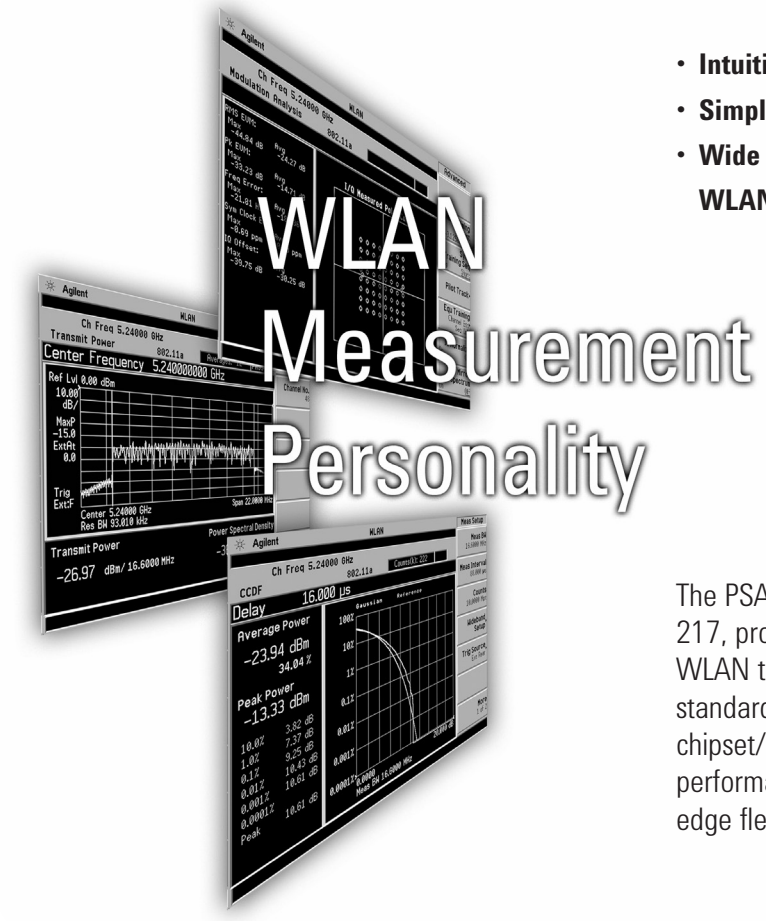
Agilent
PSA Series Spectrum Analyzers
WLAN Measurement Personality

Technical Overview with Self-Guided Demonstration
Option 217



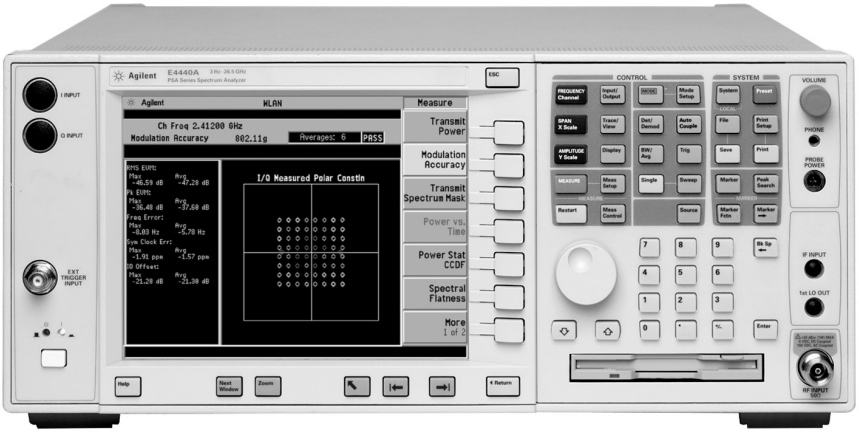
- **Intuitive, easy-to-use, one-box solution**
- **Simplified test setup with WLAN standards presets**
- **Wide analysis bandwidth for current and future WLAN applications**

The PSA Series WLAN measurement personality, Option 217, provides a single solution for your 802.11a/b/g WLAN transmitter test measurements. You can test for standards conformance, standards verification and chipset/module integration, within a single high-performance spectrum analyzer that delivers leading edge flexibility, speed, and accuracy.

Agilent Technologies

Transmit power measurement page 6

Modulation accuracy pages 6 & 12



Spectral flatness page 8

Transmit spectrum mask measurement pages 8 & 11

CCDF measurement page 9

WLAN Measurement Personality

The PSA Series WLAN measurement personality supports 802.11b DSSS, CCK, and PBCC signals, 802.11a OFDM (Orthogonal Frequency Division Multiplexing) signals, and 802.11g OFDM and mixed-mode Extended Rate PHY (ERP) signals. The WLAN measurement personality (Option 217) analyzes standards-based signals according to IEEE mandated signal tests.

The pass/fail indicators quickly give a visual indication of standards conformance. For extra flexibility, user-defined limits on parameters such as spectral flatness, EVM, center frequency leakage, and more, allow for customization of pass/fail tests to more stringent constraints than those indicated by IEEE 802.11 standards, adding a level of margin between your product and the IEEE requirement.

Measurements such as EVM vs. symbol and EVM vs. carrier provide insight into signal impairments that would otherwise go unnoticed in signal testing. On a more aggregate level, measurements such as CCDF enable characterization of devices such as power amplifiers, over an entire data burst.

