User's, Programming, and Measurement Guide

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

This guide documents firmware revision A.08.xx

This manual provides documentation for the following instruments:

Agilent 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)

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Safety Information

The following safety notes are used throughout this manual. Familiarize yourself
with these notes before operating this instrument.

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.
WARNING	**This is a Safety Class 1 Product (provided with a protective earth ground incorporated in the power cord). The mains plug shall be inserted only in a socket outlet provided with a protected earth contact. Any interruption of the protective conductor inside or outside of the product is likely to make the product dangerous. Intentional interruption is prohibited.**
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.

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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 seven chapters cover user information such as how to set up and use the instrument. Chapter 8 , "Programming Language Reference," covers the SCPI remote programming commands.

The following table gives a brief overview of each chapter.

Table 1-1 **Book Organization**
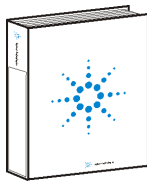
	1. Using this Document This chapter.	This chapter describes the organization of this book.
	2. Understanding Modulation Analysis See page 19.	This chapter defines modulation analysis and describes its characteristics.
	3. Getting Started See page 37.	This chapter describes how to install and uninstall this measurement personality.
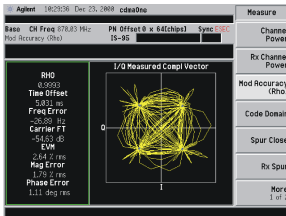
Table 1-1   Book Organization
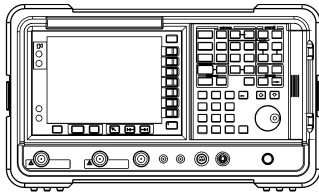
	4. Setting Up the Modulation Analysis Mode See page 49.	This chapter describes how to set the instrument up to perform modulation analysis measurements.
	5. Making Modulation Analysis Measurements See page 53.	This chapter describes how to make standard and custom measurements and interpret the results.
  ke847a	**6. Menu Maps** See page 93.	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.
	7. Front Panel Key Reference See page 109.	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.
	8. Programming Language Reference See page 131.	These are the SCPI commands available in EVM mode.
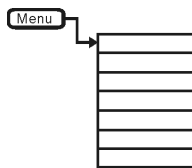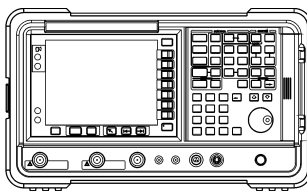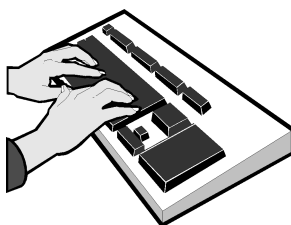
Table 1-1   **Book Organization**

9. If You Have a Problem

See .

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 cdmaOne (IS-95) Communication System

IS-95 code division multiple access (cdmaOne) is one of several digital wireless transmission methods in which signals are encoded using a specific pseudo-random sequence, or code, to define a communication channel. A receiver, knowing the code, can use it to decode the received signal in the presence of other signals in the channel. This is one of several "spread spectrum" techniques, which allows multiple users to share the same radio frequency spectrum by assigning each active user a unique code. cdmaOne offers improved spectral efficiency over analog transmission in that it allows for greater frequency reuse. Other characteristics of cdmaOne systems reduce dropped calls, increase battery life and offer more secure transmission.

The W-CDMA Communication System

Wideband code division multiple access (W-CDMA) is the first of the supported 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 of 5 MHz.

The CDMA2000 Communication System

Code division multiple access 2000 (cdma2000) is the second of the supported 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 wide RF bandwidth of 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 use correlative codes to distinguish one user from another. Frequency division (FDMA) and Time Division (TDMA) are also used. 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 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.

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:

- TIA/EIA/IS-2000 Mobile Station - Base Station Compatibility Standard

for Dual-Mode Wideband Spread Spectrum Cellular System

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 GSM Standards

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.

GSM 450, GSM 480, GSM 850, GSM 900, DCS 1800, and PCS 1900 are GSM-defined frequency bands. The term GSM 900 is used for any 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 (in the 1800 MHz frequency band) is an adaptation of GSM 900, created to allow for smaller cell sizes for higher system capacity. PCS 1900 (in the 1900 MHz frequency band) is intended to be identical to DCS 1800 except for frequency allocation and power levels. PCS 1900 is used primarily in the USA. The term GSM 1800 is sometimes used for DCS 1800, and the term GSM 1900 is sometimes used for PCS 1900. For specifics on the bands, refer to Table 2-1.

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, a control channel, and a cell broadcast channel. The GSM specification defines a channel spacing of 200 kHz.

Table 2-1 **GSM Band Data**

	P-GSM 900	E-GSM 900	R-GSM 900	DCS 1800	PCS 1900	GSM450	GSM480	GSM850
Uplink (MS Transmit)	890 - 915 MHz	880 - 915 MHz	876 - 915 MHz	1710 - 1785 MHz	1850 - 1910 MHz	450.6 - 457.4 MHz	479.0 - 485.8 MHz	824.2 - 848.8 MHz
Downlink (BTS Transmit)	935 - 960 MHz	925 - 960 MHz	921 - 960 MHz	1805 - 1880 MHz	1930 - 1990 MHz	460.6 - 467.4 MHz	489.0 - 495.8 MHz	869.0 - 894.0 MHz
Range (ARFCN)	1 to 124	0 to 124 and 975 to 1023	1 to 124 and 955 to 1023	512 to 885	512 to 810	259 to 293	306 to 340	128 to 251
TX/RX Spacing (Freq.)	45 MHz	45 MHz	45 MHz	95 MHz	80 MHz	45 MHz	45 MHz	45 MHz
TX/RX Spacing (Time)	3 timeslots	3 timeslots	3 timeslots	3 timeslots	3 timeslots	3 timeslots	3 timeslots	3 timeslots
Modulation Data Rate	270.833 kbits/s	270.833 kbits/s	270.833 kbits/s	270.833 kbits/s	270.833 kbits/s	270.833 kbits/s	270.833 kbits/s	270.833 kbits/s
Frame Period	4.615 ms	4.615 ms	4.615 ms	4.615 ms	4.615 ms	4.615 ms	4.615 ms	4.615 ms
Timeslot Period	576.9 μs	576.9 μs	576.9 μs	576.9 μs	576.9 μs	576.9 μs	576.9 μs	576.9 μs
Bit Period	3.692 μs	3.692 μs	3.692 μs	3.692 μs	3.692 μs	3.692 μs	3.692 μs	3.692 μs
Modulation	0.3 GMSK	0.3 GMSK	0.3 GMSK	0.3 GMSK	0.3 GMSK	0.3 GMSK	0.3 GMSK	0.3 GMSK
Channel Spacing	200 kHz	200 kHz	200 kHz	200 kHz	200 kHz	200 kHz	200 kHz	200 kHz
TDMA Mux	8	8	8	8	8	8	8	8

Analysis

The GSM framing structure is based on a hierarchical system consisting of timeslots, TDMA frames, multiframes, superframes, and hyperframes. One timeslot (or RF burst) consists of 148 bit periods including training sequence, encryption, guard time, and data bits. Eight of these timeslots make up one TDMA frame. Either 26 or 51 TDMA frames make up one multiframe. Frames 13 and 26 in the 26 frame multiframe are dedicated to control channel signaling.

These principles of the GSM systems lead to the need for the fundamental transmitter measurements, one of which is Phase and Frequency Error which verifies the accuracy of the transmitter's 0.3 GMSK modulation process.

NOTE   A full suite of GSM measurements (including Power vs. Time and Output RF Spectrum) can be performed with Option BAH.

Mobile Stations And Base Transceiver Stations

The cellular system includes the following:

- base transceiver stations, referred to as BTS
  (frequency ranges dependent on the standard; refer to Table 2-1)

- mobile stations, referred to as MS
  (frequency ranges dependent on the standard; refer to Table 2-1)

Uplink And Downlink

Uplink is defined as the path from the mobile station to the base transceiver station. Downlink is the path from the base transceiver station to the mobile station.

What Is An ARFCN?

An ARFCN is the Absolute Radio Frequency Channel Number used in the GSM system. Each RF channel is shared by up to eight mobile stations using Time Division Multiple Access (TDMA). The ARFCN is an integer (in a range dependent on the chosen standard, refer to Table 2-1) which designates the carrier frequency.

What Is A Timeslot?

GSM utilizes Time Division Multiple Access (TDMA) with eight time slots per RF channel which allows eight users to use a single carrier frequency simultaneously. Users avoid one another by transmitting in series. The eight users can transmit once every 4.62 ms for 1 timeslot which is 577 µs long. The eight user timeslots are numbered from 0 to 7.

Typically, each 577 µs timeslot has a length of 156.25 bit periods, which consists of 148 data bits and 8.25 guard bits. The 4.62 ms required to cycle through eight timeslots is called a frame. In a TDMA system, the shape of each transmitted burst must be controlled carefully to avoid over-lapping bursts in time.

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 (8PSK with 3pi/8 rotation) and filtering designed to provide higher data rates in the same spectrum. EDGE allows more bits to be sent in each burst. This increases 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.

NOTE   EDGE has also been adopted as the basis for IS-136HS (NADC + EDGE) signals.

GSM 450, GSM 480, GSM 850, GSM 900, 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 and 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 Does

The Agilent ESA-E Series Spectrum Analyzer with the modulation analysis measurement personality 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.

Table 2-2   **Radio Format Settings**

Radio Format	Device	Demod Format	Symbol Rate	Meas Filter	Ref Filter	Alpha/BT	Points/Symbol	Measurement Interval or Result Length	Frequency Span	Burst Search Threshold	Burst Search Length	Burst Sync (Under EVM MeasSetup)	I/Q Points	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	5	Off
cdmaOne	MS	Offset QPSK	1.2288 MS/s	Off	Chebyshev	n/a	4	200	3 MHz	–20 dB	1 s	None	4	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	5	Off
cdma2000 SR1	MS	QPSK	1.2288 MS/s	Off	Chebyshev	n/a	5	256	3 MHz	–20 dB	1 s	None	5	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	5	Off
NADC	BTS	Pi/4 DQPSK	24.3 kS/s	Root Nyquist	Nyquist	0.35	5	162	100 kHz	–20 dB	49 ms	None	5	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.	5	Off
EDGE (8PSK)	BTS	PSK EDGE	270.833 kS/s	EDGE (winRC)	EDGE	0.25	1	142	600 kHz	–20 dB	5.3 ms	Training Seq.	1	Off
EDGE (8PSK)	MS	PSK EDGE	270.833 kS/s	EDGE (winRC)	EDGE	0.25	1	142	600 kHz	–20 dB	5.3 ms	Training Seq.	1	Off
GSM (GMSK)	BTS & MS	MSK	270.833 kS/s	Off	Gauss	0.3	10	146	600 kHz	–20 dB	5.3 ms	Training Seq.	10	Off
PDC	BTS	Pi/4 DQPSK	21.0 kS/s	Root Nyquist	Nyquist	0.5	5	138	100 kHz	–20 dB	48 ms	None	5	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.	5	Off
TETRA	BTS	Pi/4 DQPSK	18.0 kS/s	Root Nyquist	Nyquist	0.35	5	246	100 kHz	–20 dB	73 ms	None	5	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.	5	Off

The ESA spectrum analyzer with modulation analysis measurement personality is capable of making the following measurements on the appropriate or relevant standards:

- 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.

- Link to a PC running Agilent's 89600 VSA Vector Signal Analysis software. This allows in-depth time, frequency and modulation domain analysis of many RF signals up to 10 MHz in bandwidth, including AM, FM, PM, BPSK, QPSK, 8PSK, DQPSK, pi/4DQPSK, FSK, GMSK, 16-256QAM, DVB, VSB, 3GPP and cdma2000. To order a free demo CD, visit our website at www.agilent.com/find/89600.

Other Sources of Measurement Information

Additional measurement application information is available through your local Agilent Technologies sales and service office, or from Agilent's web site at http://www.agilent.com. 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   Getting Started

This chapter introduces you to basic features of the instrument, including the front panel keys, rear panel connections, and display annotation. Equipment required for modulation analysis measurements, available documentation, and processes for installing and uninstalling this measurement personality are also described.

Instrument Overview

This section provides information on only Modulation Analysis mode features. For those features not described here, refer to the *Agilent ESA Spectrum Analyzers User's Guide.*

Front-Panel Features

For further information on the features mentioned in the following section, refer to Chapter 7 , "Front Panel Key Reference," of this document.

Figure 3-1   **Front-Panel Feature Overview**
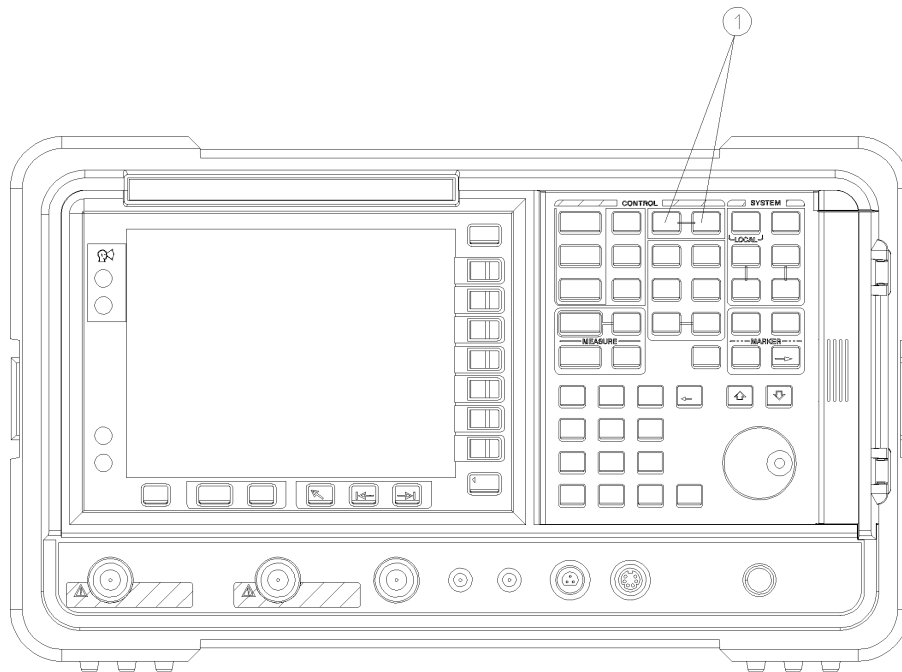
pl728b

Table 3-1   **Key to Figure 3-1 Front-Panel Feature Overview (above)**

1   Mode keys   These keys allow you to select the measurement mode and mode parameters such as input and trigger settings.

- **MODE** accesses menu keys to select the instrument mode. Each mode is independent of all other modes.

- **Mode Setup** accesses menu keys that allow you to configure the parameters specific to the current mode and affect all measurements within that mode.

Rear-Panel Features

This section provides information on Modulation Analysis rear panel features only. For those features not described here, refer to the *ESA-E Series Spectrum Analyzers User's Guide*.

Figure 3-2 **Rear-Panel Feature Overview**
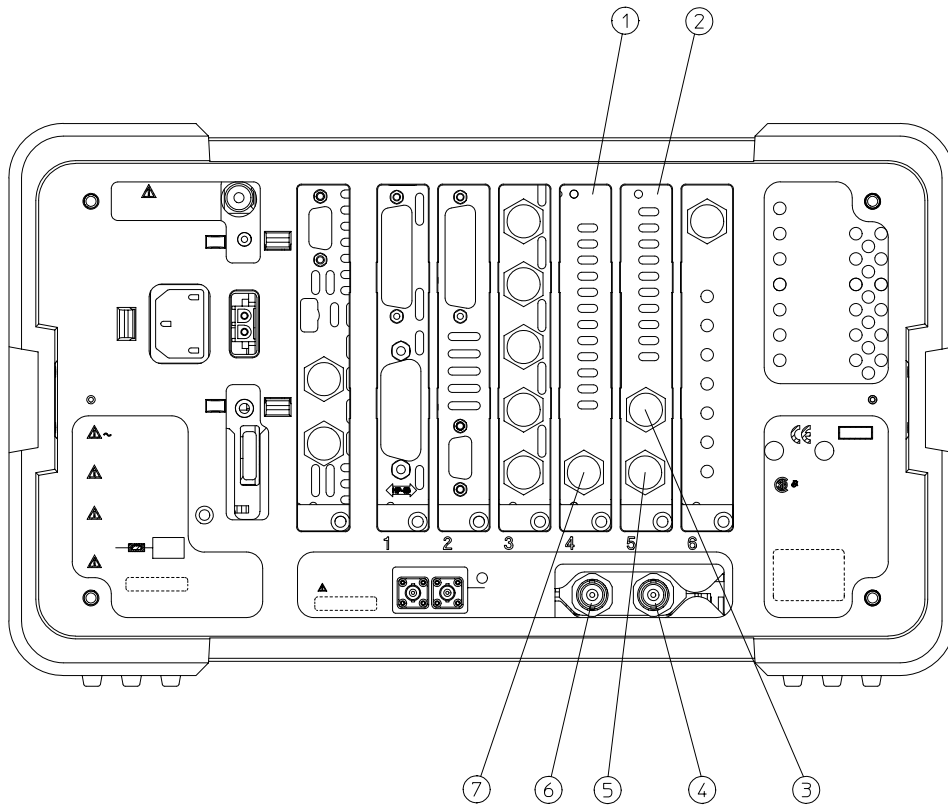
pl729b

Table 3-2   **Key to Figure 3-2 Rear-Panel Feature Overview (above)**

1	**DSP and Fast ADC**	DSP and Fast ADC (*Option B7D*) provides digital signal processing and fast ADC required for many of the digital demodulation measurements in the Modulation Analysis and other measurement personalities. It must be ordered with Option B7E and Option 1D5.
2	**RF Comms Hardware**	RF Communications Hardware (*Option B7E*) provides the RF down convertor hardware required for digital demodulation measurements. It must be ordered with Option B7D and Option 1D5.
3	**Ext Ref In**	Accepts an external 1 MHz to 30 MHz reference frequency source.
4	**10 MHz REF IN**	Accepts an external frequency source to provide the 10 MHz, −15 to +10 dBm frequency reference used by the analyzer.
5	**10 MHz Out**	Provides a 10 MHz, 0 dBm minimum, timebase reference signal phase locked to the Ext Ref In.
6	**10 MHz REF OUT**	Provides a 10 MHz, 0 dBm minimum, timebase reference signal.
7	**Ext Frame Sync**	Accepts an external 0 to 5 V TTL trigger.

