WLAN 802.11a/b/g/j/p/n/ac/af/ah/ax/be/bn X-Series Measurement App, Multi-Touch UI

WLAN 802.11a/b/g/j/p/n/af/ah: N/E/W9077EM0E WLAN

WLAN 802.11ac/ax: N/E/9077EM1E

WLAN 802.11be/bn: N/E9077EM2E

Introduction

- Perform one-button WLAN spectrum measurements and modulation analysis with pass/fail tests based on IEEE 802.11a/b/g/j/p/n/ac/af/ah/ax/be/bn
- Support 802.11ac/ax 20/40/80/160 MHz and 80+80 MHz with modulation format from BPSK to 1024QAM and 4096QAM
- Support 802.11be EHT TB PPDU and MU PPDU compressed (non-OFDMA) mode and non-compressed (OFDMA) mode with 20/40/80/160/320 MHz from BPSK to 1024QAM and 4096QAM
- Support 802.11bn with UHR PHY PPDU, new MCS, longer blocked length codes for LDPC (2x), Distributed-tone Resource dRU), and Unequaled QAM (UQAM)
- Support cross-correlated EVM (ccEVM) to extend the dynamic range of the receiver for best EVM performance using two receivers with same model number
- Support ccEVM together with MIMO on VXT M941xA, N9042B, N9032B, N9021B, E6680A/E
- Support IQ Noise Correction (IQ-NC) technology with EXA/MXA/PXA/UXA
- Multi-touch user interface and SCPI remote user interface, SCPI recorder support, and built-in, context-sensitive help
- Keysight supports tiered X-app models with N-models for UXA/PXA/PXE/PXI VSA, E-models for MXA/EXA/MXE/VXT. The higher tiered X-app models can run at the lower platforms, which means N-models can run on all platforms, and E-models can only run on MXA/EXA/MXE/VXT.

KEYSIGHT

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WLAN Measurement Application Overview

WLAN 802.11a/b/g/j/p/n/ac/af/ah/ax/be/bn measurement application

The WLAN measurement application transforms the X-Series signal analyzers into IEEE 802.11 standard-based WLAN transmitter testers by adding fast, one-button RF conformance measurements that will help you design, evaluate, and manufacture your WLAN transmitter. The software's capabilities are further enhanced because it is closely aligned with the IEEE standards — including 802.11a/b/g/j/p/n/ac/af/ah/ax/be/bn — allowing you to stay on the leading edge of design and manufacturing challenges.

Real-time spectrum analysis for WLAN 802.11

Adding real-time spectrum analysis to a PXA or MXA signal analyzer addresses the measurement challenges associated with dynamic RF signals such as bursted packet transmissions of WLAN, and to identify interference caused by various signals in the ISM (2.4 GHz, 5 GHz, or 7 GHz) bands.

- Accurately observe power changes for an 802.11 signal within a 320 MHz real-time bandwidth
- Capture random interfering signals with durations as short as 3.57 µs in ISM bands for WLAN signals
- Perform fast, wideband measurements without compromising EVM, ACPR and other RF measurements
- Enhance dynamic range with 1-dB variable attenuation (< 3.6 GHz) and fine-adjustable resolution bandwidths

X-Series measurement applications

X-Series measurement applications increase the capability and functionality of Keysight Technologies, Inc. signal analyzers to speed time to insight. They provide essential measurements for specific tasks in general-purpose, cellular communications, wireless connectivity applications, covering established standards or modulation types. Applications are supported on both benchtop and modular, with the only difference being the level of performance achieved by the hardware you select.

X-Series measurement applications can help you:

- Gain more insight into device performance with intuitive display and graphs for your application. Select from our library of over 25 different measurement applications.
- Ensure that your design meets the latest standard. Updates are made to the X-Series measurement applications as standards evolve.
- Apply the same measurement science across multiple hardware platforms for consistent measurement results over your design cycle from R&D to production.
- Choose the license structure that meets your business needs. We provide a range of license types (node-locked, transportable, floating or USB portable) and license terms (perpetual or time-based).

Top Features

Perform WLAN transmitter measurements in the time, frequency, and modulation domains. The X-Series measurement application covers WLAN specifications from IEEE 802.11a to 802.11be/802.11bn 320 MHz signals with all modulation formats. Here are a few examples.

