

# Keysight Technologies

## Cost Effective Design Verification of 802.11ac Wireless Transmitters and Receivers

### Application Brief

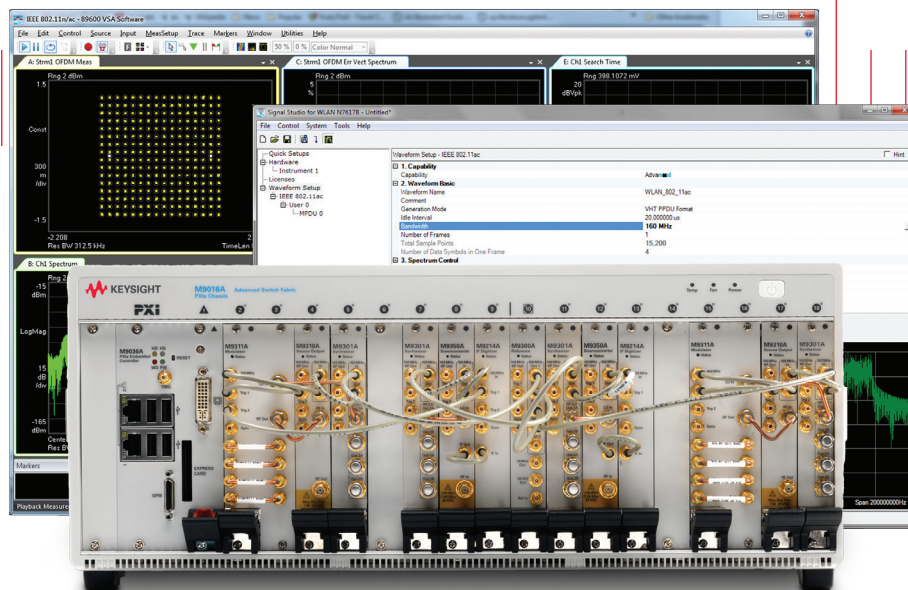


Figure 1. Keysight 802.11ac MIMO R&D / DVT test solution.

Accelerate R&D and design verification test of 802.11ac MIMO designs with a high speed, cost-effective test solution that provides accuracy, flexibility and scalability.



## Introduction

The explosive growth of mobile devices and real-time applications, such as high-definition video, pushed current wireless local area network (WLAN) technology to its limits. The 802.11ac standard, built upon the success of 802.11n, addresses this challenge by providing a new set of WLAN capabilities offering increased speed, reliability and quality of wireless communications.

Innovative design techniques and the desire to minimize manufacturing costs necessitate comprehensive testing during the R&D and design verification test stages of new WLAN devices. Design validation engineers must ensure that their 802.11ac designs will perform well under the most demanding modulation schemes, including MIMO spatial multiplexing configurations.

This document describes how the Keysight Technologies, Inc. PXI modular hardware and related software applications provide a scalable and cost-effective radio frequency (RF) test solution enabling flexible signal generation and accurate signal analysis for testing 802.11ac transmitters and receivers.

In today's high growth wireless market, the WLAN 802.11n standard reached limitations to meet the consumer's demand for higher WLAN capacity and higher quality mobile technology. Demand for higher throughput drove the development of a new set of capabilities addressed by WLAN 802.11ac.

802.11ac feature enhancements include:

- Wider channels up to 160 MHz
- Multi-user MIMO (MU-MIMO)
- 256 QAM, up to 8 spatial streams
- Faster data rates up to 6.93 Gbps

Test systems must be capable of supporting these new technically demanding test requirements, while also providing accuracy, speed, flexibility and scalability.

## Application overview

Design validation engineers must ensure that their 802.11ac designs will perform well under the most demanding modulation schemes, even for the most challenging MIMO spatial multiplexing configurations. Transmitter tests require fast and precise signal analysis to validate 802.11ac MIMO transmitter performance. A multi-channel vector signal analyzer (VSA) providing support of physical (PHY) layer measurements is required.

A PXIe VSA can be used to demodulate the multi-stream waveform, and transmitter performance can be determined through the analysis of PHY layer measurements using 89600 VSA software.

Receiver tests require the highest quality reference signals with very low distortion. A vector signal generator (VSG) capable of creating 802.11ac compliant waveforms with 80 + 80 MHz and full 160 MHz bandwidth support is required.

Receiver testing requires full support for 802.11ac standards-based generation with channel emulation and waveform sequencing capability to support receiver measurements such as sensitivity.

Test systems must meet today's functional demands for 802.11ac, while maintaining backward compatibility to support 802.11n, and be flexible enough to support bandwidths up to 160 MHz.