Options Required

Installing the Modulation Analysis measurement personality firmware and making the associated measurements require certain basic equipment. This section lists Modulation Analysis compatible Agilent ESA Spectrum Analyzers and required hardware options.

Compatible Spectrum Analyzers

The Modulation Analysis measurement personality is not compatible with all ESA spectrum analyzer models. Table 3-3 lists the models that are compatible and the upper frequency range of each.

Table 3-3   **Modulation Analysis Compatible Agilent ESA Spectrum Analyzers**

Model Number	Upper Frequency Range
E4402B	3 GHz
E4404B	6.7 GHz
E4405B	13.2 GHz
E4407B	26.5 GHz

Hardware Options Required

Additional hardware options must be installed in the spectrum analyzer before Modulation Analysis measurements can be made. Table 3-4 lists the hardware options required for optimum performance of Modulation Analysis measurements.

Not all of the options can be installed by the user. Some of the options require that the instrument be returned to the factory or an Agilent Technologies service center. In addition, some of the options require Performance Verification and Adjustments to be performed after installation. Refer to Table 3-4 for option specific information.

NOTE   When transporting the instrument, use the original packaging or comparable packaging. If the shipping container is damaged, any part is missing, or you do not have an appropriate shipping container, notify Agilent Technologies at one of the addresses shown on "Getting in touch with Agilent Technologies, Inc." on page 182.

Table 3-4 Modulation Analysis Hardware Options and Measurements

Required/recommended option	Option Number	Comments
Modulation Analysis Personality	229	Required for all measurements.
Memory extension	B72	
DSP and Fast ADC	B7D[a]	Required
RF Communications Hardware	B7E[a]	
High Stability Frequency Reference	1D5[b]	Recommended
RF and Digital Communication Hardware Option bundle	Option B74[b] Includes the following options: 1D6 B72 1D5 B7D B7E 1DS 1DR	Includes necessary hardware for the modulation analysis measurements personality.

a. Service center or factory installation; calibration required.
b. Factory installation only.

NOTE   If the appropriate hardware is not present, the measurement softkey under the **Measure** menu will be grayed out and that measurement will not be available.

Installing Optional Measurement Personalities

Active License Key

The measurement personality software you have purchased with your instrument has been installed and the license key has been enabled at the factory. With any future purchase of a new personality software, you will receive a certificate that displays the unique license key number. The license key enables you to install, or reinstall, any measurement personality you have purchased. If you return the instrument to the factory for the installation of measurement personality software, you will receive no documentation of the license key number, nor will you receive documentation of the license key number for the measurement personality software you have purchased with your instrument.

Installing the Licensing Key

If you are installing a new option, follow these steps to install the unique license key number for the measurement personality software that you want to install in your instrument:

1. Press **System**, **More**, **Licensing**, **Option**.

   When you press **Option** the alpha editor will be activated. For instructions on using the alpha editor, refer to the *Agilent ESA Spectrum Analyzers User's Guide*.

2. Use the alpha editor to enter the three letter designation for the software option that you wish to install in the instrument.

3. Press **Done** on the alpha editor menu.

4. Press **License Key**.

   When you press **Licensing Key** the alpha editor will be activated. For instructions on using the alpha editor, refer to the *Agilent ESA Spectrum Analyzers User's Guide*.

5. Use the alpha editor to enter the 12 character licensing key number for the software option that you wish to install in the instrument.

6. Press **Done** on the alpha editor menu.

7. Press **Activate** to turn on the licensing key. You may now install the measurement personality option software.

Using the Install Key

You may want to install a software revision, install new measurement software or reinstall measurement software that you have previously uninstalled, or uninstall measurement software. Before you can install software, you will need a set of installation diskettes.

If you have ordered a measurement personality, you will receive the installation disk set in the option upgrade package. If you are updating an existing, previously installed measurement option, you may order the diskettes from Agilent Technologies or create a set from the Agilent internet site shown in "Updating the Firmware" on page 48. When you order the updated software disk set, you will need to order Option UE2. (Option UE2 is a firmware update and is needed to ensure that the firmware and the software are compatible.) A set of diskettes can be ordered from your local Agilent Technologies service or sales office. Refer to "Getting in touch with Agilent Technologies, Inc." on page 182 for the location of these offices. To create a disk set refer to "Creating Software Installation Disks" below.

Creating Software Installation Disks

To create the installation disks on-line, visit the Agilent internet site shown in "Updating the Firmware" on page 48. Follow the instructions provided on the internet site for downloading the current measurement personalty software and creating the installation disk set. The instructions for creating the disk set will step you through the process to create a firmware disk set when you create the measurement personalty software disk set. (A firmware update may be needed to ensure that the firmware and the software are compatible.) After you have created the disk set, follow the on-line instructions to install the firmware. After successfully installing the firmware update, proceed with the following instructions for installing the measurement personalty software in your instrument.

Installing Personality/Software Options

This procedure gives steps to install a new software option in an ESA-E Series Spectrum Analyzer using the internal floppy drive of the instrument. Screen messages display the update progress and give directions. The instrument will not need to be re-calibrated after this procedure since no changes are made to calibration or adjustment files.

If you have a problem with the installation process, refer to "Troubleshooting the Installer" on page 46.

NOTE   When the installer starts up, it examines the instrument to ensure that all the required software and hardware options are present. If they are not, the installer will generate an error and you will not be able to install the personality.

1. If this is the installation of new personality option software, you must enter the License Key for the new option. For instructions on entering the License Key, refer to the "Installing the Licensing Key" on page 43.

When you have completed entering the license key number, continue with the next step.

2. Insert disk one of the installation disk set into the disk drive located on the right side of the ESA front panel.

3. Press **System**, **More**, **Personalities**, and **Install**. The instrument will then load the installer from the floppy drive. If there is no floppy in the drive, the incorrect disk is inserted, or there is no installer on the disk, the error "No install disk present in disk drive" will be shown.

   Once the instrument has loaded the installer, the screen will change to the installer screen and the **Install Pers.** menu will be shown. For more information on the installer screen and menu, refer to "Installer Screen and Menu" on page 47.

4. When the installer first starts up, it will show a popup message. Select **Verify Disks**.

NOTE
Once the installer has begun installing a personality, any error will cause the whole personality (including a previously installed version) to be removed from the instrument. Because of this, it is very important that you verify the disks prior to installing them. If any of the disks or files are bad, you will not be able to use the personality until you obtain a new installation disk set and run the install using them.

5. When prompted, insert the next disk and press **Verify Disks** again.

   When Verify Disks is running, the **Install Now** and **Exit Install** keys will be grayed out.

6. When the verification is complete, press **Install Now** and the installation of the personality will begin. Some of the disks may take only a short time to load or be skipped entirely, while others can take up to about 30 minutes to load.

   When installer is running, the **Verify Disks** and **Exit Install** keys will be grayed out.

7. When prompted, insert the next disk and press **Install Now** again.

8. Once the installation is complete, press **Exit Install**.

Troubleshooting the Installer

If the installation process stalls or fails in another way, follow these steps to resolve your problem.

1. If the instrument stops the update process before all the disks are loaded proceed as follows:

   a. Press **Exit Install** to abort the process.

   b. Return to step 2 under "Installing Personality/Software Options" and start the installation process again.

2. If the instrument fails after repeating the installation procedure, get in touch with your nearest Agilent sales and service office listed in "Getting in touch with Agilent Technologies, Inc." on page 182 for assistance. Please provide the following information:

   Model Number:

   Serial Number:

   State that you are having trouble installing a software option update.

Installer Screen and Menu

The top portion of the install screen is a table in which the files that are about to be installed are listed. The bottom portion of the screen contains information needed to track the progress of the install.
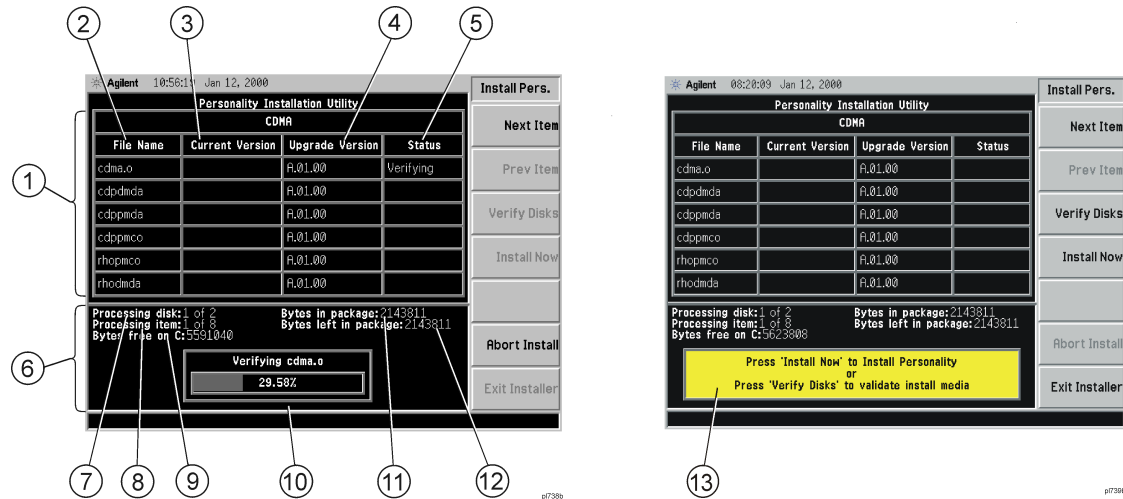
Table 3-5   **Key to Installer Screen and Menu Screen (above)**

1   **File Table** displays the files to be installed and various file information. If there are more then six files, **Next Item** and **Prev Item** allow you to scroll the table to view additional items.

2   **File Name** displays the name of the files on the installation disk.

3   **Current Version** displays the version of the file that is currently installed in the instrument. (This field will be blank if this file is not currently installed in the instrument or if the file is a data file that has no version.)

4   **Upgrade Version** shows the version of the file on the install disk. This is the version of the file that will replace the currently installed version.

5   **Status** is updated to reflect what the installer is doing to the current file as the install progress. The valid messages seen in this column are listed in Table 3-6 on page 48.

6   **Data Field** contains a status bar and various status information.

7   **Processing disk** shows the disk that is currently being read.

8   **Processing item** shows the file that is being processes by item number.

9   **Bytes free on C** is the number of bytes currently free on the instrument C: drive.

10   **Status Bar** contains a status bar that runs from 0 to 100% and tracks the progress of the current step and a message line displays the step that is currently being executed.

Table 3-5   **Key to Installer Screen and Menu Screen (above)**

11   **Bytes in package** lists the number of bytes in the install package/ fill.

12   **Bytes left in package** lists the number of bytes left to be read.

13   Message and error popup window that displays over the status bar. Information in this box will prompt you for action required to proceed to the next phase of the installation. It may also inform you of errors in the installation process and may prompt you for action required to correct the problem.

Table 3-6   **Installer Status Messages**

Failed	This means that something has gone wrong while processing this item. It is a fatal error and the installation can not be completed. The installer will try to get the system back to a good state which may entail completely removing the currently installed personality.
Loading	The file is currently being copied from the install media to the instrument's file system.
Verifying	This may mean one of two things: 1. If "Verify Disks" was pressed then Verifying means that the installer is currently reading the install media and comparing the known checksums to ensure the data is good. 2. If "Install Now" was pressed, then Verifying means that the installer is reading what was just loaded to ensure the checksum is correct.
Loaded	This means that the data has been placed on the instrument disk but has not yet been registered with the firmware.
Installed	This means that the data has been loaded into the instrument and registered. The install for this file is complete.
Skipping	This means that the installer has determined that this file does not need to be loaded into the instrument.

Agilent ESA Spectrum Analyzers Update

For the latest information about this instrument, including firmware upgrades, application information, and product information, please visit the URL listed below.

Updating the Firmware

Updated versions of the ESA-E Series Spectrum Analyzer firmware will be available via several sources. Information on the latest firmware revision can be accessed from the following URL:

> http://www.agilent.com/find/esa/

4   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 and you have not performed a preset, 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 6 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 6 , "Menu Maps," and Chapter 7 , "Front Panel Key Reference," for additional information to guide you in changing parameter settings.

You can set the instrument to use **User** preset, **Mode** preset or **Factory** preset under the **System** front panel key. If you set the preset to **Mode** or to **Factory**, pressing **Preset** causes the analyzer to immediately reset all parameters to that particular setting. Note that a **Factory Preset** will switch modes, returning the ESA to the Spectrum Analysis mode. You will then have to re-access the Modulation Analysis mode after the preset operation is completed.

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

You may change the default settings using **Meas Setup** key. 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 using the keys shown in the figure. 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**
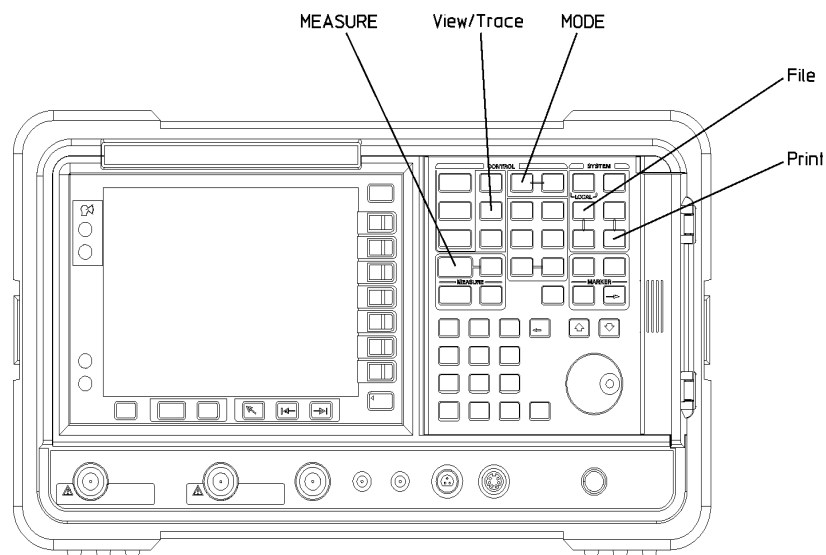
rl71b

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 to 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.

5   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:

W-CDMA (3GPP)
cdmaOne (IS-95 and J-STD-008)
cdma2000 SR1
NADC
GSM
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 (when measuring appropriate radio standards), 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 5-1.

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 5-2. 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 timebase 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 5-1 or Figure 5-2.