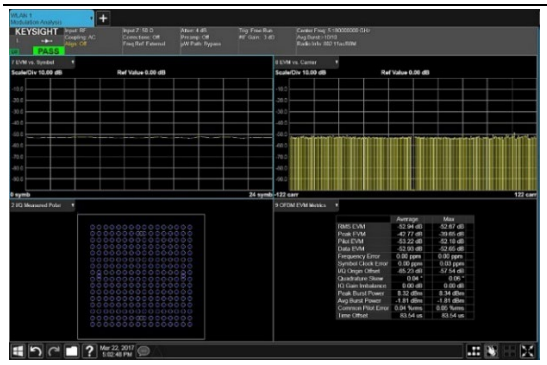
Examples

Numerical display

Numerical results summarize modulation accuracy. Parameters for WLAN signals.

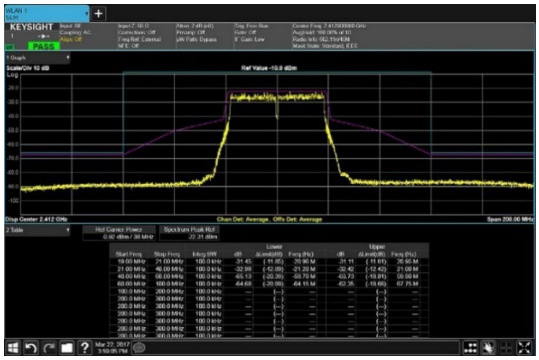
OFDM EVM display

The OFDM EVM displays four traces with EVM vs. symbol, EVM vs. subcarrier, constellation, and measurement results.



Transmit spectrum mask display

Shows a transmitter spectrum mask measurement with IEEE defined limits.



Spectrum flatness display

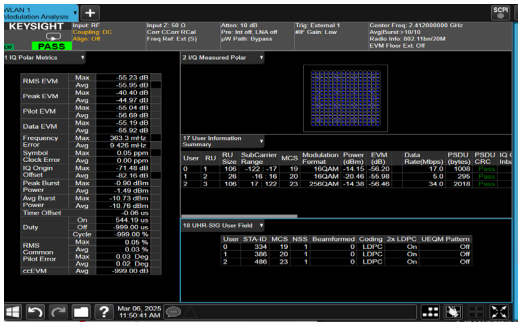
Spectrum flatness of a 40 MHz IEEE 802.11n signal (Greenfield mode).

Modulation analysis (OFDM EVM view)

The modulation analysis of a 320 MHz 802.11be EHT signal with a MCS13 4096QAM signal

Modulation analysis (I/Q Meas Polar Graph view)

802.11bn UHR MU PPDU with New MCS (19, 20, 23) and 2xLDPC.



Cross-Correlated EVM Technology

Error Vector Magnitude (EVM) is a quality metric generally used in digital communication systems to quantify the performance of a digital radio transmitter or receiver. Cross-Correlated EVM (ccEVM) is a technique used to extend the dynamic range of a receiver for best EVM performance. Two receivers with same model number are used to capture and demodulate the same signal independently and performs cross-correlation on the error vectors to cancel out uncorrelated noise added by the receivers, resulting in a much lower EVM. This technique causes the ccEVM value to primarily contain just the noise coming from the device under test (DUT), or in the case of an amplifier noise coming from signal source plus DUT. N/E9077EMxE WLAN measurement application with X-Apps 2023 Release (XA33) for ccEVM can enable accurate and best EVM performance of WLAN signals which can work with UXA, PXA, MXA, PXI VXT, E6680A/E wireless test set.

