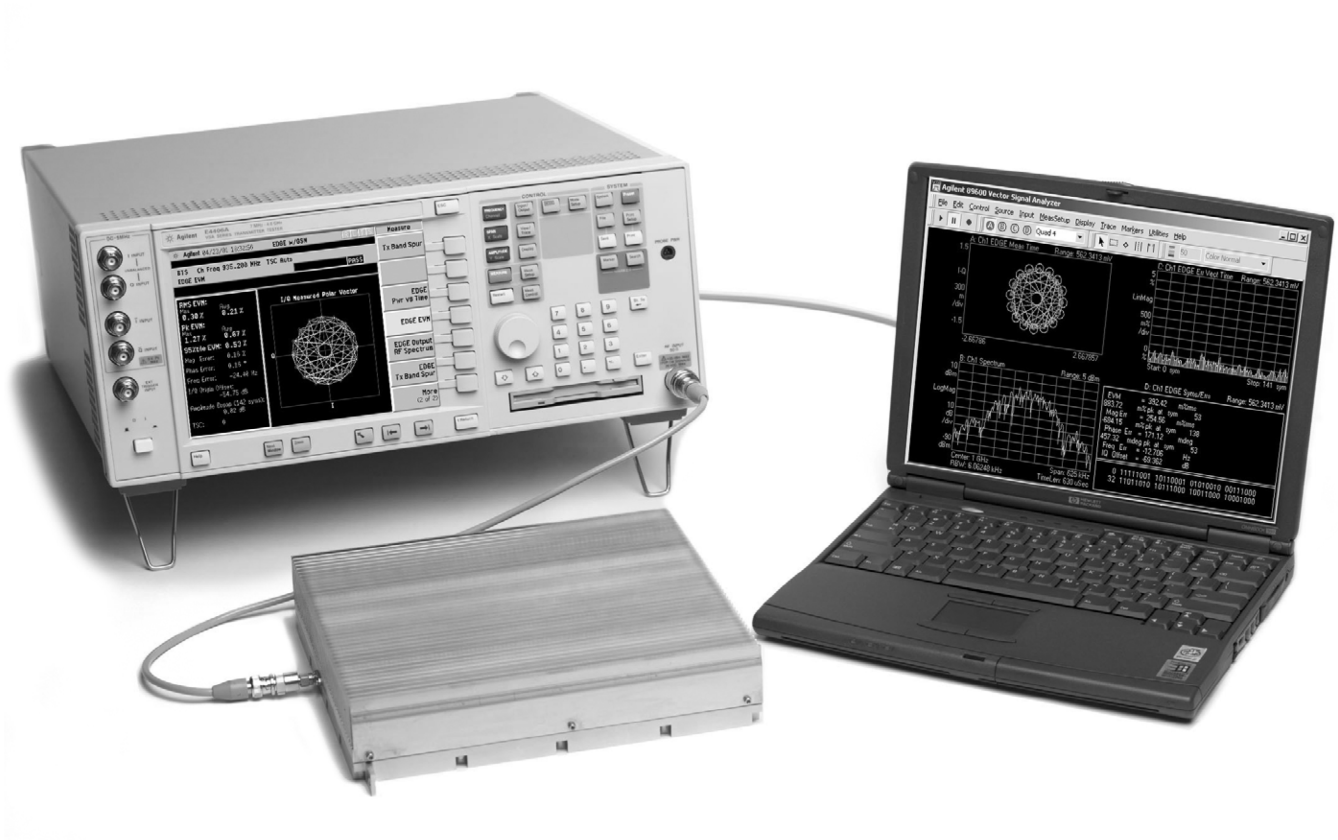
Agilent E4406A Vector Signal Analyzer Performance Guide Using 89601A Vector Signal Analysis Software

Application Note



Agilent Technologies

Table of Contents

Introduction

This guide characterizes the performance of the E4406A vector signal analyzer (VSA) and the 89601A vector signal analysis software combination. Together, these tools provide you both the flexible digital demodulation and analysis capabilities of the 89601A software and the standards-based one-button test capabilities of the E4406A. This teaming provides fast accurate testing for compliance to wireless specifications and tools to analyze the design if it fails to meet the specification.

Product Overview

E4406A VSA

The E4406A VSA is a full-featured transmitter tester designed to meet the test needs of wireless equipment developers and manufacturers. Its easily configured one-button measurements feature simple, straightforward menu structures to activate and control built-in standards-based tests. A variety of 2G and 3G communications standards including W-CDMA/HSDPA, 1xEV-DO, TD-SCDMA, cdma2000/1xEV-DV, cdmaOne, EDGE, and GSM are supported.

89601A software

The 89601A vector signal analysis software is the heart of the 89600 series PC-based VSAs. This software provides flexible tools for demodulating and analyzing even the most advanced digital formats, whether or not they are defined by an established standard. The features include variable block size signal acquisition with user-selectable pulse search and synch words, and a user-controllable adaptive equalizer.

User-selectable filter types include cosine (raised and square-root raised), Gaussian, and low-pass, all with user-selectable alpha/BT. Supported modulation formats for both continuous and burst carriers include FSK (2, 4, 8, and 16 level), BPSK, QPSK, OQPSK, DQPSK, D8PSK, π/4DQPSK, 8PSK, QAM (16 to 256 level), and VSB (8 and 16 level), EDGE and MSK.

In addition, the 89601A software provides signal capture and analysis features, the capability to download signal capture files for playback through a signal generator, high-speed spectrogram displays, and cross–channel measurement results.

E4406A/89601A combination

In the E4406A/89601A combination, the E4406A standards-based tests determine if a device under test (DUT) meets the requirements of the specification. If it does not, the 89601A software provides the modulation quality and error analysis tools to determine why the DUT failed.

The combination can measure active signals or signals captured in the E4406A memory. The E4406A alone or the E4406A/89601A combination can examine the signal. Switching between the two modes is facilitated by a quick disconnect/restart menu selection in the 89601A user interface.

