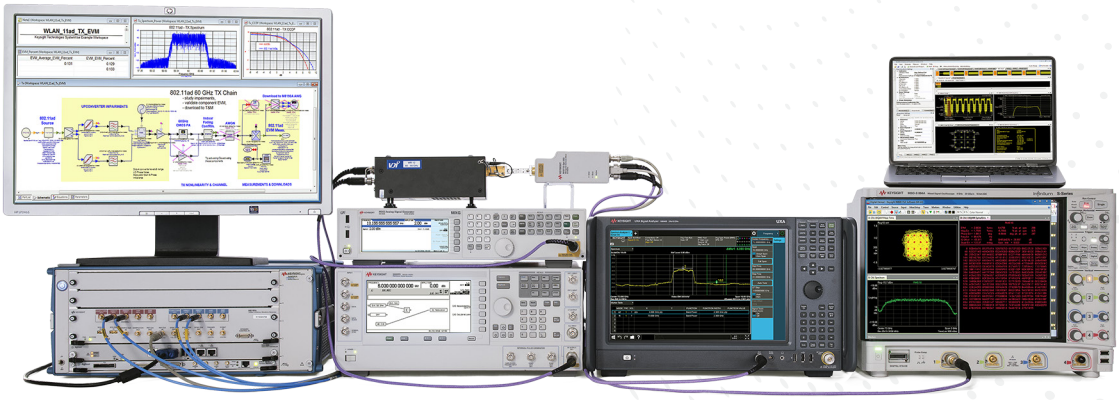
DATA SHEET

802.11ad Waveform Generation & Analysis Testbed, Reference Solution

This configuration guide contains information to help you configure your 802.11ad Waveform Generation & Analysis, Reference Solution and tailor the system to meet your requirements.



KEYSIGHT TECHNOLOGIES

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Recommended options for 802.11ad Waveform Generation & Analysis, Reference Solution indicated by ■ below.
For a visual representation of configurations, see section M.

A. Select options for arbitrary waveform generator

M8190A 12 GSa/s Arbitrary Waveform Generator			
Used to create analog differential baseband sigals and IF signals from the 81199A software.			
■	M8190A-BU1	Bundle consisting of M9505A AXIe 5-slot chassis and M9536A AXIe embedded PC controller	
■	M8190A-002	Arbitrary waveform generator, 2 channels	
■	M8190A-14B	14-bit resolution with 8 GSa/s	
■	M8190A-12G	12 GSa/s with 12-bit resolution	
☐	M8190A-DUC	Digital upconversion	Enables direct generation of 5 GHz IF signals for driving upconverters directly. Using the PSG to upconvert the analog baseband signals to IF yields better EVM performance.
☐	M8190A-801	Microwave phase matched balun, 6.5 GHz, max SMA jack	Useful for combining the differential IF signals of the M8190A into a single ended output when using the digital upconversion mode.
■	M8190A-02G	Upgrade from 128 MSDa to 2 Gsa memory per channel	
☐	M8190A-SEQ	Sequencer	
☐	M8190A-810	Cable assembly coaxial-50 Ω, SMA to SMA, 457 mm length	These are shorter versions of the cables below and may be useful depending upon the physical placement of the test equipment on the test bench or test rack.
■	M8190A-811	Cable assembly coaxial-50 Ω, SMA to SMA, 1220 mm length	4 cables are needed to connect the differential baseband signals to the PSG. An additional set of 4 cables are useful for connecting to the LO/IF of the upconverter and downcoverter.

B. Select options for signal generator

1. E8267D PSG Vector Signal Generator			
Used to create IF signals from the M8190A Arbitrary waveform generator			
■	E8267D-520	Frequency range from 250 kHz to 20 GHz	This frequency range is sufficient for generating a wide range of IFs that may be needed in an R&D environment.
☐	E8267D-532	Frequency range from 250 kHz to 31.8 GHz	
☐	E8267D-544	Frequency range from 250 kHz to 44 GHz	
■	E8267D-016	Wideband differential external I/Q inputs	Enables upconversion of 2 GHz wide bandwidth signals.
☐	E8267D-UNX	Ultra-low phase noise performance	Useful for other modulation formats that have closely spaced OFDM subcarriers. This does not add significant improvements for 802.11ad applications.
☐	E8267D-UNY	Enhanced ultra-low phase noise performance	Useful for other modulation formats that have closely spaced OFDM subcarriers. This does not add significant improvements for 802.11ad applications.
2. N5183B MXG X-Series Microwave Analog Signal Generator			
Used as the LO for the Keysight and/or VDI upconverter and downcoverter			
■	N5183B-513	Frequency range, 9 kHz to 13 GHz	One needed for each upconverter or downconverter in the system.
☐	N5183B-520	Frequency range from 9 kHz to 20 GHz	
☐	N5183B-532	Frequency range from 9 kHz to 31.8 GHz	
☐	N5183B-540	Frequency range from 9 kHz to 40 GHz	
☐	N5183B-UNY	Low phase noise	Useful for other modulation formats that have closely spaced OFDM subcarriers. This does not add significant improvements for 802.11ad applications.

