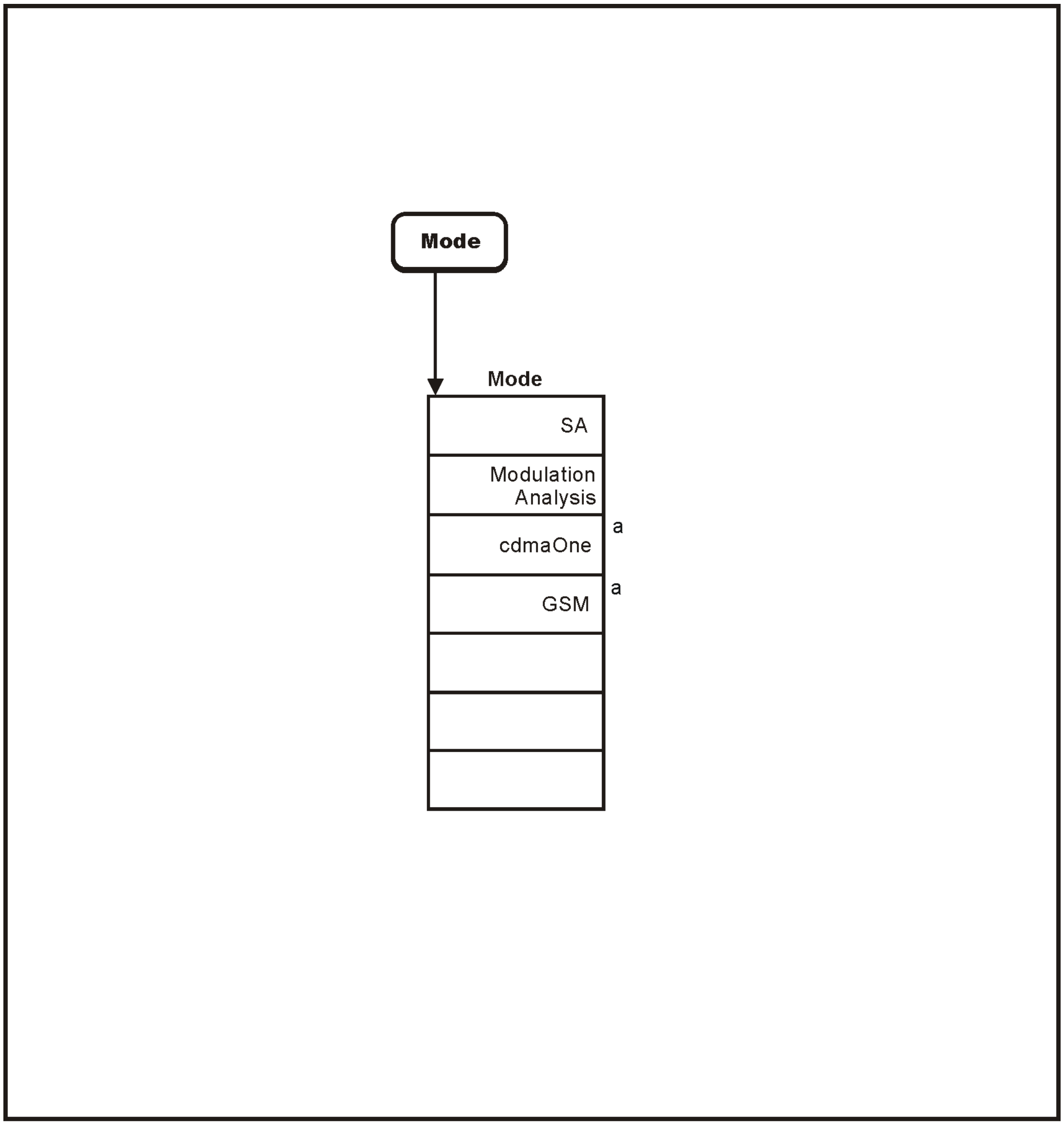
EVM Measurement Setup Menus



* An active function that allows data entry.
a. Available only when **EDGE (8 PSK)** is selected on the **Radio Std** Menu.

pt811a

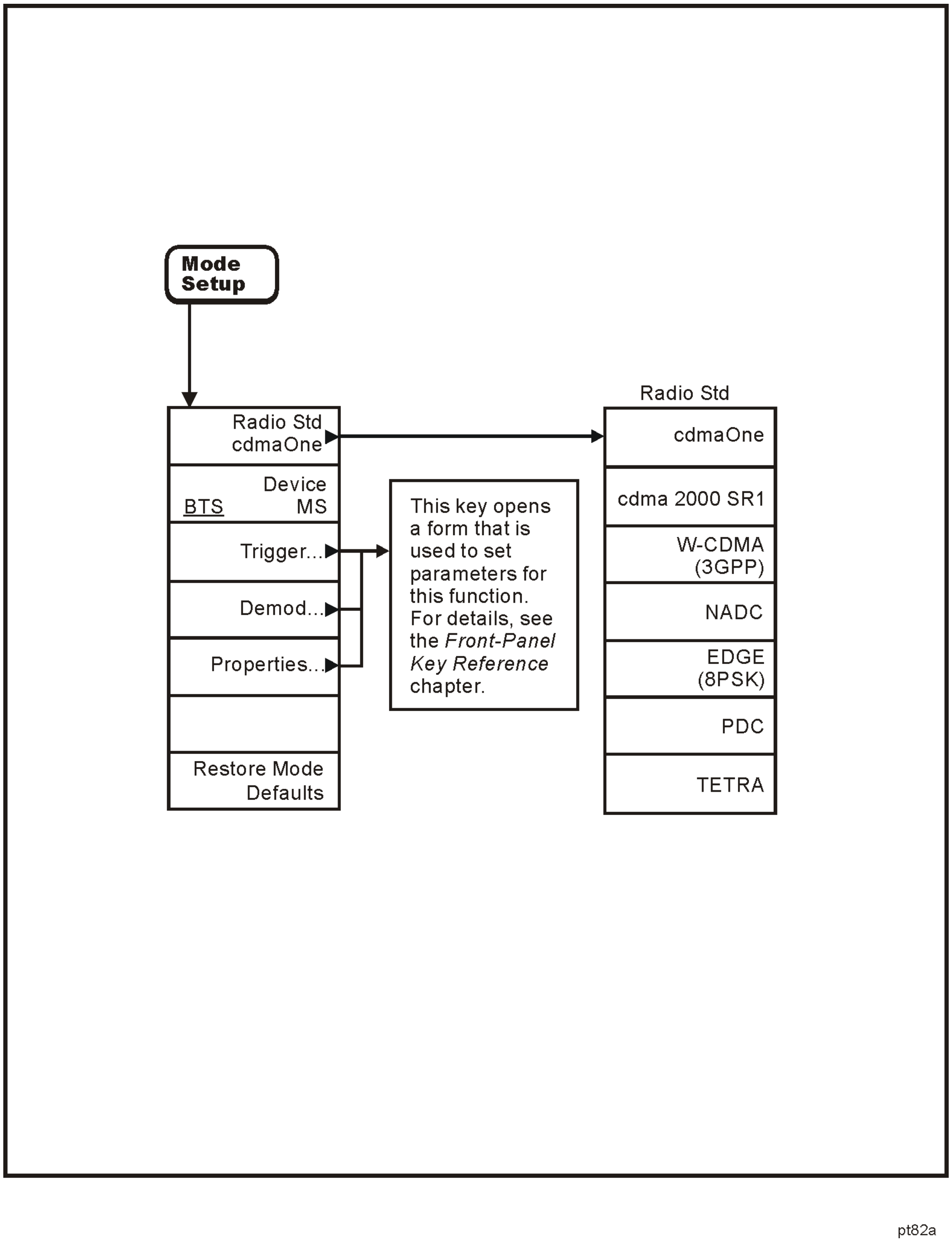
Mode Menu



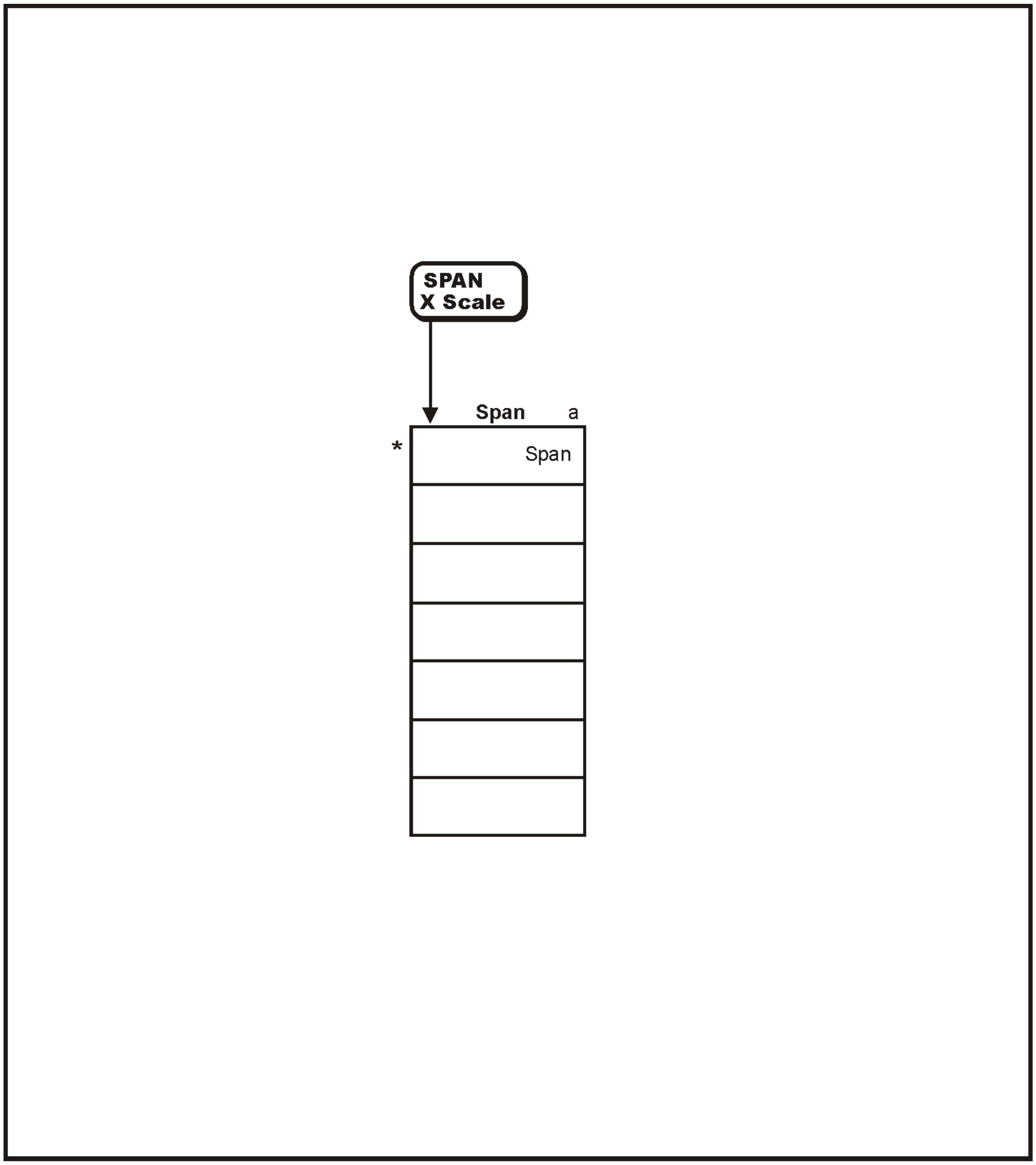
a. These menu items will appear only when the measurement personality option has been installed, and the license key has been activated. They may appear in any order.

