Agilent ESA-E Series Spectrum Analyzer Performance Guide Using the 89601A Vector Signal Analysis Software

Application Note

Agilent Technologies

Table of Contents

Introduction

This guide characterizes the performance of the ESA-E Series spectrum analyzers and the 89601A vector signal analysis (VSA) software combination. This combination adds the flexible digital demodulation and analysis capabilities of the 89601A software to the frequency coverage and general-purpose spectrum analysis capabilities of the ESA spectrum analyzers.

Product Overview

ESA-E Series spectrum analyzers

The ESA-E Series general purpose, portable spectrum analyzers offer a wide range of performance, features, and flexibility. The 1 ms RF sweep time, and up to 40 measurements per second give you virtual real-time measurement response. A continuously phase-locked synthesizer operating over the entire sweep provides improved frequency accuracy, stability, and repeatability. Up to 108 dB typical third-order dynamic range (+12.5 dBm TOI) and the 5 dB step attenuator let you see low-level distortion. Analysis is enhanced by –166 dBm sensitivity (typical, with 1 Hz RBW and optional built-in pre-amp) and fast measurement speed.

89601A vector signal analysis software

The 89601A vector signal analysis software provides flexible tools for making RF and modulation quality measurements on digital communications signals.

Analyze a wide variety of standard and non-standard signal formats with the 89601A software. Twenty-three standard signal presets cover GSM, GSM (EDGE), cdmaOne, cdma2000, W-CDMA, and more. For emerging standards, the 89601A software series offers 24 digital demodulators with variable center frequency, symbol rate, filter type, and filter alpha/BT. A user-adjustable adaptive equalizer is also provided.

Quickly evaluate and troubleshoot digitally modulated signals with the modulation analysis tools in the 89601A software. Examine symbol behavior with trellis/eye diagrams. Use the constellation and vector diagrams for an overall indication of signal behavior and to obtain clues to the cause of a problem. Take advantage of the EVM, EVM spectrum, and EVM time capabilities for a more sensitive examination of signal errors.

Perform time domain analysis using the 89601A software RF scope capability. Evaluate pulse shape with the main time display, select specific portions of a burst for analysis with the time gating feature, and use statistical tools like CCDF and CDF to characterize the noise-like behavior of your modern communications signal.

Simplify the characterization of your signal with the zero-span spectrum analysis tools in the 89601A analysis software. Match your measurement span to your signal bandwidth, thus maximizing analysis signal–to-noise ratio (SNR), with the wide selection of spans available in the 89601A software. FFT-based resolution bandwidths down to less than 1 Hz provide all the resolution needed for frequency domain investigations. A power spectral density (PSD) function is useful for estimating the level of the noise floor when calculating SNR. And, a spectrogram display is provided for monitoring the wideband behavior of hopping signals over time.

ESA-E/89601A combination

In the ESA-E/89601A combination, use the ESA-E Series to perform general-purpose RF spectrum measurements, one-button RF power measurements, and more. Use the 89601A to measure the modulation quality of your digitally modulated communication signal. Or, use it to extend testing and evaluation of GSM, cdma2000 (including code domain power or CDP measurements), and *Bluetooth*™ signals measured by the one-button measurement personalities in the ESA.

This combination can measure active signals or signals captured in the ESA-E Series' memory. The ESA alone, or the ESA-E/89601A combination can examine the active signals. Switching between the two products is facilitated by an easy disconnect/ restart menu selection in the 89601A user interface.

The 89601A software runs on a PC connected to the ESA-E via GPIB and provides hardware control, modulation analysis, evaluation, and troubleshooting along with complete results displays. The controls and display of the ESA-E are disabled while operating with the 89601A software.

ESA-E/89601A Features

The ESA-E/89601A combination requires a PC for the software's operation. Detailed configuration requirements for the ESA, the software, and the PC are provided in Appendix A. Appendix B contains information on GPIB interface hardware and the cables needed to connect the PC to the ESA.