The PSA spectrum analyzer with Option 140 (40 MHz bandwidth digitizer) or Option 122 (80 MHz bandwidth digitizer) provides the analysis bandwidth necessary to test today's WLAN signals, while providing the flexibility for tomorrow's wide-bandwidth needs.

The WLAN measurement personality leverages the PSA's excellent feature set and superb RF performance, including integration and compatibility with the Agilent 89601A vector signal analyzer (VSA) software.

Table 1. WLAN measurement personality key features and benefits

Features	Benefits
Intuitive user interface and large, graphical display measurement results with repeatable and	Easy-to-use- no need to hunt for accurate measurements.
Simplified setup for analysis of time-, frequency-, and modulation-domain characteristics of 802.11a/b/g wireless LAN signals	Reduced setup time enables quick and accurate measurements, and reduces configuration time when switching between formats.
Wide analysis bandwidth ready for future signal formats	Test test today's formats with the flexibility you need for tomorrow's signals.
View pass/fail indicators based on IEEE WLAN standards	Verify IEEE compliance quickly, easily, and accurately.
Customize signal parameters such as sub-carrier spacing, and guard intervals	Flexibility to adapt for non-standard WLAN signals
Automatic-demod of modulation type	An intelligent measurement engine that eliminates the need to manually change the modulation format from burst to burst.
Customize parameter limits based on your own tolerances	Maximize device data rate and range by ensuring device quality above and beyond the minimum required by IEEE standards.
Characterize and compare power amplifiers with wide-bandwidth CCDF measurements	Optimize power amplifier designs by correctly characterizing power statistics.
Evaluate and quantify the modulation characteristics of single carriers, pilot carriers, or aggregate multi-carrier OFDM signal data	Troubleshoot individual portions of a signal or investigate pilot imperfections.
Excellent RF and performance	Quick spectral mask tests, test harmonics, test leakage.

Demonstration Preparation

This demonstration section provides step-by-step instructions for making 802.11a and 802.11b measurements. Screenshots of example measurements are included to help guide you make accurate measurements.

The following options are required for the ESG and the PSA Series in order to perform this demonstration.

All demonstrations use the PSA Series & E4438C ESG vector signal generator; keystrokes surrounded by [ ] indicate front-panel hard keys; keystrokes surrounded by { } indicate soft keys on display.

Product type	Model number	Required options
ESG vector signal generator	E4438C firmware revision C.03.10	502, 503, 504, or 506 417 Signal Studio for 802.11 WLAN
PSA Series	E4443A, E4445A, E4440A	217, 122 or 140
PC		Signal Studio for 802.11 WLAN

Instructions

Connect the PC, PSA and ESG:

Connect a PC (loaded with the Signal Studio for 802.11 WLAN software and Agilent I/O library) to the E4438C ESG via GPIB or LAN.

The setup procedure used in this guide assumes the LAN interface is used. To use LAN interface from Signal Studio, set up LAN Client with I/O Configuration of Agilent I/O Library.

Make the necessary connections on the PSA and ESG
Perform the following steps to interconnect the PSA and ESG (see Figure 5 for a graphical overview):

- Connect the ESG RF output port to the PSA RF input port
- Connect the ESG 10 MHz out to the PSA Ext Ref in port
- Connect the ESG event trigger 1 port to the PSA Ext trigger input (front panel)

See figure 1 for diagram of this setup.

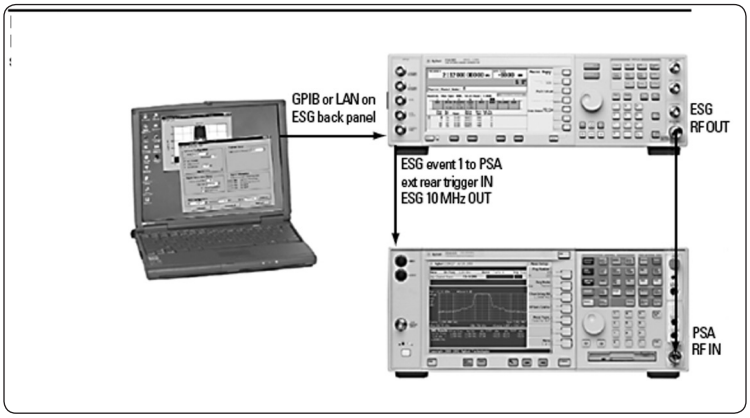


Figure 1. PSA and ESG configuration diagram.

Demonstration Preparation (continued)

E4438C Option 417 Signal Studio for 802.11 WLAN is a Windows® based utility that simplifies the creation of standards-based or customized 802.11a/b/g WLAN waveforms. The Signal Studio software is used to configure the 802.11 WLAN signal and then the parameters are downloaded into the ESG signal generator, which creates the desired waveform.

Configure the desired signal parameters using the Signal Studio for 802.11 WLAN software on a PC. Detailed instructions on how to use the software, including examples illustrating the configuration of test signals, are provided with the Signal Studio software.