The 89601A software runs on a PC connected to the E4406A, via LAN or GPIB, and provides hardware control, modulation analysis, and complete results displays. The controls and display of the E4406A are disabled while operating with the 89601A software.

Configuration Overview

The E4406A/89601A combination requires an E4406A VSA, the 89601A software with Option 200 (basic vector signal analysis) and Option 300 (hardware connectivity) and a PC with a LAN or GPIB interface card. Detailed configuration requirements for each item in the combination are provided in Appendix A.

Feature availability

When the E4460A VSA is controlled by 89601A series VSA software, users have control of the following features of the spectrum analyzer using the software:

Frequency: The center frequency will be displayed on the 89601A software GUI
Span: ≤ 8 MHz
Input attenuator and ADC gain: available indirectly through the input range feature of the 89601A software
Triggering: IF magnitude, external front/rear, hold-off, level, delay, and slope
External reference: Selectable frequency
Calibration
Overload detection
Baseband operation

In addition, you can gain immediate, direct access to all of the E4406A series spectrum analyzer's features by using the disconnect capability on the VSA software's control menu.

When the 89601A software is used with a E4406A VSA, almost all of the features of the software and its options are available.

These include:

- recording of time waveforms, allowing you to re-analyze signals and store them for future compar–isons
- complete set of of vector signal analysis and modulation analysis measurements and results
- flexible marker capabilities, including time gating, integrated band power, and offset (delta) markers
- flexible displays, including multiple trace displays, spectrogram, constellation, eye diagram, and error screens with powerful scaling
- link to the Agilent ESG Series' signal source for integrated control of source signals
- complete save and recall of your signals, trace data, and measurement screens
- easy cut and paste to other PC applications

The 89600 VSA software's swept spectrum application is not supported.

Performance[1]

The following is a summary of the features and capabilities provided by the E4406A/89601A combination. These are nominal values; they are not warranted.

Frequency range	RF Baseband	7 MHz to 314 MHz, 329 MHz to 4 GHz DC to 5 MHz
Center-frequency tuning resolution	RF Baseband	1 Hz 1 mHz
Frequency span range	RF Baseband	< 10 Hz to 8 MHz < 10 Hz to 5 MHz (2 channels active) < 15 Hz to 5 MHz (1 channel active)
Frequency points per span Calibrated points Displayable points	 51 to 102,401 51 to 131,072	
Resolution bandwidth (RBW) The range of available RBW choices is a function of the selected frequency span and the number of calculated frequency points. Users may step through the available range in 1-3-10 sequence, or directly enter an arbitrarily chosen bandwidth.		
Range	RF Baseband	< 1 Hz to 2.3 MHz < 1 Hz to 2.876 MHz

RBW shape factor
The window choices below allow you to optimize the RBW shape as needed for best amplitude accuracy, dynamic range, or response to transient signal characteristics.

Window	Selectivity (3:60 dB)	Passband flatness	Rejection
Flat top	0.41	0.01 dB	> 95 dBc
Gaussian top	0.25	0.68 dB	> 125 dBc
Hanning	0.11	1.5 dB	> 31 dBc
Uniform	0.0014	4.0 dB	> 13 dBc

Input range[2] (full scale, combines attenuator setting and ADC gain)

	RF	–18 dBm to +22 dBm in 1 dB steps
	Baseband	–5 dBm to +13 dBm in 6 dB steps

Dynamic range

RF	
Third-order intermodulation distortion	< –70 dBc or < –90 dBfs, whichever is greater
Noise density	< –124 dBfs/Hz at 1 GHz
Baseband	
Third-order intermodulation distortion	< –60 dBc
Noise density	–143 dBfs/Hz (+13 dBm range) –142 dBfs/Hz (+7 dBm range) –139 dBfs/Hz (+1 dBm range) –135 dBfs/Hz (–5 dBm range)

IF flatness	RF	± 0.2 dB

1. All RF-related values are using the E4406A with digital IF part number E4440–60025. Refer to the E4406A datasheet for more information.
2. For RF input E4406A ADC gain is set to +18 dB and attenuator is set to [18 + 89601A range (in dBm)] dB.

Time and Waveform

Baseband versus zoom measurements

These two signal processing modes affect the appearance and the duration of input waveforms as they are captured and displayed on the 89600 VSAs.

Most 89600 measurements are made with a non-zero start frequency, also called the *zoom* mode. In these cases, the time domain display shows a complex envelope representation of the input signal – that is, the magnitude and phase of the signal relative to the analyzer's center frequency. This provides powerful capability to examine the baseband components of a signal without the need to first demodulate it.

Baseband mode refers to the special case where the measurement span begins at 0 Hz. Here, the input signal is directly digitized, and the waveform display shows the entire signal (carrier plus modulation), very much as an oscilloscope would.

Time record characteristics

In the 89601A software, measurements are based on time records. For example, blocks of waveform samples from which time, frequency, and modulation domain data is derived. Time records have these characteristics:

Time record length	= (number of frequency points – 1)/span, with RBW mode set to arbitrary, auto-coupled
Time sample resolution	= 1/(k x span), where k = 1.28 for time data = zoom or where k = 256 for time data = baseband

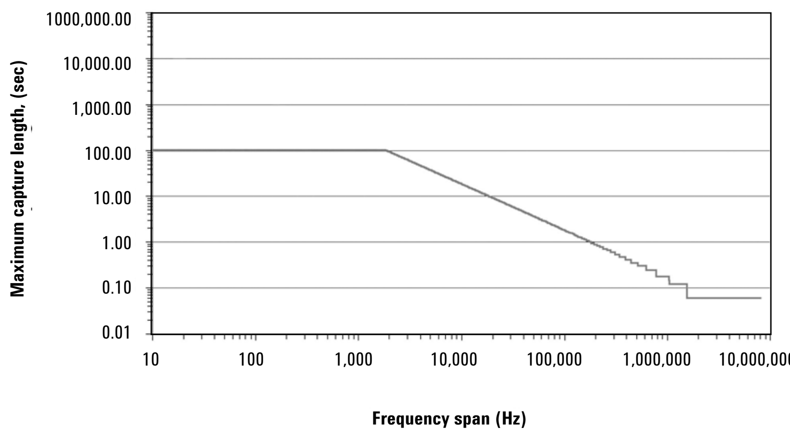
Time capture characteristics

In time capture mode, the 89601A software captures the incoming waveform in real time (i.e. gap-free) into high-speed time capture memory. This data may then be replayed through the software at full or reduced speed, saved to mass storage, or transferred to another software application.

