Keysight Technologies
Signal Studio for WLAN 802.11a/b/g/n/ac N7617B

Technical Overview

KEYSIGHT TECHNOLOGIES

Introduction

- Create Keysight Technologies, Inc. validated and performance optimized reference signals compliant with the IEEE 802.11a/b/g/j/p/n/ac standards
- Use basic options to provide partially-coded signals for testing components such as power amplifiers
- Use advanced options to provide signals with full channel coding, flexible configuration of MAC headers, spatial stream mapping, and application of channel models for testing receivers
- Support MIMO testing with up to 8 streams/antennas
- N7607B Signal Studio for DFS Radar Profiles enables creation of FCC, ETSI and Japan MIC radar test signals for DFS test
- Accelerate the signal creation process with a user interface based on parameterized and graphical signal configuration and tree-style navigation

Simplify WLAN Signal Creation

Typical Measurements

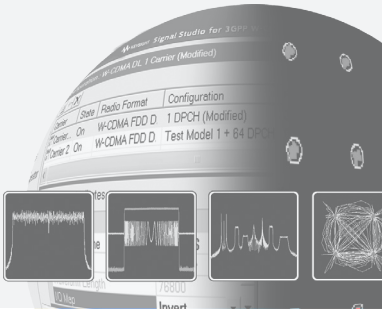
Test components with

basic capabilities

- IMD/NPR
- ACLR
- CCDF
- EVM
- Modulation accuracy
- Channel power
- Occupied bandwidth

Verify receivers with advanced capabilities

- Sensitivity
- Maximum input level
- Adjacent and nonadjacent channel rejection
- Clear channel assessment



Keysight Signal Studio software is a flexible suite of signal-creation tools that will reduce the time you spend on signal simulation. For WLAN, Signal Studio's performance-optimized reference signals—validated by Keysight—enhance the characterization and verification of your devices. Through its application-specific user-interface you'll create standards-based and custom test signals for component, transmitter, and receiver test.

Component and transmitter test

Signal Studio's basic capabilities use waveform playback mode to create and customize waveform files needed to test components and transmitters. Its user-friendly interface lets you configure signal parameters, calculate the resulting waveforms and download files for playback.

The applications for these partially-coded, statistically correct signals include

- Parametric test of components, such as amplifiers and filters
- Performance characterization and verification of RF sub-systems

Receiver test

Signal Studio's advanced capabilities enable you to create fully channel-coded signals for receiver packet-error-rate (PER) analysis. Applications include:

- Performance verification and functional test of receivers, during RF/base-band integration and system verification
- Coding verification of baseband subsystems, including FPGAs, ASICs, and DSPs

Performance Test

N7617B Signal Studio for WLAN 802.11a/b/g/n/ac and N7607B Signal Studio for DFS Radar Profiles can be integrated to set up a test system for WLAN performance tests including DFS test.

Apply your signals in real-world testing

Once you have set up your signals in Signal Studio, you can download them to a variety of Keysight instruments. Signal Studio software complements these platforms by providing a cost-effective way to tailor them to your test needs in design, development and production test.

- Vector signal generators
  - X-Series: MXG and EXG
  - PSG
  - ESG
  - First-generation MXG
  - M9381A PXIe VSG
- PXB baseband generator and channel emulator
- M8190A arbitrary waveform generator
- DigRF exerciser module
- M9252A DigRF host adaptor
- SystemVue simulation software
- E6630A wireless test set

Component and Transmitter Test

Figure 1. Typical component test configuration using Signal Studio's basic capabilities with a Keysight X-Series signal generator and an X-Series signal analyzer.

Signal Studio's basic capabilities enable you to create and customize 802.11a/b/g/j/p, 802.11n, or 802.11ac waveforms to characterize the power and modulation performance of your transmitter or receiver components, such as amplifiers and IQ modulators. Easy manipulation of a variety of signal parameters, including standard format, transmission bandwidth, guard interval, data rate, and modulation type, simplifies signal creation.