Instructions	Keystrokes
Establish a communication link with the ESG vector signal generator:	
Preset the ESG.	[Preset]
Check the IP address.	[Utility] {GPIB/RS-232/LAN} {LAN Setup} e.g.,{IP address 192.168.100.1}
Run the Agilent Signal Studio for 802.11 WLAN.	Double-click on the 802.11 WLAN shortcut on the desktop or access the program via the Windows start menu
Verify that the software is communicating with the instrument via the LAN TCP/IP link.	From the {Configuration} pull-down menu at the top of the Signal Studio program window, select {Sig Gen I/O}. Next, select TCP/IP and enter the hostname or IP address of the ESG in the address area. Finally, click Check.
After performing this operation, the software should return succeed under connection status.	If this is the case, click on {Close}. If this is not the case, re-verify the instrument is connected and re-check the IP address and TCP/IP link.

Demo Instructions: 802.11a (OFDM) signal

Note the center frequency of the signal is under the Signal Generator Configuration area, and is labeled Fc. Set the center frequency to 5.24 GHz. This overrides the channel setting in the Signal Configuration area.

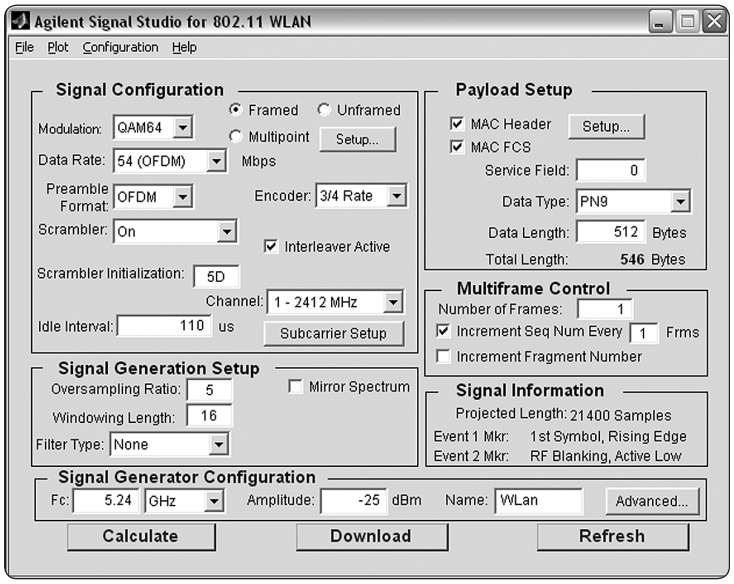


Figure 2. Signal Studio software setup parameters for generating an 802.11a signal.

Instructions	Keystrokes
Configure the ESG to create an 802.11a signal:	
Calculate and download the waveform to the ESG vector signal generator.	Calculate button, then Download button, on the 802.11 WLAN Signal Studio software
802.11a (OFDM) signal demonstration instructions:	
Prepare the PSA for an 802.11a signal. Preset the PSA.	[System] {Power On/Preset} {Preset Type} {Factory} [Preset]
Enter the WLAN mode in the analyzer.	[MODE] {More} (if necessary) {WLAN}
Preset the measurement personality to a WLAN standard, in this case, 802.11a.	[Mode Setup] {Radio} {WLAN Std} {802.11a}

Transmit power measurement

The transmit power measurement allows the user to accurately determine the total power in a specified bandwidth, and the power spectral density in the occupied channel. The results are clearly shown in large text, along with a graphical display of the spectrum.

The default measurement bandwidth for 802.11a is 16.6 MHz, but this setting is adjustable. The integration bandwidth is easily identified graphically by the white vertical band power markers on the spectrum display.

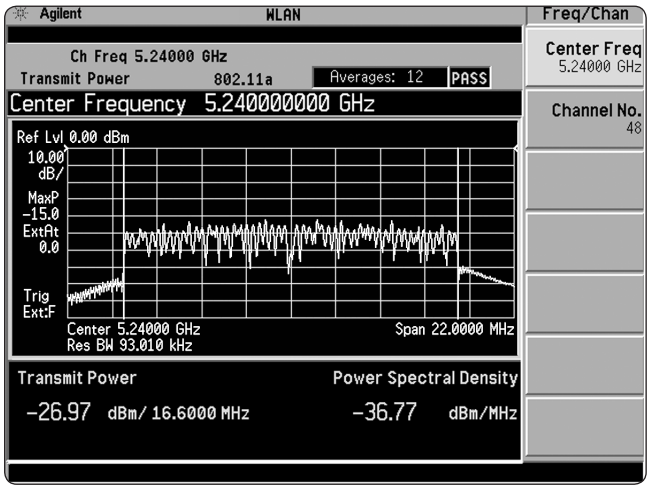


Figure 3. Transmit power measurement displays spectrum and numeric results of power parameters.

Modulation accuracy

Measurement displays such as constellation, EVM vs. symbol, and EVM vs. carrier provide insight into signal imperfections that are masked or not detectable in other measurements.

A numeric results screen gives a summary of modulation characteristics, as well as numerical values of test limits as defined by the IEEE standard, or as modified to fit a user's more stringent test requirements. If any test does not meet the limit, an indication is given next to the specific test that fails.