When post-analyzing the captured waveform, users may adjust measurement span and center frequency in order to zoom in on specific signals of interest, as long as the new measurement span lies entirely within the originally captured span.

Time capture memory size	RF	900 k samples, complex
During time capture, and for spans below 1.55 MHz (775 kHz for baseband operation) the analyzer is internally set to the next highest cardinal span available in the E4406A that equals or exceeds the currently displayed frequency span. For spans above 1.55 MHz the analyzer span is set to 8 MHz.	Baseband	900 k samples real, per channel with software zoom

Time capture length versus span
(For RF mode only)



Measurement, Display, and Control

Triggering	
Trigger types	
Vector signal analyzer application (RF, baseband, composite)	Free run, IF magnitude*, external front/rear *Not available in baseband mode
Pre-trigger delay range	500 ms or time capture length, whichever is shorter
Post-trigger delay range	500 ms

Averaging	
Number of averages, maximum	> 10^8
Overlap averaging	0 to 99.99%
Average types	
Vector signal analyzer application	rms (video), rms (video) exponential, peak hold, time, time exponential

Analog demodulation	
Demodulation types	AM, PM, FM, with auto carrier locking provided for PM or FM
Demodulator bandwidth	Same as selected measurement span
AM demodulation	
Accuracy	±1%
Dynamic range	60 dB (100%) for a pure AM signal
Cross demodulation	< 0.3% AM on an FM signal with 10 kHz modulation, 200 kHz deviation
PM demodulation	
Accuracy	±3 degrees
Dynamic range	60 dB (rad) for a pure PM signal
Cross demodulation	< 1% PM on an 80% AM signal
FM demodulation	
Accuracy	±1% of span
Dynamic range	60 dB (Hz) for a pure FM signal
Cross demodulation	< 0.5% of span FM on an 80% AM signal

Time gating

Provides time-selective frequency-domain analysis on any input or analog demodulated time-domain data. When gating is enabled, markers appear on the time data; gate position and length can be set directly. Independent gate delays can be set for each input channel. See time specifications for main time length and time resolution details.

Gate length, maximum	Main time length
Gate length, minimum	= window shape/(0.3 x freq. span) where window shape is equal to: Flat-top window 3.8 Gaussian-top window 2.2 Hanning window 1.5 Uniform window 1.0

Marker functions

Peak signal track, frequency counter, (RF band only) band power.

Band power markers

Markers can be placed on any time, frequency, or demodulated trace for direct computation of band power, rms square root (of power), C/N, or C/No, computed within the selected portion of the data.

Trace math

Trace math can be used to manipulate data on each measurement. Applications include user-defined measurement units, data correction, and normalization.

Operands	Measurement data, data register, constants, jω
Operations	+, –, x, /, conjugate, magnitude, phase, real, imaginary, square, square root, FFT, inverse FFT, windowing, logarithm, exponential, peak value, reciprocal, phase unwrap, zero
Trace formats	Log mag (dB or linear), linear mag, real (I), imag (Q), wrap phase, unwrap phase, I-Q, constellation, Q-eye, I-eye, trellis-eye, group delay
Trace layouts	1 – 6 traces on one, two, four, or six grids
Number of colors	User-definable palette
Spectrogram display	
Types	Color – normal and reversed Monochrome – normal and reversed User colormap – 1 total
Adjustable parameters	Number of colors Enhancement (color-amplitude weighting) Threshold
Trace select	When a measurement is paused any trace in the trace buffer can be selected by trace number. The marker values and marker functions apply to selected trace.
Z-axis value	The z-axis value is the time the trace data was acquired relative to the start of the measurement. The z-axis value of the selected trace is displayed as part of the marker readout.
Memory	Displays occupy memory at a rate of 128 traces/MB (for traces of 401 frequency points).

Software Interface

The 89601A software appears to other Windows® software as an ActiveX® object. Implemented according to the industry-standard Component Object Model (COM), the software exposes a rich object model of properties, events, and methods, as fully described in the 89601A documentation.

Software development environments that are capable of interacting with COM objects include Agilent VEE, Microsoft® Visual Basic®, Microsoft Visual C++®, MATLAB®, National Instruments® LabVIEW, and others.

In addition, many end-user applications are able to interact directly with COM objects, using built-in macro languages such as Visual Basic for Applications (VBA). For example, in Microsoft Excel®, a VBA macro could be used to set up the instrument, collect the measurement data, and automatically graph the results.

Macro language

The 89601A's built-in Visual Basic Script interpreter allows many types of measurement and analysis tasks to be easily automated. Scripts may be developed using any text editor, or may be recorded automatically from a sequence of menu selections. Completed scripts may be named and integrated onto the analyzer's toolbar, allowing them to be launched with a single button press.

Remote displays

To operate the 89601A/E4406A combination or view its displays from a remote location, the use of commercially-available remote PC software such as Microsoft NetMeeting® or Symantec pcAnywhere® is recommended. The 89601A software can also operate E4406A remotely via LAN networking.

Remote programming

Beginning with Microsoft Windows NT® 4.0, COM objects on one PC are accessible from software running on another PC. This capability, known as Distributed COM (DCOM), makes the 89600 object model fully programmable from any other PC having network connectivity to the analyzer's host PC.