pt81a

Mode Setup Menus



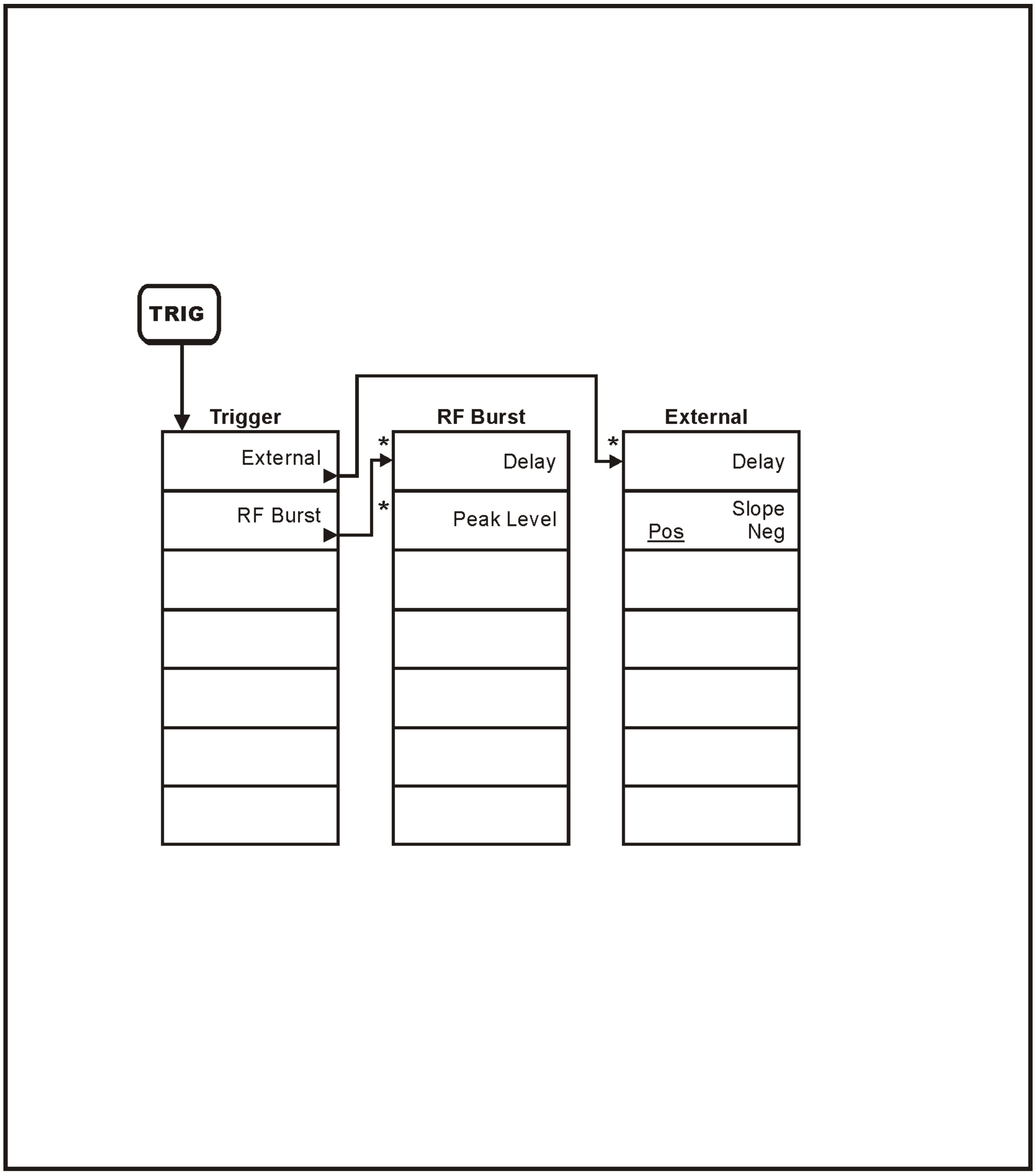
Span (X Scale) Menu



* An active function that allows data entry
a. Active only when **Monitor Spectrum** is selected under the **MEASURE** menu.

pt87a

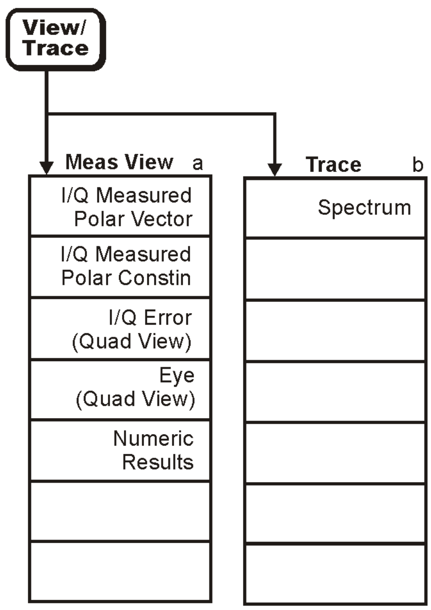
Trigger Menu



* An active function that allows data entry

pt83a

View and Trace Menus



a. Appears only when **EVM** is selected in the **MEASURE** menu.
b. Appears only when **Monitor Spectrum** is selected in the **MEASURE** menu.

pt812a

6 Front-Panel Key Reference

This chapter details the front-panel keys and menu keys that appear on the menu-maps presented in the previous chapter. The front-panel keys are listed alphabetically and are described with their associated menu keys. The menu keys are arranged as they appear in your analyzer menus.

Key Descriptions and Locations

This chapter provides information on Modulation Analysis mode functions only. Some keys are described that are either not available in Spectrum Analysis (SA) mode, or that provide functions which differ from those provided by the same keys in SA mode. Other keys are described which provide fewer functions than the same key in SA mode, but the functions that are provided are identical in both modes. For those keys not described here, refer to the *ESA Spectrum Analyzers User's Guide*.

AMPLITUDE Y Scale

Activates the reference level function, if it is available, and accesses the amplitude menu keys. Amplitude menu keys are used for setting functions that affect the way data on the vertical axis is displayed or corrected.

Ref Level

This key allows the reference level to be changed. This function is activated when **AMPLITUDE Y Scale** is pressed. The reference level is the amplitude power or voltage represented by the top graticule line on the display. Changing the value of the reference level changes the absolute amplitude level (in the selected amplitude units) of the top graticule line. The reference level can be changed using the step keys, the knob, or the numeric keypad. Pressing any digit, 0 through 9, on the numeric keypad brings up the terminator menu.

Attenuation

Sets the input attenuation in 5 dB increments. The analyzer input attenuator, which is normally coupled to the reference level control, reduces the power level of the analyzer input signal at the input mixer. Attenuation can be changed using the step keys, the knob, or the numeric keypad.

NOTE

Step keys and knob can not be used to set Atten = 0. To set the attenuator to 0 dB you must use the keypad.

CAUTION

To prevent damage to the input mixer, do not exceed a power level of +30 dBm at the input. To prevent signal compression, keep the power at the input mixer below 0 dBm. With the attenuator set to Auto, a signal at or below the reference level will result in a mixer level at or below –10 dBm.

Scale/Div

Sets the units per vertical graticule division on the display. Scale/Div values may range from 0.1 to 20 dB per division when working on a Monitor Spectrum measurement.

When working in I/Q Error (Quad View), the screen is divided into four quadrants, three of which show a measurement trace. The units of measurement vary from trace to trace, and so consequently do the units per division on the graticule, or the Scale/Div.

Mag Error Y scale on the graticule is measured in % per division.

Phase Error Y scale on the graticule is measured in degrees per division.

EVM Y scale on the graticule is measured in % per division.

Ref Value

When working in I/Q Error (Quad View), the screen is divided into four quadrants, three of which show a measurement trace. The reference position on each trace is indicated by a small chevron at either side of the graticule. The Ref Value softkey allows you to specify the value of this reference position in units of measurement which vary from trace to trace. This softkey is only available in I/Q Error (Quad View).

Mag Error Y scale unit of measurement is %.

Phase Error Y scale unit of measurement is degrees.

EVM Y scale unit of measurement is %.

Ref Position When working in I/Q Error (Quad View), the screen is divided into four quadrants, three of which show a measurement trace. The reference position on each trace is indicated by a small chevron at either side of the graticule. The Ref Position softkey allows you to vary the position of the reference trace between top, center and bottom of the graticule. This softkey is only available in I/Q Error (Quad View).

Det/Demod

This front panel key accesses the Demod set of menu keys controlling parameters for demodulation functions. These parameters can be accessed and set using the Mode Setup, Demod… data form and menus. To use the data form, refer to Demod... on page 91.

Demod Format Accesses the demodulation format menu keys allowing you to specify the demodulation format to use.

QPSK	Sets the demodulation format to Quadrature Phase Shift Keying
Pi/4 DQPSK	Sets the demodulation format to $\pi/4$ Differential Quadrature Phase Shift Keying
OFFSET QPSK	Sets the demodulation format to Offset Quadrature Phase Shift Keying

Symbol Rate Allows you to use the numeric keypad to input the symbol rate to be used with the measurement.

NOTE The symbol rate should be set equal to the chip rate for CDMA formats.

Meas Filter Accesses the Measurement Filter menu, allowing you to either switch the measurement filter off or to specify one of six different filters.

Off	Switches measurement filtering off
Root Nyquist	Selects Root Nyquist filtering
Nyquist	Selects Nyquist filtering
Gaussian	Selects Gaussian filtering
cdma BS Ph EQ	Selects cdma Base Station Phase Equalization filtering
Rectangle	Selects Rectangular filtering
Low Pass	Selects Low Pass filtering

Ref Filter Accesses the Reference Filter menu, allowing you to specify one of five different filters.

Root Nyquist	Selects Root Nyquist filtering
Nyquist	Selects Nyquist filtering
Gaussian	Selects Gaussian filtering
Chebyshev	Selects cdma Base Station Phase Equalization filtering
Rectangle	Selects Rectangular filtering

Alpha / BT Allows you to use the numeric keypad to determine the filter shape of the Nyquist and Gaussian filters. Alpha, sometimes called 'excess bandwidth factor', applies only to Nyquist filters and BT ('Bandwidth Time' product) applies only to Gaussian filters. This key is grayed out for all filters that are neither Nyquist nor Gaussian.

Burst Accesses the Burst menu, allowing you to set the search threshold level and the search length

Search Threshold Allows you to set the burst power threshold relative to the signal's peak power. This is used by the alignment algorithm when **Burst Sync = RF Amptd**. All settings are in negative dB which can be entered in either of two ways. To enter a value of -10 dB, for example, either select **Det/Demod**, **Burst**, **Search Threshold**, **-10**, **dB** or select **Det/Demod**, **Burst**, **Search Threshold**, **10**, **-dB**

Search Length Allows you to specify the length of time over which the burst search is performed

IQ Invert This inverts the quadrature-phase component of the signal.

Wideband Cal This allows you to effectively perform a factory calibration on the instrument prior to doing an EVM measurement. As the instrument is calibrated before leaving the factory, it should only need to be done after new firmware has been installed.

To perform the calibration, first select **Wideband Cal**. The instrument will display a diagram showing the cable connection you have to make. Once you have connected a cable from the **Cal Output** to the **Input 50**Ω (as shown in the screen diagram), select Continue. The instrument calibration is complete once the instrument returns to previous measurement screen.

NOTE If an alignment is required, pressing Continue will cause the alignment to be performed before the Wideband Calibration.

NOTE Don't forget to remove the cable from the **Cal Output** connection and reconnect your DUT upon completion of the Wideband Cal procedure.

Opt Freq Ref This allows you to select and set the reference oscillator for your EVM measurements. **Int** selects the internal reference oscillator and **Ext** selects the external reference oscillator. The frequency of the external oscillator can be set at any time, regardless of whether you have selected the internal or the external oscillator. However, it only has an effect when you set the instrument to use the external oscillator.

Int Selects the internal reference oscillator

Ext Selects an external reference oscillator

NOTE The instrument will only synchronize to the external reference signal if there is a loop connection between 10 MHz OUT connection and the 10 MHz REF IN connection on the rear of the machine.

Opt 10MHz Out Allows you to set the 10 MHz Ref Out jack to On or Off. This is automatically set to Off when the Opt Freq Ref is set to Int.

On Enables the 10 MHz Ref Out jack

Off Disables the 10 MHz Ref Out jack

Display

This front panel key accesses the menu key that allows you to see and setup different measurement displays. For Modulation Analysis, it is used for the Error Vector Magnitude (EVM) measurement.

I/Q Points

Allows you to specify the total number of I/Q points displayed, after each measurement interval, in the Measured IQ Polar Vector diagram and in the I and Q eye diagrams.

I/Q Points Offset

This allows you to specify an offset from the first IQ point in the constellation diagram. If you have opted to display only a subset of the *I/Q Points*, this subset of displayed points is offset from the first IQ point by this *I/Q Points Offset* number of points.

NOTE

When you make a single measurement (press the **Single** key on the front panel), the data for that single measurement is held within instrument memory. If you then set the I/Q Points Offset to 0, you can see how the measurement is built up by slowly increasing the I/Q Points figure from zero using the RPG knob.

Similarly you can set the I/Q Points figure to a low number (say, 5 or 10) and vary the I/Q Points Offset figure using the RPG knob. Now you will see a ‘snake’ marking out the signal’s trace on the display.

Points/Symbol

This softkey determines the number of points displayed between symbols for demodulated data. Selecting Points/Symbol brings up a sub-menu giving you options of 1, 2, 4, 5 and 10 points per symbol.

For example, if the value of *points/symbol* is 1, each display point corresponds to a symbol. If the value is 5, every 5th display point corresponds to a symbol - in this case, a vector diagram would show 4 display points between each symbol.

NOTE

Invalid option keys are grayed out. Valid options vary between demod formats.

Symbol Dots Polar Vector

Allows you to highlight the positions of the symbols on the polar vector trace by switching the display of symbol points on or off

Symbol Dots Quad View

Allows you to highlight the positions of the symbols on the graphical views by turning the display of the symbols on or off.

FREQUENCY / Channel

Accesses the menu of frequency functions.

NOTE When changing both the center frequency and the span, change the frequency first since the span can be limited by the frequency value.