The numeric results screen shows these parameters, and their corresponding limit:

- Frequency error (17.3.9.4 transmit center frequency tolerance)
- Symbol clock error (17.3.9.5 symbol clock frequency tolerance)
- IQ Offset (17.3.9.6.1 transmitter center frequency leakage)
- Quadrature skew
- IQ gain imbalance

Instructions	Keystrokes
Transmit power measurement on the PSA:	
Activate the transmit power measurement.	[Measure] {Transmit Power}
Configure the PSA to trigger off the ESG vector signal generator.	[Meas Setup] {More 1 of 2} {Trig Source} {Ext Rear}

Instructions	Keystrokes
Modulation accuracy on the PSA:	
Access the modulation accuracy measurement.	[Measure] {Modulation Accuracy}

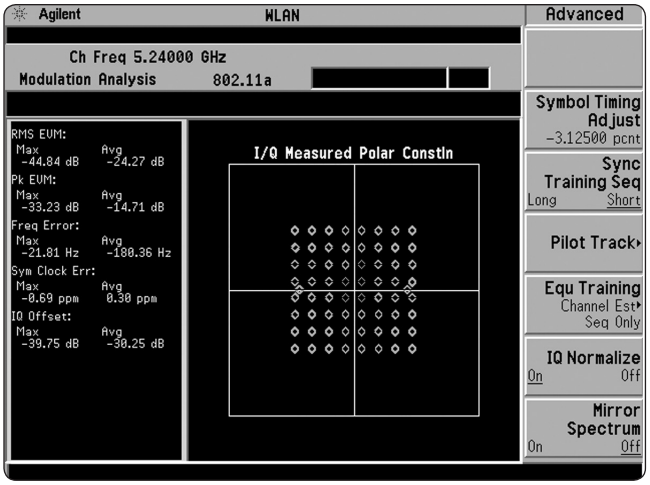


Figure 4. Constellation of 54 Mbps OFDM signal showing overlayed 64QAM and BPSK points.

Figure 5 shows the results summary screen. On the right side of the screen, the user can customize pass/fail limits to values different from the IEEE standard. For example, the user can set the maximum tolerable EVM limit at the 54 Mbits/s data rate to be –35.00 dB, rather than the default value of –25.00 dB.

Instructions	Keystrokes
View other results screens on the PSA:	
OFDM EVM view.	[Trace/View] {OFDM EVM}
Zoom in on a window of interest, for example, EVM vs. carrier.	[Next Window] [Zoom]
View the results summary screen.	[Trace/View] {Numeric Results}

Figure 5. Numeric results summarize key modulation accuracy parameters.

Keystrokes
Results summary screen on the PSA:
[Meas Setup] {More 1 of 2} {Limit} {More 1 of 2} {54 Mbits/s RMS EVM} {–35.00} {Enter}

Spectral flatness

The Spectral flatness measurement allows for IEEE standard-based pass/fail measurements, as specified by the IEEE 802.11a-1999 standard, section 17.3.9.6.2 transmit spectral flatness.

Transmit spectrum mask measurement

The spectrum emission mask measurement allows for IEEE standard-based pass/fail measurements, as specified by the IEEE 802.11a-1999 standard, section 17.9.3.2 transmit spectrum mask.

Instructions	Keystrokes
Spectral flatness on the PSA:	
Access the spectral flatness measurement.	[Measure] {Spectral Flatness}

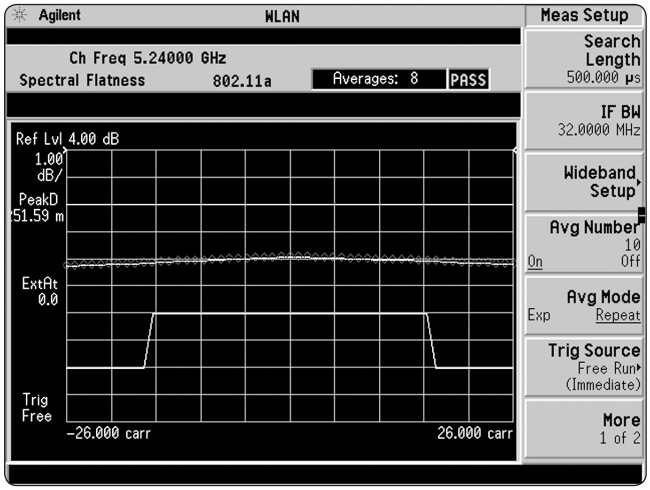


Figure 6. OFDM spectral flatness measurement across 52 carriers.

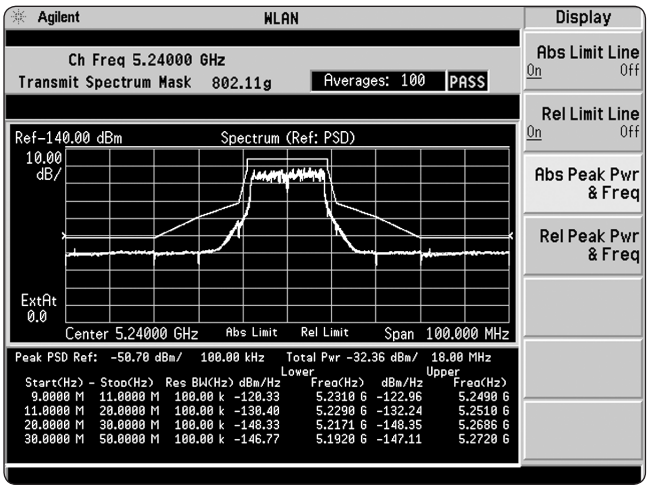


Figure 7. Transmit spectrum mask measurement showing IEEE defined limits.