File formats

For storage and recall of measured or captured waveforms, spectra, and other measurement results:

ASCII	Tab-delimited (.txt), comma-delimited (.csv)
Binary	Agilent standard data format (.sdf, .cap, .dat)
Binary	Agilent E3238 time snapshot (.cap) and time recording (.cap) files under 2 GB in size. Signal generator files (.bin) under 2 GB in size.
MATLAB 5 and later	MAT-file (.mat)

Source

In source mode the 89601A software can control a signal generator via GPIB or LAN. Control is provided via the VSA GUI. Frequency and level control of CW signals is provided. Arbitrary signals may be downloaded from the time capture memory to the signal generator for replay. The same time record may be played over and over contiguously. A window function can be applied to smooth start-up and finish of replay.

Compatible sources	ESG-D or ESG-DP (firmware version B.03.50 or later), with the Option E44xxA-UND internal dual arbitrary waveform generator (firmware version 1.2.92 or later). E4438C with internal baseband generator Option E4438C-001, -002, -601, or -602. E8267C vector signal generator with Option E8267C-002 or -602 internal baseband generator.
Signal types	CW (fixed frequency sinewave) Arbitrary
Frequency range	Determined by signal generator
Level range	–136 dBm to 20 dBm in 0.02 dBm steps

For all other specifications see the technical data sheet for the signal generator used.

Vector Modulation Analysis
(Option 89601A-AYA)

Signal acquisition Note: Signal acquisition does not require an external carrier or symbol clock.	
Data block length	Adjustable to 4,096 symbols
Samples per symbol	1 – 20
Symbol clock	Internally generated
Carrier lock	Internally locked
Triggering	Single/continuous, external, pulse search (searches data block for beginning of TDMA burst and performs analysis over selected burst length)
Data synchronization	User-selected synchronization words

Supported modulation formats	
Carrier types	Continuous and pulsed/burst (such as TDMA)
Modulation formats	2, 4, 8, and 16 level FSK (including GFSK) MSK (including GMSK) QAM implementations of: BPSK, QPSK, OQPSK, DQPSK, D8PSK, π/4DQPSK, 8PSK, $\frac{3\pi}{8}$ 8PSK (EDGE) 16QAM, 32QAM, 64QAM, 128QAM, 256QAM (absolute encoding) 16QAM, 32QAM, 64QAM (differential encoding per DVB standard) 8VSB, 16VSB
Single-button presets for	**Cellular:** CDMA (base), CDMA (mobile), CDPD, EDGE, GSM, NADC, PDC, PHP (PHS), W-CDMA **Wireless networking:** *Bluetooth*™, HIPERLAN/1 (HBR), HIPERLAN/1 (LBR), 802.11b **Digital video:** DTV8, DTV16, DVB16, DVB32, DVB64 **Other:** APCO 25, DECT, TETRA, VDL mode 3

Filtering	
Filter types	Raised cosine, square-root raised cosine, IS-95 compatible, Gaussian, EDGE, low pass, rectangular, none
Filter length	40 symbols: VSB, QAM, and DVB-QAM where $\alpha < 0.2$ 20 symbols: all others
User-selectable alpha/BT	Continuously adjustable from 0.05 to 10
User-defined filters	User-defined impulse response, fixed 20 points/symbol Maximum 20 symbols in length or 401 points

Maximum symbol rate

Symbol rate is limited only by the measurement span, that is, the entire signal must fit within the analyzer's currently selected frequency span. Example: with raised-cosine filtering

Max symbol rate* = $\frac{\text{frequency span}}{1 + \alpha}$

*Maximum symbol rate doubled for VSB modulation format.

Measurement results (formats other than FSK)	
I-Q measured	Time, spectrum (filtered, carrier locked, symbol locked)
I-Q reference	Time, spectrum (ideal, computed from detected symbols)
I-Q error versus time	Magnitude, phase (I-Q measured versus reference)
Error vector	Time, spectrum (vector difference between measured and reference)
Symbol table and error summary	Error vector magnitude is computed at symbol times only
Instantaneous	Time, spectrum, search time

Measurement results (FSK)	
FSK measured	Time, spectrum
FSK reference	Time, spectrum
Carrier error	Magnitude
FSK error	Time, spectrum

Display formats

The following trace formats are available for measured data and computed ideal reference data, with complete marker and scaling capabilities and automatic grid line adjustment to ideal symbol or constellation states.

Polar diagrams

Constellation	Samples displayed only at symbol times
Vector	Display of trajectory between symbol times with 1 – 20 points/symbol

I or Q versus time

Eye diagrams	Adjustable from 0.1 to 40 symbols
Trellis diagrams	Adjustable from 0.1 to 40 symbols

Continuous error vector magnitude versus time

Continuous I or Q versus time

Error summary (formats other than FSK)	
Measured rms and peak values of the following:	Error vector magnitude, magnitude error, phase error, frequency error (carrier offset frequency), I-Q offset, amplitude droop (PSK and MSK formats), SNR (8/16VSB and QAM formats), quadrature error, gain imbalance
For VSB formats, VSB pilot level is shown in dB relative to nominal. SNR is calculated from the real part of the error vector only.	
For DVB formats, EVM is calculated without removing IQ offset.	
Error summary (FSK)	
Measured rms and peak values of the following:	FSK error, magnitude error, carrier offset frequency, deviation
Detected bits (symbol table)	
Binary bits are displayed and grouped by symbols. Multiple pages can be scrolled for viewing large data blocks. Symbol marker (current symbol shown as inverse video) is coupled to measurement trace displays to identify states with corresponding bits. For formats other than DVBQAM and MSK, bits are user-definable for absolute states or differential transitions.	
Note: Synchronization words are required to resolve carrier phase ambiguity in non-differential modulation formats.	