Center Freq Allows you to specify the frequency in the center of the display. This should be set to the modulated signal's carrier frequency before trying to make an EVM demodulation measurement.

Start Freq Sets the frequency at the left side of the graticule. The left and right sides of the graticule correspond to the start and stop frequencies.

NOTE This option is only valid in the Monitor Spectrum measurement. It is grayed out at all other times

Stop Freq Sets the frequency at the right side of the graticule. The left and right sides of the graticule correspond to the start and stop frequencies.

NOTE This option is only valid in the Monitor Spectrum measurement. It is grayed out at all other times

Timeslot Sets the EDGE timeslot function on or off, and allows you to enter a value for the Timeslot. This option is only valid when performing measurements on EDGE signals and then only when using an external trigger source. It is grayed out at all other times.

On Allows you to select a specific timeslot over which to make demodulation measurements.

Off The demodulation measurement is made over the entire frame.

NOTE The frame reference burst will be unpredictable if more than one timeslot has the same TSC code.

TSC (Std) Used to select the EDGE Training Sequence Code to for which to search and demodulate.

Auto The first burst found to have a valid Training Sequence Code (in the range 0 - 7) will be demodulated.

Man The first burst found to have the specified Training Sequence Code (in the range 0 - 7) will be demodulated.

Meas Setup

Displays a menu that allows you to enter custom setup parameters for a measurement. The setup menu displayed depends on whether the Monitor Spectrum or the EVM measurement was selected in the **MEASURE** menu.

Avg Number Allows you to specify the number of measurements that will be averaged. After the specified number of average counts, the **Avg Mode** setting determines the averaging action. You can also set the averaging function to **On** or **Off**.

On Enables the measurement averaging.

Off Disables the measurement averaging.

NOTE Trace values are averaged in Monitor Spectrum measurement only. The Monitor Spectrum measurement results are taken from the averaged trace values.

Avg Mode Allows you to select the type of termination control used for the averaging function. This determines the averaging action after the specified number of measurements (average count) is reached.

Exp After the average count is reached, each successive data acquisition is exponentially weighted and combined with the existing average.

Repeat After the average count is reached, the averaging is reset and a new average is started.

Chan Setup Provides the menu keys that allow you to set up the measurement of your channel.

Res BW Manually specify the resolution bandwidth of your current measurement, or leave the instrument to set it automatically.

Video BW Manually specify the video bandwidth used on your current measurement, or leave the instrument to set it automatically.

Max Hold With Max Hold set to On, the maximum level reached during any previous sweep is retained and displayed as a separate trace.

Detector Specifies whether **Peak**, **Sample** or **Negative Peak** detection is used on the measurement. Measurements are made by sampling at regularly spaced discrete points in the frequency domain, and these are the measurements returned with **Sample** detection. **Peak** detection returns the highest peak measurement between sample points and returns this value, and **Negative Peak** detection returns the minimum value measured between sample points.

Sweep Time Manually specify the time taken for each sweep of the spectrum, or leave the instrument to set it automatically. A balance has to be struck between speed and accuracy as faster sweeps can cause measurement inaccuracy.

Trace Provides the menu keys to specify the characteristics of the instrument's screen trace.

Trace Allows you to select one of a maximum of three different traces to display

Clear Write As the display point sweeps across the graticule, the previous sweep's display is cleared.

Max Hold The maximum level reached during any previous sweep is retained and displayed.

Min Hold The minimum level reached during any previous sweep is retained and displayed.

View Freezes the display at this point to enable easier viewing of the trace.

Blank Erases the currently selected trace.

Operations Accesses the following **Operations** menu keys:

1↔2 Exchanges the contents of the trace 1 register with the trace 2 register and puts trace 1 and 2 in view mode.

2 – DL → 2 Subtracts the display line from trace 2 and places the result in trace 2. Trace 2 is then put in view mode. The **2 – DL → 2** function is a math operation.

2 ↔ 3 Exchanges the contents of trace 2 with trace 3 and puts trace 2 and 3 in view mode.

1 → 3 Copies trace 1 into trace 3 and puts trace 3 in view mode.

2 → 3 Copies trace 2 into trace 3 and puts trace 3 in view mode.

Normalize Accesses the following **Normalize** menu keys:

Store Ref Copies the Trace 1 register into the Trace 3 register. Trace 3 is then displayed in a different color, and is used as the reference trace to which other signals are compared.

Normalize	Switches **Normalization** on or off. When **Normalization** is On, the measured signal is displayed in dB relative to the stored reference trace. When **Normalization** is Off, the measured signal is displayed in absolute dB.
Norm Ref Lvl	Allows you to specify the reference level in dB.
Norm Ref Posn	Allows you to specify the position of the reference trace on the display's graticule. Position 10 refers to the top (10th) graticule line and Position 0 refers to the bottom base line of the graticule.

Meas Interval This allows you to set the number of symbols that are used in calculating the measurement. This key is linked to the **I/Q Points** key and the **Points/Symbol** key in the Display menu.

Trig Source Provides the menu keys that allow you to select the source for the demodulation synchronization trigger.

Free Run	The next measurement is taken immediately, capturing the signal asynchronously (also called 'immediate').
External	Sets the trigger directly to an external signal connected to the rear-panel EXT TRIG IN connector. No measurement will be made unless a signal is connected to the EXT TRIG IN connector on the rear panel.
RF Burst	Sets the measurement trigger to the leading edge of an RF Burst signal. No measurement will be made unless a bursted signal is being measured.

Burst Sync This specifies how the measurement will synchronize with the correct part of the burst.

RF Amptd	Synchronization, and hence demodulation, starts at the beginning of the first valid burst detected. This is only applicable to bursted radio signals such as NADC, PDC and TETRA.
None	No synchronization occurs. Demodulation starts from the beginning of the sample record.

Droop Comp Allows you to set Droop Compensation on or off. This setting is only used with EDGE (8PSK) signals. The softkey is grayed out for non-EDGE signals.

On	Sets Droop Compensation On.
Off	Sets Droop Compensation Off

3Pi/8 Rotation Allows you to specify whether or not rotation is applied to the IQ constellation diagram. This softkey is only valid for the EDGE (8PSK) modulation format.

On Applies rotation to the constellation diagram, thus displaying 16 symbol points

Off Does not apply rotation to the constellation diagram, thus displaying only 8 symbol points

Restore Meas Defaults Sets up the instrument parameters for the measurement using the factory default instrument settings. (This only affects measurement parameters for this measurement and does not affect any mode parameters.) If you have made any manual changes to the measurement parameters, restoring the measurement defaults will ensure valid measurements.

Advanced Accesses advanced function menus allowing you to adjust Max Mixer Lvl for Error Vector Magnitude measurement.

Max Mixer Lvl Allows you to set the maximum power level at the input of the mixer for the measurement. The instrument uses this value to automatically set the required input attenuation to maintain the mixer input power below this level.

MEASURE

Accesses menu keys that allow you to make Monitor Spectrum and EVM measurements.

Monitor Spectrum

Display the frequency-domain spectrum of the transmit or receive channel for the selected device (mobile or base station). The channel presets are standard specific.

EVM

Error Vector Magnitude (EVM) displays the I/Q Measured Polar Vector trace of your current signal, and also displays numeric results for the following measurements:

EVM (rms)	Maximum and average RMS Error Vector Magnitude measured in percent.
EVM (peak)	Maximum and average peak EVM measured in percent.
Mag Error (rms)	Maximum and average RMS Magnitude Error measured in percent.
Mag Error (peak)	Maximum and average peak Magnitude Error measured in percent. You must press the Zoom key on the front panel to see this measurement.
Phase Error (rms)	Maximum and average RMS Phase Error measured in degrees.
Phase Error (peak)	Maximum and average peak Phase Error measured in degrees. You must press the Zoom key on the front panel to see this measurement.
Freq Error	Maximum and average frequency error measured in Hz.
I/Q Offset	Maximum and average I/Q Offset measured in dBc.
Droop Error (per symbol)	Maximum and average amplitude Droop Error measured in dB.

MODE

Accesses menu keys allowing you to select the measurement mode of your analyzer. The basic spectrum analyzer comes with only the SA mode installed. Additional measurement personality software must be installed and activated in the instrument for other mode soft keys to be labeled and functional.

SA Accesses the spectrum analyzer menu keys and associated functions.

Modulation Analysis Accesses the Modulation Analysis measurement personality menu keys and associated functions. This allows you to setup and make valid Modulation Analysis measurements.

NOTE This menu will have additional entries if other personalities have been installed, for example GSM Option BAH or cdmaOne Option BAC.

Mode Setup

Accesses menu keys that allow you to set various parameters for the selected operational mode. Mode settings are persistent, and they will remain as set if you leave and return to the Modulation Analysis mode you previously set up.

To access the following keys for setting up the measurement mode, press **Mode**, select **Modulation Analysis**, and then the front panel **Mode Setup** key.

The submenu displayed allows you to set **Radio Std**, **Device**, **Trigger**, and **Demod** parameters, to view your analyzer's software **Properties** and to **Restore Mode Setup Defaults**.

Radio Std Provides the menu keys that allow you to select the standard used as a basis for the digital wireless communications EVM measurements. For more information on the standards, refer to the relevant standards publications.

cdmaOne cdmaOne radio standard.

cdma2000 cdma2000 radio standard.

W-CDMA Wideband cdma radio standard.

NADC North American Digital Cellular radio standard.

EDGE (8PSK) Enhance Data Rate for GSM Evolution with 8 Phase Shift Keying modulation radio standard

PDC Personal Digital Cellular radio standard.

TETRA Terrestrial Trunked Radio standard.

Device Accesses menu keys allowing you to set the **Device** or system type to be tested, **Base** or **Mobile**.

Base Sets the instrument to measure base transceiver station equipment.

Mobile Sets the instrument to measure mobile equipment.

Trigger... Provides menu keys to set both external and RF Burst trigger parameters.

External Allows you to set the parameters for use with the rear panel external trigger. You can set the time delay and whether the trigger occurs on a positive or negative edge. Peak Level is fixed at TTL level.

RF Burst Allows you to set the parameters associated with an RF Burst trigger. You can set the time delay and the peak level in dB. The trigger slope is fixed as positive.

Demod... Provides access to the Demod data form screen which allows control of all demodulation function parameters. Use the Tab buttons to move to the next or previous parameter. See “Det/Demod” on page 79 for a description of the demodulation functions and their parameters

Properties... This displays the version number and revision number of the modulation analysis measurement software running on your instrument. You would normally only need to access this screen when contacting Agilent Customer Support.

Restore Mode Setup Defaults Sets up the instrument parameters for the mode using the factory default mode settings.

Preset

Provides a convenient starting point for making most measurements.

Depends on the preset (user vs. factory) setting in the System keys. If the preset type is set to **Factory**, pressing **Preset** results in an immediate instrument preset to the factory defaults. If it is set to **User**, pressing **Preset** accesses a menu that allows you choose your preset settings from either the factory default values or the settings you have previously defined as the **User** preset state.

User Preset

Restores the analyzer to a user defined state. The state was defined from the System menu when the Power On/Preset function was selected and Save User Preset was pressed. If the you did not save a user state, then the current power-up state is stored as the user preset file for use when Preset is pressed.

Factory Preset

A full factory preset is executed so the instrument is returned to the factory default state. The preset type can be set to **Factory** from the **Power On/Preset** function in the System menu.

SPAN / X Scale

Span

Allows you to change the frequency range symmetrically about the center frequency. The frequency-span readout describes the total displayed frequency range. To determine frequency span per horizontal graticule division, divide the frequency span by 10. Setting the span to 0 Hz puts the analyzer into zero span and changes the horizontal axis from frequency to time.

Trig

Accesses the RF Burst and external menu keys allowing you to set various parameters. These parameters can be accessed and set using the Mode Setup, Trigger data form and menus, refer to Trigger... on page 90.

Accesses the External and RF Burst menu keys allowing you to set various parameters. For the external configuration you can set **External Delay**, and **External Slope**. For the RF Burst configuration you can set **RF Burst Delay** and **RF Peak Level**.

External	**Delay**	Allows you to set the trigger delay when using the rear panel external trigger source.
	Slope	Allows you to set the triggering to occur on a positive-going edge or a negative-going edge of the trigger when using the rear panel external trigger source.
RF Burst	**Delay**	Allows you to set the trigger delay when using the RF burst trigger source.
	Peak Level	Allows you to set the trigger level when using the RF burst trigger source.

NOTE Option B7E: RF Comms Hardware has two possible part numbers. Press **System, More, Show Hdwr** to show your instrument’s RF Comms Hardware and to find out the part number. If the part number is E440160087, it is important to set the RF Burst Peak Level to an appropriate level that will avoid the AM transitions which can occur during the active part of the burst, and which can lead to mis-triggering of the measurement.

To set the RF Burst Peak level, press **Trigger**, **RF Burst**, **Peak Level** and enter the peak level in dB.