C. Select options for oscilloscope

DSOS804A High-Defintion Oscilloscope			
Used to digitize the IF from the downconverter			
■	DSOS804A	DSO S-Series: 8 GHz, 4-channel oscilloscope	
■	DSOS000-400	Memory - 400 Mpts/ch memory installed	
■	DSOS000-821	Precision BNC to SMA adapters (includes 2)	A set of four adapters is useful for directly looking at differential baseband analog IQ signals.

D. Select power meter and sensors

Power Meter and Sensor for Making Calibrated Power Measurements at Millimeter Wave Frequencies		
■	N1911A	Power meter - P-series, single channel
■	V8486A	Power sensor, waveguide, 50 to 75 GHz , –30 to +20 dBm
■	V8486A-H02	V-Band power sensor, 50-75 GHz, –60 to 20 dBm

E. Select options for signal analyzer

N9040B UXA X-Series Signal Analyzer			
Other X-Series signal analyzers can be used which offer additional price/performance choices.			
Signal analyzer for making traditional swept-tuned measurements			
☐	N9040B-508	Frequency range, 3 Hz to 8.4 GHz	
☐	N9040B-513	Frequency range, 3 Hz to 13 GHz	
■	N9040B-526	Frequency range, 3 Hz to 26.5 GHz	Provides frequency coverage high enough to analyze a wide range of IF signals.
☐	N9040B-544	Frequency range, 3 Hz to 44 GHz	
☐	N9040B-550	Frequency range, 3 Hz to 50 GHz	
☐	N9040B-B2X	Analysis bandwidth, 255 MHz	
☐	N9040B-H1G	Analysis bandwidth, 1 GHz	
☐	N9040B-P50	Preamplifier, 50 GHz	

F. Select smart mixer

M1971E Waveguide Harmonic Smart Mixer			
Used with signal analzyers to make measurements at millimeter wave frequencies. The smart mixers have a convenient waveguide interface.			
■	M1971E	E-Band smart mixer	The base smart mixer frequency range is 60 to 90 GHz.
■	M1971E-003	E-Band smart mixer: Frequency range 55 to 90 GHz	Enables traditional swept-tuned measurements at millimeter wave frequencies. The auxillery wideband IF output enables demodulation measurements when used with an oscilloscope.

G. Select upconverters and downconverters[1]

Upconvert/Downconvert from IF to Millimeter Wave			
Keysight products			
■	N5152A-505	5 GHz IF/57-66 GHz upconverter	
☐	N5152A-1E1	IF input step attenuator	Useful for driving from a DUT with no amplitude control.
■	N1999A-505	5 GHz IF/57-66 GHz downconverter	
Virginia Diodes products			
☐	N9029AV15	Millimeter-wave converter: V-band, 50 to 75 GHz	
☐	N9029AV15-UDC	Upconverter capability	
☐	N9029AV12-UDC	Millimeter-wave converter: E-band, 60 to 90 GHz	
☐	N9029AV12-UDC	Upconverter capability	

G1. Upconverter selection criteria

Vendor	Model	Frequency range	Output power level	Built-in amplifier to increase output power	Isolator to improve match	Built-in filter to remove mixing image
Keysight	N5152A	57-66 GHz	~0 dBm	X	X	X
VDI[2]	N9029AV15-UDC	50-75 GHz	~–25 dBm (~–3 dBm with optional amp)			

G1. Downconverter selection criteria

Vendor	Model	Frequency range	Optimal input power range for EVM	Built-in preamplifier to increase sensitivity	Isolator to improve match	Variable attenuator to optimize signal level at mixer
Keysight	N1999A	57-66 GHz	–40 dBm to –25 dBm	X	X	X
Keysight	M1971E-003	55-90 GHz	–15 dBm to –5 dBm			
VDI[2]	N9029AV15	50-75 GHz	–30 dBm to –15 dBm			

1. Keysight offers several frequency converter options. The best choice depends on the specific application and the freqeuncies, power levels, etc. needed for the desired measurements. See the following tables for additional details.
2. The VDI converters are also available in other bands that may be useful for other projects. Note, E-Band overlaps V-Band for part of the channels used for 802.11ad, i.e. part of channel 2, channel 3, and channel 4.