Accuracy (typical)

Formats other than FSK, 8/16VSB and OQPSK. Averaging = 10

Conditions: Specifications apply for a full scale signal, fully contained in the selected measurement span, random data sequence, range ≥ –18 dBm, start frequency ≥ 15% of span, alpha/BT ≥ 0.3*, and symbol rate ≥ 1 kHz. For symbol rates less than 1 kHz accuracy may be limited by phase noise.

*0.3 ≤ alpha ≤ 0.7 offset QPSK

Residual errors (result = 150 symbols, averages = 10)	
Residual EVM	
span ≤ 100 kHz	< 0.5% rms
span ≤ 1 MHz	< 0.5% rms
span ≤ 8 MHz[1]	< 1.0% rms
Magnitude error	
span ≤ 100 kHz	0.5% rms (RF), 0.3% rms (baseband)
span ≤ 1 MHz	0.5% rms
span ≤ 8 MHz[1]	1.0% rms
Phase error (for modulation formats with equal symbol amplitudes)	
span ≤ 100 kHz	0.3° rms
span ≤ 1 MHz	0.4° rms
span ≤ 8 MHz[1]	0.6° rms
Frequency error (added to frequency accuracy if applicable)	symbol rate/500,000
I-Q/origin offset	–60 dB or better

1. For RF only, ≤ 5 MHz for baseband.

Video modulation formats Applies for RF and composite (I+jQ) modes only.	
Residual errors 8/16 VSB: Symbol rate = 10.762 MHz, α = 0.115, 7 MHz span, full-scale signal, range ≥ –18 dBm, result length = 800, averages = 10	
Residual EVM	≤ 1.5% (SNR ≥ 36 dB)
16, 32, 64, or 256 QAM: Symbol rate = 6.9 MHz, α = 0.15, 8 MHz span, full-scale signal, range ≥ –18 dBm, result length = 800, averages = 10	
Residual EVM	≤ 1.0% (SNR ≥ 40 dB)

Adaptive equalizer	
Removes the effects of linear distortion (e.g. non-flat frequency response, multipath, etc.) from modulation quality measurements. Equalizer performance is a function of the setup parameters (equalization filter length, convergence, taps/symbol) and the quality of the signal being equalized.	
Equalizer type	
Decision-directed, LMS, feed-forward equalization with adjustable convergence rate	
Filter length	3 – 99 symbols, adjustable
Filter taps	1, 2, 4, 5, 10, or 20 taps/symbol
Measurement results provided	
Equalizer impulse response	
Channel frequency response	
Supported modulation formats	MSK, BPSK, QPSK, OQPSK, DQPSK, π/4DQPSK, 8PSK, 16QAM, 32QAM, 64QAM, 256QAM, 8VSB, 16VSB, $\frac{3\pi}{8}$ 8PSK (EDGE), D8PSK

3G Modulation Analysis
(Option 89601A-B7N)

Includes:
W-CDMA/HSDPA
cdma2000/1xEV-DV
1xEV-DO
TD-SCDMA

W-CDMA/HSDPA modulation analysis	
Signal acquisition	
Result length	Adjustable between 1 and 64 slots
Samples per symbol	1
Triggering	Single/continuous, external
Measurement region	Length and offset adjustable within result length
Signal playback Baseband or RF modes only	
Result length	Adjustable between 1 and 64 slots[1]
Capture length (gap-free analysis at 0% overlap; at 5 MHz span)	88 slots[1]
Supported formats	
Formats	Downlink, uplink
Single-button presets	Downlink, uplink
Other adjustable parameters	
Chip rate	Continuously adjustable
User-selectable alpha	Continuously adjustable between 0.05 and 1
Scramble code (downlink)	Continuously adjustable between 0 and 511
Scramble code (uplink)	Continuously adjustable between 0 and $2^{24} – 1$
Scramble code offset (downlink)	Continuously adjustable between 0 and 15
Scramble code type (downlink)	Standard, left, right
Sync type (downlink)	CPICH, SCH, CPICH (STTD antenna-2), symbol-based (specify code channel and spread code length)
tDPCH (downlink)	Auto, manual (0x256 to 149x256 chips)
Test models supported (downlink)	Test models 1 - 5
Sync type (uplink)	DPCCH (slot format 0 - 5), PRACH message
Channel modulation scheme (downlink)	Auto-detect, QPSK, 16 QAM
Active channel threshold	Auto, manual (0 dBc to -120 dBc)
Enable HSDPA analysis	Off, On
Gated active channel detection	Off, On
Test Model	
None (auto active channel detection)	
Test Model 1	16 DPCH, 32 DPCH, 64 DPCH (with or without S-CCPCH)
Test Model 2	With or without S-CCPCH
Test Model 3	16 DPCH, 32 DPCH (with or without S-CCPCH)
Test Model 4	With or without P-CPICH
Test Model 5[2]	2 HS-PDSCH with 6 DPCH, 4 HS-PDSCH with 14 DPCH, 8 HS-PDSCH with 30 DPCH
Gated modulation detection[2]	Off, On
Modulation scheme[2]	Auto, QPSK, 8 PSK, 16 QAM

1. Forty-three slots maximum for channel 1, baseband mode.
2. Parameter used only when HSDPA analysis is enabled.

Measurement results	
Composite (all code channels at once or all symbol rates taken together)	
Code domain power	All symbol rates together Individual symbol rates (7.5, 15, 30, 60, 120, 240, 480, 960 ksps)
Code domain error	Composite (all symbol rates taken together) Individual symbol rates (7.5, 15, 30, 60, 120, 240, 480, 960 ksps)
IQ measured	Time, spectrum
IQ reference	Time, spectrum
IQ error versus time	Magnitude and phase (IQ measured versus reference)
Error vector	Time, spectrum (vector difference between measured and reference)
Composite errors	Summary of EVM, magnitude error, phase error, rho, peak active CDE, peak CDE, Ttrigger, frequency error, IQ offset, slot number
Code domain offset table	Timing and phase offset for each active code
Channel (individual code channel)	
IQ measured	Time
IQ reference	Time
IQ error versus time	Magnitude and phase (IQ measured versus reference)
Error vector	Time (vector difference between measured and reference)
Symbol table and error summary	Summary of EVM, magnitude error, phase error, slot number, pilot bits, tDPCH
Other	
Pre-demodulation	Time, spectrum