- Create spectrally-correct signals for channel power, ACP, spectral mask, and spurious testing
- Set parameters such as channel bandwidth and modulation and coding scheme (MCS) for modulation verification and analysis, such as EVM tests
- Configure up to three 802.11a/b/g/j/p carriers with individual channel parameters such as data rate, modulation type, payload data, PN data seed value, and frequency offset
- The 802.11ac option provides a downclocking ratio parameter to allow creation of signals proposed by the IEEE 802.11af and 802.11 WNG (Wireless Next Generation) working groups.
- View CCDF, spectrum and time domain graphs to investigate the effects of modulation formats, power changes, filtering, and other effects on the test signal

Receiver Test

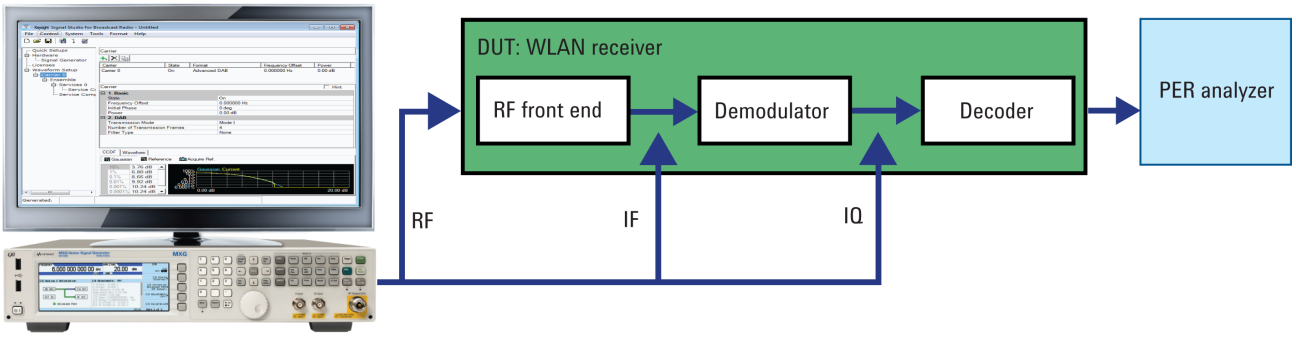


Figure 2. Generate fully channel-coded signals to evaluate the PER of your receiver with Keysight X-Series signal generators and Signal Studio's advanced capabilities.

Signal Studio's advanced mode capabilities provide additional features to help you create IEEE 802.11 WLAN standard-compliant signals for testing receiver designs in all stages of development. Use the baseband signal to perform demodulation and decoding verification on ASIC and DSP chips. To thoroughly test the demodulation capabilities of a receiver, a fully-coded test signal is necessary. This level of coding enables you to determine if each functional stage of a receiver is operating correctly and enables you to use this test signal to perform PER measurements.

- Enable or disable channel coding, scrambling and interleaving
- Configure MAC header settings, MAC FCS, sequence control, data type, and data length
- A multi-frame waveform with an incrementing Sequence Control field can be created for PER testing
- For the 802.11n and 802.11ac options, the software also supports Aggregation MPDU mode and LDPC encoding
- Test MIMO receivers with up to 4 antennas for 802.11n or up to 8 antennas for 802.11ac (hardware dependent). Choose the number of transmit chains and space-time streams, and select direct mapping or configure a spatial expansion matrix. The effects of fading can also be incorporated into a longer waveform file with MIMO channel modeling. Users can choose one of the 802.11n or 802.11ac channel models (A through F), or select a user-defined channel model. A beamforming matrix can be added for 802.11ac.