H. Select accessories

Additional Useful Items in The Lab			
■	N9029AV15-BF1	57.24 to 59.40 GHz filter, Channel 1	Useful removing unwanted spurs and images
■	N9029AV15-BF2	59.40 to 61.56 GHz filter, Channel 2	Useful removing unwanted spurs and images
■	N9029AV15-BF3	61.56 to 63.72 GHz filter, Channel 3	Useful removing unwanted spurs and images
■	N9029AV15-BF4	63.72 to 65.88 GHz filter, Channel 4	Useful removing unwanted spurs and images
■	N9029AV15-BF5	57.24 to 65.88 GHz filter, covers Channel 1 through Channel 4	Useful removing unwanted spurs and images
■	N9029AV15-AMP	59 to 66 GHz amplifier, 20 dB gain	Useful for increasing signal level out of VDI converter
□	N9029AV12-AM1	67 to 87 GHz amplifier, 20 dB gain	Useful for increasing signal level out of VDI converter
■	N9029AH15	50 to 75 GHz horn antenna (V-band)	Useful for making over-the-air measurements
□	N9029AH12	60 to 90 GHz horn antenna (E-band)	Useful for making over-the-air measurements

I. Select options for signal creation and analysis software

Wideband Waveform Creator and Analyzer software			
Used to create and analyze 802.11ad waveforms			
■	81199A	Wideband waveform software center	
■	81199A-001	Wideband waveform creator	
■	81199A-002	Wideband waveform analyzer	89600 VSA software not included but required (see below)
■	81199A-IAD	Library for IEEE 802.11ad	
■	81199A-DFP	Access for unencrypted waveform	Useful for post processing waveform using another tool like C++ or for loading into DUT memory for playback.

J. Select options for signal acquisition software

89600 VSA Software			
Flexible 89600 VSA software for general troubleshooting and debugging. This software provides connectivity to a variety of Keysight hardware and provides IQ samples to the 81199A software for analysis			
■	89601B-200	Basic vector signal analysis	Required for analysis with wideband waveform center software

K. Select options for simulation software

SystemVue Software			
SystemVue software enables system level simulation of 802.11ad transmitters and receivers			
☐	W1461BP	SystemVue comms architect	Not required for using the Wideband Waveform Center software
☐	W1915BP	SystemVue mmWave WPAN baseband verification library	Not required for using the Wideband Waveform Center software

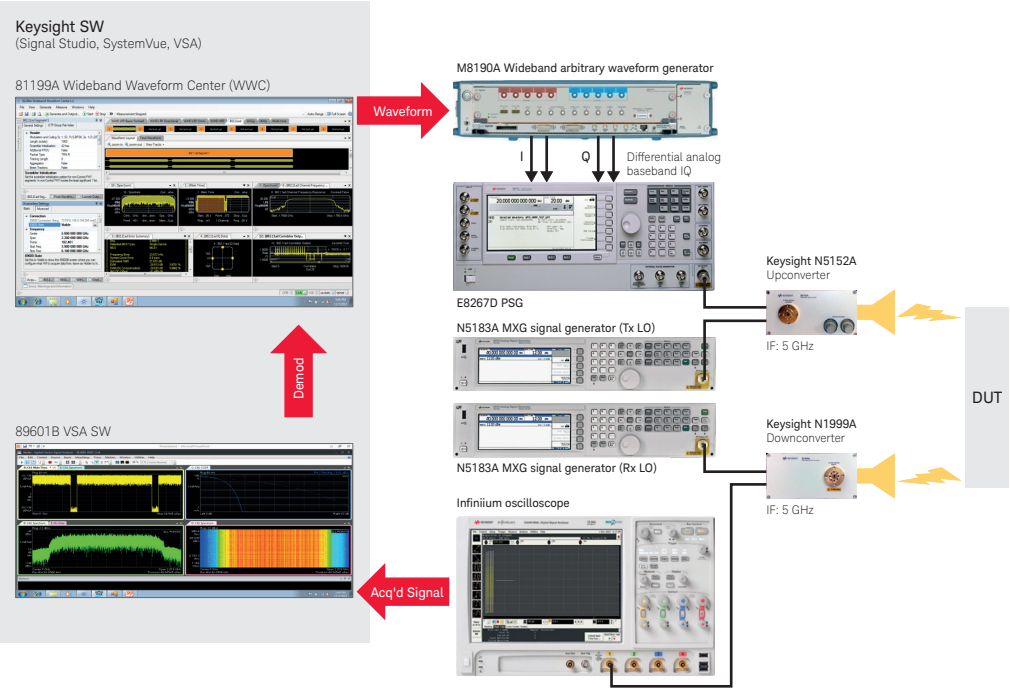
L. Select services

Startup assistance		
☐	PS-S10-100	Remote scheduled productivity assistance
■	PS-S20-100	Daily instrument and application consulting with customer equipment. Recommended 3 to 5 days for initial system setup.
■	PS-X10-100	Application specific technical assistance. Recommended 3 to 10 days of post sales application support.