View/Trace

Accesses the view menu keys that allow you to set the way measurement result information is displayed. The menu options will vary depending on the measurement that is selected under the **Measure** menu.

Monitor Spectrum

No further options are available when using the Monitor Spectrum measurement

Error Vector Magnitude (EVM)

I/Q Measured Polar Vector Sets the view to display an I/Q polar vector diagram and numeric results.

I/Q Measured Polar Constln Sets the view to display an I/Q constellation diagram and numeric results.

I/Q Error (Quad View) Divides the screen into four quadrants displaying Magnitude Error, Phase Error, Error Vector Magnitude (EVM) and the numeric results.

Eye (Quad View) Divides the screen into four quadrants displaying the Eye I trace, the Eye Q trace, the I/Q Measured Polar Vector trace, and the numeric results.

Numeric Results Sets the view to display only the numeric results.

7 Programming Language Reference

These commands are only available when the Modulation Analysis mode has been selected using INSTrument:SELect. If this mode is selected, commands unique to another mode are not available.

ABORt Subsystem

:ABORt

Stops any sweep or measurement in progress and resets the sweep or trigger system. A measurement refers to any of the measurements found in the **MEASURE** menu.

If **:INITiate:CONTinuous** is off (single measure), then **:INITiate:IMMediate** will start a new single measurement.

If :**INITiate:CONTinuous** is on (continuous measure), a new continuous measurement begins immediately.

The INITiate and/or TRIGger subsystems contain additional related commands.

Front Panel Access: For the continuous measurement mode, the **Restart** key is equivalent to **ABORt**.

CALibrate Subsystem

These commands control the self-alignment and self-diagnostic processes.

Radio Standard Calibration - Abort

:CALibration:WIDeband:ABORt

Abort the instrument calibration.

Front Panel Access: **Det/Demod, More, Wideband Cal**

Radio Standard Calibration - Continue

:CALibration:WIDeband:CONTinue

Perform the instrument calibration. This command can only be used after issuing the :CALibration:WIDeband[:NOW] command (below).

Front Panel Access: **Det/Demod, More, Wideband Cal**

Radio Standard Calibration - Start

:CALibration:WIDeband:[:NOW]

Start instrument calibration. The CALibration:WIDeband:CONTinue command is required to complete the calibration.

Front Panel Access: **Det/Demod, More**

CONFigure Subsystem

The CONFigure commands are used with several other commands to control the measurement process. These commands are described in the section on the “MEASure Group of Commands” on page 113.

Each measurement sets the instrument state that is appropriate for that measurement. Other commands are available for each **Mode** to allow changing settings, view, limits, etc. Refer to:

SENSe:CHANnel, SENSe:EVM, SENSe:FREQuency,
SENSe:MONitor, SENSe:OPTion, SENSe:RADio, SENSe:SYNC
DISPlay:<measurement>,
TRIGger

Configure the Selected Measurement

:CONFigure:<measurement>

A CONFigure command must specify the desired measurement. It will set the instrument settings for that measurement’s standard defaults, but will not initiate the taking of data. The available measurements are described in the MEASure subsystem.

DISPlay Subsystem

The DISPlay subsystem controls the selection and presentation of textual, graphical, and trace information. Within a display, information may be separated into individual windows.

Display Viewing Angle

:DISPlay:ANGLe <integer>

:DISPlay:ANGLe?

Changes the viewing angle for better viewing in different environments.

Factory Preset and *RST:	The factory default is 4. This parameter is persistent, which means that it retains the setting previously selected, even through a power cycle.
Range:	Integer, 1 to 7
Front Panel Access:	**Viewing angle keys**

Date and Time Display Format

:DISPlay:ANNotation:CLOCk:DATE:FORMat MDY|DMY

:DISPlay:ANNotation:CLOCk:DATE:FORMat?

Allows you to set the format for displaying the real-time clock. To set the date time use: SYSTem:DATE <year>, <month>, <day>.

Factory Preset and *RST:	The factory default is MDY. This parameter is persistent, which means that it retains the setting previously selected, even through a power cycle.
Front Panel Access:	**System, Time/Date, Date Format MDY DMY**

Date and Time Display

:DISPlay:ANNotation:CLOCk[:STATe] OFF|ON|0|1

:DISPlay:ANNotation:CLOCk[:STATe]?

Turns on and off the display of the date and time on the spectrum analyzer screen.

Factory Preset and *RST: The factory default is On. This parameter is persistent, which means that it retains the setting previously selected, even through a power cycle.

Front Panel Access: **System, Time/Date, Time/Date On Off**

Display Annotation Title Data

:DISPlay:ANNotation:TITLe:DATA <string>

:DISPlay:ANNotation:TITLe:DATA?

Enters the text that will be displayed in the user title area of the display.

Front Panel Access: **Display, Title**

Turn the Entire Display On/Off

:DISPlay:ENABle OFF|ON|0|1

Turns the display on or off. Having the display turned off may increase repetitive measurement rate.

Factory Preset and *RST: On

Remarks: The following key presses will turn display enable back on:

1. If in local, press any key
2. If in remote, press the local (system) key
3. If in local lockout, no key

Front Panel Access: None

Window Annotation

:DISPlay:WINDow:ANNotation[:ALL] OFF|ON|0|1

:DISPlay:WINDow:ANNotation[:ALL]?

Turns the screen annotation on or off for all windows.

Factory Preset and *RST:	On
Front Panel Access:	**Display, Preferences, Annotation On Off**

Trace Graticule Display

:DISPlay:WINDow:TRACe:GRATicule:GRID[:STATe] OFF|ON|0|1

:DISPlay:WINDow:TRACe:GRATicule:GRID[:STATe]?

Turns the graticule on or off.

Factory Preset and *RST:	On
Front Panel Access:	**Display, Preferences, Graticule On Off**

Set the Display Line

:DISPlay:WINDow:TRACe:Y:DLINe <ampl>

:DISPlay:WINDow:TRACe:Y:DLINe?

Defines the level of the display line, in the active amplitude units if no units are specified.

Factory Preset and *RST:	2.5 divisions below the reference level
Range:	10 display divisions below the reference level to the reference level
Default Unit:	Current active units
Front Panel Access:	**Display, Display Line On Off**

Control the Display Line

:DISPlay:WINDow:TRACe:Y:DLINe:STATe OFF|ON|0|1

:DISPlay:WINDow:TRACe:Y:DLINe:STATe?

Turns the display line on or off.

Factory Preset and *RST:	Off
Front Panel Access:	**Display, Display Line On Off**

Normalized Reference Level

:DISPlay:WINDow:TRACe:Y[:SCALe]:NRLevel <rel_ampl>

:DISPlay:WINDow:TRACe:Y[:SCALe]:NRLevel?

Sets the normalized reference level.

Factory Preset and *RST:	0 dB
Range:	–327.6 to 327.6 dB
Default Unit:	Current active units
Front Panel Access:	**Meas Setup, Trace, More, Normalize, Norm Ref Levl**

Normalized Reference Level Position

:DISPlay:WINDow:TRACe:Y[:SCALe]:NRPosition <integer>

:DISPlay:WINDow:TRACe:Y[:SCALe]:NRPosition?

Selects the position of the normalized reference level. The top and bottom graticule lines correspond to 10 and 0, respectively.

Factory Preset and *RST:	10
Range:	integer
Front Panel Access:	**Meas Setup, Trace, More, Normalize, Norm Ref Posn**

Trace Y-Axis Amplitude Scaling

:DISPlay:WINDow:TRACe:Y[:SCALe]:PDIVision <rel_ampl>

:DISPlay:WINDow:TRACe:Y[:SCALe]:PDIVision?

Sets the per-division display scaling for the y-axis when y-axis units are set to amplitude units.

Factory Preset and *RST:	10 dB
Range:	0.1 to 20.0 dB
Default Unit:	dB
Front Panel Access:	**AMPLITUDE/Y Scale, Scale/Div**

Trace Y-Axis Reference Level

:DISPlay:WINDow:TRACe:Y[:SCALe]:RLEVel <ampl>

:DISPlay:WINDow:TRACe:Y[:SCALe]:RLEVel?

Sets the amplitude value of the reference level for the y-axis.

Factory Preset and *RST:	0 dBm
Range:	With zero reference level offset: ESA E4402B: –327.6 to 55 dBm ESA E4404B: –327.6 to 55 dBm ESA E4405B: –327.6 to 55 dBm ESA E4407B: –327.6 to 55 dBm –149.9 to 55 dBm with zero reference level offset and max mixer level = –10 dBm. In external mixing, the range is –327.5 to –10 dBm.
Default Unit:	Current active units
Remarks:	The input attenuator setting may be affected. The minimum displayed value of reference level is –327.6 dBm, and the maximum displayed value is 327.6 dBm.
Front Panel Access:	**Amplitude Y Scale, Ref Level**

Vertical Axis Scaling

:DISPlay:WINDow:TRACe:Y[:SCALe]:SPACing LINear|LOGarithmic

:DISPlay:WINDow:TRACe:Y[:SCALe]:SPACing?

Specifies the vertical graticule divisions as log or linear units.

Factory Preset and *RST:	Logarithmic
Front Panel Access:	There is no front panel access

FETCh Subsystem

The FETCh? commands are used with several other commands to control the measurement process. These commands are described in the section on the "MEASure Group of Commands" on page 113.

FETCh subsystem commands apply only to measurements found in the MEASURE menu. FETCh commands can only be used as queries.

FETCh commands put valid data into the output buffer, but do not initiate data acquisition. Use the :INITiate[:IMMediate] command to acquire data. You can only fetch results from the measurement that is selected, and when current measurement results are valid.

:FETCh <meas>? will return valid data only when the measurement is in one of the following states:

idle
initiated
paused

Fetch the Current Measurement Results

:FETCh:<measurement>[n]?

A FETCh? command must specify the desired measurement. It will return the valid results that are currently available, but will not initiate the taking of any new data. You can only fetch results from the measurement that is currently selected. The code number n selects the kind of results that will be returned. The available measurements and data results are described in the "MEASure Group of Commands" on page 113.

INITiate Subsystem

The INITiate subsystem is used to control the initiation of the trigger. Refer to the TRIGger and ABORt subsystems for related commands.

Continuous or Single Measurements

:INITiate:CONTinuous OFF|ON|0|1

:INITiate:CONTinuous?

Selects whether the trigger system is continuously initiated or not.

This command affects sweep in normal spectrum analyzer mode, and affects trigger when in a measurement. A "measurement" refers to any of the functions under the MEASURE key. This corresponds to continuous sweep or single sweep operation when not in a measurement, and continuous measurement or single measurement operation when in a measurement.

NOTE When not in a measurement, this command does the following:

- When ON at the completion of each sweep cycle, the sweep system immediately initiates another sweep cycle.
- When OFF, the sweep system remains in the "idle" state until an :INITiate[:IMMediate] command is received. On receiving the :INITiate[:IMMediate] command, it will go through a single sweep cycle, and then return to the "idle" state.
- The query returns 1 or 0 into the output buffer. 1 is returned when there is continuous sweeping. 0 is returned when there is only a single sweep.

When in a measurement, this command does the following:

- When ON at the completion of each trigger cycle, the trigger system immediately initiates another trigger cycle.
- When OFF, the trigger system remains in an "idle" state until CONTinuous is set to ON or an :INITiate[:IMMediate] command is received. On receiving the :INITiate[:IMMediate] command, it will go through a single trigger cycle, and then return to the "idle" state.
- The query returns 1 or 0 into the output buffer. 1 is returned when there is continuous triggering. 0 is returned when there is only a single trigger.

Factory Preset: ON

*RST: ON (OFF recommended for remote operation)

Front Panel Access: **Single**

Meas Control, Measure Cont Single

Take New Data Acquisitions

:INITiate[:IMMediate]

This command initiates a sweep if not in a measurement. If in a measurement and the measurement is in the idle state (i.e. not running), it triggers the instrument if trigger conditions are met. If the measurement is currently running, the command is ignored. A “measurement” refers to any function under the MEASURE key.

Remarks: See also the *TRG command and the TRIGger subsystem.

Use the [:SENSe]:<meas>:TRIGger:SOURce command to select the desired trigger. The instrument must be in the single measurement mode. If :INITiate:CONTinuous is ON then the command is ignored.

Use :FETCh? to transfer a measurement result from memory to the output buffer. Refer to individual commands in the FETCh subsystem for more information.

Front Panel Access: **Sweep** (SA mode)

Single

Meas Control

Pause the Measurement

:INITiate:PAUSe

Pauses the current measurement by changing the current measurement state from the “wait for trigger” state to the “paused” state. If the measurement is not in the “wait for trigger” state, when the command is issued, the transition will be made the next time that state is entered as part of the trigger cycle. When in the paused state, the spectrum analyzer auto-align process stops. If the analyzer is paused for a long period of time, measurement accuracy may degrade.

Front Panel
Access: **Meas Control**

Restart the Measurement

:INITiate:RESTart

This command applies to measurements found in the MEASURE menu.