Features Summary

802.11 WLAN	Component & transmitter testing	Receiver testing
	Basic waveform playback mode	Advanced waveform playback mode
802.11a/b/g/j/p		
Modulation types		
OFDM	●	●
DSS-OFDM	●	●
DSSS/PBCC/CCK	●	●
ERP-PBCC	●	●
Data source types: all 0s, PN9, PN15, user-defined file	●	●
PN9 and PN15 seed value (requires Option HFP)	●	●
Preamble type: long DSSS, short DSSS, OFDM	●	●
Multi-carrier support (up to 3)	●	●
Baseband I/Q impairments	●	●
OFDM subcarrier mask	●	●
Windowing and filtering for spectrum control	●	●
Multipath, up to 20 paths	●	●
Multi-frame control	●	●
Channel encoder		
Scrambler ON/OFF		●
Convolutional encoder ON/OFF		●
OFDM scrambler and reserved service bits		●
PBCC encoder ON/OFF		●
DSSS scrambler		●
MAC parameter configuration		
Header		●
FCS		●
Sequence number		●
802.11n		
20 or 40 MHz bandwidth	●	●
MCS index from 0 to 32	●	●
MCS index from 33 to 76 (requires Option SFP)	●	●
Data source types: all 0s, PN9, PN15, user-defined file	●	●
PN9 and PN15 seed value (requires Option HFP)	●	●
Operating mode: legacy, mixed, green field	●	●
Beacon frame		●
Windowing and filtering for spectrum control	●	●
MIMO configurations for up to 4 transmitter signals	●	●
Direct mapping or spatial expansion	●	●
Space-time block coding	●	●
MIMO channel models A through F or user-defined	●	●
Channel encoder		
Scrambler ON/OFF		●
Channel coding ON/OFF		●
BCC encoding		●
LDPC encoding (requires Option HFP)		●
Interleaver On/Off		●
MAC parameter configuration		
Header (general, RTS, CTS)		●
FCS		●
Sequence number		●
Aggregation MPDU		●
Minimum MPDU start spacing (requires Option HFP)		●
Frequency selective I/Q impairment (VHT-PPDU)	●	●

802.11 WLAN	Component & transmitter testing	Receiver testing
	Basic waveform playback mode	Advanced waveform playback mode
802.11ac		
20, 40, 80, 80+80, or 160 MHz bandwidth	●	●
Non-HT and VHT NDP format generation	●	●
Beacon frame		●
MCS index from 0 to 9	●	●
Data source types: all 0s, PN9, PN15, user-defined file	●	●
PN9 and PN15 seed value	●	●
Windowing and filtering for spectrum control	●	●
Downclocking ratio	●	●
MIMO configurations for up to 8 transmitter signals	●	●
Direct mapping or spatial expansion	●	●
Space-time block coding	●	●
Beamforming	●	●
802.11ac MIMO channel models A through F or user-defined	●	●
Channel encoder ON/OFF		●
Scrambler ON/OFF		●
BCC or LDPC channel coding		●
Interleaver On/Off		●
MAC parameter configuration		
Header (general, RTS, CTS)		●
FCS		●
Sequence number		●
Aggregation MPDU		●
Minimum MPDU start spacing		●
Single or multi-user MIMO (up to 8 streams)		●
Frequency selective I/Q impairment (VHT-PPDU)	●	●

Supported Standards

WLAN format	IEEE technical specification	Approval date
802.11a	802.11-2007 802.11p-2010 802.11n-2009 802.11-03/940r4[1] 802.11ac/D4.1 802.11-09/0308r12[2]	1999
802.11b		1999
802.11g		2003
802.11j		2004
802.11p		2010
802.11n		2009
802.11ac		2014 (planned)

1. *802.11n channel models.*
2. *802.11ac channel models.*

Performance Characteristics

Definitions

Typical (typ):

Represents characteristic performance, which 80% of the instruments manufactured will meet. This data is not warranted, does not include measurement uncertainty, and is valid only at room temperature (approximately 25 °C).

Characteristic Performance:

Non-warranted value based on testing during development phase of this product.

In the following table, characteristics for the N5162A/N5182A apply to all instruments with serial number 4742xxxx or greater, and to instruments with lower serial numbers that have Option 1EA (high power output).