ESA-E feature availability

When the ESA-E is controlled by 89601A software, users have control of the following features via the 89601A software:

Frequency: The center frequency of the ESA-E is controlled and the 89601A software displays its current setting.
Span: Only zero-span is available. Maximum setting is 10 MHz. Zero-span control and the display of its current setting are provided by the 89601A software.
Input attenuation: Available through input range feature of 89601A software.
Triggering: IF magnitude, external TTL, level, delay, and slope.
External reference: 10 MHz or 1 to 30 MHz.
Calibration
Overload detection

All other functions, including display, markers, and all one-button tests are normally disabled. You can suspend the 89601A software operation and gain immediate front panel access to all ESA-E features, including display, markers, and all one-button tests, using the disconnect capability provided in the 89601A control menu.

89601A feature availability

When the 89601A software is used with the ESA-E spectrum analyzers, almost all of the features of the 89601A and its options (see Appendix A for details) are available.

These include:

- recording of time waveforms, allowing you to re-analyze signals and store them for future comparisons
- 24 flexible digital demodulators settable in center frequency, symbol rate, filter type, and filter α/BT
- a complete set of vector signal analysis and modulation analysis displays including: constellation, eye diagram, EVM spectrum, EVM time, error screens, multiple trace displays, and a spectrogram display
- flexible marker capabilities including time gating, integrated band power, and offset (delta) markers
- a link to Agilent signal sources for download and playback of signals in the signal capture memory
- complete save and recall of your signals, trace data, and measurement screens
- easy cut and paste to other PC applications

The 89601A software's swept spectrum analysis capability is not supported.

Additional feature availability

When the 89601A software is controlling the ESA-E, three additional features are provided:

Disconnect/restart: This control allows the user to suspend the 89601A software control of the ESA-E without exiting the 89601A software. The user can then operate the ESA-E from its front panel. Immediate restart of 89601A control of the ESA-E with automatic reset to the last measurement state is also provided.

Alias protection vs. time capture length: The 89601A software lets you choose signal sampling modes to trade-off alias protection for more signal capture time. Setting the alias protect parameter to *true* provides maximum alias protection but restricts the signal capture time to 8.28 ms maximum. Signal capture time can be extended to 10 seconds (for span < 10 kHz, see performance features section for details) by setting the alias protect parameter to *false*. This mode offers minimum alias protection near the center frequency of the analysis span. However, alias products can be reduced by band limiting the input signal to the analysis span. To change the alias protect parameter go to the utilities menu and click: **Hardware>[ADC 1]>ESA>Configure>Alias Protect**. This parameter defaults to false (minimum alias protection/maximum signal capture time).

Selectable inputs for external frequency reference: The software lets you choose between external frequency reference inputs. Use the 10 MHz reference for best phase error and EVM results. Using the variable external frequency input will degrade phase error and EVM performance for lower symbol rate signals like NADC, PDC, and TETRA, but will allow you to use reference frequencies from 1 MHz to 30 MHz.

Spurious performance

When the 89601A software and the ESA-E spectrum analyzers are used together, measurements may be affected by spurious responses caused by out-of-span signals. Of particular importance are signals within ±16 MHz of the analyzer's center frequency that may affect multi-carrier modulation analysis measurements. To avoid these spurious responses the input signal should be band limited to the analysis span.

Performance Summary[1,2]

The following is a summary of the features and capabilities provided by the ESA-E Series spectrum analyzers in combination with the 89601A software. These are nominal values and are not warranted.

Frequency range[3]		Overall range depends on ESA-E model
Center-frequency tuning resolution		1 Hz
Frequency span range	Alias protection enabled Alias protection disabled (default)	< 50 kHz to 10 MHz < 50 Hz to 10 MHz
Frequency points per span	Calibrated points Displayable points	51 to 102,401 51 to 131,072
Frequency stability (spectral purity)		
Phase noise, 1 GHz input[2]	> 10 kHz offset	–96 dBc/Hz

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 a 1-3-10 sequence or directly enter an arbitrarily chosen bandwidth.