CCDF measurement

To accurately perform a useful CCDF measurement of a device such as a power amplifier (PA), the measurement must be made on the data portion of the OFDM burst. In an 802.11g ERP-OFDM signal, the first portion of the burst includes training symbols to aid in coarse, and then fine, frequency estimation. This sequence occupies the first 16 µs of the burst. It is followed by the signal field, and then the data field. The signal field information is mapped onto all OFDM carriers, using BPSK modulation. The information in the data portion of the burst is then mapped onto 48 (not including 4 BPSK pilot carriers) carriers using BPSK, 16QAM, and/or 64QAM modulation.

In order to accurately characterize the PA, only the signal and data portions of the burst should be included. This can be done by adjusting the trigger parameters within the CCDF measurement.

OFDM bursts are variable in length. Therefore, the first task is to identify the total length of the burst. This can be done using the waveform measurement. Keystrokes: [Measure] {Waveform}

The total length of the burst can be found using markers. Place a marker on the left edge of the burst, to indicate the start of that burst. Then place a delta marker at the end of the same burst.

Instructions	Keystrokes
CCDF measurement on the PSA:	
First, select the correct trigger source.	[Meas Setup] {Trig Source} {Ext Rear}
Now, zoom in on the first burst only. Set the measurement time to 150 µs.	[Meas Setup] {Meas Time} {150 µs}
Set a marker at the rising edge of the burst.	[Marker]
Set another marker, using marker delta, at the falling edge of the burst. This will determine the total length of the burst.	[Marker] {Delta} {use the knob to place the marker at the falling edge of the burst}

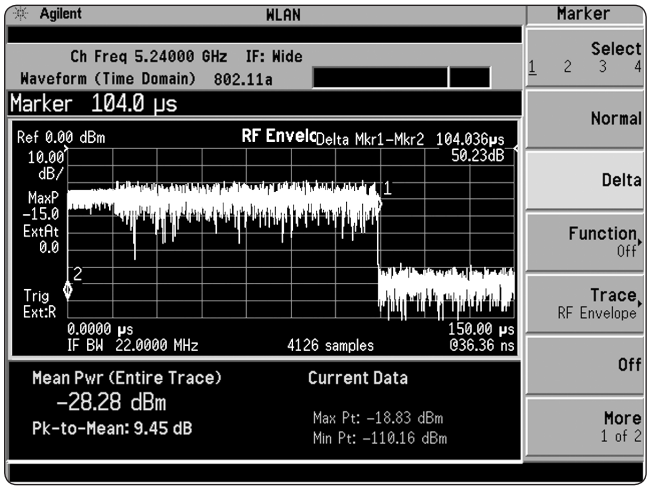


Figure 8. Time-domain view of 802.11a burst.

CCDF measurement (continued)

In the measurement shown below, the burst is 104 µs long. The training portion of the OFDM burst occupies the first 16 µs. This determines the trigger offset that will be set for the CCDF measurement. Therefore, the CCDF measurement should only analyze the portion of the burst between 16 µs and 104 µs, for a total length of 88 µs.

Instructions	Keystrokes
CCDF measurement on the PSA continued:	
Now, enable the CCDF measurement.	[Measure] {Power Stat CCDF}
Select the correct trigger source.	[Meas Setup] {Trig Source} {Ext Rear}
Select the appropriate measurement interval.	[Meas Setup] {Meas Interval} {88 µs}
Adjust the trigger offset.	[Trig] {Ext Rear} {Delay} {16 µs}
Now the CCDF measurement is correctly made.	

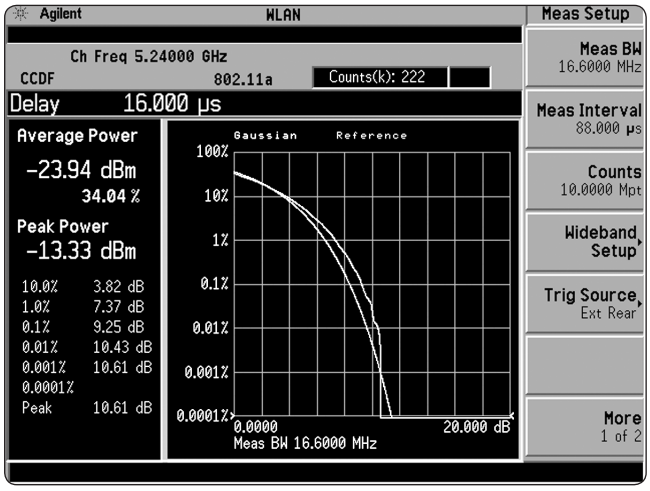


Figure 9. CCDF measurement performed over the data portion of an OFDM burst.

Demo Instructions (802.11b signal)

Many of the required measurements for 802.11b are procedurally similar to those for 802.11a. Some differences of 802.11b signal measurements are illustrated here.

Figure 10 shows the appropriate configuration for the ESG to create 802.11b signals.