		EVM (typical), valid power range				
Standard	Frequency	N5172B/ N5182B	N5162A/ N5182A	E4438C	E8267D	M9381A
802.11a/g/j/p OFDM	2.412 GHz	< 0.28%, ≤ +10 dBm	< 0.28%, ≤ +10 dBm	< 1%, ≤ –1 dBm	< 0.8%, ≤ –1 dBm	< 0.27%, ≤ +6 dBm
	5.805 GHz	< 0.35%, ≤ +4 dBm	< 0.45%, ≤ +4 dBm	< 1%, ≤ –1 dBm	< 0.6%, ≤ +6 dBm	< 0.47%, ≤ 0 dBm
802.11b/g DSSS	2.412 GHz	< 0.34%, ≤ +10 dBm	< 0.34%, ≤ +10 dBm	< 1%, ≤ –1 dBm	< 0.7%, ≤ +8 dBm	< 0.24%, ≤ +10 dBm
802.11n OFDM 20 MHz BW	2.412 GHz	< 0.35%, ≤ +10 dBm	< 0.3%, ≤ +10 dBm	< 0.5%, ≤ +4 dBm	< 0.8%, ≤ –2 dBm	< 0.27%, ≤ +4 dBm
	5.805 GHz	< 0.5%, ≤ +6 dBm	< 0.4%, ≤ +6 dBm	< 0.5%, ≤ 0 dBm	< 0.5%, ≤ +6 dBm	< 0.49%, ≤ 0 dBm
802.11n OFDM 40 MHz BW	2.422 GHz	< 0.35%, ≤ +10 dBm	< 0.35%, ≤ +10 dBm	< 0.5%, ≤ +4 dBm	< 0.8%, ≤ –2 dBm	< 0.24%, ≤ +4 dBm
	5.795 GHz	< 0.4%, ≤ +6 dBm	< 0.4%, ≤ +6 dBm	< 0.5%, ≤ 0 dBm	< 0.5%, ≤ +6 dBm	< 0.49%, ≤ 0 dBm
802.11ac OFDM 40 MHz BW	5.795 GHz	< 0.5%, ≤ +4 dBm	< 0.5%, ≤ +4 dBm	< 0.5%, ≤ 0 dBm	< 0.5%, ≤ +6 dBm	< 0.45%, ≤ 0 dBm
802.11ac OFDM 80 MHz BW	5.775 GHz	< 0.5%, ≤ +4 dBm	< 0.5%, ≤ +4 dBm	< 1%, ≤ 0 dBm	< 0.6%, ≤ +6 dBm	< 0.49%, ≤ 0 dBm
802.11ac OFDM 160 MHz BW	5.25 GHz	< 0.5%, ≤ +4 dBm	Not supported	Not supported	Not supported	< 0.64%, ≤ +2 dBm

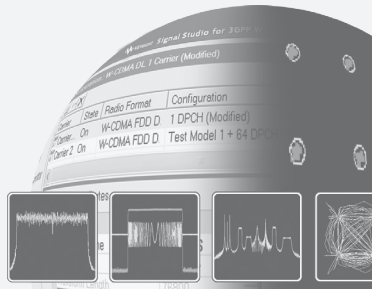
Instrument and software settings are listed below. The EVM for 802.11a/b/g/j/p was measured with an 89641A vector signal analyzer with Option B7R for the E4438C and E8267D.

All other EVM measurements were made with an N9030A PXA signal analyzer with Option B1X (160 MHz bandwidth), using the 89601B vector signal analyzer software with Options B7R, B7Z, and BHJ for 802.11a/b/g/j/p, 802.11n, and 802.11ac modulation analysis.