Range	Alias protection enabled Alias protection disabled (default)	< 500 Hz to > 2.8 MHz < 1 Hz to > 2.8 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 (3.30 dB)	Pass band flatness (dB)	Rejection (dBc)
Flat top	0.41	0.01	> 95
Gaussian top	0.25	0.68	> 125
Hanning	0.11	1.5	> 31
Uniform	0.0014	4.0	> 13

Input range	Without preamp (Option E44xx-1DS) or for frequencies > 3 GHz With preamp (Option E44xx-1DS)	 –55 dBm to +30 dBm 1 dB steps –75 dBm to +30 dBm 1 dB steps
ADC overload		+5.2 dBfs
Amplitude accuracy[3]	Accuracy values apply with flat-top window selected	
Absolute full-scale accuracy		±1.5 dB
Flatness[3] Frequency response across the measurement span (included in amplitude accuracy value)		±0.2 dB

1. All RF-related values are using the ESA-E Series RF input and a maximum mixer level of –10 dBm.
2. These features apply using the internal reference or 10 MHz REF IN only. Using EXT REF IN and 10 MHz OUT ports degrades close-in (< 600 Hz) phase noise performance.
3. Nominal values for amplitude accuracy, flatness, and dynamic range apply between 30 MHz and 3 GHz.

Dynamic range[1] Dynamic range indicates the amplitude range that is free of erroneous signals within the measurement span.		
Third-order intermodulation distortion (two signals in-span; each –6.5 dBfs to –10 dBfs; separation > 100 kHz; referenced to either signal)		–55 dBc
Spurious responses[2] Spurious responses due to in-span signals		< –45 dBc
Residual responses	Alias protection enabled	–90 dBm
	Alias protection disabled (default)	< –60 dBfs or < –90 dBm
Noise density[3]		< –120 dBfs/Hz at 1 GHz (range > –20 dBm)
Sensitivity[3]		
With preamp (Option E44xx-1DS)		< –158 dBm/Hz at 1 GHz (most sensitive range)
Without preamp		< –144 dBm/Hz at 1 GHz (most sensitive range)

Time and Waveform

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

1. Nominal values for amplitude accuracy, flatness, and dynamic range apply between 30 MHz and 3 GHz.
2. Spurious response values apply to signals that are band limited to the analysis span.
3. Noise and sensitivity are degraded by approximately 3 dB x $\log_2$ (10 MHz/span) when the alias protection parameter is set to *false* (see feature availability section).

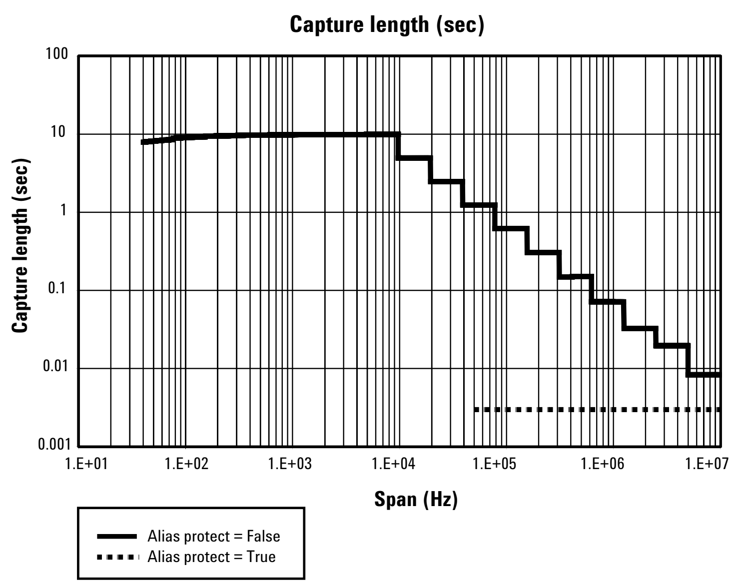
Time capture characteristics

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 During time capture, the analyzer is internally set to the next highest cardinal span available in the ESA that equals or exceeds the currently displayed frequency span.	124,388 samples complex

Time capture length versus span



Measurement, Display, and Control

Triggering	
Trigger types	
Vector signal analyzer application	Free run, IF magnitude*, external TTL *Requires Option E44xx-B7E. See Appendix A for configuration information
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	55 dB (100%) for a pure AM signal (distortion) 45 dB (100%) for a pure AM signal (spurious)
Cross demodulation	< 0.5% AM on an FM signal with 10 kHz modulation, 200 kHz deviation
PM demodulation	
Accuracy	±3 degrees
Dynamic range	55 dB (rad) for a pure PM signal
Cross demodulation	< 1% PM on an 80% AM signal
FM demodulation	
Accuracy	±1% of span
Dynamic range	50 dB (Hz) for a pure FM signal (distortion) 45 dB (Hz) for a pure FM signal (spurious)
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, 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 – 4 traces on one, two, or four 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/ESA-E 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 the ESA remotely using the E2050 LAN-to-GPIB gateway.