It restarts the current measurement from the “idle” state regardless of its current operating state. It is equivalent to:

INITiate[:IMMediate] (for single measurement mode)

ABORt (for continuous measurement mode)

Front Panel
Access: **Restart**

or

Meas Control

Resume the Measurement

:INITiate:RESume

Resumes the current measurement by changing the current measurement state from the “paused state” back to the “wait for trigger” state. If the measurement is not in the “paused” state, when the command is issued, an error is reported. Only include if INIT:IMM is implemented as an overlapping command.

Front Panel
Access: **Meas Control**

INSTrument Subsystem

This subsystem includes commands for querying and selecting instrument measurement (personality option) modes.

Select Application by Number

:INSTrument:NSELect <integer>

:INSTrument:NSELect?

Select the measurement application by its instrument number. The actual available choices depends upon which applications are installed in the instrument.

1 = SA

229 = MAN

NOTE

If you are using the SCPI status registers and the analyzer mode is changed, the status bits should be read, and any errors resolved, prior to switching modes. Error conditions that exist prior to switching modes cannot be detected using the condition registers after the mode change. This is true unless they recur after the mode change, although transitions of these conditions can be detected using the event registers.

Changing modes resets all SCPI status registers and mask registers to their power-on defaults. Hence, any event or condition register masks must be re-established after a mode change. Also note that the power up status bit is set by any mode change, since that is the default state after power up.

Factory Preset and *RST:	Persistent state with factory default of 1
Range:	1 to x, where x depends upon which applications are installed.
Front Panel Access:	**Mode**

Select Application

:INSTrument[:SELect] SA|MAN

:INSTrument[:SELect]?

Select the measurement application mode by enumerated choice. The actual available choices depend upon which applications (modes) are installed in the instrument. See the manual for installed options for the mode designator (if any) for that option.

Once the instrument mode is selected, only the commands that are valid for that mode can be executed.

NOTE If you are using the status bits and the analyzer mode is changed, the status bits should be read, and any errors resolved, prior to switching modes. Error conditions that exist prior to switching modes cannot be detected using the condition registers after the mode change. This is true unless they recur after the mode change, although transitions of these conditions can be detected using the event registers.

Changing modes resets all SCPI status registers and mask registers to their power-on defaults. Hence, any event or condition register masks must be re-established after a mode change. Also note that the power up status bit is set by any mode change, since that is the default state after power up.

Factory Preset and *RST: Persistent state with factory default of Spectrum Analyzer

Front Panel Access: **Mode**

MEASure Group of Commands

This group includes the CONFigure, FETCH, MEASure, and READ commands that are used to make measurements and return results. The different commands can be used to provide fine control of the overall measurement process, like altering measurement parameters from their default settings. Most measurements should be done in single measurement mode, rather than doing the measurement continuously.

Measure Commands

:MEASure:<measurement>[n]?

This is a fast single-command way to make a measurement using the factory default instrument settings. These are the settings and units that conform to the Radio Standard that is currently selected.

- Stops the current measurement and sets up the instrument for the specified measurement using the factory defaults.
- Initiates the data acquisition for the measurement.
- Blocks other SCPI communication, waiting until the measurement is complete before returning results.
- Turns the averaging function on and sets the number of averages to 10 for all measurements.
- After the data is valid it returns the scalar results, or the trace data, for the specified measurement.

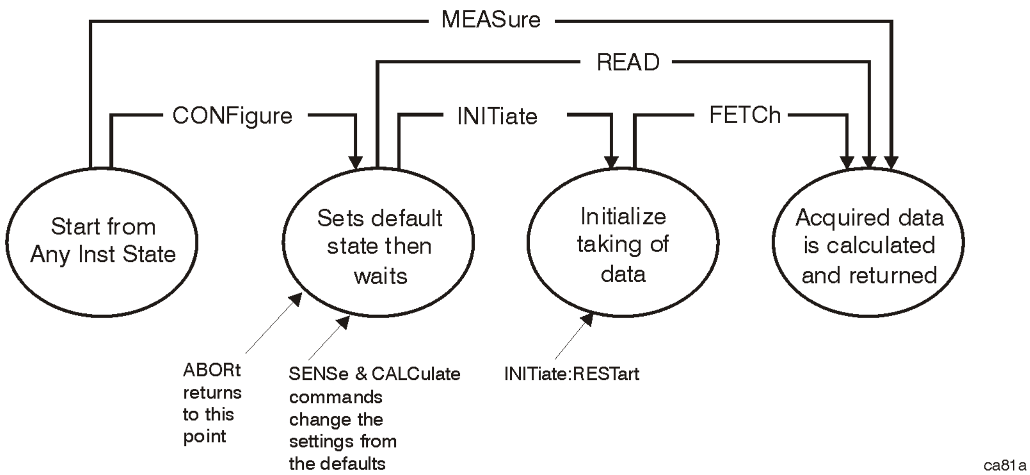
  If the optional [n] value is not included, or is set to 1, the scalar measurement results will be returned. If the [n] value is set to a value other than 1, the selected trace data results will be returned. See each command for details of what types of scalar results or trace data results are available.

If you need to change some of the measurement parameters from the factory default settings you can set up the measurement with the CONFigure command. Use the commands in the SENSe:<measurement> subsystem to change the settings. Then you can use the READ? command, or the INITiate and FETCh? commands, to initiate the measurement and query the results. See Figure 7-1.

If you need to repeatedly make a given measurement with settings other than the factory defaults, you can use the commands in the SENSe:<measurement> subsystem to set up the measurement. Then use the READ? command or INITiate and FETCh? commands, to initiate the measurement and query results.

Measurement settings persist if you initiate a different measurement and then return to a previous one. Use READ:<measurement>? if you want to use those persistent settings. If you want to go back to the default settings, use MEASure:<measurement>?.

Figure 7-1 Measurement Group of Commands



Configure Commands

:CONFigure:<measurement>

This command stops the current measurement and sets up the instrument for the specified measurement using the factory default instrument settings. It does not initiate the taking of measurement data. This command also turns the averaging function on, sets the number of averages to 10 for all measurements and sets the measurement to single mode.

The CONFigure? query returns the current measurement name.

Fetch Commands

:FETCh:<measurement>[n]?

This command puts selected data from the most recent measurement into the output buffer (data acquisition is not initiated, however). Use the INITiate[:IMMediate] command to acquire data before you use the FETCh command. You can only fetch results from the measurement that is currently selected.

If the optional [n] value is not included, or is set to 1, the scalar measurement results will be returned. If the [n] value is set to a value other than 1, the selected trace data results will be returned. See each command for details of what types of scalar results or trace data results are available.

FETCh may be used to return results other than those specified with the READ or MEASure commands.

Read Commands

:READ:<measurement>[n]?

- Does not preset the measurement to the factory defaults. (The MEASure? and CONFigure? commands reset the parameters to the default values.) READ uses the settings from the last measurement.
- Initiates the measurement which puts new data into the output buffer. If a measurement other than the current one is specified, the instrument will switch to that measurement before it initiates the measurement and returns results.
- Blocks other SCPI communication, waiting until the measurement is complete before returning the results.

  For the EVM measurement, if the optional [n] value is not included, or is set to 1, the scalar measurement results will be returned. If the [n] value is set to a value other than 1, the selected trace data results will be returned. For the Monitor Spectrum measurement, the trace data will always be returned. See each command for details of what types of scalar results or trace data results are available.

Measurement settings persist if you initiate a different measurement and then return to a previous one. Use READ:<measurement>? if you want to use those persistent settings. If you want to go back to the default settings, use MEASure:<measurement>?.

Monitor Spectrum

Displays the frequency-domain spectrum of the receive channel or band for the selected device (mobile or base station). This allows you to a quickly check that there is a signal that can be measured.

:CONFigure:MON

:FETCh:MON [n]?

:READ:MON [n]?

:MEASure:MON [n]?

NOTE The numeric parameter [n] can be omitted altogether, or if used, it must be equal to 1. The same measurement is performed in either case.

Front Panel
Access: **Measure**

Table 7-1 Results Returned

n	Results Returned
Not specified or n=1	Returns the RF Envelope Trace (data array). This trace contains 401 data points.

Error Vector Magnitude (EVM)

Displays the I/Q Measured Polar Vector of the received signal, and lists both the maximum and the average values for EVM (rms), EVM (peak), Mag Error (rms), Mag Error (peak), Phase Error (rms), Phase Error (peak), Frequency Error, I/Q Offset and the Droop Error.

:CONFigure:EVM

:FETCh:EVM [n]?

:READ:EVM [n]?

:MEASure:EVM [n]?

Front Panel
Access: **Measure**

Table 7-2 Results Returned from the EVM Measurement

n	Results Returned
0	Returns processed raw, unprocessed I/Q trace data, as a data array of comma-separated trace points, in volts. The I values are listed first in each pair, using the 0 through even-indexed values. The Q values are the odd-indexed values.
not specified or n=1	Returns 24 comma separated floating point numbers in the following order: 1. **EVM (rms) Avg** has units of percent. The calculation is based on the composite of the phase error and magnitude error, between the measured signal and the ideal signal. If averaging is on, this is the average of the individual rms measurements. 2. **EVM (rms) Max** has units of percent. The calculation is based on the composite of the phase error and magnitude error, between the measured signal and the ideal signal. This is the maximum of the individual rms measurements. 3. **EVM (peak) Avg** has units of percent. The calculation is based on the composite of the phase error and magnitude error, between the measured signal and the ideal signal. If averaging is on, this is the average of the individual peak measurements. 4. **Symbol position of the EVM (peak) Avg error** – an integer number of the symbol position where the last averaged peak EVM error is detected. 5. **EVM (peak) Max** has units of percent. The calculation is based on the composite of the phase error and magnitude error, between the measured signal and the ideal signal. If averaging is on, this is the maximum of the individual peak measurements. 6. **Symbol position of the EVM (peak) Max error** – an integer number of the symbol position where the maximum peak EVM error is detected. 7. **Magnitude Error rms Avg** (with units of percent) is the rms error between the measured (compensated) magnitude and the ideal magnitude. If averaging is on, this is the average of the individual rms measurements. 8. **Magnitude Error rms Max** (with units of percent) is the rms error between the measured (compensated) magnitude and the ideal magnitude. This is the maximum of the individual rms measurements. 9. **Magnitude Error (peak) Average** (with units of percent) is the peak error between the measured (compensated) magnitude and the ideal magnitude. If averaging is on, this is the average of the individual peak measurements.

Table 7-2 Results Returned from the EVM Measurement

n	Results Returned
Not specified or n = 1	10. **Symbol position of the Magnitude Error (peak) Avg** – an integer number representing the symbol position where the last averaged peak magnitude error was detected. 11. **Magnitude Error (peak) Max** (with units of percent) is the peak error between the measured (compensated) magnitude and the ideal magnitude. This is the maximum of the individual peak measurements. 12. **Symbol position of the Magnitude Error (peak) Max** – an integer number representing the symbol position where the maximum peak magnitude error was detected. 13. **Phase Error (rms) Average** (with units in degrees) is the rms error between the measured (compensated) phase and the ideal phase. If averaging is on, this is the average of the individual rms measurements. 14. **Phase Error (rms) Max** (with units in degrees) is the rms error between the measured (compensated) phase and the ideal phase. This is the maximum of the individual rms measurements. 15. **Phase Error Average Peak** (with units in degrees) is the peak error between the measured (compensated) phase and the ideal phase. If averaging is on, this is the average of the individual peak measurements. 16. **Symbol position of the Phase Error (peak) Avg** – an integer number representing the symbol position where the last averaged peak Phase error was detected. 17. **Phase Error (peak) Max** (with units in degrees) is the peak phase error between the measured phase and the ideal phase. This is the maximum of the individual peak measurements. 18. **Symbol position of the Phase Error (peak) Max** – an integer number representing the symbol position where the maximum peak Phase error was detected. 19. **Frequency Error Avg** of the measured signal, has units of Hz. This is based on the linear best fit of the uncorrected measured phase. If averaging is on, this is the average of the individual frequency error measurements. 20. **Frequency Error Max** of the measured signal, has units of Hz. This is based on the linear best fit of the uncorrected measured phase. This is the maximum of the individual frequency error measurements. 21. **I/Q Offset Avg** (with units of dB) is the dc error offset of I/Q, from the origin. If averaging is on, this is the average of the individual carrier feed-through measurements.