Figure 5-1   Measurement Setup
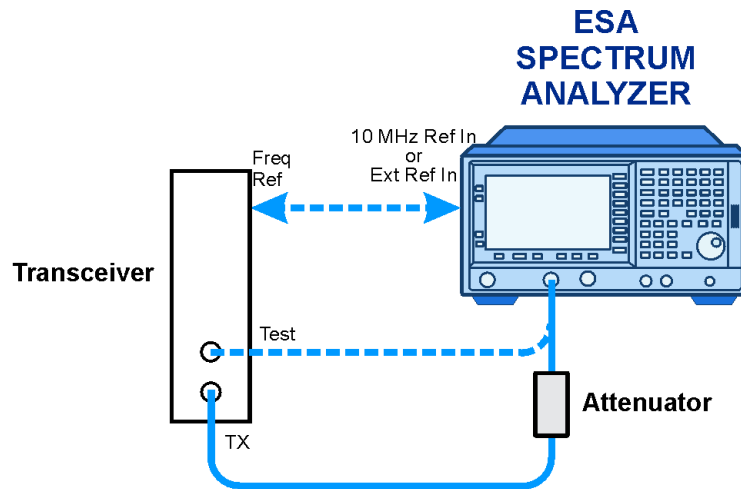
* Use Attenuator to protect the instruments if RF power exceeds 30 dBm.

bt83b

Figure 5-2   **Alternative Measurement Setup**
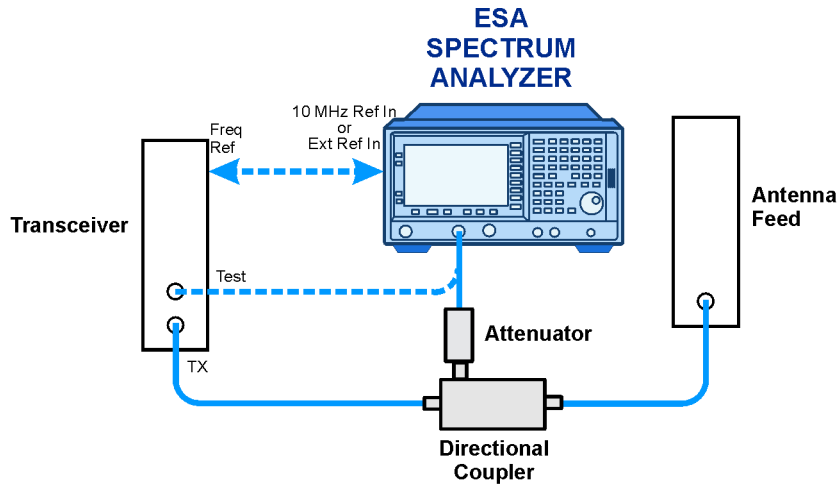
* Use Attenuator to protect the instruments if RF power exceeds 30 dBm.

bt84b

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 5-3 (Wideband CDMA signal shown). If not, then refer to "Problems Obtaining a Measurement" later in this chapter.

Figure 5-3   **Monitor Spectrum Display**
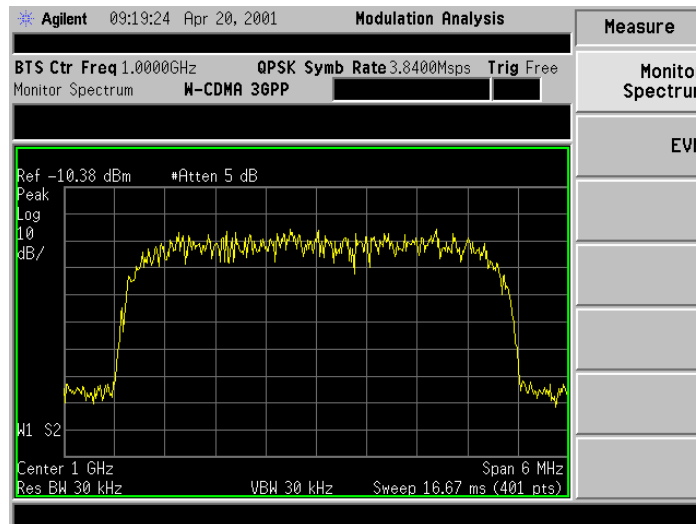
7. Press **EVM**. You should see an I/Q polar vector display of the signal, similar to that shown in Figure 5-4. Results are listed in a table left of the vector display.

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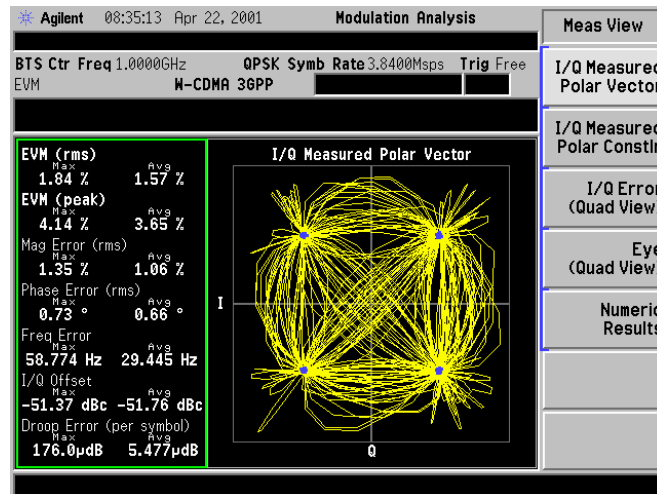
8. Press **View/Trace, I/Q Measured Polar Constln**. You should see an I/Q polar constellation display of the signal and the table of critical parameter values, similar to that shown in Figure 5-5.

NOTE   As a troubleshooting 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 5-5   **Polar Constellation Display**
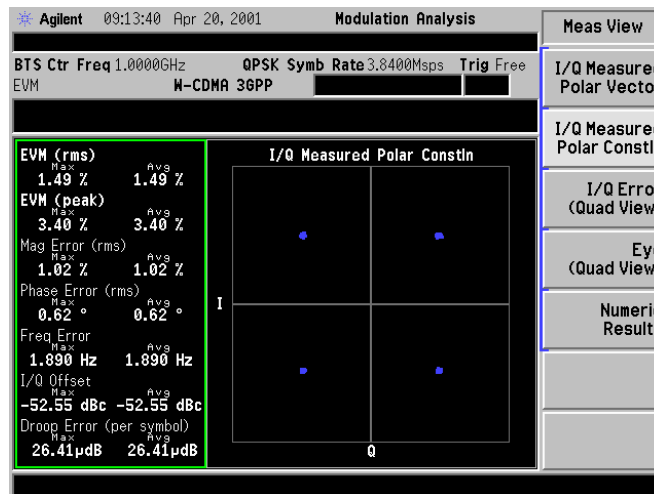
9. Press **I/Q Error (Quad View)** and refer to Figure 5-6. You should see graphical displays of magnitude error versus time, phase error versus time, EVM versus time, and tabular results.

Figure 5-6   **I/Q Errors Showing Magnitude, Phase, and EVM**
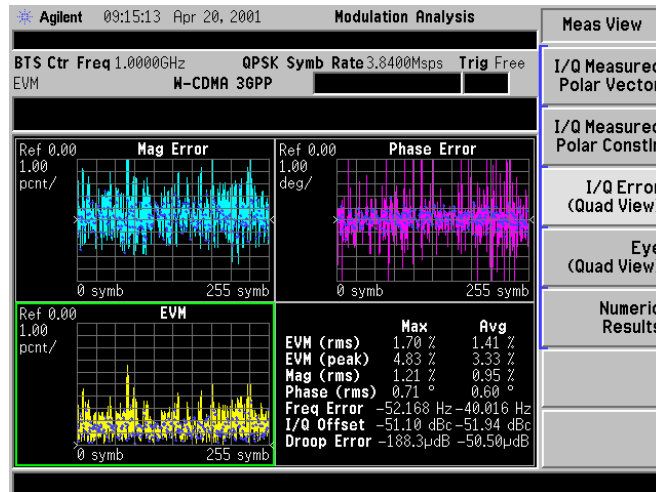
10. Press **Next Window** (a key located below the display). Each of the four individual windows are "highlighted" by a colored border as you press this key. Press **Next Window** again and then press **Zoom.** The size of the selected window expands for easier viewing.

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 5-7. You should see individual eye diagrams for I and Q, along with a polar vector display, and tabular results of critical parameter values.

NOTE   As a troubleshooting 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 5-7   **Eye Diagrams with Polar Vector Constellation**
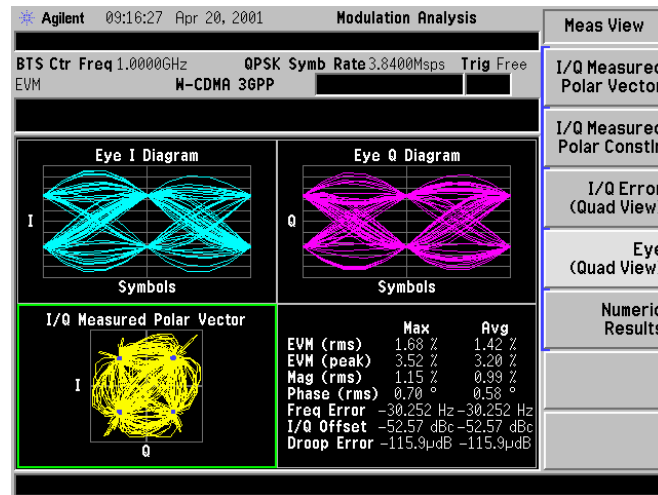
15. Press **Numeric Results** and refer to Figure 5-8. You should see a tabular display of the critical parameter values similar to the tables in the previous views. This table differs in that it also includes peak values for magnitude error and phase error. The specific symbols are identified with each of these values.

Figure 5-8   **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 5-9. This is a normal Wideband CDMA signal shown with a filter α of 0.22.

Figure 5-9   **Polar Vector of Signal Using a 0.22 Filter** α
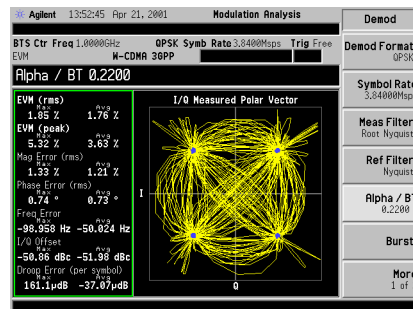
2. In contrast, refer to Figure 5-10. A Wideband CDMA signal is shown with a filter α of 1. Observe that there are smaller overshoots in the trajectories between the symbol points (item 1) due to the increased alpha. This limits the required peak power and reduces the transmitter power requirements. 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 5-10   **Polar Vector of Signal Using a 1.0 Filter α**
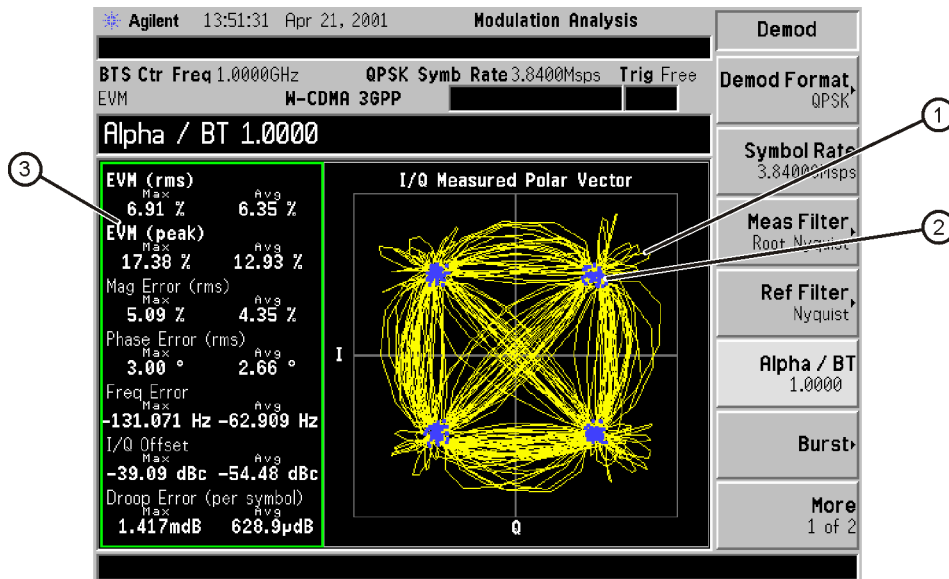
pt826b

3. Press **View/Trace, Eye (Quad View), Next Window, Next Window, Next Window, Zoom**. The display should look similar to that shown in Figure 5-11 (W-CDMA signal shown with filter $\alpha = 0.22$.)

Figure 5-11   **I Eye Diagram of Signal Using a 0.22 Filter α**
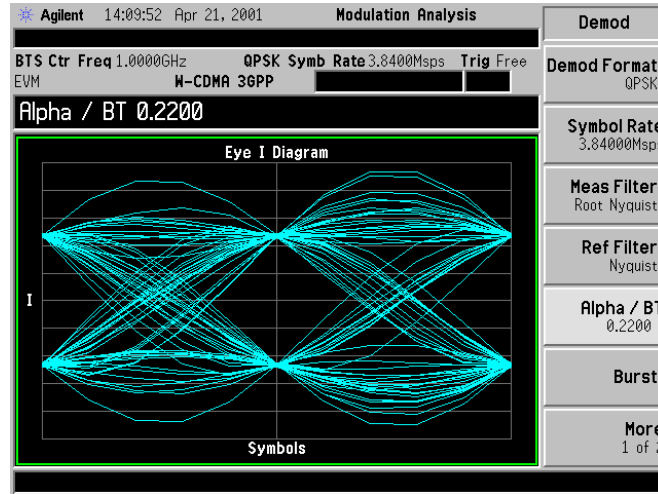
4. In contrast, refer to Figure 5-12. This shows a Wideband CDMA signal with a filter α of 1 (item 2). An incorrect filter alpha is indicated when the center diamond shape is distorted with rounding and widened crossover points at the top and bottom corners (item 1.) The eye diagram tends to "spread out" in this case.

Figure 5-12   **I Eye Diagram of Signal Using a 1.0 Filter α**
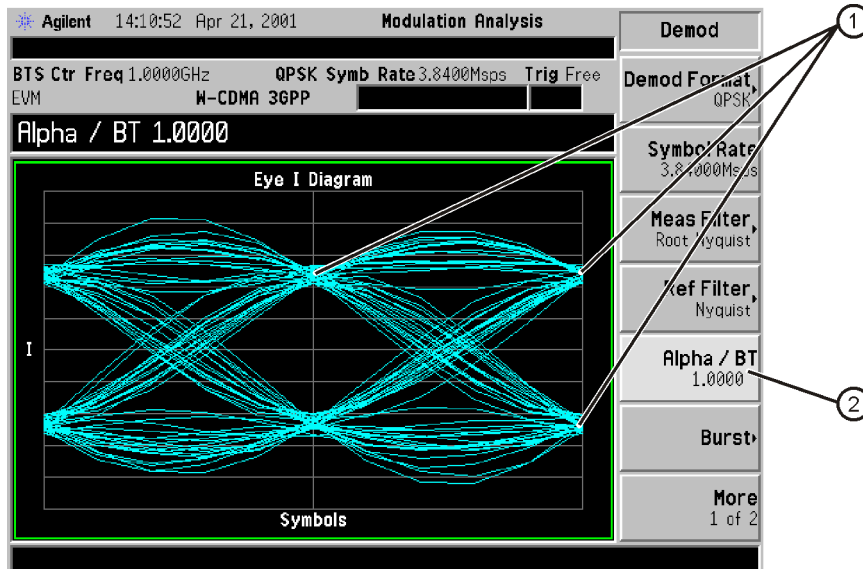
pt827b

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 5-13 (W-CDMA signal shown with filter α = 0.22.)

Figure 5-13   **Zoomed EVM Display of Signal Using a 0.22 Filter** α
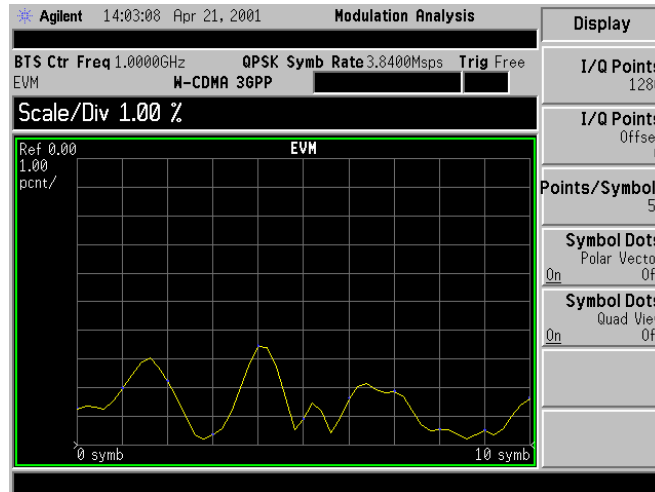
6. In contrast, refer to Figure 5-14 (W-CDMA signal shown with filter $\alpha = 1$.)

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 5-14   **Zoomed EVM Display of Signal Using a 1.0 Filter** α
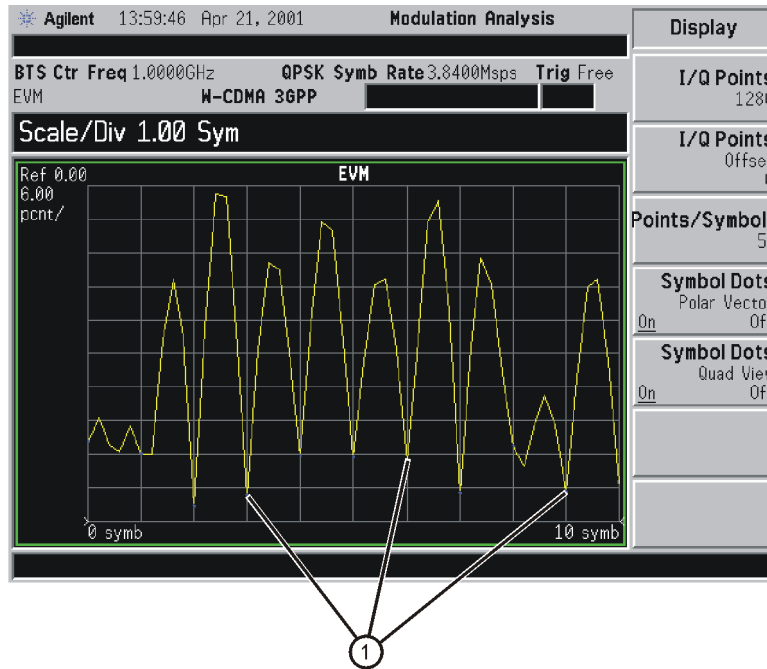
pt828b

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 5-15. 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 5-15   **Polar Constellation Showing an I/Q Gain Imbalance**
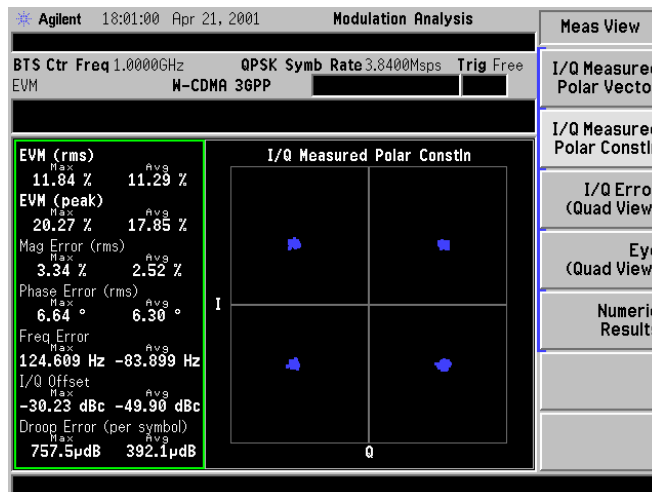
2. The polar vector diagram is shown in Figure 5-16. Observe that the rectangular shape has shifted by 90°, with the longer side of the rectangle along the Q axis. As stated earlier, this is normal, and will arbitrarily shift back and forth.