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 Gsa in size. No additional calibration
MATLAB 5	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 or E4438C-002. E8267C vector signal generator with Option E826C-002 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 4096 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 between 30 MHz and 3 GHz fully contained in the selected measurement span, random data sequence, range ≥ –20 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	< 1.2% rms
100 kHz < span ≤ 1 MHz	< 0.4% rms
span ≤ 10 MHz	< 1.8% rms
Magnitude error	
span ≤ 100 kHz	0.6% rms
span ≤ 1 MHz	0.6% rms
span ≤ 10 MHz	1.3% rms
Phase error (for modulation formats with equal symbol amplitudes)	
span ≤ 100 kHz	0.7% rms
100 kHz < span ≤ 1 MHz	0.5% rms
span ≤ 10 MHz	0.8% rms
Frequency error (added to frequency accuracy if applicable)	symbol rate/500,000
I-Q/origin offset	–57 dB or better

Video modulation formats	
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	≤ 1.7% (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	≤ 1.5% (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, 128QAM, 256QAM, 8VSB, 16VSB, $\frac{3\pi}{8}$ 8PSK (EDGE), D8PSK

3G Modulation Analysis
(Option 89601A-B7N)
Includes:
W-CDMA
cdma2000
1xEV-DO
TD-SCDMA

W-CDMA modulation analysis	
Signal acquisition	
Result length	Adjustable between 1 and 27 slots[1]
Samples per symbol	1
Triggering	Single/continuous, external
Measurement region	Length and offset adjustable within result length
Signal playback	
Result length	Adjustable between 1 and 27 slots[1]
Capture length (gap-free analysis at 0% overlap; at 5 MHz span)	27 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 offset (downlink)	Continuously adjustable between 0 and 15
Scramble type (downlink)	Standard, left, right
Sync type (downlink)	CPICH, SCH
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
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

1. Requires alias protect = false, 11 slots when alias protect = true.

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[1] (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	1.6% or less for pilot only
EVM floor	1.6% or less for test model 1 with 16 DPCH signal
Frequency error	
Range (CPICH sync type)	±500 Hz
Accuracy	±10 Hz

cdma2000 modulation analysis

Signal acquisition		
Result length (adjustable)	Forward link, RF Reverse link, RF	1 – 24 PCG[2] 1 – 24 PCG[2]
Samples per symbol	1	
Triggering	Single/continuous, external	
Measurement region	Length and offset adjustable within result length	
Signal playback		
Result length	Forward link, RF Reverse link, RF	1 – 24 PCG[2] 1 – 4 PCG[2]
Capture length (gap-free analysis at 0% overlap; at 1.5 MHz span)		24 PCG[2]
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	

1. Values apply between 30 MHz and 3 GHz.
2. Requires alias protect = false, 5 PCG when alias protect = true.

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)
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
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[1] (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	1.6% or less
Frequency error	
Range (CPICH sync type)	±500 Hz
Accuracy	±10 Hz

1. Values apply between 30 MHz and 3 GHz.

1xEV-DO modulation analysis	
Signal acquisition	
Result length	
Forward link	1 – 18 slots[1]
Reverse link	1 – 18 slots[1]
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 – 18 slots[1]
Reverse link	1 – 18 slots[1]
Capture length (gap-free analysis at 0% overlap at 1.5 MHz span)	18 slots[1]
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 (forward)	Continuously adjustable from 0x64 to 511x64 chips
Preamble length (forward)	Auto detection or settable 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	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

1. For alias protection = false, three slots when alias protection true.

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[1] (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	1.6% max
Frequency error	
Lock range	±500 Hz
Accuracy	±10 Hz

TD-SCDMA modulation analysis[2]	
Signal acquisition	
Result length	1 – 5 subframes[3]
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 – 5 subframes[3]
Capture length (gap-free analysis at 0% overlap at 1.6 MHz span)	5 subframes[3]
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

1. Values apply between 30 MHz and 3 GHz.
2. Requires alias protect = false.
3. Requires frequency span ≤ 2.5 MHz, subframe start boundary. Drops to two subframes for two frame start boundary.