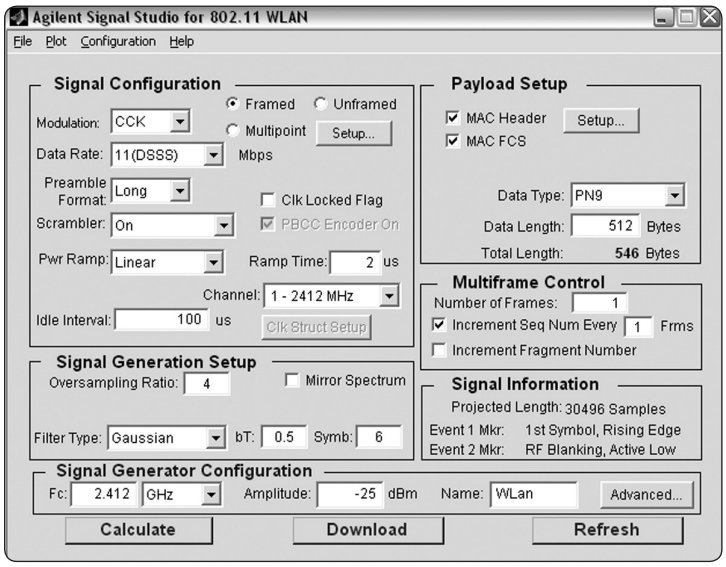


Figure 10. Signal Studio software setup parameters for generating an 802.11b signal.

Instructions	Keystrokes
Prepare the PSA for an 802.11b signal:	
Preset the PSA.	[System] {Power On/Preset} {Preset Type} {Factory} [Preset]
Enter the WLAN mode in the analyzer.	[MODE] {More} (if necessary) {WLAN}
Preset the measurement personality to a WLAN standard, in this case, 802.11b.	[Mode Setup] {Radio} {WLAN Std} {802.11b}

Transmit spectrum mask measurement

Instructions	Keystrokes
Prepare the PSA for an 802.11b signal:	
Access the spectrum emission mask measurement.	[Measure] {Spectrum Emission Mask}

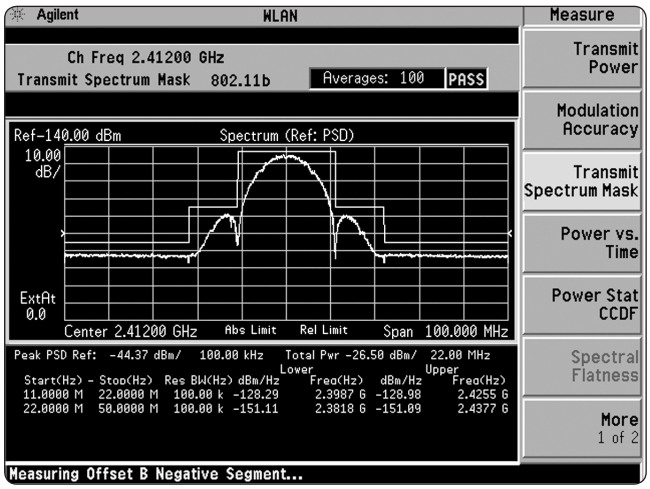


Figure 11. Transmit spectrum mask measurement showing IEEE defined limits.

Modulation accuracy

Instructions	Keystrokes
Modulation accuracy on the PSA:	
Access the modulation accuracy measurement.	[Measure] {Modulation Accuracy}
View the results summary screen.	[Trace/View] {Numeric Results}

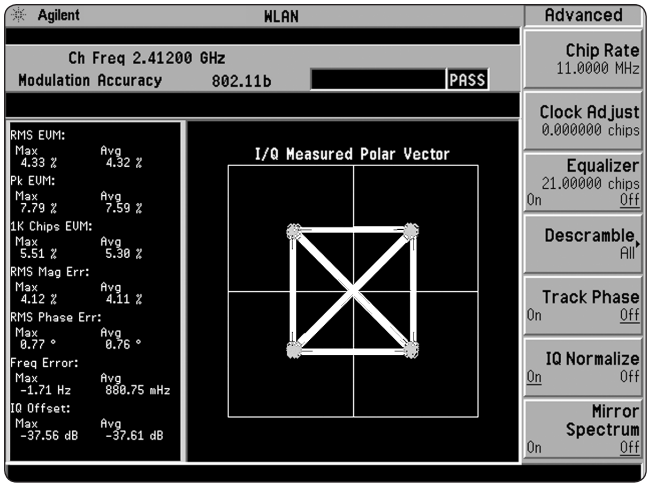


Figure 12. Constellation of an 11 Mbps 802.11b signal.

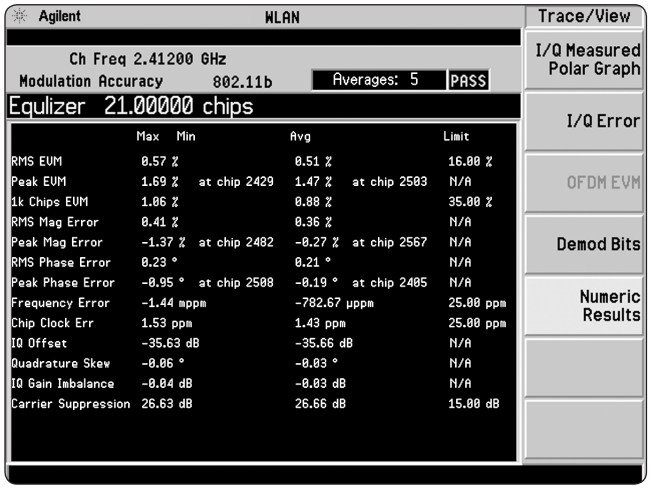


Figure 13. 802.11a numeric results.