Table 7-2 Results Returned from the EVM Measurement

n	Results Returned
Not specified or n = 1	22. **I/Q Offset Max** (with units of dB) is the dc error offset of I/Q, from the origin. This is the maximum of the individual carrier feed-through measurements. 23. **Amplitude Droop Error Avg** has units dB/symbol. This is the linear best fit of the amplitude slope of the measured signal. If averaging is on, this is the average of the individual measurements. 24. **Amplitude Droop Error Max** has units dB/symbol. This is the linear best fit of the amplitude slope of the measured signal. This is the maximum of the individual measurements.
2	**EVM Trace -** Returns a trace of the error vector magnitude (EVM), as comma-separated trace points in percent. The first value is the symbol 0 decision point. The trace is interpolated for the currently selected points/symbol displayed on the front panel. The number of trace points depends on the current measurement interval setting.
3	**Mag Error Trace -** Returns a trace of the magnitude error, as comma-separated trace points in percent. The first value is the symbol 0 decision point. The trace is interpolated for the currently selected points/symbol displayed on the front panel. The number of trace points depends on the current measurement interval setting.
4	**Phase Error Trace -** Returns a trace of the phase error, as comma-separated trace points in percent. The first value is the symbol 0 decision point. The trace is interpolated for the currently selected points/symbol displayed on the front panel. The number of trace points depends on the current measurement interval setting.
5	**Measured Polar Vector IQ trace -** Returns a trace of the IQ measured polar vector IQ complex data array, as comma-separated trace points in dB. The first value is the symbol 0 (I component) decision point. The second value is the symbol O (Q component) decision point, and so on. The trace is interpolated for the currently selected points/symbol displayed on the front panel. The number of trace points depends on the current measurement interval setting.

READ Subsystem

The READ? commands are used with several other commands and are documented in the section on the "MEASure Group of Commands" on page 113.

SENSe Subsystem

Sets the instrument state parameters so that you can measure the input signal.

SENSe subsystem commands used for measurements in the MEASURE and Meas Setup menus may only be used to set parameters of a specific measurement when the measurement is active. Otherwise, an error will occur. You must first select the appropriate measurement using the :CONFigure:<measurement> command. If a :SENSe command is used to change a parameter during a measurement (while not in its idle state), the measurement will be restarted.

Channel Commands

Time Slot number

[:SENSe]:CHANnel:SLOT <integer>

[:SENSe]:CHANnel:SLOT?

Select the time slot number that you want to measure.

In the EDGE (8PSK) radio standard, the measurement frame is divided into the eight expected measurement timeslots.

Factory Preset and *RST:	0
Range:	0 to 7
Remarks:	You must be making an EDGE (8PSK) EVM measurement on an externally triggered EDGE signal to use this command.
Front Panel Access:	**Frequency Channel**

Time Slot Auto

[:SENSe]:CHANnel:SLOT:AUTO OFF|ON|0|1

[:SENSe]:CHANnel:SLOT:AUTO?

Select auto or manual control for slot searching. The feature is only supported in external trigger source mode. In external trigger mode when timeslot is set On, the demodulation measurement is made on the nth timeslot specified by the external trigger point + n timeslots, where n is the selected timeslot value 0 to 7. When not using an external trigger, or when the timeslot is set to Off, the demodulation measurement is made on the entire frame.

Factory Preset and *RST: Off and disabled

Remarks: You must be making an EVM measurement on an externally triggered EDGE signal to use this command.

Front Panel Access: **Frequency Channel**

Training Sequence Code (TSC)

[:SENSe]:CHANNel:TSCode <integer>

[:SENSe]:CHANNel:TSCode?

Set the normal training burst sequence code for which to search when TSC auto is set to Off.

Factory Preset and *RST: 0

Range: 0 to 7

Remarks: You must be making an EVM measurement on an EDGE (8PSK) signal to use this command.

Front Panel Access: **FREQUENCY Channel**

Training Sequence Code (TSC) Auto

[:SENSe]:CHANNel:TSCode:AUTO OFF|ON|0|1

[:SENSe]:CHANNel:TSCode:AUTO?

Select auto or manual control for training sequence code (TSC) search. With auto on, the measurement is made on the first burst found to have one of the valid TSCs in the range 0 to 7 (i.e. normal bursts only). With auto off, the measurement is made on the 1st burst found to have the selected TSC.

Factory Preset and *RST: On

Remarks: You must be making an EVM measurement on an EDGE (8PSK) signal to use this command.

Front Panel Access: **FREQUENCY Channel**

Default Reset

[:SENSe]:DEFaults

Restores personality Mode Setup defaults.

Remarks: This command sets all the SENSe defaults but has no effect on the MEASure default settings. Use the CONFigure:<measurement> command to set measurement defaults

Front Panel Access: **Mode Setup**

Error Vector Magnitude Measurement

Commands for querying the error vector magnitude measurement results and for setting to the default values are found in the "MEASure Group of Commands" on page 113. The equivalent front panel keys for the parameters described in the following commands, are found under the **Meas Setup** key, after the **EVM** measurement has been selected from the **MEASURE** key menu.

Error Vector Magnitude—Average Count

[:SENSe]:EVM:AVERage:COUNt <integer>

[:SENSe]:EVM:AVERage:COUNt?

Set the number of data acquisitions that will be averaged. After the specified number of average counts, the average mode (termination control) setting determines the average action.

Factory Preset and *RST: 10

Range: 1 to 1000

Front Panel Access: **Meas Setup**

Error Vector Magnitude—Averaging State

[:SENSe]:EVM:AVERage[:STATe] OFF|ON|0|1

[:SENSe]:EVM:AVERage[:STATe]?

Turn average on or off.

Factory Preset and *RST: Off in front panel mode

On if you perform CONFigure:EVM

Front Panel Access: **Meas Setup**

Error Vector Magnitude—Averaging Termination Control

[:SENSe]:EVM:AVERage:TCONtrol EXPonential|REPeat

[:SENSe]:EVM:AVERage:TCONtrol?

Select the type of termination control used to averaging. This determines the averaging action after the specified number of data acquisitions (average count) is reached.

EXPonential – Each successive data acquisition after the average count is reached, is exponentially weighted and combined with the existing average.

REPeat – After reaching the average count, the averaging is reset and a new average is started.

Factory Preset and *RST: Repeat

Front Panel Access: **Meas Setup**

Error Vector Magnitude—Burst Synchronization

[:SENSe]:EVM:BSYNc:SOURce RFAMplitude|NONE

[:SENSe]:EVM:BSYNC:SOURce?

Factory Preset and *RST: None

Front Panel Access: **Meas Setup**

Error Vector Magnitude—Droop Compensation

`[:SENSe]:EVM:DROop:COMPensation[:STATe] OFF|ON|0|1`

`[:SENSe]:EVM:DROop:COMPensation?`

Sets Droop Compensation on or off.

Factory Preset and *RST: On

Remarks: This key is only used with EDGE signals only. The softkey is disabled for all other standards.

Front Panel Access: **Meas Setup, More**

Error Vector Magnitude - Symbol Dots (Quad View)

`[:SENSe]:EVM:GSDOTs[:STATe] ON|OFF|1|0`

`[:SENSe]:EVM:GSDOTS[:STATe]?`

Allows you to highlight the positions of the symbol decision points on the graphical views by turning the display of the symbols on or off.

Factory Preset and *RST: On

Front Panel Access: **Display**, **Symbol Dots Quad View**

Error Vector Magnitude - I/Q Points Offset

`[:SENSe]:EVM:IQOOffset <integer>`

`[:SENSe]:EVM:IQOOffset?`

Specifies an offset from the first IQ point in the constellation diagram.

Factory Preset and *RST: 0

Maximum Value: (Meas Interval × Points/Symbol) - I/Q Points

Minimum Value: 0

Front Panel Access: **Display**

Error Vector Magnitude - I/Q Points

Allows you to set the total number of I/Q points used in the display before both the measurement and the display are restarted.

[:SENSe]:EVM:IQPoint <integer>

[:SENSe]:EVM:IQPoints?

Factory Preset and *RST: 1000

Maximum Value: Dependent on the radio standard selected. Limited to the number of points per symbol multiplied by the measurement interval.

Minimum Value: 1

Front Panel Access: **Display**

Error Vector Magnitude—RF Mixer Input Maximum Power

[:SENSe]:EVM:MIXer:RANGe <power>

[:SENSe]:EVM:MIXer:RANGe?

Specifies the maximum power at the input mixer for the EVM measurement.

Factory Preset and *RST: –10 dBm

Range: –100 dBm to 10 dBm

Default Unit: dBm

Front Panel Access: **Meas Setup, Advanced**

Error Vector Magnitude—Points/Symbol

[:SENSe]:EVM:PPSYmbol ONE|TWO|FOUR|FIVE|TEN

[:SENSe]:EVM:PPSYmbol?

Determines the number of points displayed between symbols for digitally demodulated data. For example, if the value of *points/symbol* is 1, each display point corresponds to a symbol. If the value is 5, every 5th display point corresponds to a symbol--in this case, a vector diagram would show 4 display points between each symbol.

When in cdmaOne and the device is set to mobile station (MS), Points/Symbol is needs to be an even number, due to the Offset QPSK demodulation format. The choices in this case are therefore 2, 4 or 10 (1 and 5 would be greyed out). In EDGE it is fixed at 1 (all others greyed out). All other cases can choose either 1, 5 or 10.

Factory Preset and *RST: 5

Range: One, two, four, five, ten

Remarks: Invalid option keys are grayed out. Valid options vary between radio standards.

Front Panel Access: **Display**

Error Vector Magnitude - 3Pi/8 Rotation

[:SENSe]:EVM:ROTation[:STATe] ON|OFF|1|0

[:SENSe]:EVM:ROTation[:STATe]?

Specifies whether or not $3\pi/8$ rotation is applied to the IQ constellation diagram. This softkey is only valid for EDGE (8PSK) radio standard modulation formats.

Factory Preset and *RST: On

Front Panel Access: **Meas Setup, More**

Error Vector Magnitude—Display Symbol Dots

[:SENSe]:EVM:SDOTS[:STATe] OFF|ON|0|1

[:SENSe]:EVM:SDOTS[:STATe]?

Turns the symbol dots on or off for the EVM measurements. Symbol dots are the blue markers that indicate the decision points on the Polar Vector trace.

Factory Preset and *RST: On

Front Panel Access: **Display**

Error Vector Magnitude—Measurement Interval

[:SENSe]:EVM:SWEep:POINts <integer>

[:SENSe]:EVM:SWEep:POINts?

Sets the number of symbols per measurement sweep or measurement interval.

Factory Preset and *RST: 200

Range: 10 to 350

Front Panel Access: **Meas Setup**

Error Vector Magnitude—Trigger Source

[:SENSe]:EVM:TRIGger:SOURce IMMediate|EXTernal|RFBurst

[:SENSe]:EVM:TRIGger:SOURce?

Select the trigger source used to control the data acquisitions.

IMMediate – the analyzer will process input data immediately without waiting for any sort of trigger signal. This is sometimes called ‘Free Run’.

EXTernal – rear panel external trigger input

RFBurst – wideband RF burst envelope trigger that has automatic level control for periodic burst signals

Factory Preset and *RST: Immediate

Front Panel Access: **Meas Setup, Trig Source**

Frequency Commands

Center Frequency

[:SENSe]:FREQuency:CENTer <freq>

[:SENSe]:FREQuency:CENTer?

Set the center frequency.

Factory Preset and *RST: 1 GHz for Modulation Analysis

Range The same as the SA mode range

Default Unit: Hz

Remarks: Global to the current mode.

Front Panel
Access: **FREQUENCY/Channel**

Frequency Span

[:SENSe]:FREQuency:SPAN <freq>

[:SENSe]:FREQuency:SPAN?

Set the frequency span.

Factory Preset
and *RST: 3 MHz for Modulation Analysis

Range: The same as the SA mode range

Default Unit: Hz

Front Panel
Access: **SPAN/X Scale**

Start Frequency

[:SENSe]:FREQuency:STARt <freq>

[:SENSe]:FREQuency:STARt?

Set the start frequency.

Factory Preset
and *RST: 998.5 MHz

Range: The same as the SA mode range

Default Unit: Hz

Remarks: Only valid when performing a Monitor Spectrum measurement. The option is grayed out at all other times.

Front Panel
Access: **FREQUENCY/Channel**

Stop Frequency

[:SENSe]:FREQuency:STOP <freq>

[:SENSe]:FREQuency:STOP?

Set the start frequency.

Factory Preset and *RST:	1.0015 GHz
Range:	The same as the SA mode range
Default Unit:	Hz
Remarks:	Only valid when performing a Monitor Spectrum measurement. The option is grayed out at all other times
Front Panel Access:	**FREQUENCY/Channel**

Phase and Quadrature Commands

In-phase and Quadrature Control

[:SENSe]:IQInvert[:STATe] ON|OFF|1|0

[:SENSe]:IQInvert[:STATe]?

Allows you to swap the In-phase and Quadrature signals.

Factory Preset and *RST:	Off
Front Panel Access:	**Det/Demod, More**

Monitor Spectrum Measurement

Commands for querying the monitor spectrum measurement results and for setting to the default values are found in the “MEASure Group of Commands” on page 113. The equivalent front panel keys for the parameters described in the following commands, are found under the **Meas Setup** key, after the **Monitor Spectrum** measurement has been selected from the **MEASURE** key menu.

Monitor Spectrum—Average Count

[:SENSe]:MONitor:AVERage:COUNt <integer>

[:SENSe]:MONitor:AVERage:COUNt?