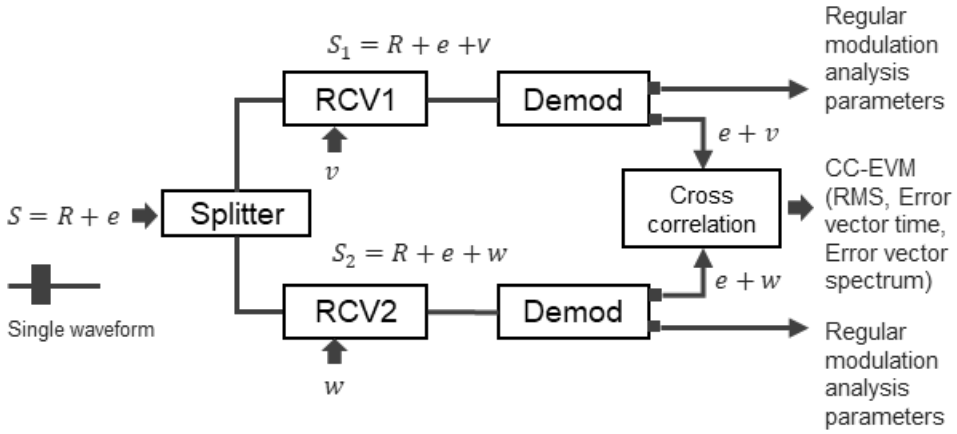


Figure. ccEVM data processing procedure

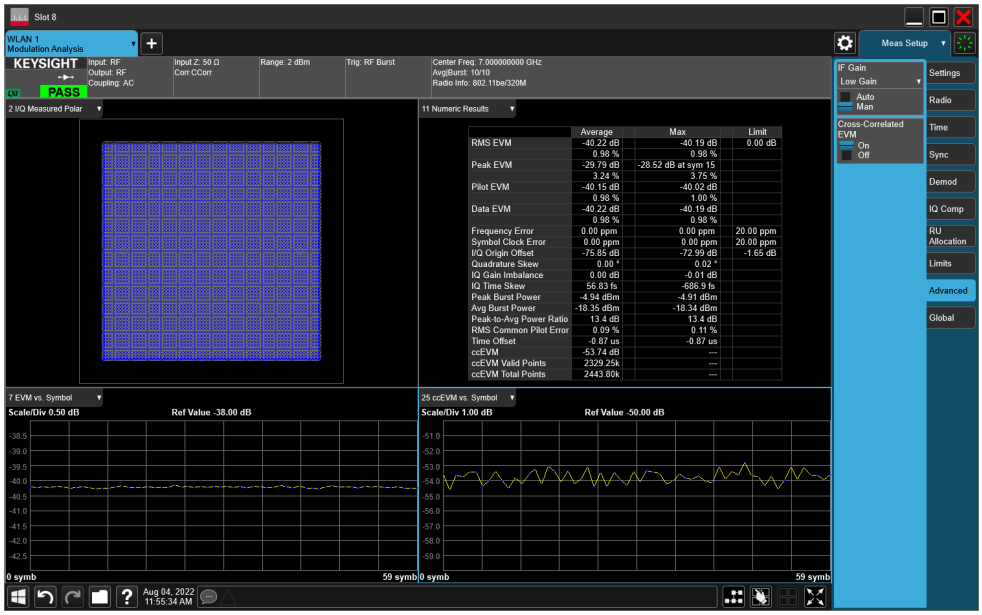


Figure. Cross-correlated EVM result (-50.81 dB) is compared with RMS EVM of one individual receiver (-46.39 dB). In this example of a signal generator and two receivers, ccEVM results in a more than 4 dB EVM improvement of 802.11be WLAN 320 MHz signal.

IQ Noise Correction (IQ-NC) EVM Technology

IQ-NC means the IQ with Noise Correction which only uses one receiver to acquires repetitive waveforms and apply the algorithm called coherent average which will totally remove the noise inside the received signal as average IQ or noise free IQ data. Then the receiver can switch to the path without signal input and estimate the receiver itself noise. Then we can deduct the receiver noise from the total noise and get the SUT (system under test) noise and then add it back to the averaged IQ data. Then we can calculate the EVM with the summed signal including both averaged IQ and SUT noise using the traditional modulation analysis to get the EVM results. N/E9077EMxE WLAN measurement application with X-Apps 2025 Update 1.0 (XA41) for IQ-NC can enable accurate and best EVM performance of WLAN signals which can work with UXA, PXA, MXA and EXA.