Figure 5-16   Polar Vector Showing an I/Q Gain Imbalance
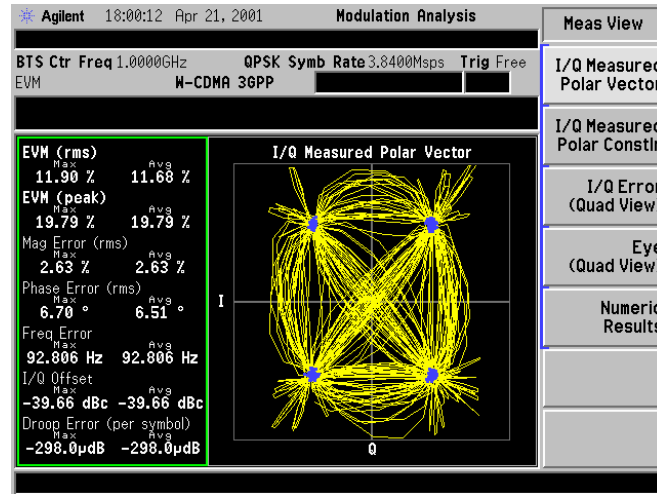
3. Figure 5-17 shows the same signal using the eye diagram. Observe that with a gain imbalance, the I and Q eye diagrams will not be similar in shape, and these shapes will be swapped back and forth between each other. In this figure, the Q eye diagram vertical amplitude (item 1) is greater than that of the I eye diagram (item 2.)

Figure 5-17   Eye Diagram Showing an I/Q Gain Imbalance
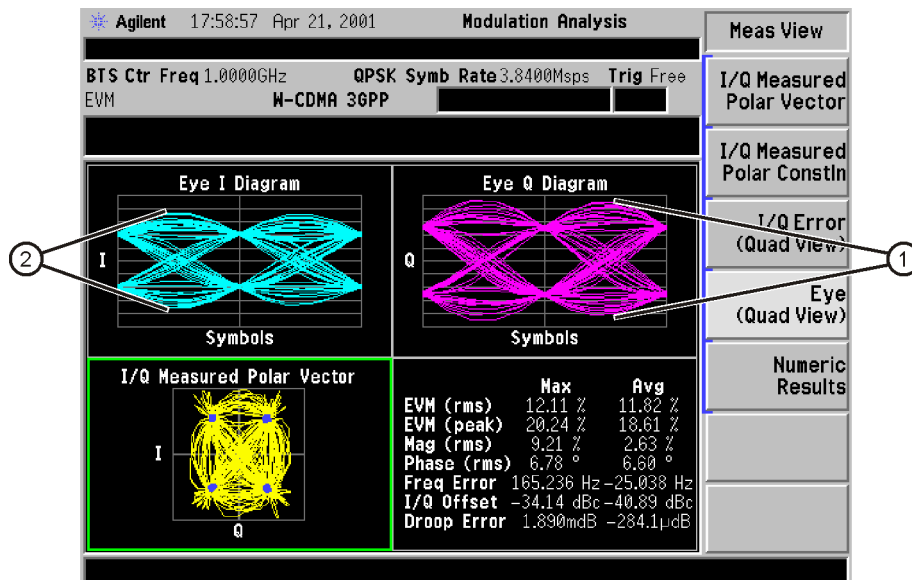
pt829b

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 5-18. 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 5-18 **Polar Constellation Showing I/Q Quadrature Error**
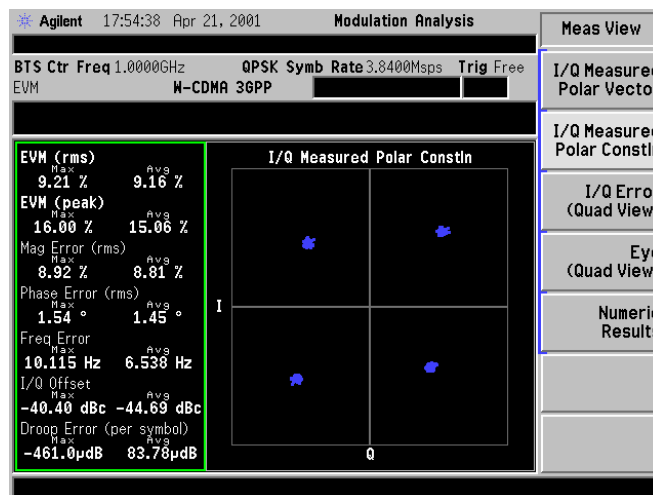
NOTE The shape of the parallelogram will shift 90° along the two axes and back again in random fashion. This is normal.

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 5-19. Observe that the parallelogram shape has shifted by 90°. As stated earlier, this is normal, and will arbitrarily shift back and forth.

Figure 5-19   Polar Vector Showing I/Q Quadrature Error
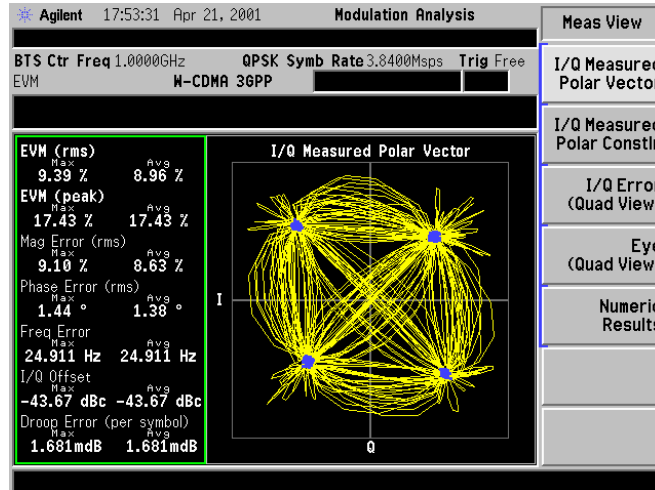
3. The zoomed I eye diagram is shown in Figure 5-20. Observe that with a quadrature error, the crossover points alternately shift between time records. Because of this, an open triangle pattern begins to take shape at the decision points (item 1.)

Figure 5-20   Zoomed I Eye Diagram Showing I/Q Quadrature Error
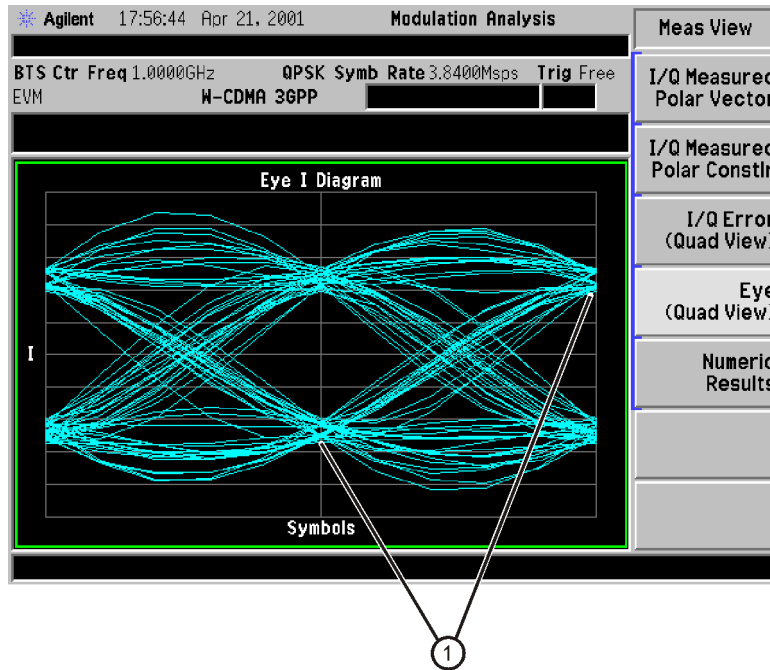
pt830b

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 5-21. 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 5-21   **Polar Constellation Showing Symbol Rate Error**
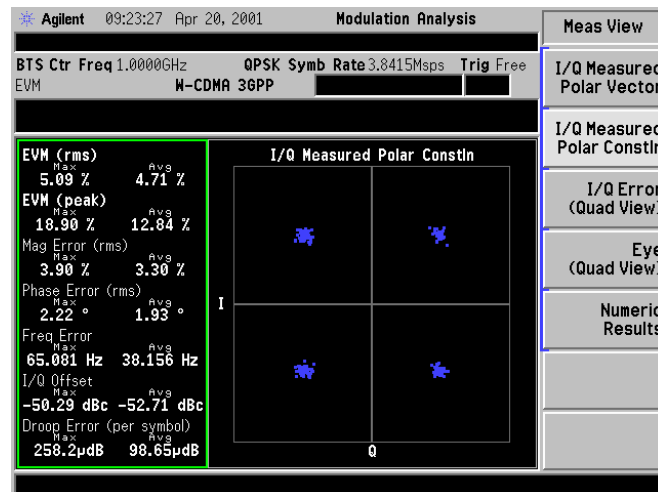
2. Figure 5-22 shows the polar vector diagram of this signal, with a received symbol rate of 3.84150 Msps (this symbol rate can be seen above the vector diagram in the figure.) The transmitted symbol rate is 3.840 Msps.

Figure 5-22   Polar Vector Showing Symbol Rate Error
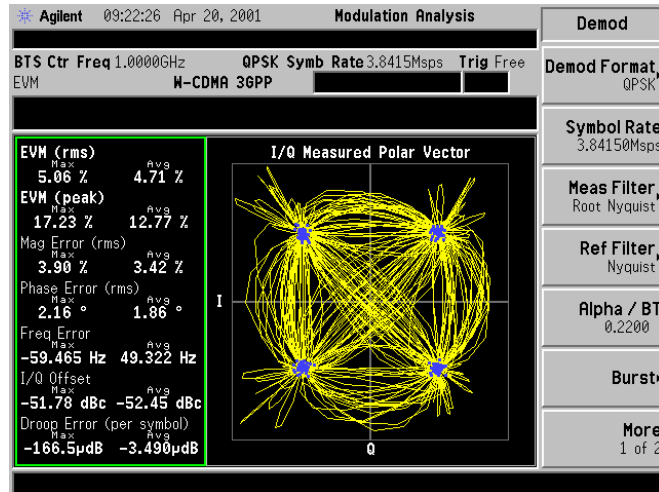
3. Figure 5-23 shows the I/Q error views of this signal. Observe at item 1 that with a symbol rate error, the EVM versus time graph shows a "V" shape.

Figure 5-23   I/Q Error Diagram Showing Symbol Rate Error
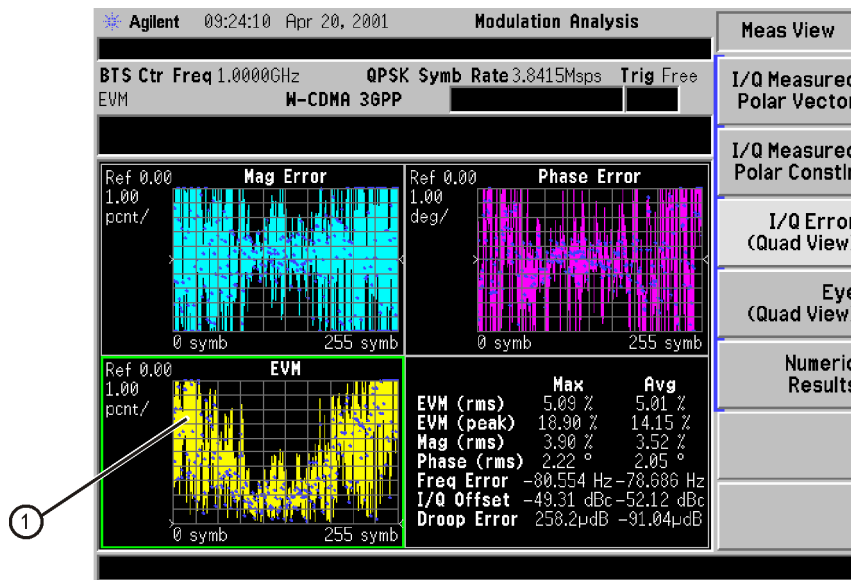
pt831b

4. Figure 5-24 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 5-24   **Zoomed EVM Versus Symbol Display Showing Symbol Rate Error**
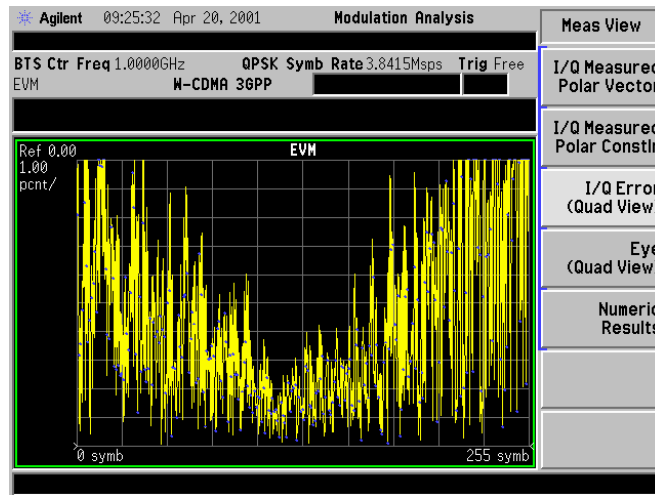
I/Q DC Offset Error

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 5-25. 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 5-25   **Polar Vector Showing I/Q DC Offset Error**
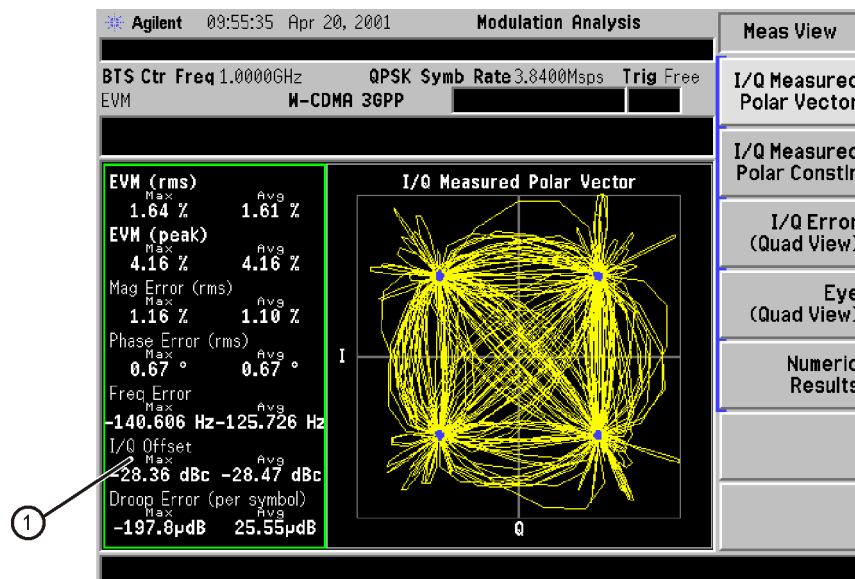
pt832b

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 ConstIn**. Figure 5-26 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 5-26   **Polar Constellation Showing PM Interference**
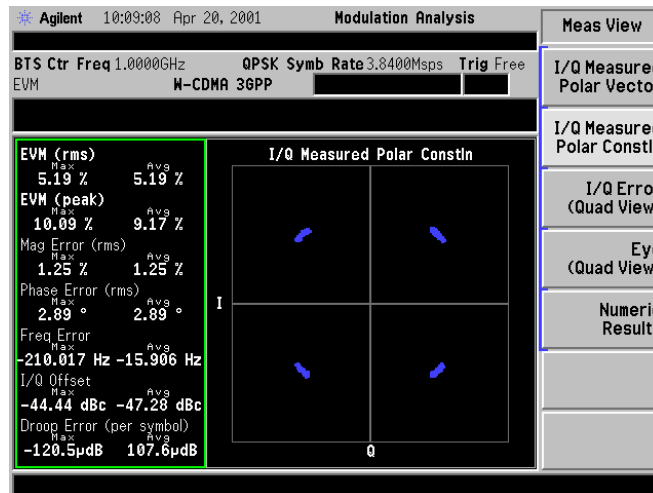
2. The I/Q error views are shown in Figure 5-27. Observe that the sinusoidal
    modulating waveform of the interfering PM signal is shown in the phase error
    versus time graph. If the graphical result was random, it would have indicated
    phase noise and not a PM interfering signal.