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[1] (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

1. Values apply between 30 MHz and 3 GHz.

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
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
Required hardware and software

When ordering an ESA-E spectrum analyzer

The ESA-E/89601A combination works with any new ESA-E Series model E4402B, E4404B, E4405B, E4407B with firmware version A.08.04 or higher.

Unless otherwise marked the following options must be installed in the ESA-E used in the combination.

Table 1. Options required in the ESA-E

Option	Description
B7D	Digital signal processing and fast ADC
B7E	RF communication hardware (ID 117 or higher required for IF magnitude triggering)
1D5	High stability frequency reference
A4H	GPIB and Centronic interfaces

Existing ESA-E spectrum analyzers

The following options are needed in an existing ESA-E spectrum analyzer for it to work with the 89601A software.

Table 2. ESA-E existing analyzer options

Option	Description
B7D	Digital signal processing and fast ADC
B7E	RF communication hardware, ID 117 or higher required for IF magnitude triggering
1D5	High stability frequency reference
A4H	GPIB and Centronic interfaces
B72	Increase memory to 16 MB
229*	Modulation analysis personality (version A.02.01 or higher)
231*	89600 VSA link personality (version A.02.00 or higher)

* Ordering at least one option is required.

To find whether these options are in your ESA-E press the following buttons on the ESA-E front panel: [**System**]>[**More**]>[**Show System**].

89601A vector signal analysis software

The ESA-E/89601A combination works with 89601A vector signal analysis software version 3.01, or greater.

The following options must be installed with 89601A software.

Table 3. Required options

Option	Description
100	Vector analysis software

The following options are recommended for use with the 89601A software.

Table 4. Recommended options for 89601A software

Option	Description
AYA	Vector modulation analysis
B7N	3G modulation analysis (W-CDMA, cdma2000, 1xEV-DO, and TD-SCDMA)

PC for 89601A software

The 89601A requires a PC connected via GPIB I/O to the ESA-E to run. Either 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-K6
- 128 MB RAM (256 MB recommended)
- 4 MB video RAM (8 MB recommended)
- Hard disk with 100 MB of available space
- Microsoft® Windows 2000, NT 4.0 (service pack 6a, or greater required), or XP Professional®
- CD ROM drive (can be provided via network access), 3.5 inch floppy disk drive (can be provided via network access)
- GPIB interface

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

Appendix B
PC to ESA-E spectrum analyzer interface configuration

The ESA-E Series spectrum analyzers with Option E44xxA-A4H support GPIB I/O. The following interface cards and cables are recommended for connecting the ESA-E to a PC via GPIB[1].

Table 5. PC interface 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.
One-meter GPIB cable	10833A	Available from Agilent.
USB/GPIB	82357A	Available from Agilent.

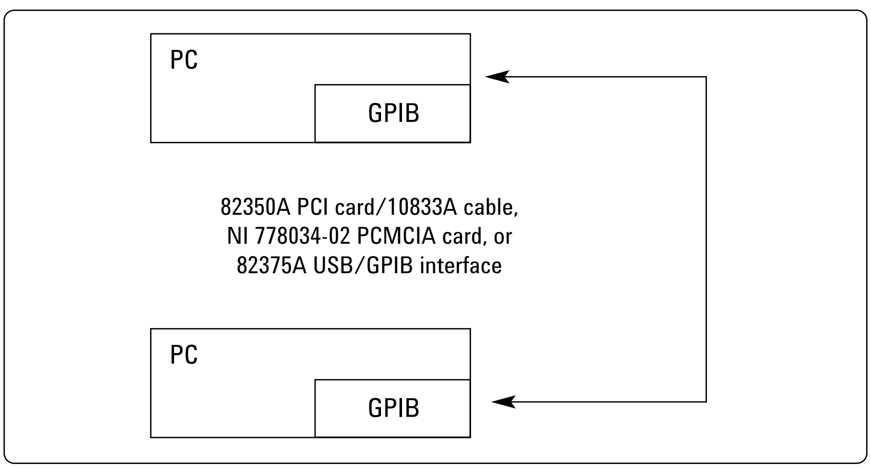


Figure 1. GPIB connection

1. LAN connection available using Agilent Technologies E2050A LAN/GPIB Gateway.

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

ESA-E Series Spectrum Analyzers, data sheet literature number 5968-3386E

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