Key Specifications

Description	Specifications	Supplemental information
Supported standards	802.11a 802.11g ERP-OFDM 802.11g DSSS-OFDM 802.11b 802.11g DSSS/CCK/PBCC	
Modulation formats	BPSK, QPSK, 16QAM, 64QAM	(auto detect or manual override)
Capture length	5.12 seconds	(20 MHz span)
Amplitude accuracy		
Absolute amplitude accuracy Center frequency = 2.442 GHz	±0.86 dB	±0.17 dB (typical)
Absolute amplitude accuracy Center frequency = 5.240 GHz	±1.78 dB	±0.7 dB (typical)
Transmit spectral mask accuracy or relative power accuracy	±0.30 dB	
Modulation accuracy **Residual EVM (20 averages)**		
802.11a, 802.11g ERP-OFDM		
Equalizer training = chan est seq + data		≤ –48 dB (0.4%) (nominal)
Equalizer training = chan est seq		≤ –45 dB (0.56%) (nominal)
802.11b		
Equalizer on		≤ 0.4% dB (nominal)
Equalizer off		≤ 1.0% dB (nominal)

Ordering Information

PSA Series spectrum analyzer

E4443A	3 Hz to 6.7 GHz
E4445A	3 Hz to 13.2 GHz
E4440A	3 Hz to 26.5 GHz
E4446A	3 Hz to 44 GHz
E4447A	3 Hz to 42.98 GHz
E4448A	3 Hz to 50 GHz

Options

To add options to a product, use the following ordering scheme:

Model	E444xA (x = 0, 3, 5, 6, 7 or 8)
Example options	E4440A-B7J
	E4448A-1DS

Measurement personalities

E444xA-226	Phase noise
E444xA-219	Noise figure, requires 1DS
E444xA-241	Flexible digital modulation analysis
E444xA-BAF	W-CDMA, requires B7J
E444xA-210	HSDPA, requires B7J and BAF
E444xA-202	GSM w/ EDGE, requires B7J
E444xA-B78	cdma2000, requires B7J
E444xA-214	1xEV-DV, requires B7J and B78
E444xA-204	1xEV-DO, requires B7J
E444xA-BAC	cdmaOne, requires B7J
E444xA-BAE	NADC, PCD, requires B7J
E444xA-217	WLAN, requires 122 or 140
E444xA-211	TD-SCDMA
E444xA-215	External source control
E444xA-266	Programming code compatibility suite

Hardware

E444xA-1DS	100 kHz to 3 GHz built-in preamplifier
E444xA-B7J	Digital demodulation hardware
E4440A-122	80 MHz bandwidth digitizer (E4440A/43A/45A only, excludes 140, H70)
E4440A-140	40 MHz bandwidth digitizer (E4440A/43A/45A only, excludes 122, H70)
E444xA-123	Switchable MW preselector bypass (E4440A/43A/45A only, excludes AYZ)
E444xA-124	Y-axis video output
E444xA-AYZ	External mixing (E4440A/46A/47A/48A only, excludes 123)
E4440A-BAB	Replaces type-N input connector APC 3.5 connector (E4440A only)
E444xA-H70	70 MHz IF output, excludes 122, 140, not available for E4447A
E444xA-H26	Highband preamplifier, requires 1DS

PC software

E444xA-230	BenchLink web remote control software
E4440A-233	N5530S measuring receiver software & license requires B7J, E4443A/45A/40A only
E4440A-235	Wide bandwidth digitizer external calibration wizard, requires 122

Accessories

E444xA-1CM	Rack mount kit
E444xA-1CN	Front handle kit
E444xA-1CP	Rack mount with handles
E444xA-1CR	Rack slide kit
E444xA-015	6 GHz return loss measurement accessory kit
E444xA-045	Millimeter wave accessory kit
E444xA-0B1	Extra manual set including CD ROM

Warranty and service

Standard warranty is three years.

R-51B-001-5C	Warranty Assurance Plan, Return to Agilent, 5 years

Calibration[1]

R-50C-011-3	Calibration Assurance Plan, Return to Agilent, 3 years
R-50C-011-5	Calibration Assurance Plan, Return to Agilent, 5 years
R-50C-016-3	Agilent Calibration + Uncertainties + Guardbanding, 3 years
R-50C-016-5	Agilent Calibration + Uncertainties + Guardbanding, 5 years
AMG	Agilent Calibration + Uncertainties + Guardbanding (accredited calibration)
A6J	ANSI Z540-1-1994 Calibration
R-50C-021-3	ANSI Z540-1-1994 Calibration, 3 years
R-50C-021-5	ANSI Z540-1-1994 Calibration, 5 years
UK6	Commercial calibration certificate with data To be ordered with PSA
E444xA-0BW	Service manual, assembly level
N7810A	PSA Series calibration application software

1. Options not available in all countries.

Product Literature

Selecting the Right Signal Analyzer for Your Needs, selection guide, literature number 5968-3413E

PSA Series, brochure, literature number 5980-1283E

PSA Series, data sheet, literature number 5980-1284E
PSA Series, configuration guide, literature number 5989-2773EN