Display formats	
CDP measurement results	I and Q shown separately on same trace for uplink
Channel measurement results	I and Q show separately
Code order	Hadamard, bit reverse
Other	Same as Option 89601A-AYA

Accuracy (typical input range within 5 dB of total signal power)	
Code domain	
CDP accuracy	±0.3 dB (spread channel power within 20 dB of total power)
Symbol power versus time	±0.3 dB (spread channel power within 20 dB of total power averaged over a slot)
Composite EVM	
EVM floor	1.5% or less for pilot only
EVM floor	1.5% or less for test model 1 with 16 DPCH signal
EVM floor	1.5% or less for test model 5, 8 HS-PDSCH with 30 DPCH, HSDPA enabled
Frequency error	
Range (CPICH sync type)	±500 Hz
Accuracy	±10 Hz

cdma2000/1xEV-DV modulation analysis		
Signal acquisition		
Result length (adjustable)	Baseband, 1 channel Baseband, 2 channels Forward link, RF Reverse link, RF	1 – 22 PCG 1 – 46 PCG 1 – 64 PCG 1 – 48 PCG
Samples per symbol	1	
Triggering	Single/continuous, external	
Measurement region	Length and offset adjustable within result length	
Signal playback		
Result length	Baseband, 1 channel Baseband, 2 channels Forward link, RF Reverse link, RF	1 – 22 PCG 1 – 46 PCG 1 – 64 PCG 1 – 48 PCG
Capture length (gap-free analysis at 0% overlap; at 1.5 MHz span)	Baseband, 1 channel Baseband, 2 channels RF	22 PCG 46 PCG 94 PCG
Supported formats		
Formats	Forward, reverse	
Single-button presets for	Forward, reverse	
Other adjustable parameters		
Chip rate	Continuously adjustable	
Long code mask (reverse)	0	
Base code length	64, 128	
Channel modulation scheme (forward)	Auto, QPSK, 8 PSK, 16 QAM	
Active channel threshold	Auto, manual (0 dBc to -120 dBc)	
Enable 1xEV-DV analysis	Off, On	
Gated active channel detection	Off, On	
Multi-carrier filter	Off, On	
PN offset	0x64 to 511x64 chips	
Walsh code QOF	0, 1, 2, 3	
Defined active channels[1]	Off, On	
Walsh code column index[1]	0, 1, 2, 3	
Walsh mask[1]	0 to 1111111111111 (binary)	
F-PDCH0/1 number of codes[1]	F-PDCH0 + F-PDCH1 ≤ 28	
F-PDCH0/1 modulation scheme[1]	QPSK, 8 PSK, 16 QAM	
Gated modulation detection[1]	Off, On	
Modulation scheme[1]	Auto, QPSK, 8 PSK, 16 QAM	
Measurement results		
Composite (all code channels at once or all symbol rates taken together)		
Code domain power	All symbol rates together Individual symbol rates (9.6, 19.2, 38.4, 76.8, 153.6, 307.2 ksps)	
Code domain error	Composite (all symbol rates taken together) Individual symbol rates (9.6, 19.2, 38.4, 76.8, 153.6, 307.2 ksps)	
IQ measured	Time, spectrum	
IQ reference	Time, spectrum	
IQ error versus time	Magnitude and phase (IQ measured versus reference)	

1. Parameter is only used when 1xEV-DV analysis is enabled.

Measurement results, continued	
Error vector	Time, spectrum (vector difference between measured and reference)
Composite errors	Summary of EVM, magnitude error, phase error, rho, peak active CDE, peak CDE, Ttrigger, frequency error, IQ offset, slot number
Code domain offset table	Timing and phase offset for each active code
Channel (individual code channel)	
IQ measured	Time
IQ reference	Time
IQ error versus time	Magnitude and phase (IQ measured versus reference)
Error vector	Time (vector difference between measured and reference)
Symbol table and error summary	Summary of EVM, magnitude error, phase error, PCG number, modulation format
Other	
Pre-demodulation	Time, spectrum

Display formats	
CDP measurement results	I and Q shown separately on same trace for uplink
Channel measurement results	I and Q show separately
Code order	Hadamard, bit reverse
Other	Same as Option 89601A-AYA

Accuracy (typical) (input range within 5 dB of total signal power)	
Code domain	
CDP accuracy	±0.3 dB (spread channel power within 20 dB of total power)
Symbol power versus time	±0.3 dB (spread channel power within 20 dB of total power averaged over a slot)
Composite EVM	
EVM floor	1.5% or less for pilot only
EVM floor	1.5% or less 9 active channels
EVM floor	1.5% or less 16 QAM, F-PDCH with 15 codes, 1xEV-DV enabled
Frequency error	
Range (CPICH sync type)	±500 Hz
Accuracy	±10 Hz

1xEV-DO modulation analysis

Signal acquisition	
Result length	
Forward link	1 – 64 slots
Reverse link	1 – 64 slots
Samples per symbol	1
Triggering	Single/continuous, external
Measurement region (applies to CDP results)	Interval and offset adjustable within result length