Set the number of data acquisitions that will be averaged. After the specified number of average counts, the averaging mode (terminal control) setting determines the averaging action.

Factory Preset and *RST:	10
Range:	1 to 1,000
Remarks:	You must be in the Modulation Analysis mode to use this command. Use INSTrument:SELect to set the mode.
Front Panel Access:	**Meas Setup**

Monitor Spectrum—Averaging State

[:SENSe]:MONitor:AVERage[:STATe] OFF|ON|0|1

[:SENSe]:MONitor:AVERage[:STATe]?

Turn averaging on or off.

Factory Preset and *RST:	Off
Front Panel Access:	**Meas Setup**

Monitor Spectrum—Averaging Termination Control

[:SENSe]:MONitor:AVERage:TCONtrol EXPonential|REPeat

[:SENSe]:MONitor:AVERage:TCONtrol?

Select the type of termination control used for the averaging function. This determines the averaging action after the specified number of data acquisitions (average count) is reached.

Exponential - After the average count is reached, each successive data acquisition is exponentially weighted and combined with the existing average.

Repeat - After reaching the average count, the averaging is reset and a new average is started.

Factory Preset and *RST: Exponential

Remarks: You must be in the Modulation Analysis mode to use this command. Use INSTrument:SELect to set the mode.

Front Panel Access: **Meas Setup**

Monitor Spectrum—Resolution Bandwidth

[:SENSe]:MONitor:CHANnel:BWIDth|BANDwidth[:RESolution] <freq>

[:SENSe]:MONitor:CHANnel:BWIDth|BANDwidth[:RESolution]?

Set the value of the resolution bandwidth.

Factory Preset and *RST: 30 kHz

Range: 1 kHz to 5 MHz

Front Panel Access: **Meas Setup**, **Chan Setup**

Monitor Spectrum—Video Bandwidth

[:SENSe]:MONitor:CHANnel:BWIDth|BANDwidth:VIDeo <freq>

[:SENSe]:MONitor:CHANnel:BWIDth|BANDwidth:VIDeo?

Set the value of the video bandwidth.

Factory Preset and *RST: 30 kHz

Range: 30 Hz to 3 MHz

Front Panel Access: **Meas Setup**, **Chan Setup**

Monitor Spectrum—Maximum Hold Trace State

[:SENSe]:MONitor:CHANnel:MAXHold[:STATe] ON|OFF|1|0

[:SENSe]:MONitor:CHANnel:MAXHold[:STATe]?

Turn maximum hold trace feature on or off.

Factory Preset and *RST: Off

Front Panel Access: **Meas Setup**, **Chan Setup**

Monitor Spectrum—Detector Mode

[:SENSe]:MONitor:CHANnel:DETector POSitive|SAMPle|NEGative

[:SENSe]:MONitor:CHANnel:DETector?

Measurements are made by sampling at regularly spaced discrete points in the frequency domain. The detector mode, set by this command, determines whether the maximum or the minimum values between each sample point or the value at each sample point itself is returned.

POSitive - positive peak detection returns the maximum peak measurement made between each sample point.

SAMPle - sample detection returns the measurement value made at each sample point.

NEGative - negative peak detection returns the minimum peak measurement made between each sample point.

Factory Preset and *RST: Positive

Front Panel Access: **Meas Setup**, **Chan Setup**

Monitor Spectrum—Sweep Time Control

[:SENSe]:MONitor:CHANnel:SWEep:TIME <seconds>

[:SENSe]:MONitor:CHANnel:SWEep:TIME?

This determines the length of time taken for each measurement sweep. A balance has to be struck between speed and accuracy as faster sweeps can cause measurement inaccuracy.

Factory Preset and *RST: 9.167 msec

Range: 10 µsec to 4 ksec

Remarks: You must be in the Modulation Analysis mode to use this command. Use INSTrument:SELect to set the mode.

Front Panel Access: **Meas Setup**, **Chan Setup**

Monitor Spectrum—Sweep Time Automation

[:SENSe]:MONitor:CHANnel:SWEep:TIME:AUTO ON|OFF|1|0

[:SENSe]:MONitor:CHANnel:SWEep:TIME:AUTO?

Automatically selects the fastest sweep time compatible with measurement accuracy, or allows you to set it manually.

Factory Preset and *RST:	On
Remarks:	You must be in the Modulation Analysis mode to use this command. Use INSTrument:SELect to set the mode.
Front Panel Access:	**Meas Setup, Chan Setup**

Monitor Spectrum—Trigger Synchronization Control

[:SENSe]:MONitor:TRIGger:SOURce: IMMediate|EXTernal|RFBurst

[:SENSe]:MONitor:TRIGger:SOURce?

Provides the menu keys that allow you to select the source for the demodulation synchronization trigger.

- Immediate - the next measurement is taken immediately, capturing the signal asynchronously.
- External - sets the trigger directly to an external signal connected to the rear-panel TRIGGER IN connector. No measurement will be made unless an appropriate trigger signal is connected to the Trigger In connector on the rear panel.
- RF Burst - sets the measurement trigger to the leading edge of a RF Burst signal. No measurement will be made unless a bursted signal is being measured.

Factory Preset and *RST:	Immediate
Remarks:	You must be in the Modulation Analysis mode to use this command. Use INSTrument:SELect to set the mode.
Front Panel Access:	**Meas Setup, Trig Source**

Reference Oscillator Frequency

[:SENSe]:OPTion:ROSCillator:EXTernal:FREQuency <Hz>

[:SENSe]:OPTion:ROSCillator:OUTPut?

Set the frequency of the external reference oscillator.

Preset
and *RST: 10 MHz

Maximum Value: 30 MHz

Minimum Value: 1 MHz

Front Panel
Access: **Mode Setup, Demod...**

or

Det/Demod, More

Reference Oscillator Rear Panel Output

[:SENSe]:OPTion:ROSCillator:OUTPut[:STATe] OFF|ON|0|1

[:SENSe]:OPTion:ROSCillator:OUTPut?

This enables or disables the 10 MHz output reference signal from the rear panel port labelled **10 MHz OUT**. This output signal needs to be connected to the **10 MHz REF IN** port on the rear panel whenever the reference oscillator source is set to external mode.

Preset
and *RST: Off

Front Panel
Access: **Mode Setup, Demod...**

or

Det/Demod, More

Reference Oscillator Source

[:SENSe]:OPTion:ROSCillator:SOURce INTernal|EXTernal

[:SENSe]:OPTion:ROSCillator:SOURce?

Select the reference oscillator (time base) source to the internal reference oscillator or an external oscillator. Use OPT:ROSC:EXT:FREQ to tell the instrument the frequency of the external reference.

INTernal - uses 10 MHz internal time base

EXTernal - uses the signal at the rear panel external reference input port.

Preset
and *RST: INTernal

Front Panel
Access: **Mode Setup, Demod...**

or

Det/Demod, More

Radio Standards Commands

Radio Standard Alpha / BT ratio

[:SENSe]:RADio:STANdard:ALPHA <alpha / BT number>

[:SENSe]:RADio:STANdard:ALPHA?

Enter the required Alpha / BT filter characteristics of a Nyquist, Root Nyquist, or Gaussian filter.

Alpha/BT is only applicable if either the reference or measure filters are set to: Gaussian, Nyquist or Root Nyquist. All other cases will be greyed out.

Factory Preset
and *RST: 0.22

Maximum Value: 1.0

Minimum Value: 0

Front Panel
Access: **Mode Setup, Demod...**

or

Det/Demod

Radio Device Under Test

[:SENSe]:RADio:STANdard:DEVice[:SELect] BTS|MS

[:SENSe]:RADio:STANdard:DEVice[:SELect]?

Select the type of radio device to be tested.

BTS – Base transceiver station test.

MS – Mobile transceiver station test.

Factory Preset and *RST: BTS

Front Panel Access: **Mode Setup**

Radio Standard Measurement Filter

[:SENSe]:RADio:STANdard:FILTer:MEASurement <OFF|RNYQ|NYQ|GAUS|CBPE|RECT|LPF>

[:SENSe]:RADio:STANdard:FILTer:MEASurement?

Select the type of measurement filter to be used in the current measurement.

OFF - No filter is used.

RNYQ - Root Nyquist.

NYQ - Nyquist.

GAUS - Gaussian.

CBPE - cdma Base Station Phase Equalization.

RECT - Rectangular.

LPF - Low Pass Filter.

Factory Preset and *RST: CBPE

Front Panel Access: **Det/Demod, Meas Filter**

or

Mode Setup, Demod...

Radio Standard Reference Filter

[:SENSe]:RADio:STANdard:FILTer:REFerence <RNYQ|NYQ|GAUS|CHEB|RECT>

[:SENSe]:RADio:STANdard:FILTer:REFerence?

Select the type of filter to be used in the reference signal generation for the current measurement.

RNYQ - Root Nyquist

NYQ - Nyquist

GAUS - Gaussian

CHEB - Chebyshev

RECT - Rectangular

Factory Preset and *RST: CHEB

Front Panel Access: **Det/Demod, RefFilter**

or

Mode Setup, Demod...

Radio Standard Modulation

[:SENSe]:RADio:STANdard:MODulation <QPSK|P4DQPSK|OQPSK>

[:SENSe]:RADio:STANdard:MODulation?

Select the type of modulation used in the current measurement

QPSK – Quadrature Phase Shift Keying.

P4DQPSK – Pi/4 Differential Quadrature Phase Shift Keying.

OQPSK – Offset Quadrature Phase Shift Keying.

Factory Preset and *RST: QPSK

Front Panel Access: **Det/Demod, Demod Format**

or

Mode Setup, Demod...

Radio Standard Under Test

[:SENSe]:RADio:STANdard[:SELect] CDMA|CDMA2K|WCDMA|NADC|EDGE|PDC|TETRA

[:SENSe]:RADio:STANdard[:SELect]?

Select the radio standard to be tested.

CDMA - cdmaOne.

CDMA2K - cdma2000.

WCDMA - Wideband CDMA

NADC - North American Digital Cellular

EDGE - Enhanced Data rate for GSM Evolution

PDC - Personal Digital Cellular

TETRA - Trans-European Trunked Radio

Factory Preset and *RST: CDMA

Front Panel Access: **Mode Setup, Radio Std**

Radio Standard Symbol Rate

[:SENSe]:RADio:STANdard:SRATe <symbol rate>

[:SENSe]:RADio:STANdard:SRATe?

Select the symbol rate of the radio signal being measured. EDGE signals are limited to plus or minus 10%, but other signal standards allow values up to 8 Msps. Calibration, however, is always limited to the default value for each radio standard plus or minus 10%.

Factory Preset and *RST: 1.22880 Msps

Maximum Value: 8 Msps

Minimum Value: 1 ksps

Front Panel Access: **Det/Demod, Symbol Rate**

or

Mode Setup, Demod...

Synchronization Commands

Burst Search Threshold

[:SENSe]:SYNC:BURSt:STHReshold <rel_power>

[:SENSe]:SYNC:BURSt:STHReshold?

Set the power threshold, relative to the peak power, that is used to determine the burst rising edge and falling edge.

Factory Preset and *RST: –20 dB

Range: –200 dB to –0.01 dB

Default Unit: dB

Front Panel

Access: **Mode Setup, Demod....**

or

Det/Demod, Burst

Burst Search Threshold

[:SENSe]:SYNC:BURSt:SLENgth <value>

[:SENSe]:SYNC:BURSt:SLENgth?

Set the burst search length over which the search algorithm will be performed if burst sync has been set to RF Amptd.

Factory Preset and *RST: 1.0 sec

Range: 0.0 to 1.0 sec (but upper limit is dependent on the symbol rate)

Default Unit: seconds

Front Panel Access: **Mode Setup, Demod....**

or

Det/Demod, Burst

STATus Subsystem

The STATus subsystem controls the SCPI-defined instrument-status reporting structures. Each status register has a set of five commands used for querying or masking that particular register.

Operation Register

Operation Condition Query

:STATus:OPERation:CONDition?

This query returns the decimal value of the sum of the bits in the Status Operation Condition register.

NOTE The data in this register is continuously updated and reflects the current conditions.

Operation Enable

:STATus:OPERation:ENABle <integer>

:STATus:OPERation:ENABle?

This command determines what bits in the Operation Event register, will set the Operation Status Summary bit (bit 7) in the Status Byte Register. The variable <number> is the sum of the decimal values of the bits you want to enable.

NOTE The preset condition is to have all bits in this enable register set to 0. To have any Operation Events reported to the Status Byte Register, one or more bits need to be set to 1.

Factory Preset and *RST:	0
Range:	0 to 32767

Operation Event Query

:STATus:OPERation[:EVENt]?

This query returns the decimal value of the sum of the bits in the Operation Event register.

NOTE The register requires that the associated PTR or NTR filters be set before a condition register bit can set a bit in the event register.

The data in this register is latched until it is queried. Once queried, the register is cleared.