Figure 5-27   **I/Q Error Display Showing PM Interference**
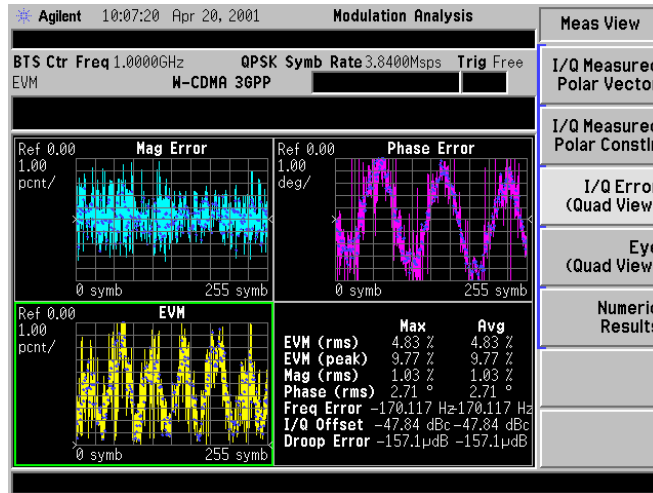
3. The zoomed phase error graph is shown in Figure 5-28. If the number of cycles can be accurately determined, the phase modulating signal frequency can be calculated. Use the **Span** and **Amplitude** keys to adjust the scaling, if necessary, to make this determination. It may also be helpful to pause 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 5-28. 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 5-28   **Zoomed Phase Error Display Showing PM Interference**
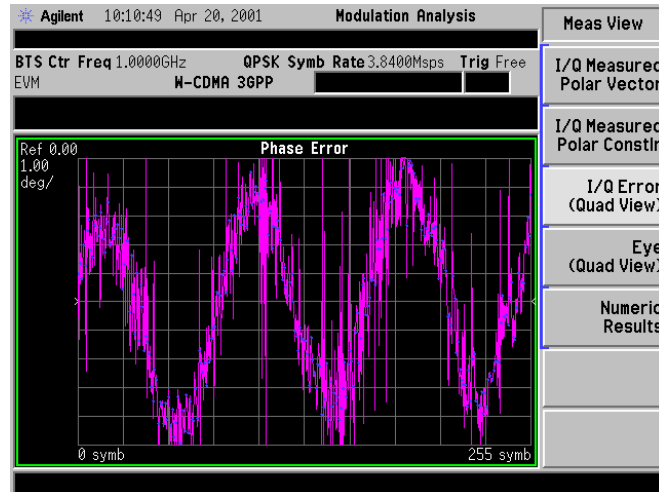
In-Channel Amplitude Modulation Interference

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 5-29 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 depth of 10% and a modulating frequency of 15 kHz.

Figure 5-29   Polar Constellation Showing AM Interference
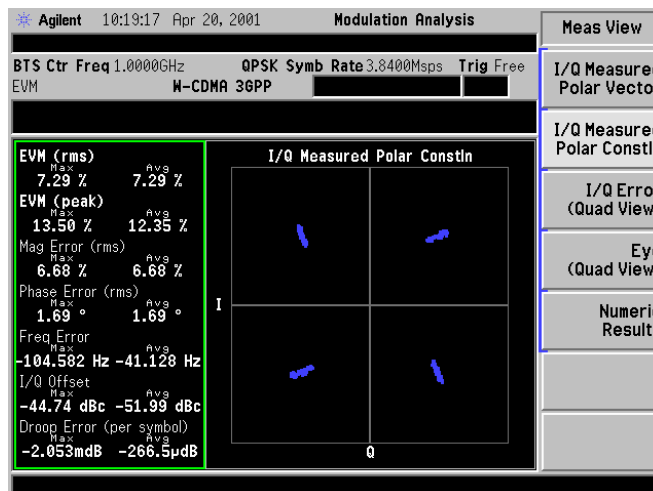
2. The I/Q error view graphs are shown in Figure 5-30.

Figure 5-30   **I/Q Error Display Showing AM Interference**
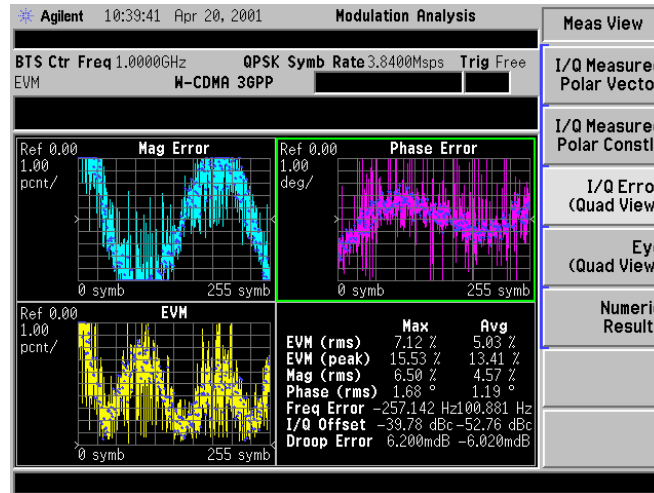
3. The zoomed phase error graph is shown in Figure 5-31. If the number of cycles can be accurately determined, the amplitude modulating signal frequency can be calculated. Use the **Span** and **Amplitude** keys to adjust the scaling, if necessary, to make this determination. It may also be helpful to 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 3.84×10^6

$AM_f = 1.1/256 \times 3.84 \times 10^6$, or about 16 kHz

Figure 5-31   **Zoomed Phase Error Display Showing AM Interference**
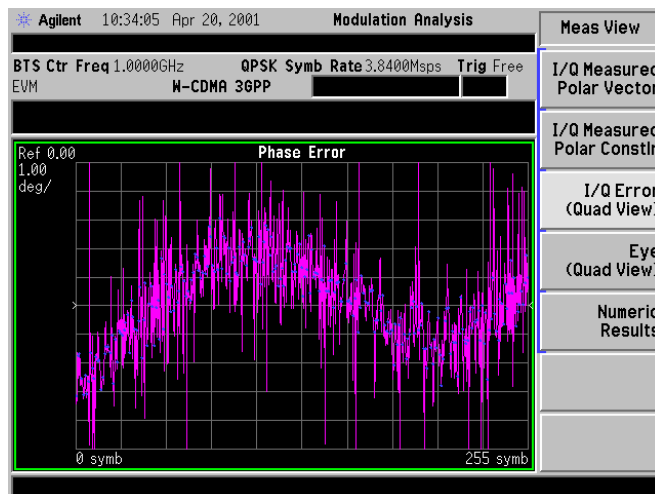
4. Peak deviation of the amplitude modulating signal is easily determined from Figure 5-32, the zoomed magnitude error versus time graph. There are about 7 divisions of peak-to-peak amplitude modulation at 3% per division, yielding 10.5% peak amplitude. This approximates the actual 10% of amplitude modulation applied to create this signal.

Figure 5-32   Zoomed Magnitude Error Display Showing AM Interference
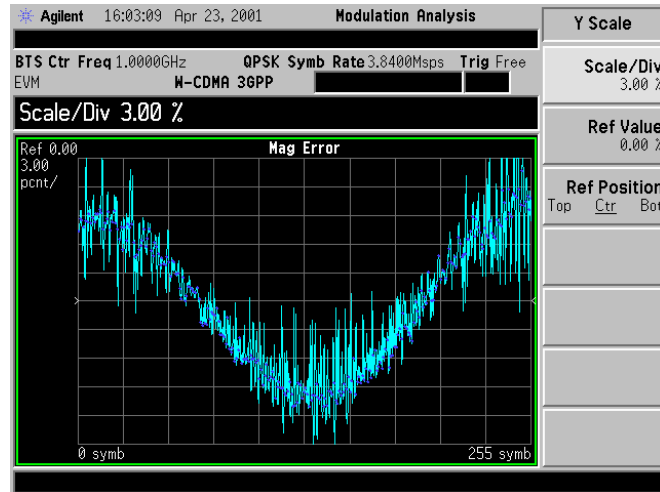
In-Channel Spurious Signal Interference

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 ring-shaped 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. The ring diameter increases as the magnitude of the spur increases. If the signal is modulated without spurious interference, the clusters of symbol decision points in each quadrant will form a solid spot rather than a ring.

1. Figure 5-33 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 5-33   **Spectrum Display Showing In-Channel Spurious Interference**
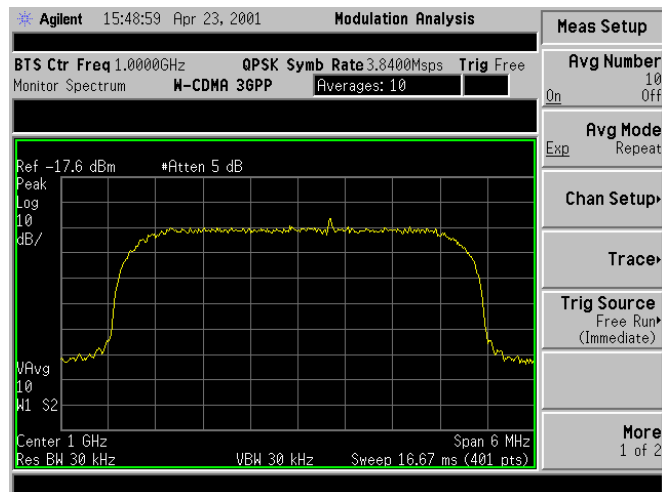
2. Use the I/Q polar constellation diagram first to identify this problem. Press **I/Q Measured Polar Constln**. Figure 5-34 shows the results created using the same interfering signal as was used in Figure 5-33.

Figure 5-34 **Polar Constellation Showing Spurious Interference at –15 dBc**
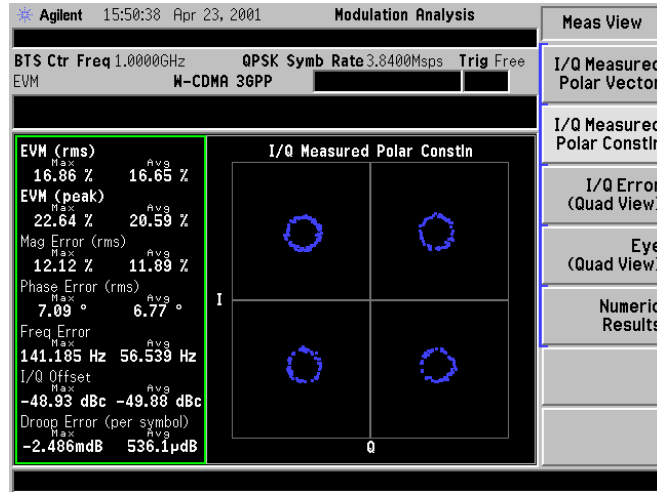
3. The same view of the interfering signal is shown in Figure 5-35, but at –28 dBc. The characteristic ring shape can still be seen.

Figure 5-35 **Polar Constellation Showing Spurious Interference at –28 dBc**
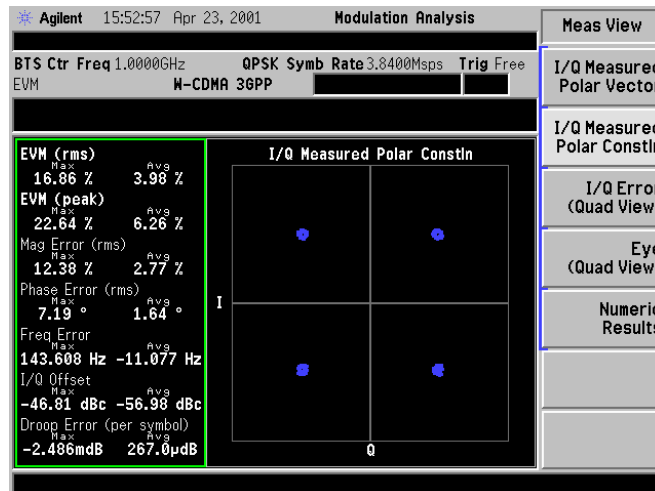
Measuring a Custom QPSK Format Signal

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 5-36.

Figure 5-36   **Polar Constellation of a QPSK Signal**
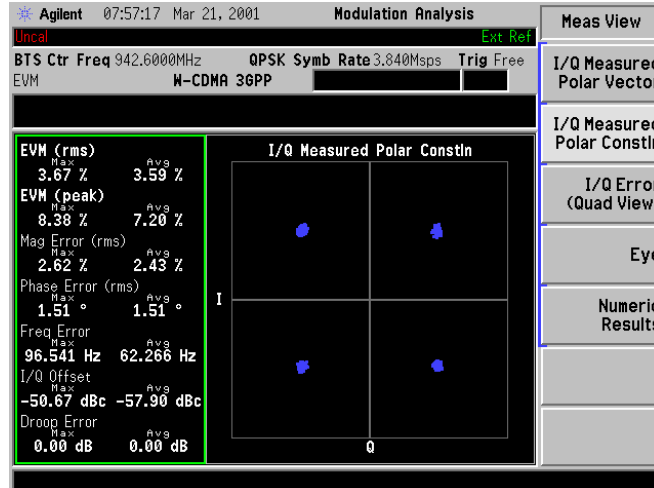
Other Customized Changes You Can Make

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 GSM or EDGE standards, 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 GSM or EDGE standard. The spectrum should look like Figure 5-37 for both GSM and EDGE signals with only one active timeslot.

Figure 5-37   **Spectrum Display of an EDGE Signal with One Active Timeslot**
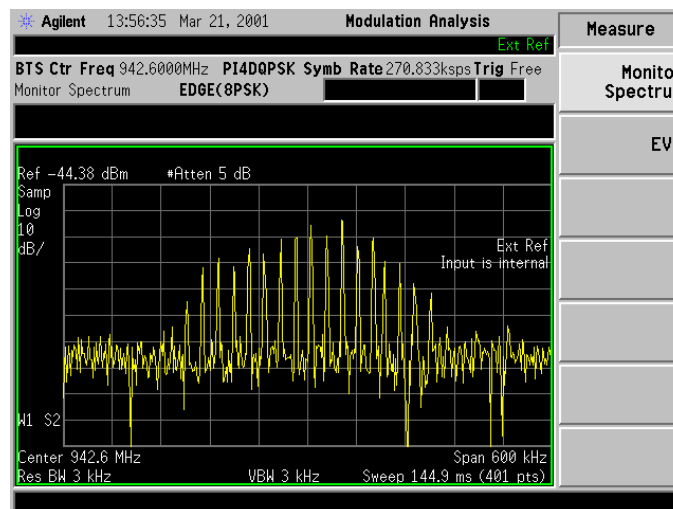
An NADC, TETRA, or PDC signal looks incorrect

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

If your NADC, TETRA or PDC BTS signal is bursted, all inactive timeslots are transmitted as a series of the numeral 1. If fewer than six down channels (or four for TETRA) are active, one or more of the down channels will be transmitting all ones and the EVM results will be inaccurate. If all six down channels (or all four in the case of TETRA) are active, this is detected as a continuous signal and can be demodulated. The **RF Amptd** parameter of **Burst Sync** needs to be set to **None** to demodulate a continuous signal.

If your NADC or PDC MS signal has two adjacent active timeslots, the signal will be demodulated as one timeslot centered on the adjoining edges of the two timeslots, and again the results will be inaccurate.

To alleviate the problems described above, there are several possible workarounds. These include:

- Test your BTS signals with all timeslots active.

- Artificially create a pulse envelope by adjusting the amplitude of the timeslot of interest.

- Use an external trigger with **External Trigger Delay** to manually align the timeslots of interest.

A "Wideband Cal Required" error message appears

- Press **Det/Demod**, **More 1 of 2, Wideband Cal**. Follow any instructions given on the display and then continue the measurement. Once the calibration has been completed, the analyzer will return to the previous measurement screen.

  Wideband Cal allows you to perform a factory calibration of the modulation analysis software. As the analyzer is calibrated on leaving the factory, this only has to be done after installing new software. Calibration is best done after the analyzer has reached its normal operating temperature. When the internal temperature changes, a partial calibration is automatically carried out and is indicated on the screen.

  If a Wideband Cal is done when the analyzer has reached its normal operating temperature, the number of automatic cals will be reduced. If the ESA has not been aligned, a full Alignment is done before the Wideband Cal. Calibration is complete once the analyzer returns to its previous screen. A Wideband Cal on its own should take about 90 secs; a Wideband Cal with Alignment takes up to 10 mins.

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.

- When using an external reference signal, there is a possibility of significant degradation in some EVM measurement results. This is more likely to be a problem if your EVM measurements are being made on signals with low symbol rates, such as TETRA, NADC or PDC. If your external reference signal can be set to 10 MHz, connect it directly into the 10 MHz REF IN port to alleviate this problem.