M. Configurations

802.11ad reference solution

Signal creation & analysis overview



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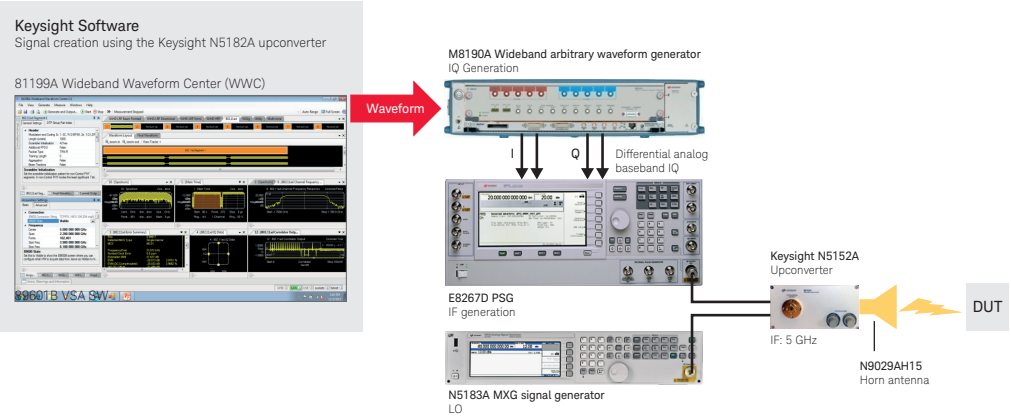
Signal creation using the Keysight N5182A upconverter



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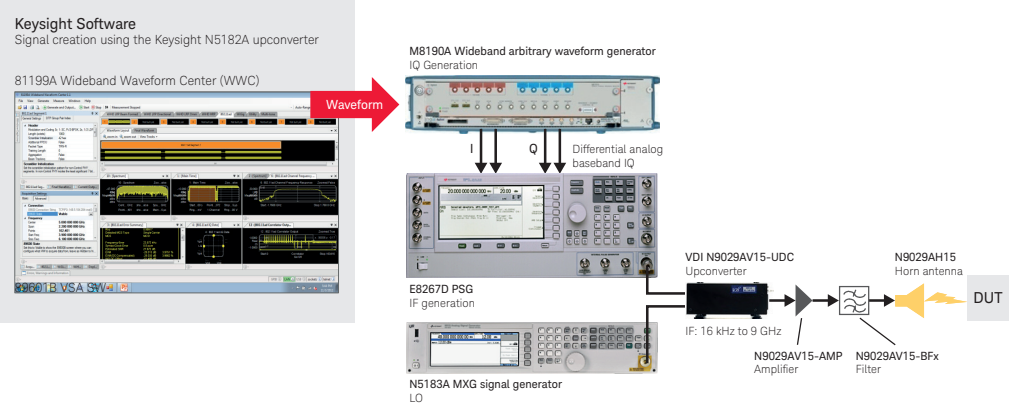
Signal creation using the VDI N9029AV12-UDC converter



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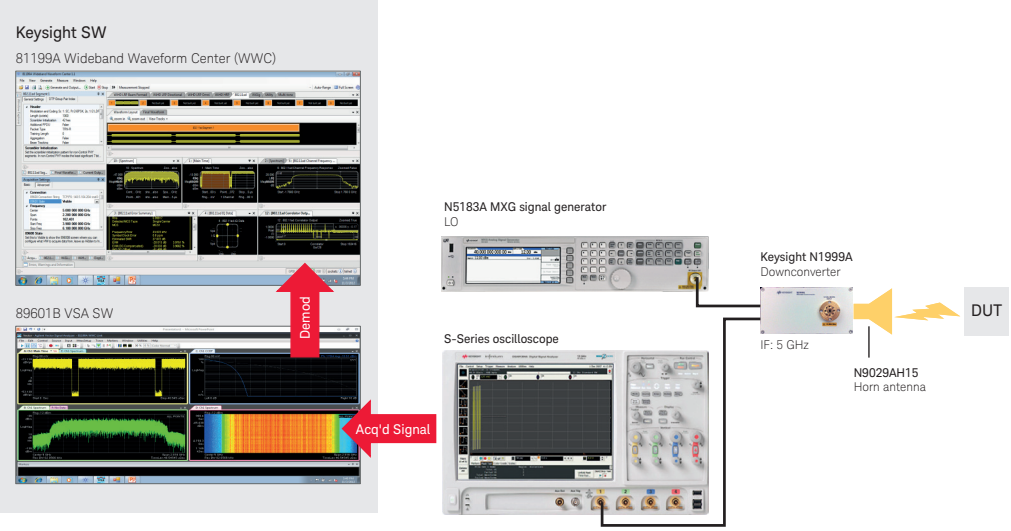
Demodulation using Keysight downconverter