Operation Negative Transition

:STATus:OPERation:NTRansition <integer>

:STATus:OPERation:NTRansition?

This command determines what bits in the Operation Condition register will set the corresponding bit in the Operation Event register when the condition register bit has a negative transition (1 to 0). The variable <number> is the sum of the decimal values of the bits that you want to enable.

Factory Preset and *RST:	0
Range:	0 to 32767

Operation Positive Transition

:STATus:OPERation:PTRansition <integer>

:STATus:OPERation:PTRansition?

This command determines what bits in the Operation Condition register will set the corresponding bit in the Operation Event register when the condition register bit has a positive transition (0 to 1). The variable <number> is the sum of the decimal values of the bits that you want to enable.

Factory Preset and *RST:	32767 (all 1's)
Range:	0 to 32767

8 If You Have a Problem

This chapter includes information on how to check for a problem with your ESA spectrum analyzer, and how to return it for service. It also includes descriptions of all of the analyzer built-in messages.

If you have a Problem

Your analyzer is built to provide dependable service. However, if you experience a problem, or if you desire additional information or wish to order parts, options, or accessories, the Agilent Technologies worldwide sales and service organization is ready to provide the support you need.

In general, a problem can be caused by a hardware failure, a software error, or a user error. Follow these general steps to determine the cause and to resolve the problem.

1. Perform the quick checks listed in “Check the Basics” in this chapter. It is possible that a quick check may eliminate your problem altogether.
2. If the problem is a hardware problem, you have two options:
    - Repair it yourself; see the “Service Options” section in this chapter.

WARNING **No operator serviceable parts inside the analyzer. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers.**

- Return the analyzer to Agilent Technologies for repair; if the analyzer is still under warranty or is covered by an Agilent Technologies maintenance contract, it will be repaired under the terms of the warranty or plan (the warranty is at the front of this manual).

  If the analyzer is no longer under warranty or is not covered by an Agilent Technologies maintenance plan, Agilent Technologies will notify you of the cost of the repair after examining the instrument. See “Getting in touch with Agilent Technologies, Inc.” and “How to Return Your Analyzer for Service” for more information.

3. If the problem is a software problem, you have two options:
    - Reinstall the firmware and or the measurement personality DLP.
    - Return the analyzer to Agilent Technologies for repair; if the analyzer is still under warranty or is covered by an Agilent Technologies maintenance contract, it will be repaired under the terms of the warranty or plan (the warranty is at the front of this manual).

      If the analyzer is no longer under warranty or is not covered by an Agilent Technologies maintenance plan, Agilent Technologies will notify you of the cost of the repair after examining the instrument. See “Getting in touch with Agilent Technologies, Inc.” and “How to Return Your Analyzer for Service” for more information.

Before You Call Agilent Technologies

Check the Basics

A problem can often be resolved by repeating the procedure you were following when the problem occurred. Before calling Agilent Technologies or returning the analyzer for service, please make the following checks:

- Check the line fuse.
- Is there power at the receptacle?
- Is the analyzer turned on? Make sure the fan is running, this indicates that the power supply is on.
- If the display is dark or dim, press the upper **Viewing Angle** key in the upper-left corner of the front panel. If the display is too bright, adjust the lower **Viewing Angle** key in the upper-left corner of the front panel.
- If other equipment, cables, and connectors are being used with your ESA spectrum analyzer, make sure they are connected properly and operating correctly.
- Review the procedure for the measurement being performed when the problem appeared. Are all the settings correct?
- If the analyzer is not functioning as expected, return the analyzer to a known state by pressing the **Preset** key.

  Some analyzer settings are not affected by a Preset. If you wish to reset the analyzer configuration to the state it was in when it was originally sent from the factory, press **System**, **Power On/Preset**, **Preset (Factory)**.

- Is the measurement being performed and the results that are expected, within the specifications and capabilities of the analyzer? Refer to the “Specifications” chapters in the *ESA Spectrum Analyzers Specification Guide* for analyzer specifications.
- In order to meet specifications, the analyzer must be aligned. Either Auto Align All must be selected (press **System**, **Alignments**, **Auto Align**, **All**), or the analyzer must be manually aligned at least once per hour, or whenever the temperature changes more than 3 degrees centigrade. When **Auto Align**, **All** is selected, AA appears on the left edge of the display (in SA mode only).
- Is the analyzer displaying an error message? If so, refer to Error Messages in the *Agilent ESA Spectrum Analyzers User’s Guide*.
- If the necessary test equipment is available, perform the performance verification tests in the *ESA Spectrum Analyzers Calibration Guide*. Record all results on a Performance Verification Test Record form located after the test descriptions.
- If the equipment to perform the performance verification tests is not available, you may still be able to perform the functional checks in the *ESA Spectrum Analyzers User’s Guide*.

Read the Warranty

The warranty for your analyzer is at the front of this manual. Please read it and become familiar with its terms.

If your analyzer is covered by a separate maintenance agreement, please be familiar with its terms.

Service Options

Agilent Technologies offers several optional maintenance plans to service your analyzer after the warranty has expired. Call your Agilent Technologies sales and service office for full details.

If you want to service the analyzer yourself after the warranty expires, you can purchase the service documentation that provides all necessary test and maintenance information.

You can order the service documentation, **Option OBW** (assembly level troubleshooting and adjustment procedures) and **Option OBV** (component level information including parts lists, component location diagrams and schematic diagrams), through your Agilent Technologies sales and service office. Service documentation is described under “Service Documentation and Adjustment Software (Option OBW)” and “Component Level Service Documentation (Option OBV)” in *ESA Spectrum Analyzers User’s Guide*.

Getting in touch with Agilent Technologies, Inc.

Agilent Technologies has call centers around the world to provide you with complete support for your analyzer. To get assistance with all your test and measurement needs, get in touch by internet, phone, or fax, with the nearest Agilent Technologies call center listed in Table 8-1. In any correspondence or telephone conversations, refer to your analyzer by its product number, full serial number, and firmware revision. (Press **System**, **More**, **Show System**, and the product number, serial number, and firmware revision information will be displayed on your analyzer screen.) A serial number label is also attached to the rear panel of the analyzer.

Table 8-1 Getting in touch with Agilent

On-line assistance: `www.agilent.com/find/assist`			
United States (tel) 1 800 452 4844	**Japan** (tel) (+81) 426 56 7832 (fax) (+81) 426 56 7840	**New Zealand** (tel) 0 800 738 378 (fax) (+64) 4 495 8950	**Europe** (tel) (+31) 20 547 2323 (fax) (+31) 20 547 2390
Canada (tel) 1 877 894 4414 (fax) (905) 282 6495	**Latin America** (tel) (305) 269 7500 (fax) (305) 269 7599	**Australia** (tel) 1 800 629 485 (fax) (+61) 3 9210 5947	

Asia Call Center Numbers

Country	Phone Number	Fax Number
Singapore	1-800-375-8100	(65) 836-0252
Malaysia	1-800-828-848	1-800-801664
Philippines	(632) 8426802 1-800-16510170 (PLDT Subscriber Only)	(632) 8426809 1-800-16510288 (PLDT Subscriber Only)
Thailand	(088) 226-008 (outside Bangkok) (662) 661-3999 (within Bangkok)	(66) 1-661-3714
Hong Kong	800-930-871	(852) 2506 9233
Taiwan	0800-047-866	(886) 2 25456723
People’s Republic of China	800-810-0189 (preferred) 10800-650-0021	10800-650-0121
India	1-600-11-2929	000-800-650-1101

How to Return Your Analyzer for Service

Service Tag

If you are returning your analyzer to Agilent Technologies for servicing, fill in and attach a blue service tag. Several service tags are supplied at the end of this chapter. Please be as specific as possible about the nature of the problem. If you have recorded any error messages that appeared on the display, or have completed a Performance Test Record, or have any other specific data on the performance of your analyzer, please send a copy of this information with your analyzer.

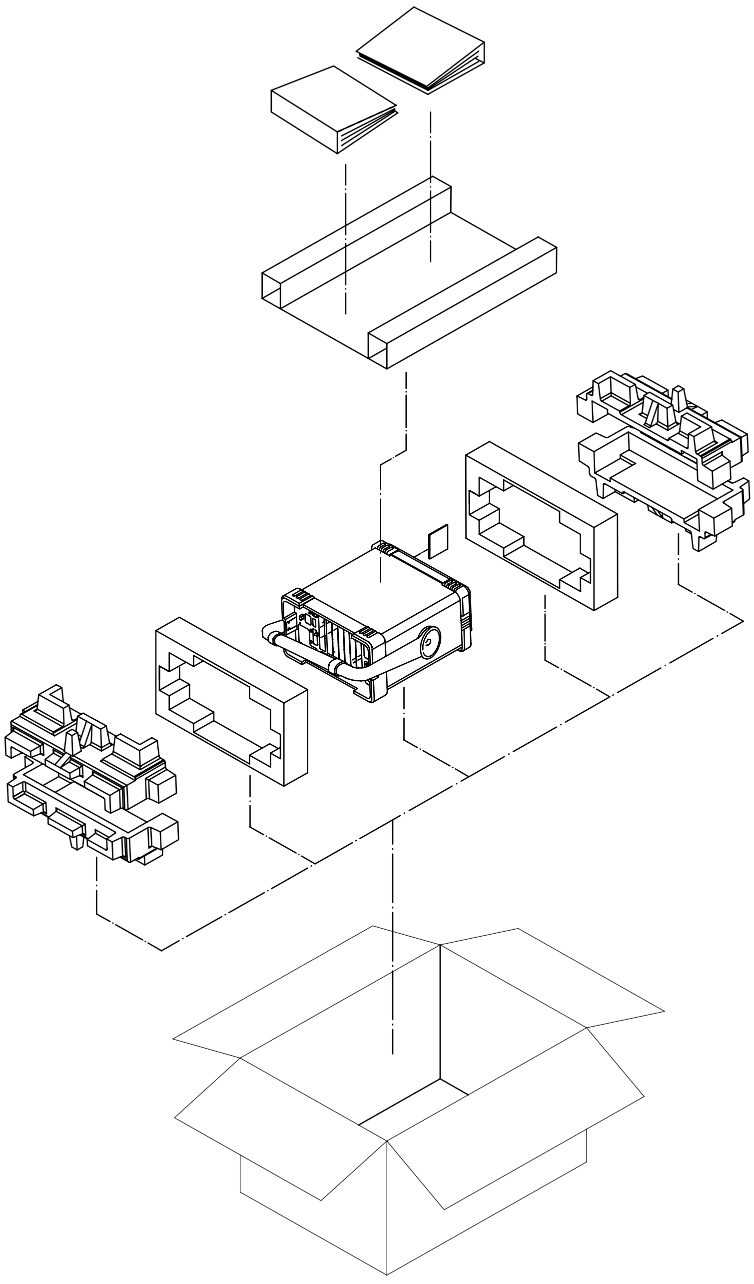
Original Packaging

Before shipping, pack the unit in the original factory packaging materials if they are available. If the original materials were not retained, see "Other Packaging".

NOTE Ensure that the instrument handle is in the rear-facing position in order to reduce the possibility of damage during shipping. Refer to Figure 8-1.

NOTE Install the transportation disk into the floppy drive to reduce the possibility of damage during shipping. If the original transportation disk is not available, a blank floppy may be substituted.

Figure 8-1



Other Packaging

CAUTION Analyzer damage can result from using packaging materials other than those specified. Never use styrene pellets in any shape as packaging materials. They do not adequately cushion the equipment or prevent it from shifting in the carton. They cause equipment damage by generating static electricity and by lodging in the analyzer louvers, blocking airflow.

You can repackage the instrument with commercially available materials, as follows:

1. Attach a completed service tag to the instrument.
2. Install the transportation disk or a blank floppy disk into the disk drive.
3. If you have a front-panel cover, install it on the instrument. If you do not have a front panel cover, make sure the instrument handle is in the forward-facing position to protect the control panel.
4. Wrap the instrument in antistatic plastic to reduce the possibility of damage caused by electrostatic discharge.
5. Use a strong shipping container. The carton must be both large enough and strong enough to accommodate the analyzer. A double-walled, corrugated cardboard carton with 159 kg (350 lb) bursting strength is adequate. Allow at least 3 to 4 inches on all sides of the analyzer for packing material.
6. Surround the equipment with three to four inches of packing material and prevent the equipment from moving in the carton. If packing foam is not available, the best alternative is S.D.-240 Air Cap™ from Sealed Air Corporation (Hayward, California, 94545). Air Cap looks like a plastic sheet filled with 1-1/4 inch air bubbles. Use the pink-colored Air Cap to reduce static electricity. Wrapping the equipment several times in this material should both protect the equipment and prevent it from moving in the carton.
7. Seal the shipping container securely with strong nylon adhesive tape.
8. Mark the shipping container “FRAGILE, HANDLE WITH CARE” to assure careful handling.
9. Retain copies of all shipping papers.

Index

Index

Index

Index

Index

Index