- If you are measuring a bursted signal, go to the **I/Q Error** view and ensure that the burst edges are not being used in the EVM measurement. If you can see the burst edges, you can either change the input signal properties or reduce the **Meas Interval** under the **Meas Setup** key.

6   Menu Maps

This chapter provides a visual representation of the front-panel keys and their associated menu keys. Refer to Chapter 7 , "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

```
        ┌─────────────┐
        │ AMPLITUDE   │
        │ Y Scale     │
        └─────────────┘
               │
               ▼
          Amplitude  a
    *  ┌───────────────┐
       │   Ref Level   │
    *  ├───────────────┤
       │  Attenuation  │
       │ Auto    Man   │
    *  ├───────────────┤
       │   Scale/Div   │
       ├───────────────┤
       │               │
       ├───────────────┤
       │               │
       ├───────────────┤
       │               │
       ├───────────────┤
       │               │
       └───────────────┘
```

* An active function that allows data entry

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

pt88a

Det/Demod Menus

Det/
Demod

Demod

Demod Format▶

Symbol Rate

Meas Filter▶

Ref Filter▶

Alpha/BT

Burst▶

More
1 of 2

Burst

Search
Threshold

Search Length

Ref Filter

Root Nyquist

Nyquist

Gaussian

Chebyshev

Rectangle

Meas Filter

Off

Root Nyquist

Nyquist

Gaussian

cdma BS pH EQ

Rectangle

Low pass

Demod Format

QPSK

Pi/4 DQPSK

OFFSET QPSK

Demod

I/Q Invert
On   Off

Wideband Cal
Now

Opt Freq Ref
10.00 MHz
Int   Ext

Opt 10MHz Out ᵃ
On   Off

More
2 of 2

a Only available when **Opt 10 MHz Out**
is set to **Ext**

b Only available when **Ref Filter** or
Meas Filter is set to **Gaussian**,
Nyquist or **Root Nyquist**

detdemod.vsd

Display Menus

a This menu only appears when **Monitor Spectrum** is selected in the **MEASURE** menu

b This menu only appears when **EVM** is selected in the **MEASURE** menu

c Unavailable and grayed out when using **OQPSK** demod format. An example is **cdmaOne** with **Device** set to **MS**

d Unavailable and grayed out when **EDGE (8PSK)** or **GSM** is selected under the **Radio Std** menus

e Unavailable and grayed ou t when using **non-OQPSK** formats

display.cdr

Frequency/Channel Menu

Freq/Channel

- Center Freq
- Start Freq a
- Stop Freq a
- Timeslot b
  0
  On   Off
- Burst Type c
- TSC (Std) d
  0
  Auto   Man

Burst Type

- Normal
  (TCH & CCH)
- Sync
  (SCH)
- Access
  (RACH)

a Only active under **Monitor Spectrum** measurements

b Only active when **EDGE (8PSK)** or **GSM** is selected under the Radio Std menu, and Trigger is set to **External**

c Only active when **GSM** is selected under the Radio Std menu

d Only active when **EDGE (8PSK)** or **GSM** is selected under the Radio Std menu

freqchan.vsd

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
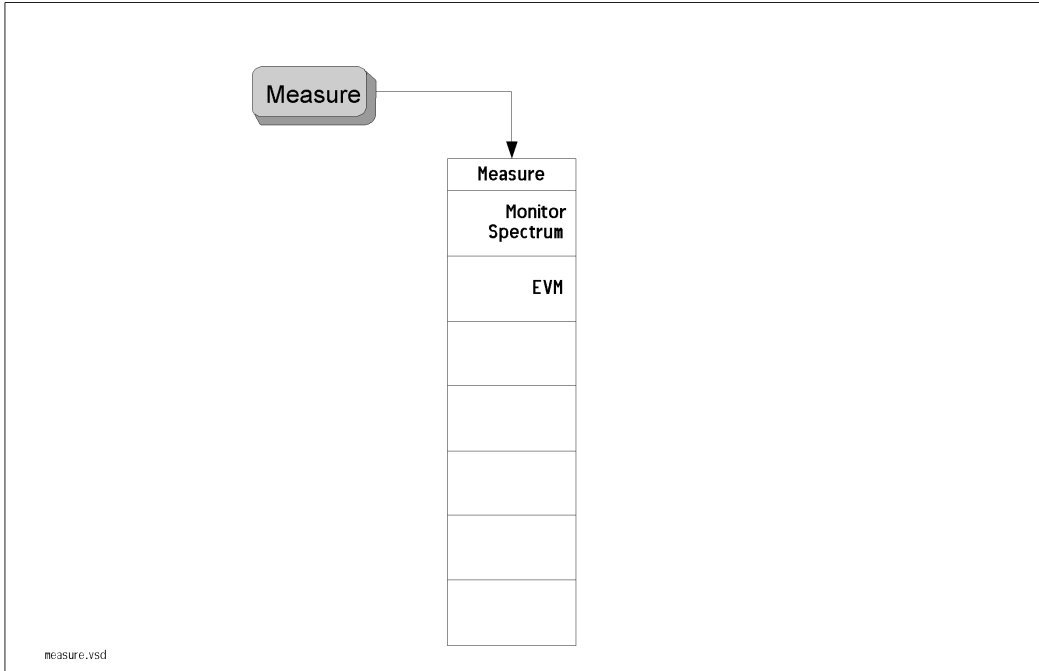
Measurement Setup Menus

Monitor Spectrum Setup Menus

monsetup.vsd

EVM Measurement Setup Menus

Meas Setup

Meas Setup
Avg Number
On   Off

Avg Mode
Exp   Repeat

Meas Interval

Trig Source ▶

Burst Sync

More
1 of 2

Burst Sync
RF Amptd

None

Trig Source
Free Run

RF Burst

External

Meas Setup
Droop Comp   a
On   Off

3 pi/8 Rotation   a
On   Off

Restore Meas
Defaults

Advanced

More
2 of 2

Advanced
Max Mixer Lvl

a Only available when using the EDGE Std.

evmsetup.vsd

Getting Started

Analysis Mode

Measurements

Mode Menu

```
            Mode

            Mode
          Spectrum
          Analysis

         Modulation
          Analysis

          cdmaOne      a

             GSM       a
```

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

mode.vsd

Mode Setup Menus

Mode
Setup

Mode Setup
Radio Std W-CDMA ▶ (3GPP)
Device BTS   MS
Trigger...
Demod...
Properties...
Restore Mode Setup Defaults

a
a
a

Radio Std
W-CDMA (3GPP)
cdmaOne
cdma2000 SR1
NADC
EDGE (8PSK)
GSM (GMSK)
More 1 of 2

Radio Std
PDC
TETRA
Additional Radio Stds..
.
More 2 of 2

a These keys open a form that is used
to set parameters for this function. For
details see the *Front Panel Key
Reference* chapter.

modsetup.vsd

Span (X Scale) Menu

```
        ┌──────────┐
        │  SPAN    │
        │  X Scale │
        └────┬─────┘
             │
             ▼
             Span      a
      *  ┌────────────────┐
         │       Span     │
         ├────────────────┤
         │                │
         ├────────────────┤
         │                │
         ├────────────────┤
         │                │
         ├────────────────┤
         │                │
         ├────────────────┤
         │                │
         ├────────────────┤
         │                │
         └────────────────┘
```

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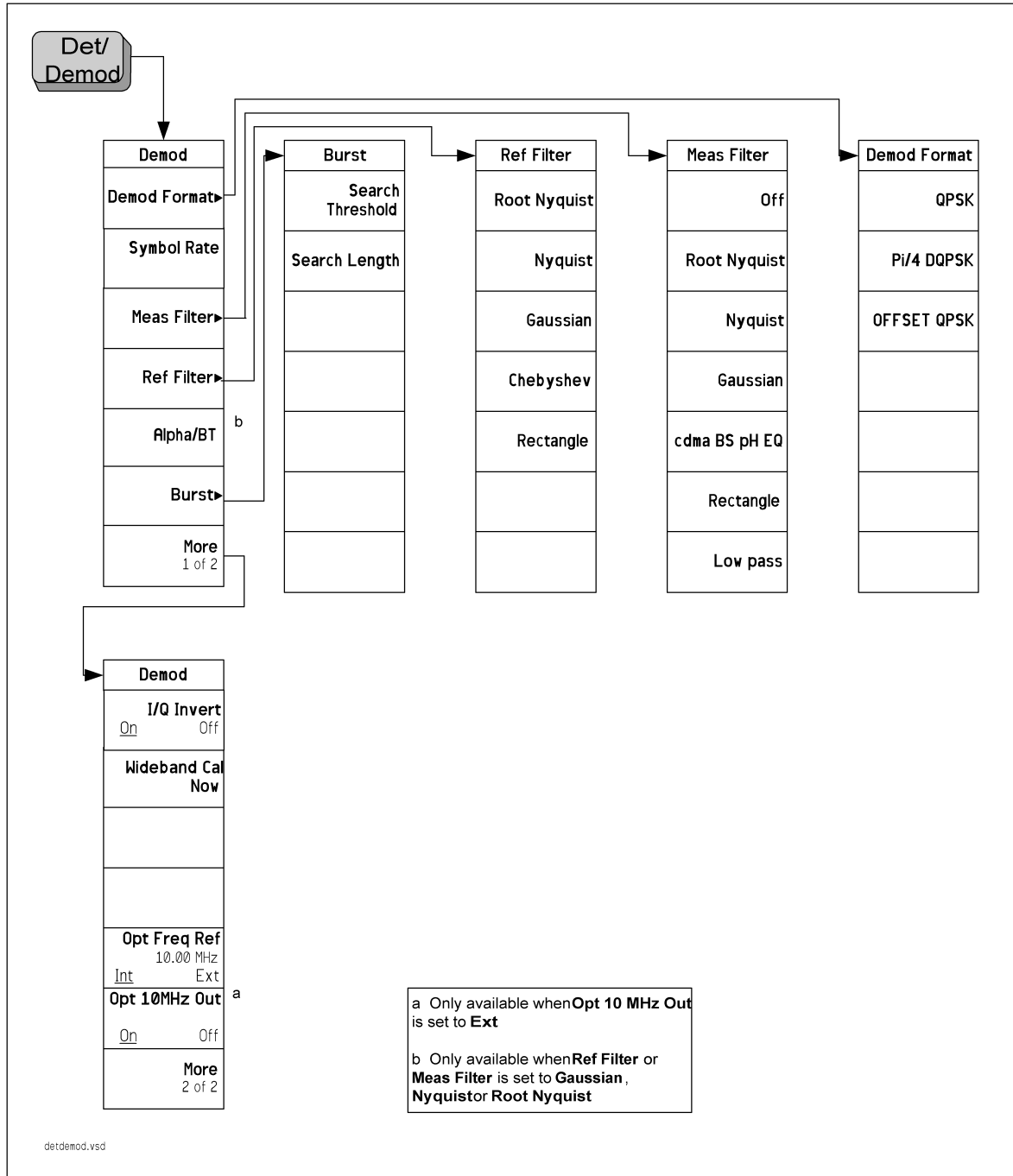
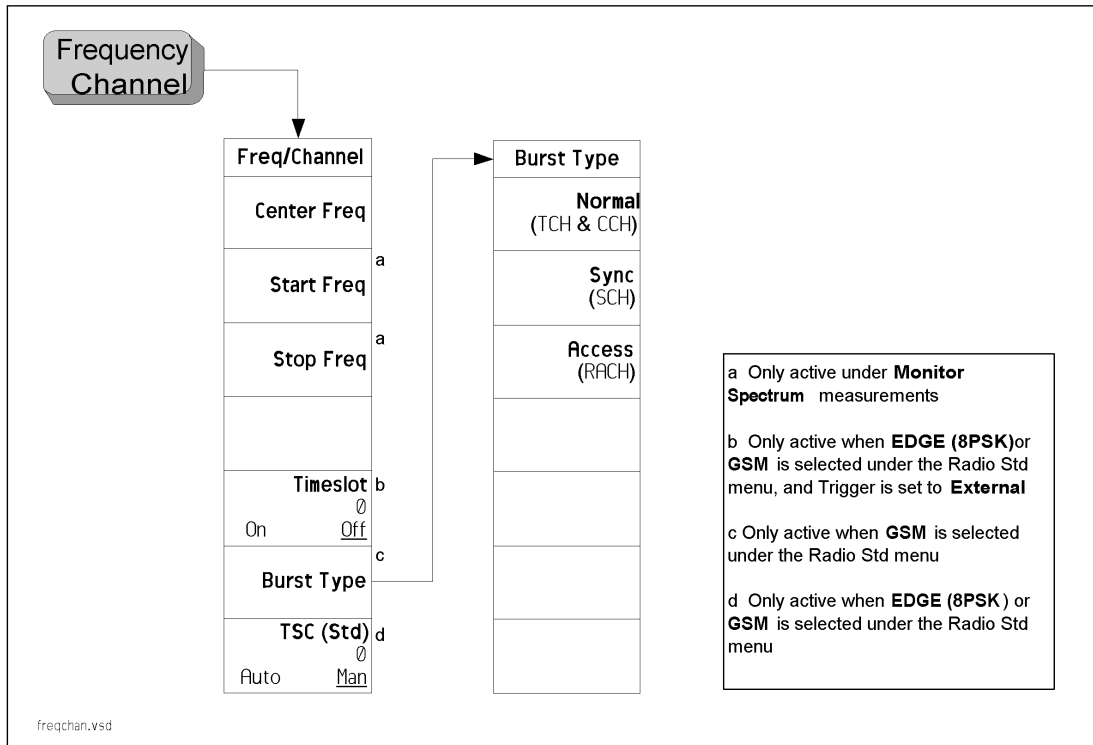a. Active only when **Monitor Spectrum** is selected under the **MEASURE** menu.