Self-Guided Demonstration for Spectrum Analysis, product note, literature number 5988-0735EN

Phase Noise Measurement Personality, technical overview, literature number 5988-3698EN

Noise Figure Measurement Personality, technical overview, literature number 5988-7884EN

External Source Measurement Personality, technical overview, literature number 5989-2240EN

Flexible Modulation Analysis Measurement Personality, technical overview, literature number 5989-1119EN

W-CDMA and HSDPA Measurement Personalities, technical overview, literature number 5988-2388EN

GSM with EDGE Measurement Personality, technical overview, literature number 5988-2389EN

cdma2000 and 1xEV-DV Measurement Personalities, technical overview, literature number 5988-3694EN

1xEV-DO Measurement Personality, technical overview, literature number 5988-4828EN

cdmaOne Measurement Personality, technical overview, literature number 5988-3695EN

WLAN Measurement Personality, technical overview, literature number 5989-2781EN

NADC/PDC Measurement Personality, technical overview, literature number 5988-3697EN

TD-SDCMA Measurement Personality, technical overview, literature number 5989-0056EN

80/40 MHz Bandwidth Digitizer, technical overview, literature number 5989-1115EN

Programming Code Compatibility Suite, technical overview literature number 5989-1111EN

PSA Series Spectrum Analyzers Video Output (Option 124), technical overview, literature number 5989-1118EN

PSA Series Spectrum Analyzers, Option H70, 70 MHz IF Output, product overview, literature number 5988-5261EN

Optimizing Dynamic Range for Distortion Measurements, product note, literature number 5980-3079EN

PSA Series Amplitude Accuracy, product note, literature number 5980-3080EN

PSA Series Swept and FFT Analysis, product note, literature number 5980-3081EN

PSA Series Measurement Innovations and Benefits, product note, literature number 5980-3082EN

PSA Series Spectrum Analyzer Performance Guide Using 89601A Vector Signal Analysis Software, product note, literature number 5988-5015EN

89650S Wideband VSA System with High Performance Spectrum Analysis, technical overview, literature number 5989-0871EN

BenchLink Web Remote Control Software, product overview, literature number 5988-2610EN

IntuiLink Software, Data Sheet, Literature Number 5980-3115EN

89600 Series Vector Signal Analyzers, brochure, literature number 5980-0723E

Agilent N5530S Measuring Receiver System, technical overview, literature number 5989-1113EN

Application literature

Spectrum Analysis Basics, application note 150, literature number 5952-0292

Using Extended Calibration Software for Wide Bandwidth Measurements, PSA Option 122 & 89600 VSA, application note 1443, literature number 5988-7814EN

8 Hints for Millimeter Wave Spectrum Measurements, application note, literature number 5988–5680EN

Spectrum Analyzer Measurements to 325 GHz with the Use of External Mixers, application note 1453, literature number 5988-9414EN

EMI, application note 150-10, literature number 5968-3661E

Vector Signal Analysis Basics, application note 150-15, literature number 5989-1121EN

www.agilent.com
www.agilent.com/find/psa

myAgilent

www.agilent.com/find/myagilent
A personalized view into the information most relevant to you.

www.lxistandard.org

LAN eXtensions for Instruments puts the power of Ethernet and the Web inside your test systems. Agilent is a founding member of the LXI consortium.

Three-Year Warranty

www.agilent.com/find/ThreeYearWarranty
Beyond product specification, changing the ownership experience. Agilent is the only test and measurement company that offers three-year warranty on all instruments, worldwide

Agilent Assurance Plans

www.Agilent.com/find/AssurancePlans
Five years of protection and no budgetary surprises to ensure your instruments are operating to specifications and you can continually rely on accurate measurements.

www.agilent.com/quality

Agilent Electronic Measurement Group
DEKRA Certified ISO 9001:2008
Quality Management System

Agilent Channel Partners

www.agilent.com/find/channelpartners
Get the best of both worlds: Agilent's measurement expertise and product breadth, combined with channel partner convenience.

For more information on Agilent Technologies' products, applications or services, please contact your local Agilent office. The complete list is available at:
www.agilent.com/find/contactus

Americas

Canada	(877) 894 4414
Brazil	(11) 4197 3600
Mexico	01800 5064 800
United States	(800) 829 4444

Asia Pacific

Australia	1 800 629 485
China	800 810 0189
Hong Kong	800 938 693
India	1 800 112 929
Japan	0120 (421) 345
Korea	080 769 0800
Malaysia	1 800 888 848
Singapore	1 800 375 8100
Taiwan	0800 047 866
Other AP Countries	(65) 375 8100

Europe & Middle East

Belgium	32 (0) 2 404 93 40
Denmark	45 45 80 12 15
Finland	358 (0) 10 855 2100
France	0825 010 700* *0.125 €/minute
Germany	49 (0) 7031 464 6333
Ireland	1890 924 204
Israel	972-3-9288-504/544
Italy	39 02 92 60 8484
Netherlands	31 (0) 20 547 2111
Spain	34 (91) 631 3300
Sweden	0200-88 22 55
United Kingdom	44 (0) 118 927 6201

For other unlisted countries:
www.agilent.com/find/contactus
(BP-09-27-13)

Product specifications and descriptions in this document subject to change without notice.

Published in USA, November 25, 2013
5989-2781EN

Agilent Technologies