	802.11a/g/j/p OFDM	802.11b/g DSSS	802.11n OFDM 20 MHz BW	802.11n OFDM 40 MHz BW	802.11ac OFDM 40 MHz BW	802.11ac OFDM 80 MHz BW
Sofware settings						
Data rate	54 Mbps	11 Mbps	—	—	—	—
MCS index	—	—	15	15	6	6
Modulation	64QAM	—	64QAM	64QAM	64QAM	64QAM
Coding rate	3/ 4	—	5/6	5/6	3/ 4	3/ 4
Encoder	On	CCK	On	On	On (BCC)	On (BCC)
Scrambler	On	DSSS On	On	On	On	On
Interleaver	On	On	On	On	On	On
Scrambler initialization	93	—	93	93	93	93
Support carrier setup	all channels active	—	—	—	—	—
Idle interval	100 µs	100 µs	20 µs	20 µs	20 µs	20 µs
Oversampling ratio	≥ 2	≥ 2	≥ 2	2	2	1.25
Data type	PN15	PN15	PN15	PN15	PN15	PN15
Data length	1024	1024	1024	1024	1024	1024
Window length	≥ 8	—	≥ 16	≥ 16	2	2
Spectrum control filter type	—	Gaussian	—	—	Root raised cosine	Root raised cosine
Length (symbols)	—	6	—	—	100	100
Filter parameter	—	BT = 0.7	—	—	Alpha = 0.2	Alpha = 0.05
Bandwidth	—	—	20 MHz	40 MHz	40 MHz	80 MHz
Aggregation MPDU	—	—	Off	Off	On	On
Signal generation settings						
Reconstruction filter	thru	thru	thru	thru	thru	thru
ALC	On	On	On	On	On	On
RF blanking	Off	Off	Off	Off	Off	Off
Modulation attenuation	8 to 10 dBm	8 to 10 dBm	Auto	Auto	Auto	Auto
Waveform runtime scaling	70%	70%	70%	70%	70%	70%
89641A settings						
Range	optimal	optimal				
RMS video average	20	20	—			
89601B settings						
Range			optimal	optimal	optimal	optimal
Equalizer training			Preamble, pilots & data	Preamble, pilots & data	Preamble, pilots & data	Preamble, pilots & data

Try Before You Buy!

Free 30-day trials of Signal Studio software provide unrestricted use of the features and functions, including signal generation, with your compatible platform. Redeem a trial license online at
www.keysight.com/find/SignalStudio_trial



Hardware configurations

To learn more about compatible hardware and required configurations, please visit:
www.keysight.com/find/SignalStudio_platforms

PC requirements

A PC is required to run Signal Studio.
www.keysight.com/find/SignalStudio_pc

Additional Information

Websites

Access the comprehensive online documentation, which includes the complete software HELP, download the software, and request a trial license.

www.keysight.com/find/n7617b

www.keysight.com/find/n7607b

www.keysight.com/find/SignalStudio

Keysight's WLAN design and test solutions

www.keysight.com/find/wlan
www.keysight.com/find/802.11ac

Ordering Information

Software licensing and configuration

Signal Studio offers flexible licensing options, including:

- **Fixed license**: Allows you to create unlimited I/Q waveforms with a specific Signal Studio product and use them with a single, specific platform.
- **Transportable/floating license**: Allows you to create unlimited I/Q waveforms with a specific Signal Studio product and use them with a single platform (or PC in some cases) at a time. You may transfer the license from one product to another.
- **Waveform license**: Allows you to generate up to 545 user-configured I/Q waveforms with any Signal Studio product and use them with a single, specific platform.

The table below lists fixed, perpetual licenses only; additional license types may be available. For detailed licensing information and configuration assistance, please refer to the Licensing Options web page at www.keysight.com/find/SignalStudio_licensing.

N7617B Signal Studio for WLAN 802.11a/b/g/n/ac

Model-Option	Description
Connectivity	
N7617B-1FP	Connect to E4438C ESG
N7617B-2FP	Connect to E8267D PSG
N7617B-3FP	Connect to N5182/62 MXG, N5172 EXG
N7617B-6FP	Connect to N5106A PXB
N7617B-7FP	Connect to Keysight simulation software
N7617B-9FP	Connect to M9381A, M9252A, E6630A
N7617B-AFP	Connect to M8190A arbitrary waveform generator
Capability	
N7617B-EFP	Basic 802.11a/b/g/j/p WLAN
N7617B-FFP	Basic 802.11n WLAN
N7617B-GFP	Basic 802.11ac WLAN
N7617B-HFP	Update to 802.11a/b/g/j/p and 802.11n
N7617B-QFP	Advanced 802.11a/b/g/j/p WLAN
N7617B-RFP	Advanced 802.11n WLAN
N7617B-SFP	Update to 802.11n WLAN
N7617B-TFP	Advanced 802.11ac WLAN

Literature

Testing New-generation Wireless LAN, Application Note, 5990-8856EN

Creating and Optimizing 802.11ac Signals and Measurements, Application Note, 5991-0574EN

T*esting Very High Throughput 802.11ac Signals, Application Note*, 5990-9987EN

Signal Studio Software, Brochure, 5989-6448EN

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