pt87a

Analysis Mode

Measurements

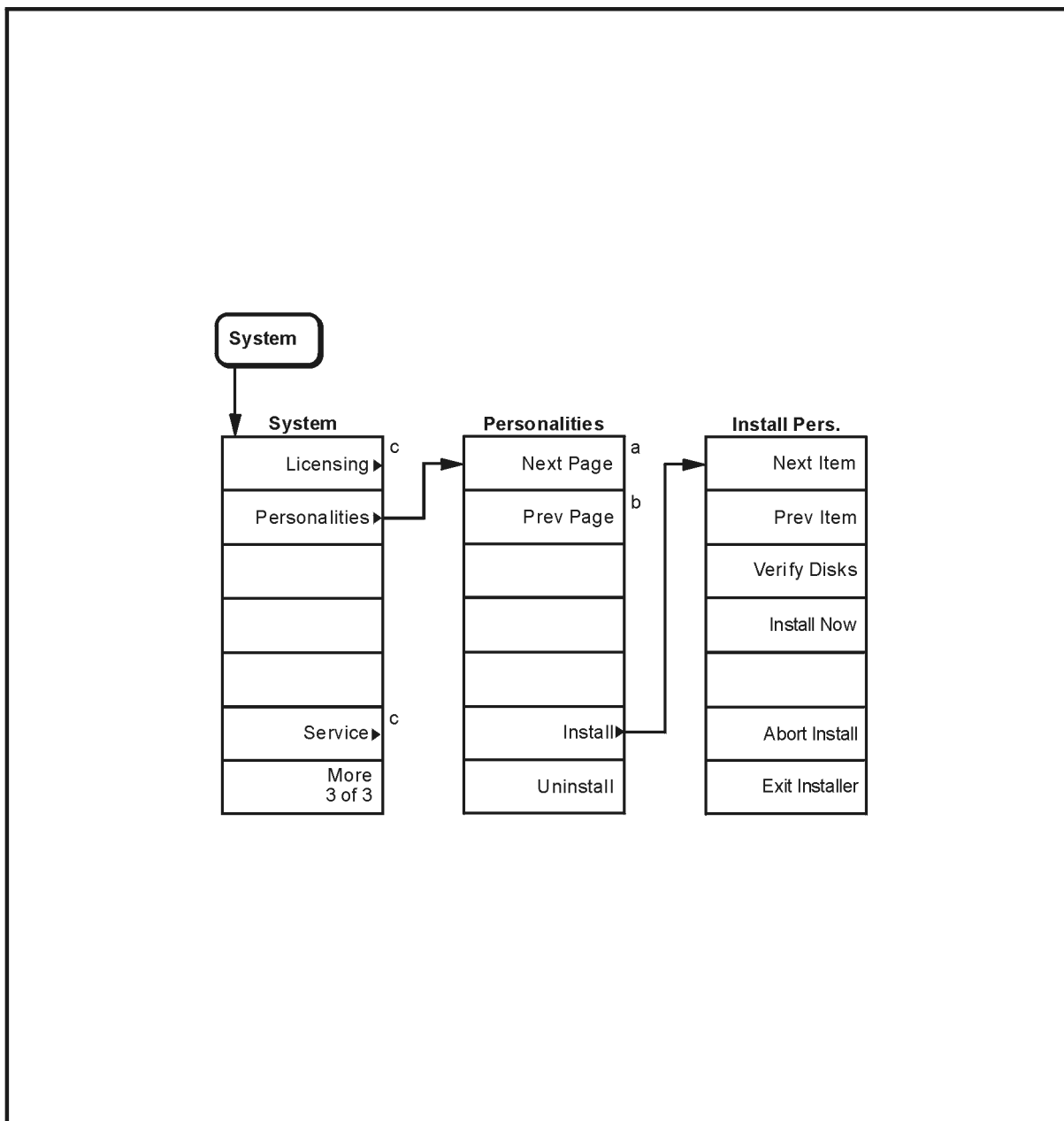## Trigger Menu
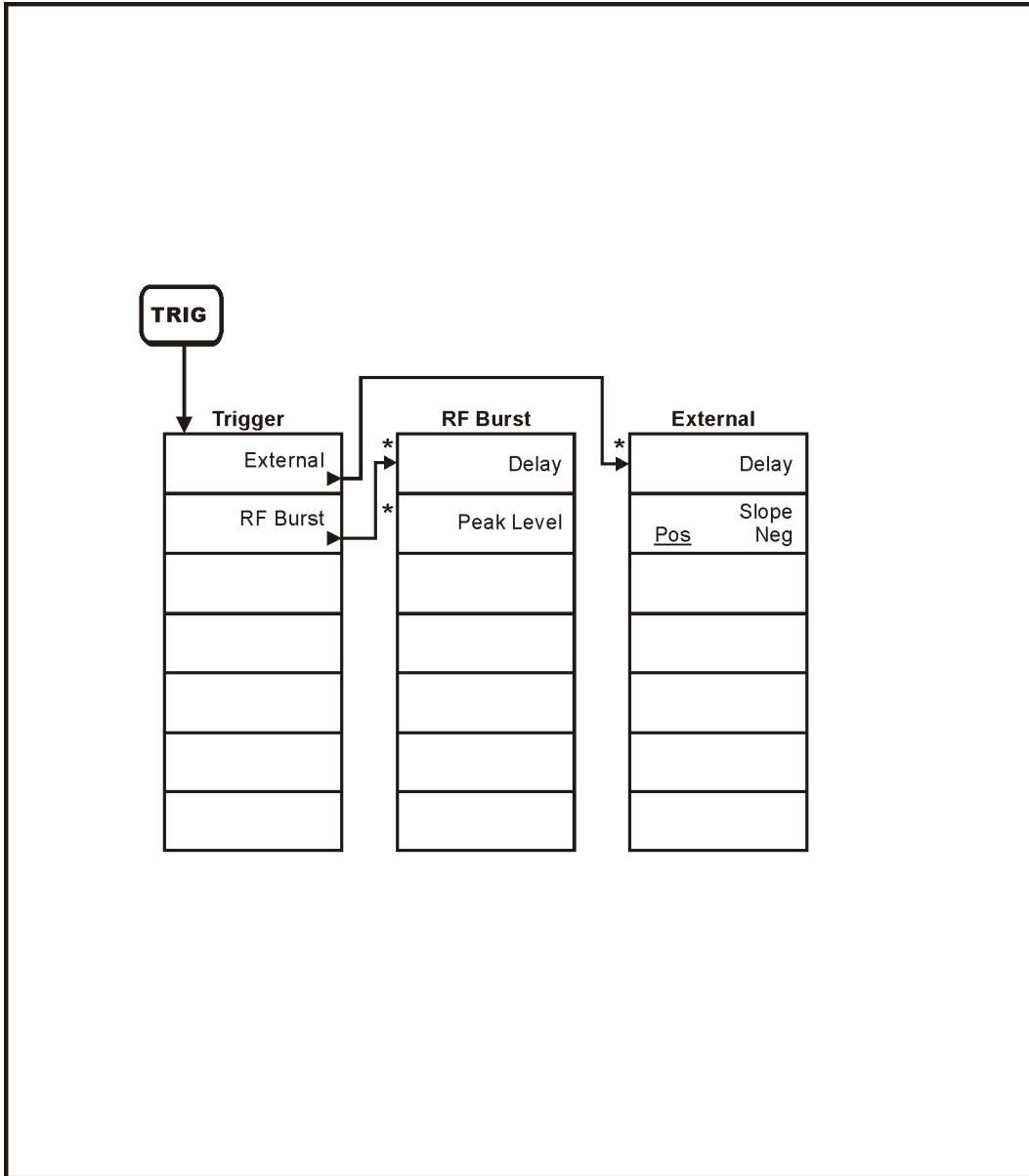
* An active function that allows data entry

pt83a

View and Trace Menu


```
View/                          View/
Trace                          Trace

  ▼                              ▼

┌─────────────┐               ┌─────────────┐
│  Meas View  │ a             │  Meas View  │ b
├─────────────┤               ├─────────────┤
│ I/Q Measured│               │             │
│ Polar Vector│               │  Spectrum   │
├─────────────┤               ├─────────────┤
│ I/Q Measured│               │             │
│ Polar Constln│              │             │
├─────────────┤               ├─────────────┤
│  I/Q Error  │               │             │
│ (Quad View) │               │             │
├─────────────┤               ├─────────────┤
│     Eye     │               │             │
│ (Quad View) │               │             │
├─────────────┤               ├─────────────┤
│   Numeric   │               │             │
│   Results   │               │             │
├─────────────┤               ├─────────────┤
│             │               │             │
├─────────────┤               ├─────────────┤
│             │               │             │
├─────────────┤               ├─────────────┤
│             │               │             │
└─────────────┘               └─────────────┘
```

a Active only when EVM is selected
    under the Measure menu

b Active only when Monitor Spectrum is
    selected under the Measure menu

vievtrac.cdr

Analys's Mode

Measurements

Menu Maps
Menus

7   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....

Demod Format   Accesses the demodulation format menu keys allowing you to specify the demodulation format to use. This parameter is automatically set when a radio standard is selected.

    QPSK   Sets the demodulation format to Quadrature Phase Shift Keying

    Pi/4 DQPSK   Sets the demodulation format to p/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   This determines which filter is applied to the incoming signal - that is, to the signal that you are measuring. The Meas Filter key 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   This determines which filter is applied to the reference signal - that is, the ideal signal with which you compare your measurement signal. The Ref Filter key 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 Chebyshev filtering, also known as IS-95 Baseband filtering (as specified in IS-95).

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 (-dB).

Search Length Allows you to specify the length of time over which the burst search is performed. As the symbol rate increases, more and more samples are needed to correctly demodulate the burst. Increasing the **Search Length** increases the size of the sample record up to its maximum value. Beyond this point, the Search Length will be clipped

NOTE In order to successfully find a burst, it is necessary for the entire burst to fall within the Search Length.

IQ Invert This inverts the internal Q signal, reversing the direction of phase rotation. This is required by some radio standards, and is also useful for lower sideband mixing applications.

Wideband Cal Now This allows you to effectively perform a factory calibration on the modulation analysis software prior to doing an EVM measurement. Both phase and magnitude calibrations are performed. As the instrument is calibrated before leaving the factory, it should only need to be recalibrated after new firmware has been installed.

To perform the calibration, first select **Wideband Cal Now**. If a cable is not connected, or the Modulation Analysis application has just been installed or upgraded, the analyzer will display a diagram showing the cable connection you have to make. Once you have connected a cable from the **AMPTD REF OUT** to the **Input 50**W (as shown in the screen diagram), select **Continue**. A Wideband Cal will be performed immediately.

If the ESA has not been aligned, a full Alignment will be performed before the Wideband Cal. The instrument calibration is complete once the instrument returns to its previous measurement screen.

If the analyzer's internal temperature has changed enough to affect measurement accuracy, a partial calibration will be automatically carried out. This will be indicated by a message on the screen.

NOTE	Although pressing the **Cancel** softkey will cancel the calibration, the Alignment cannot be cancelled. If **Cancel** is pressed while Alignment is in progress, the alignment will continue until it has been completed. Only the Wideband Cal will be cancelled.

A Wideband Cal on its own will normally take about one and a half minutes. A Wideband Cal with an Align can take up to 10 minutes.

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 analyzer will only synchronize to the external reference signal if there is a loop connection between 10 MHz OUT port of the RF Communications Hardware (Option B7E) board and the 10 MHz REF IN connection on the rear of the analyzer. When using an external reference signal in this manner, there is a possibility that some EVM measurement results will be degraded. This is more likely to be a problem if your EVM measurements are being made on signals with low symbol rates, such as TETRA, NADC or PDC. If your external reference signal can be set to 10 MHz, connect it directly into the 10 MHz REF IN port to alleviate this problem.

Opt 10MHz Out   Allows you to set the Option B7E variable frequency reference **10 MHz Out** port (on the rear of the analyzer) to On or Off. This is automatically set to Off when the Opt Freq Ref is set to Int.

> **On**   Enables the Option B7E **10 MHz Out** port. If a fixed frequency signal in the range 1 MHz - 30 MHz is fed to the Option B7E **EXT REF IN** port, a fixed amplitude 10 MHz reference signal is output to the Option B7E **10 MHz Out** port. To use this signal as your reference signal, the Option B7E **10 MHz Out** port must be connected to the **10 MHz REF IN** port on the rear of the analyzer.
>
> **Off**   Disables the Option B7E **10 MHz Ref Out** port.

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 during 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 and eye diagrams. 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 of points/symbol is 5, every 5th display point corresponds to a symbol - in this case, a vector diagram would show 4 display points between each symbol, with a yellow trace joining each of the points.

NOTE   Invalid Points/Symbol values are grayed out. Valid values vary between demod formats.

Symbol Dots Polar Vector   Allows you to highlight the positions of the symbols (that is, the blue dots) 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 IQ Error Quad view 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   The Start Freq 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   The Stop Freq option is only valid in the Monitor Spectrum measurement. It is grayed out at all other times

Timeslot   Sets the EDGE or GSM 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 or GSM 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.

Burst Type   Used to select the type of burst being measured. This is relevant only to the GSM Radio Std. and is therefore grayed out for all other formats.

> **Normal**   Measures a Normal 147 bit GSM burst in a combined Traffic Channel (TCH) and Control Channel (CCH).
>
> **Sync**   Measures a GSM Synchronization burst (SCH) of 147 bits.
>
> **Access**   Measures a GSM Access burst (RACH, or Random Access Channel) of 87 bits.

TSC (Std)   Used to select the EDGE or GSM Training Sequence Code 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. In EVM measurements, only the numeric values displayed reflect any averaging that has been specified. The EVM traces are never averaged, even when Averaging is **On**.

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.
	Ref Trace	Switches the display of your Reference Trace On or Off. The number of the trace which you are using as your reference trace is displayed in the softkey label.
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 received.
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.

| NOTE | If you are having problems demodulating NADC, PDC or TETRA signals, see the section An NADC, TETRA, or PDC signal looks incorrect |

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. Droop compensation corrects amplitude variations across a burst. You may want to turn off this compensation so you can see the changes in the measured magnitude error. Droop can result from signal impairments such as a power amplifier problem.

   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
Displays the I/Q Measured Polar Vector trace of your current signal, and also
displays numeric results for the measurement. Some of the following numeric
results will be visible to the left of the trace. To see the remaining numeric results,
you will have to press the Zoom key below the screen.

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.

Spectrum Analysis
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 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 EVM measurements. For more information on the standards, refer to the relevant standards publications.

W-CDMA	Wideband cdma radio standard.
cdmaOne	cdmaOne radio standard.
cdma2000	cdma2000 radio standard.
NADC	North American Digital Cellular radio standard with Pi/4 DQPSK modulation.
EDGE (8PSK)	Enhanced Data Rate for GSM Evolution with 8 Phase Shift Keying modulation radio standard
GSM (GMSK)	Global System for Mobile Telecommunications with Gaussian Minimum Shift Keying.
TETRA	Terrestrial Trunked Radio standard with Pi/4 DQPSK modulation.
PDC	Personal Digital Cellular radio standard with Pi/4 DQPSK modulation.
Additional Radio Stds...	Demodulation of other radio standards and connection to a Windows based PC are possible with extra software. Further details, including a free demonstration disk, are available from Agilent's website at www.agilent.com/find/89600

Device   Accesses menu keys allowing you to set the **Device** or system type to be tested, **BTS** (base station) or **MS** (mobile).

BTS	Sets the instrument to measure base transceiver station equipment.
MS	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 113 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. You can set the analyzer to any of three different pre-defined states, details of which are below.

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.

Mode Preset   Restores the analyzer to a pre-defined state suitable for your current mode. All measurement settings within the current mode are set to their mode default values. Settings pertinent to other modes remain unchanged.

NOTE   When new software is installed, the analyzer is set to its **Mode Preset** settings.

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 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**. These parameters can be accessed and set using the **Mode Setup**, **Trigger** data form and menus - refer to "Trigger..." on page 126.

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	The normal trigger delay range is from -500.0 ms to 500.0 ms. In some cases, however, negative values will be clipped because of limitations imposed by the sample record memory size. When measuring EDGE and GSM signals, the negative trigger delay is limited to no more than -6.238 ms.

NOTE	Option B7E: RF Comms Hardware has at least three 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 (the original version), 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.

NOTE   The quadrants displaying Magnitude Error and Error Vector Magnitude are blanked out when measuring GSM signals.

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.

8   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 the Instrument is in the process of completing a sweep, that sweep is aborted and another sweep is initiated.

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

:CALibration:WIDeband?

Start instrument calibration. If the analyzer requires an Alignment, this will be performed before the Wideband Calibration.The Wideband Calibration calibrates the demodulation path up to the 10 MHz IF bandwidth.

Returned Values: 0 - Success

1 - Cable not connected

2 - Calibration data corrupt; using previous calibration data

3 - Unknown

Remarks: Wideband Cal on its own normally takes about 1.5 minutes

Wideband Cal together with Align can take up to 10 minutes

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

Radio Standard Calibration - Required

:CALibration:WIDeband:REQuired?

This returns a value of 1 if a Wideband Cal is required for accurate measurement results. Zero is returned if no calibration is required.

Returned Values: 0 - No calibration is required.

1 - Calibration is required

Remarks: This command is only applicable when making EVM measurements. It has no effect when making any other measurement although 0 will be returned.

Front Panel
Access: Not applicable.

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 147.

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.

NOTE   This command sets Averaging to On and sets the number of averages to 10.

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:GRATiculate:GRID[:STATe] OFF|ON|0|1`

`:DISPlay:WINDow:TRACe:GRATiculate: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 147.

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 147.

INITiate Subsystem

The INITiate subsystem is used to initiate a trigger for a measurement. They only initiate measurements from the MEASURE front panel key or the "MEASure Group of Commands" on page 147. 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.

Example:	INIT:CONT ON
Factory Preset:	On
*RST:	On (Off recommended for remote operation)
Front Panel Access:	**Sweep, Sweep Cont Single** (SA mode)
	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.

Example:	INIT:IMM
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.
	For SA mode:
	If the analyzer is in signal identification mode, two sweeps are required, as this mode relies on the acquisition of data from two successive sweeps. Therefore, if the analyzer is in single sweep mode, two sweep triggers are needed to generate the sweep pair. In image suppress mode, synchronization is ensured by first turning off signal identification, initiating a single sweep, then turning on signal identification followed by two single sweeps. See [:SENSe]:SIDentify for more information about signal identification state.
Front Panel Access:	**Sweep, Sweep Cont Single**
	Single
	Meas Control, Measure Cont Single

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.

Example: INIT:PAU

Front Panel
Access: **Meas Control, Pause**

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)

Example: INIT:REST

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. Note: INITiate:PAUSE was TEST:RESume.

Front Panel
Access: **Meas Control**

INSTrument Subsystem

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

Catalog Query

:INSTrument:CATalog?

Returns a comma separated list of strings which contains the names of all the installed applications. These names can only be used with the **INST:SELECT** command.

Example: INST:CAT?

                Query response: "CDMA"4,"PNOISE"14

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.

- If the function does averaging, it is turned on and the number of averages is set to 10.

- After the data is valid it returns the scalar results, or the trace data, for the specified measurement. The type of data returned may be defined by an [n] value that is sent with the command.

  The scalar measurement results will be returned if the optional [n] value is not included, or is set to 1. 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.

  ASCII is the default format for the data output. The binary data formats should be used for handling large blocks of data since they are smaller and faster than the ASCII format. Refer to the FORMat:DATA command for more information.

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 8-1.