Figure 2. M9391A PXIe vector signal analyzer and M9381A PXIe vector signal generator modules.

## Solution

Keysight Technologies provides a cost-effective radio frequency (RF) test solution for 802.11ac MIMO R&D/DVT with its M9391A PXIe VSA, M9381A PXI VSG and related software applications.

The M9391A PXIe VSA is a modular solution that provides frequency coverage up to 6 GHz and works seamlessly with Keysight's 89600 VSA software to provide a cost-effective solution for 802.11ac MIMO transmitter testing. The M9391A supports RF modulation bandwidths up to 160 MHz and up to 4 synchronized channels with  $< \pm 5$  ns of synchronization accuracy.

The M9381A PXIe VSG with Signal Studio software provides full support for 802.11ac standards-based signal generation for receiver testing. The M9381A supports up to 160 MHz bandwidth signal generation and up to 4 channels with  $< 20$  ns of synchronization accuracy.

## Solution details

### System setup

A 4-channel VSA and 4-channel VSG (4x4) 802.11ac MIMO measurement setup is shown in Figure 3. The setup includes two M9018A PXIe 18-slot chassis and two internal M9036A embedded controllers. Four M9381A PXIe VSGs are housed in one chassis and four M9391A PXIe VSAs in the other. Each chassis also includes a single M9300A reference to drive the 10 MHz reference on the backplane of the PXI chassis and synchronize the timing of multiple modules.



Figure 3. Measurement setup for 4x4 802.11ac MIMO transmitter and receiver testing.

### Transmitter test

The M9391A VSA supports input signals from 10 MHz to 6 GHz, easily covering the 802.11ac frequency bands and enables scalable deployment, with 1 to 4 channels configurable in a single 18-slot PXI chassis.

Keysight's 89600 VSA software controls the M9391A PXIe VSAs and provides the measurement algorithms for MIMO WLAN transmitter testing. Analysis of a 2-channel MIMO configuration with 2-streams at 80 MHz is shown in Figure 4.

Transmitter performance can be determined through the analysis of PHY-layer measurements such as error vector magnitude (EVM), cross-channel isolation, channel flatness and spectrum measurements such as occupied bandwidth and channel power.

### Receiver test

For testing receivers, Keysight's M9381A VSG with Signal Studio software provides full support of 802.11ac standards-based signals. Signal Studio software is used to generate 802.11ac standard compliant waveforms including MIMO/MU-MIMO, MAC layer, ARB-based channel fading models, multi-frame and sequencer playback for PER/sensitivity tests. The M9381A VSG provides frequency coverage up to 6 GHz, support for 256 QAM, and RF modulation bandwidth up to 160 MHz with  $\pm 0.5$  dB flatness. Keysight's 802.11ac MIMO test solution provides the accuracy, speed, flexibility and scalability required during research and development and design verification test of 802.11ac MIMO transmitters and receivers.



Figure 4. Keysight 89600 VSA software illustrating a 2-channel configuration with two streams at 80 MHz bandwidth.

## Ordering information

Quantity	Model	Description
1-4	M9391A	PXIe vector signal analyzer 1 MHz – 6 GHz
1-4	M9381A	PXIe vector signal generator 1 MHz – 6 GHz
1-2	M9300A	PXI frequency reference

Optional		
1	M9018A	PXIe 18-slot chassis
1	M9036A	PXIe embedded controller
1	89601B-200	89600 VSA software, transportable license
1	89601B-300	Hardware connectivity
1	89601B-BHJ	WLAN 802.11ac modulation analysis
1	89601B-B7Z	WLAN 802.11n modulation analysis
1	89601B-B7R	WLAN 802.11a/b/g modulation analysis
1	N7617B	Signal Studio for WLAN 802.11a/b/g/n/ac

## Want to know more?

- 802.11 WLAN Test  
[www.keysight.com/find/wlan](http://www.keysight.com/find/wlan)
- Technical Overview: Testing New-generation Wireless LAN, publication number 5990-8856EN
- PXI RF Vector Signal Analyzer:  
[www.keysight.com/find/M9391A](http://www.keysight.com/find/M9391A)
- PXI RF Vector Signal Generator:  
[www.keysight.com/find/M9381A](http://www.keysight.com/find/M9381A)
- 89600 VSA software:  
[www.keysight.com/find/89600](http://www.keysight.com/find/89600)
- Signal Studio software:  
[www.keysight.com/find/N7617B](http://www.keysight.com/find/N7617B)

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