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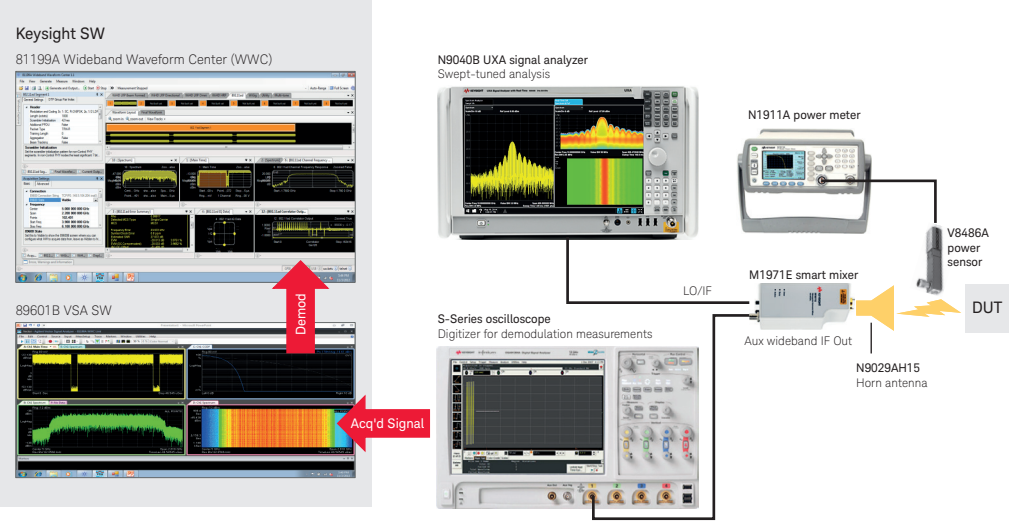
Demodulation & swept tuned analysis using Keysight M1971E smart mixer



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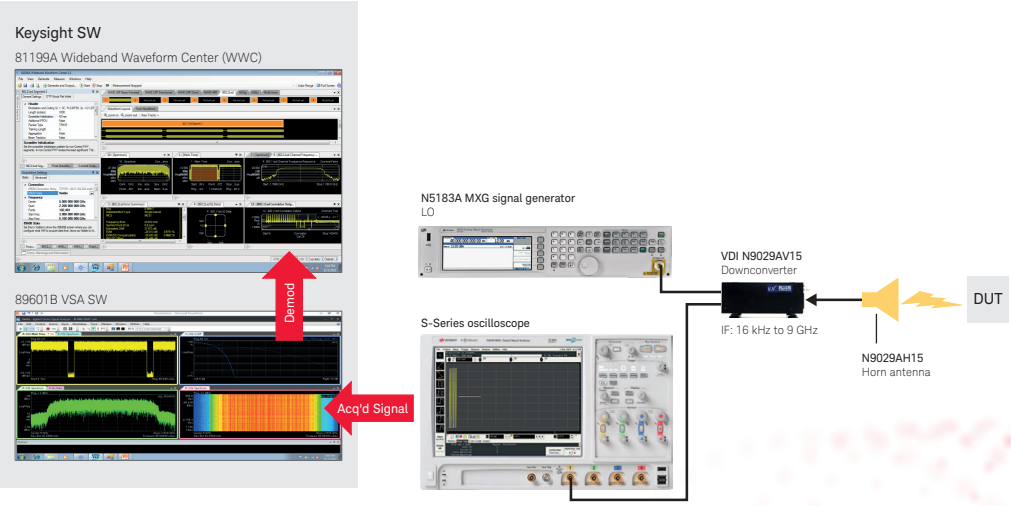
Demodulation using VDI downconverter



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