Signal playback	
Result length	
Forward link	1 – 64 slots
Reverse link	1 – 64 slots
Capture length (gap-free analysis at 0% overlap at 1.5 MHz span)	70 slots
Supported formats	
Formats	Forward (BTS), reverse (AT)
Single-button presets	Forward, reverse
Other adjustable parameters	
Chip rate	Continuously adjustable
Analysis channel (forward)	Preamble, pilot, MAC, data
PN offset	Continuously adjustable from 0x64 to 511x64 chips
Preamble length (forward)	Auto detection or adjustable from 0 – 1024 chips
Data modulation type (forward)	QPSK, 8PSK, 16QAM
Long code masks (reverse)	Continuously adjustable from 0x0000000000 to 0x3FFFFFFFFF
Measurement results	
Overall	
Error summary (forward)	Overall 1 and overall 2 results for: rho, EVM, magnitude error, phase error, frequency error, slot number and IQ offset
Composite (all code channels at once or all symbol rates taken together)	
Code domain power (forward)	All symbols taken together Individual symbol rates (9.6, 19.2, 38.4, 76.8, 153.6, 307.2 ksps)
Code domain error (reverse)	All symbols taken together Individual symbol rates (9.6, 19.2, 38.4, 76.8, 153.6, 307.2 ksps)
IQ measured	Time, spectrum
IQ reference	Time, spectrum
IQ error versus time	Magnitude and phase (IQ measured versus reference)
Error vector	Time, spectrum (vector difference between measured and reference)
Error summary (forward)	EVM, magnitude error, phase error, rho, frequency error, IQ offset, slot number, preamble length
Error summary (reverse)	EVM, magnitude error, phase error, rho, frequency error, IQ offset, slot number, peak CDE, pilot, RRI, ACK, DRC, data power
Channel (individual code channel, reverse only)	
IQ measured	Time
IQ reference	Time
IQ error versus time	Magnitude and phase (IQ measured versus reference)
Error vector	Time (vector difference between measured and reference)
Symbol table and error summary	EVM, magnitude error, phase error, slot number
Other	
Pre-demodulation	Time, spectrum

Display formats	
CDP measurement results	I and Q shown separately on same trace
Channel measurement results (reverse)	I and Q shown separately
Code order	Hadamard, bit reverse
Accuracy (typical) (input range within 5 dB of total signal power)	
Code domain	
CDP accuracy	±0.3 dB (spread channel power within 20 dB of total power)
Symbol power versus time	±0.3 dB (spread channel power within 20 dB of total power)
Composite EVM	
EVM floor	1.5% max
Frequency error	
Lock range	±500 Hz
Accuracy	±10 Hz

TD-SCDMA modulation analysis	
Signal acquisition	
Result length	1 – 8 subframes
Start boundary	Sub-frame, 2 frames
Time reference	Trigger point, downlink pilot, uplink pilot
Samples per symbol (code channel results)	1
Samples per chip (composite results)	1
Triggering	Single/continuous, external
Measurement region	Analysis timeslot selectable within first sub-frame
Signal playback	
Result length	1 – 8 subframes
Capture length (gap-free analysis at 0% overlap at 1.6 MHz span)	10 subframes
Supported formats	
Formats	Downlink, uplink
Single-button presets	TSM (v3.0.0)
Other adjustable parameters	
Chip rate	Continuously adjustable
Filter alpha	Continuously adjustable between 0.05 and 1.0
Downlink pilot sequence	0 – 31
Uplink pilot sequence	0 – 255 or limited to code group
Scramble sequence	0 – 127 or limited to code group
Basic midamble sequence	0 – 127 or limited to code group
Max users (selectable for each timeslot)	2, 4, 6, 8, 10, 12, 14, 16
Midamble shift	1 – max users

Measurement results	
Composite (all code channels at once or all symbol rates taken together)	
Code domain power	All symbol rates and code channels taken together; Individual symbol rates (80, 160, 320, 640, 1280 ksps)
Code domain error	All symbol rates and code channels taken together; Individual symbol rates (80, 160, 320, 640, 1280 ksps)
IQ measured	Time, spectrum
IQ reference	Time, spectrum
IQ error versus time	Magnitude and phase (IQ measured versus reference)
Error vector	Time, spectrum (vector difference between measured and reference)
Error summary	EVM, magnitude error, phase error, rho, peak active CDE, peak CDE, frequency error, IQ offset, IQ skew, slot amplitude droop
Channel (individual code channel)	
IQ measured	Time
IQ reference	Time
IQ error versus time	Magnitude and phase (IQ measured versus reference)
Error vector	Time (vector difference between measured and reference)
Symbol table and error summary	EVM, magnitude error, phase error, data bits
Layer (all code channels at once)	
Code domain power	All symbol rates taken together; Individual symbol rates (80, 160, 320, 640, 1280 ksps)
Code domain error	All symbol rates taken together; Individual symbol rates (80, 160, 320, 640, 1280 ksps)
Overall	
Time	Aligned analysis region; active timeslots highlighted
Filtered time	IQ time; RRC filtered; resampled to 4x chip rate
Gate time	Gated IQ time
Gate spectrum	Averaged and instantaneous
Gate PDF, CDF	PDF, CDF of gate time magnitude
Error summary	Timing error, total power, midamble power, and data power for each timeslot
Other	
Analysis timeslot	CCDF
Pre-demodulation	Time, spectrum, correction
Display formats	
Overall time measurement results	Active timeslots highlighted with background color
CDP and CDE measurement results	Active code channels highlighted by CDP layer color
Accuracy (typical) (input range within 5 dB of total signal power)	
Code domain	
CDP accuracy	±0.3 dB (spread channel power within 20 dB of total power)
Symbol power versus time	±0.3 dB (spread channel power within 20 dB of total power)
Composite EVM	
EVM floor	1.5% max
Frequency error	
Lock range	±500 Hz
Accuracy	±25 Hz

Dynamic Links to EEsof ADS
(Option 89601A-105)

This option links the 89600 VSA with design simulations running on the Agilent EEsof Advanced Design System, providing real-time, interactive analysis of results. It adds vector signal analyzer sink and source components to the Agilent Ptolemy simulation environment. When a simulation is run, the 89600 software is automatically launched. The VSA sink component analyzes waveform data from a simulation. Its user interface and measurement functions are the same in this mode as for hardware-based measurements. The VSA source component outputs measurement data to a simulation. Its input data can be from a recording or hardware. Front-end hardware need not be present when using either component, unless live measurements are to be sourced into a simulation.