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 8-1   **Measurement Group of Commands**

ca81a
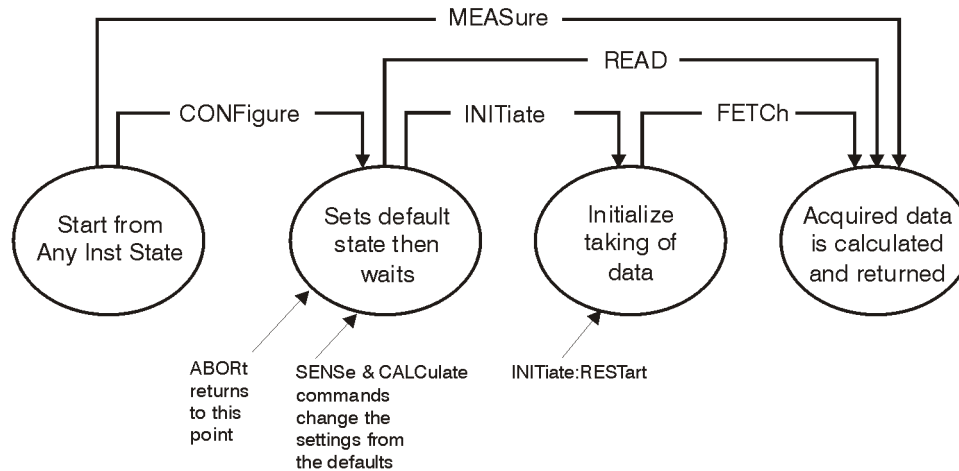
Configure Commands

`:CONFigure:<measurement>`

This command stops the current measurement (if any) and sets up the instrument for the specified measurement using the factory default instrument settings. It sets the instrument to single measurement mode but should not initiate the taking of measurement data unless INIT:CONTinuous is ON. After you change any measurement settings, the READ command can be used to initiate a measurement without changing the settings back to their defaults. The CONFigure command also turns the averaging function on and sets the number of averages to 10 for all measurements.

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. Use FETCh if you have already made a good measurement and you want to return several types of data (different [n] values, e.g. both scalars and trace data) from a single measurement. FETCh saves you the time of re-making the measurement. You can only FETCh results from the measurement that is currently

active, it will not change to a different measurement.

If you need to get new measurement data, use the READ command, which is equivalent to an INITiate followed by a FETCh.

The scalar measurement results will be returned if the optional [n] value is not included, or is set to 1. 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. The binary data formats should be used for handling large blocks of data since they are smaller and transfer faster then the ASCII format. (FORMat:DATA)

FETCh may be used to return results other than those specified with the original READ or MEASure command that you sent.

Read Commands

`:READ:<measurement>[n]?`

- Does not preset the measurement to the factory default settings. For example, if you have previously initiated the ACP measurement and you send READ:ACP? it will initiate a new measurement using the same instrument settings.

- Initiates the measurement and puts valid 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.

  For example, suppose you have previously initiated the ACP measurement, but now you are running the channel power measurement. Then you send READ:ACP? It will change from channel power back to ACP and, using the previous ACP settings, will initiate the measurement and return results.

- Blocks other SCPI communication, waiting until the measurement is complete before returning the results

  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. The binary data formats should be used when handling large blocks of data since they are smaller and faster then the ASCII format. (FORMat:DATA)

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 8-1   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 8-2   **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 26 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. 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.

Table 8-2   Results Returned from the EVM Measurement

n	Results Returned
Not specified or n = 1	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.
	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.
	25. **Trace Time Sample** is a floating point number (in seconds) of the time between samples for the Corrected I/Q trace. This is the time between I/Q pairs.

Table 8-2   Results Returned from the EVM Measurement

n	Results Returned
Not specified or N=1	26. **Corrected I/Q Vector Trace Length** is an integer (in number of samples) representing the number of samples returned by the Corrected I/Q Trace. In other words, this number divided by 2 represents the number of sample pairs in the trace.
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. For GSM, one NAN will be returned as this is an unsupported trace.
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. For GSM, one NAN will be returned as this is an unsupported trace.
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 147.

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

Channel Burst Type

`[:SENSe]:CHANnel:BURSt NORMal|SYNC|ACCess`

`[:SENSe]:CHANnel:BURSt?`

Set the burst type that the analyzer will search for and to which it will sync. This only applies with normal burst selected.

    NORMal: Traffic Channel (TCH) and Control Channel (CCH)

    SYNC: Synchronization Channel (SCH)

    ACCess: Random Access Channel (RACH)

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

                  Global to the current mode.

Front Panel
Access: **FREQUENCY Channel, Burst Type**

Time Slot number

`[:SENSe]:CHANnel:SLOT <integer>`

`[:SENSe]:CHANnel:SLOT?`

Select the time slot number that you want to measure.

In the EDGE (8PSK) or GSM 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) or a GSM EVM

measurement on an externally triggered EDGE or GSM 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 or GSM 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) or a GSM 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) or a GSM (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 147. 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: 10

Range: 1 to 10,000

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

Error Vector Magnitude—Averaging State

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

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

Turn average on or off.

Factory Preset: ON

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

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: EXPonential

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

Error Vector Magnitude—Burst Synchronization Source

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

`[:SENSe]:EVM:BSYNc:SOURce?`

Select the method of synchronizing the measurement to the bursts.

RFAMplitude – The burst sync approximates the start and stop of the useful part of the burst without demodulation of the burst. The measurement is then synchronized with the center point of the burst.

NONE – The measurement is performed without searching for the burst.

Factory Preset: NONE

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

Error Vector Magnitude—Droop Compensation

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

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

Turn droop compensation on or off. Droop compensation corrects amplitude variations across a burst. You may want to turn off this compensation so you can see the changes in the measured magnitude error. Droop can result from signal impairments such as a power amplifier problem.

Factory Preset

and *RST: On

Remarks: This key is only used with EDGE or GSM 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 IQ Error
Quad views by turning the display of the symbols represented by the blue dots on
or off.

Factory Preset
and *RST: On

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

Error Vector Magnitude - I/Q Points Origin Offset

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

`[:SENSe]:EVM:IQOOffset?`

This allows you to specify an offset from the first IQ point in the constellation and
eye diagrams. 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.

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:IQPoints <integer>`

[:SENSe]:EVM:IQPoints?

Factory Preset
and *RST: 1280 (256 x 5)

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

Minimum Value: 1

Remarks: Valid values vary between demod formats.

Front Panel
Access: **Display**

Error Vector Magnitude—RF Mixer Input Maximum Power

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

[:SENSe]:EVM:MIXer:RANGe[:UPPer]?

Allows you to set the maximum power level at the input of the mixer for the
measurement. The analyzer uses this value to automatically set the input
attenuation to maintain the mixer input power below this level.

Factory Preset: −10 dBm

Range: −70 dBm to 10 dBm

Default Unit: dBm

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, Advanced, Max Mixer Lvl**

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 joined by yellow vectors 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, and in GSM is fixed at 10. All other cases can choose either

1, 5 or 10.

Factory Preset
and *RST: 5

Range: One, two, four, five, ten

Remarks: Valid values 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 3p/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 polar vector view. Symbol dots are the blue dots 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: 256

Range: 10 to 1000

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. Setting the span to 0 Hz puts the analyzer into zero span. If the resolution bandwidth is set to a value less than 1 kHz, maximum span is limited to 5 MHz.

Factory Preset:	ESA E4401B, E4411B:	1.5 GHz
	ESA E4402B, E4403B:	3.0 GHz
	ESA E4404B:	6.7 GHz
	ESA E4405B:	13.2 GHz
	ESA E4407B, E4408B:	26.5 GHz
Range:	ESA E4401B, E4411B:	100 Hz to 1.58 GHz
	ESA E4402B, E4403B:	100 Hz to 3.10 GHz
	ESA E4404B:	100 Hz to 6.78 GHz
	ESA E4405B:	100 Hz to 13.3 GHz
	ESA E4407B, E4408B:	100 Hz to 27.0 GHz

Default Unit: Hz

Remarks: Only valid in Monitor Spectrum measurements.

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

Start Frequency

`[:SENSe]:FREQuency:STARt <freq>`

`[:SENSe]:FREQuency:STARt?`

Set the start frequency.

Factory Preset
and *RST: 997 MHz

Range: The same as the SA mode range

Default Unit: Hz

Remarks: Only valid when performing a Monitor Spectrum measurement.

Front Panel
Access: **FREQUENCY/Channel**

Stop Frequency

[:SENSe]:FREQuency:STOP <freq>

[:SENSe]:FREQuency:STOP?

Set the stop frequency.

Factory Preset
and *RST: 1.003 GHz

Range: The same as the SA mode range

Default Unit: Hz

Remarks: Only valid when performing a Monitor Spectrum measurement.

Front Panel
Access: **FREQUENCY/Channel**

Phase and Quadrature Commands

In-phase and Quadrature Control

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

[:SENSe]:IQInvert[:STATe]?

This allows you to swap the In-phase and Quadrature signals, reversing the direction of phase rotation. This is required by some radio standards, and is also useful for lower sideband mixing applications.

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 147. 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: For ESA: You must be in the Bluetooth, cdmaOne, GSM, Modulation Analysis or Phase Noise mode to use this command. Use INSTrument:SELect to set the mode.

                    For PSA: You must be in the Phase Noise 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

Remarks: For ESA: You must be in the Bluetooth, cdmaOne, GSM,
                     Modulation Analysis or Phase Noise mode to use this command.
                     Use INSTrument:SELect to set the mode.

                     For PSA: You must be in the Phase Noise mode to use this
                     command. Use INSTrument:SELect to set the mode.

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 resolution bandwidth for the channel method of the monitor band/channel
measurement. If span is set to a value greater than 5 MHz, minimum resolution

bandwidth is limited to 1 kHz.

Factory Preset
and *RST: 30 kHz

Range: Option 1DR alone—10 Hz to 5 MHz

                  Option 1DR + 1D5—1 Hz to 5MHz

                  non-Option 1DR—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 video bandwidth for the channel method of the monitor band/channel measurement.

Factory Preset
and *RST: 30 kHz

Default Unit: Hz

Range: Option 1DR—1 Hz to 3 MHz

                  non-Option 1DR—30 Hz to 3 MHz

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—Detector Mode

`[:SENSe]:MONitor:CHANnel:DETector POSitive│SAMPle│NEGative`

`[:SENSe]:MONitor:CHANnel: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. Sample detection displays the first sample taken during the display interval. Peak detection returns the maximum value measured during the display interval, and Negative Peak detection returns the minimum value.

POSitive - positive peak detection returns the maximum value made during each display interval. Positive peak detection is used primarily when measuring CW signals out of the noise floor.

SAMPle - sample detection returns the first sample made during each display interval. Sample detection is used primarily when measuring or displaying noise-like signals

NEGative - negative peak detection returns the minimum value made during each measurement interval. Negative Peak detection is used primarily when measuring signals that are close to, but below the noise floor.

Factory Preset
and *RST: Positive

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—Maximum Hold Trace State

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

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

Turn maximum hold trace average feature on or off for the channel method of the monitor band/channel measurement. When max hold is turned on, trace averaging is turned off.

Factory Preset
and *RST: Off

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 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: 8.589 msec

Range: 5 ms 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—Channel Sweep Time Auto

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

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

Select auto or manual control of the sweep (acquisition) time. This is an advanced control that normally does not need to be changed.

AUTO - couples the Sweep Time to the Frequency Span and Resolution BW

Manual - the Sweep Time is uncoupled from the Frequency Span and Resolution BW.

Factory Preset: AUTO

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**, **Channel Setup**, **Sweep Time**

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 being supplied to the option B7E RF assembly Ext Ref In jack. This provides the proper frequency division in the option B7E RF assembly to achieve the required 10 MHz reference frequency. Switch to the external reference with OPT:ROSC:SOUR.

Preset
and *RST: 10 MHz

Maximum Value: 30 MHz

Minimum Value: 1 MHz

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

Reference Oscillator Rear Panel Output

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

`[:SENSe]:OPTion:ROSCillator:OUTPut?`

Set the frequency source for the option B7E RF assembly 10 MHz Out jack to the option reference oscillator.

Preset
and *RST: Off

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

Reference Oscillator Source

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

`[:SENSe]:OPTion:ROSCillator:SOURce?`

Select the reference oscillator (timebase) 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 timebase

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

Preset
and *RST: INTernal

Front Panel
Access: **Mode Setup, Properties**

RF Port Input Attenuation

`[:SENSe]:POWer[:RF]:ATTenuation <rel_power>`

`[:SENSe]:POWer[:RF]:ATTenuation?`

Set the RF input attenuator. This value is set at its auto value if RF input attenuation is set to auto.

Factory Preset: 5 dB for Bluetooth, cdmaOne, GSM, Modulation Analysis

Range: 0 to 75 dB in 5 dB steps for cdmaOne, GSM, Modulation Analysis

Default Unit: dB

Front Panel
Access: **AMPLITUDE/Y Scale, Attenuation** for SA, cdmaOne, GSM, Modulation Analysis

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.

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|EMF`

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

This determines which filter is applied to the incoming signal - that is, the signal that you are measuring. The Meas Filter key accesses the Measurement Filter menu, allowing you to either switch the measurement filter off or to specify one of six different filters.

    OFF - No filter is used.

    RNYQ - Root Nyquist.

    NYQ - Nyquist.

    GAUS - Gaussian.

    CBPE - cdma Base Station Phase Equalization.

    RECT - Rectangular.

    LPF - Low Pass Filter.

    EMF - EDGE Measurement Filter (EDGE measurements only).

Factory Preset
and *RST: RNYQ

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|EDGE`

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

This determines which filter is applied to the reference signal - that is, the ideal signal with which you compare your measurement signal. The Ref Filter key accesses the Reference Filter menu, allowing you to specify one of five different filters.

RNYQ - Root Nyquist

NYQ - Nyquist

GAUS - Gaussian

CHEB - Chebyshev

RECT - Rectangular

EDGE - EDGE

Factory Preset
and *RST: NYQ

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│GSM`

`[: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

GSM - Global System for Mobile communications

Factory Preset
and *RST: WCDMA

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 and GSM signals are limited to plus or minus 10% of their standard/nominal value, but other signal standards allow values between 5 ksps and 10 Msps.

Factory Preset
and *RST: 3.84 Msps

Maximum Value: 10 Msps

Minimum Value: 5 ksps

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

                 or

                 Mode Setup, Demod...

Synchronization Commands

Burst Search Threshold

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

`[:SENSe]:SYNC:BURSt:SLENgth?`

Allows you to specify the length of time over which the burst search is performed. As the symbol rate increases, more and more samples are needed to correctly demodulate the burst. Increasing the **Search Length** increases the size of the sample record up to its maximum limit which is dependent on the current symbol rate.

Factory Preset
and *RST: 1.0 σεχ

Range: 0.0 to 1.0 sec (or 15k samples)

Default Unit: seconds

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

                    or

                    Det/Demod, Burst

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

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

9   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.

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:

   • Uninstall and 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 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 9-1. 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 9-1   **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 9-1.

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 9-1
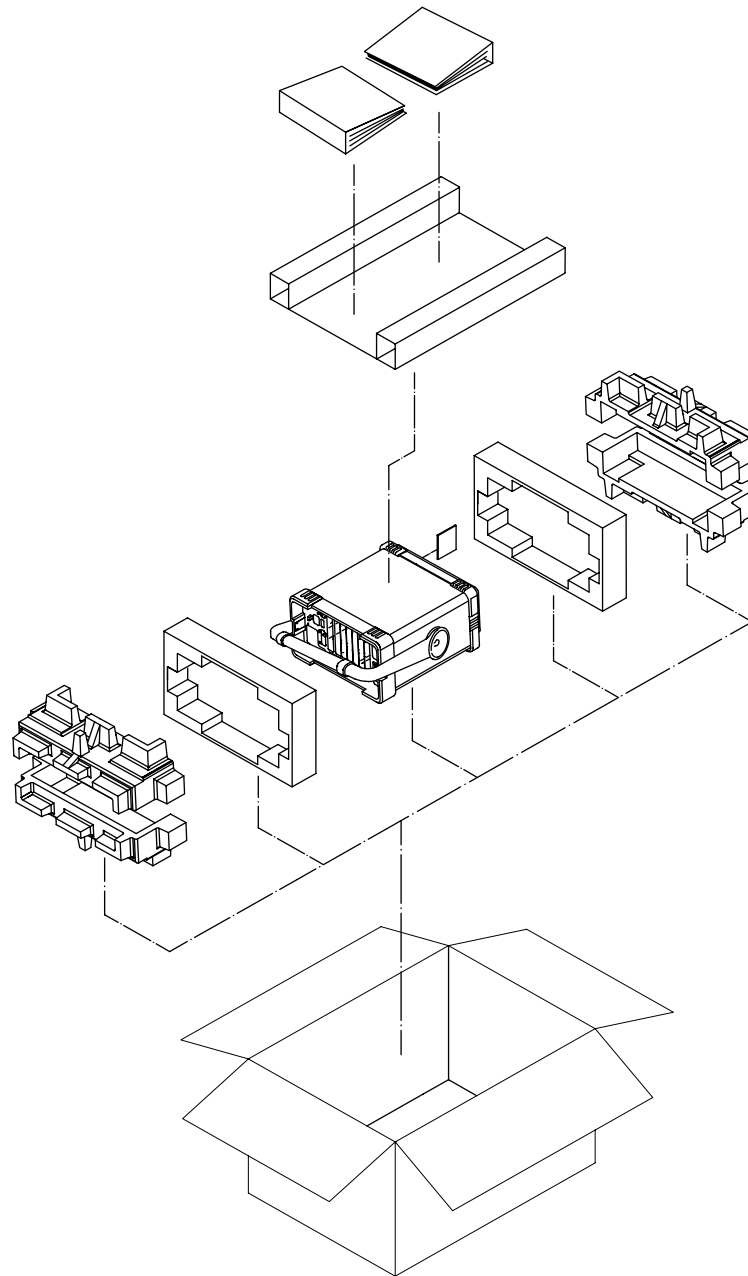
formt122

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.

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