Source component

ADS version required	ADS 2001 or later
ADS output data types supported	Data: Timed Frequency Demod errors Complex scalar Float scalar Integer scalar Control: Data gap indicator
VSA input modes	Hardware Recording
VSA analysis range	Dependent on input mode and hardware installed
VSA component parameters (user settable)	VSATitle ControlSimulation OutputType Pause VSATrace TStep SetUpFile RecordingFile SetUpUse AutoCapture DefaultHardware AllPoints
VSA component parameters (passed to ADS, timed output only)	Carrier frequency TStep

Sink component

ADS version required	ADS 1.3 or later
ADS input data types supported	Float Complex Timed – baseband Timed – ComplexEnv
VSA input modes	Single channel Dual channel I + jQ
VSA analysis range	
Carrier frequency	dc to > 1 THz
TStep (sample time)	$< 10^{-12}$ to $> 10^{3}$ seconds

VSA component parameters (user-settable)	VSATitle TStep SamplesPerSymbol RestoreHW SetupFile Start Stop TclTkMode RecordMode SetFreqProp
VSA component parameters (passed from ADS)	Carrier frequency TStep Data type
Number of VSAs that can run concurrently	
ADS version 1.5 and later	20
ADS version 1.3	1
Required ADS components	
EEsof Design Environment	E8900A/AN
EEsof Data Display	E8901A/AN
EEsof Ptolemy Simulator	E8823A/AN
Recommended ADS configurations:	
EEsof Communication System Designer Pro	E8851A/AN
EEsof Communication System Designer Premiere	E8852A/AN

Appendix A:
Configuration requirements

The E4406A/89601A combination requires an E4406A VSA, the 89601A vector signal analysis software with required options, a PC to run the software, and interface cables. The following are the detailed configuration requirements for each item.

E4406A VSA transmitter tester

The E4406A comes equipped with the I/O required to connect it into the combination. Firmware version A.05.32, or later, is required. Option E4406A-B7C, I/Q inputs, is required for baseband measurements.

Option 89601A-B7R WLAN modulation analysis is not recommended due to bandwidth constraints. Software version 3.0, or later is required for baseband I/Q measurements.

89601A vector signal analysis software

The 89601A software requires vector signal analysis, Option 89601A-100, and vector signal analysis. Option 89601A-B7N is required to analyze W-CDMA, cdma2000, TD-SCDMA, and 1xEV-DO signals.

PC for 89601A software

A laptop or desktop PC may be used as long as it meets or exceeds the following minimum requirements[1]:

- > 300 MHz Pentium® or AMD-K6a,
- 192 MB RAM (256 MB recommended)
- 4 MB video RAM (8 MB recommended)
- Hard disk with 100 MB of available space
- Microsoft Windows 2000, XP Professional® (laptop or desktop) or Windows NT 4.0 (service pack 5, or greater required, desktop only)
- CD-ROM drive (can be provided via network access), 3.5-inch floppy disk drive (can be provided via network access)
- GPIB or LAN interface (see Table 2)

PC to E4406A interface

The E4406A supports both LAN and GPIB I/O. Table 2 shows the interface cards and connection cables that are recommended for the PC. Figures 1 and 2 show how to make the physical connections.

Table 2. PC interfaces and connection cables

Description	Part number	Notes
PCMCIA GPIB card	778034-02	For laptop PCs, comes with a two-meter GPIB cable. Available from National Instruments.
PCI GPIB interface card	82350	For desktop PCs, requires GPIB cable (10833A). Available from Agilent
USB/GPIB interface	82357A	For desktop and laptop PCs, requires USB port and Windows 2000 or XP Professional.
One-meter GPIB cable	10833A	Available from Agilent
LAN cross-over cable	8121-0545	Available from Agilent

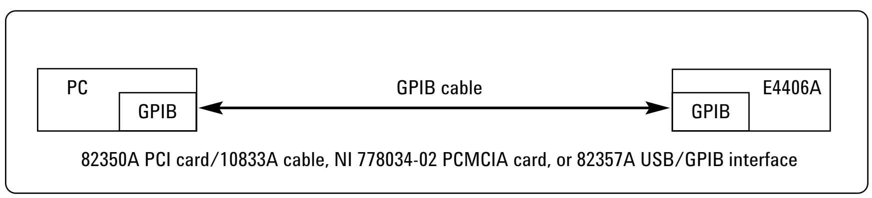


Figure 1. GPIB connection

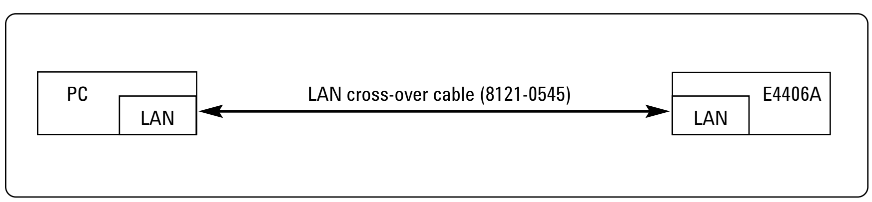


Figure 2. Point-to-point LAN connection. The PC and the E4406A may also be connected to a multipoint LAN network.

1. For best immunity from electrostatic discharge (ESD), use a desktop PC.

Related Literature

89600 Series Wide-Bandwidth Vector Signal Analyzer, brochure
literature number 5980-0723E

89610A, dc-40 MHz, Vector Signal Analyzer, data sheet
literature number 5980-1259E

89640A, dc-2700 MHz, Vector Signal Analyzer, data sheet
literature number 5980-1258E

E4406A Vector Signal Analyzer, brochure
literature number 5968-7618E

E4406A Vector Signal Analyzer, data sheet
literature number 5968-3030E

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