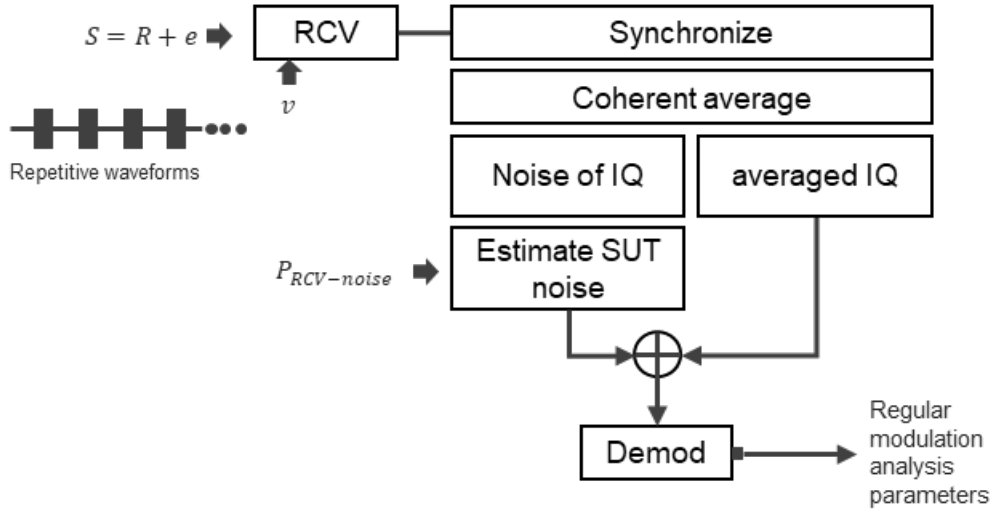


Figure. the procedure to calculate the EVM using IQ-NC technology

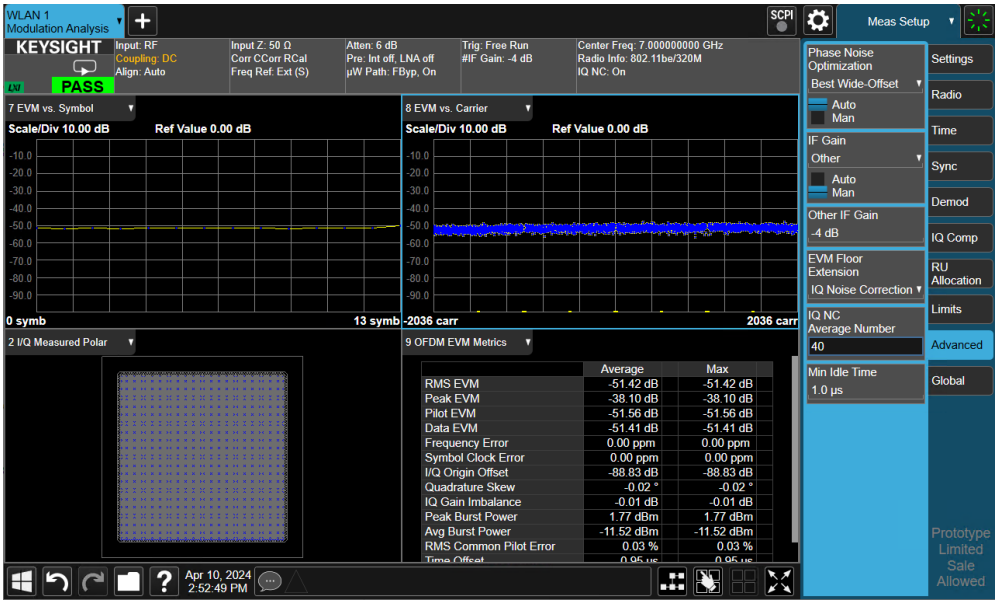


Figure. 802.11be with 320 MHz and MCS13, Frequency: 7 GHz; Power: -10 dBm; IQ-NC on with average 40
Result: EVM performance is improved from -45.5 dB to 51.4 dB

WLAN Standard-Based Measurement Summary

Standard-based RF transmitter tests

Table 1. Required 802.11a/b/g WLAN transmitter measurements and the corresponding measurements in the X-Series measurement application and 89600 VSA software

IEEE 802.11a/j/p	IEEE 802.11b	IEEE 802.11g	Transmitter test	N/E/W9077EM0E WLAN measurement application	89601B7RC Wireless Connectivity modulation analysis
18.3.9.2	17.4.7.2	18.3.9.2 19.4.8.2	Transmit power	Channel power	Can be performed using band power marker
18.3.9.3	17.4.7.4	18.3.9.3 19.5.5	Spectrum mask	Spectrum emission mask	Not available [1]
18.3.9.4	17.4.6.9	18.3.9.4	Transmission spurious	Spurious emission	Not available [1]
18.3.9.5	17.4.7.5	18.3.9.5 19.4.8.3	Center frequency tolerance	Frequency error [2]	Frequency error [2]
18.3.9.6	17.4.7.6	18.3.9.6 19.4.8.4	Symbol (chip) clock frequency tolerance	Symbol (chip) clock error [2]	Symbol clock error [2]
18.3.9.7.1		18.3.9.7.1	Center frequency leakage	IQ origin offset [2]	IQ offset [2]
	17.4.7.7		Power on/down ramp	Power vs time	Not available
	17.4.7.8		RF carrier suppression	Carrier suppression [2]	Not available
18.3.9.7.3		18.3.9.7.3	Spectral flatness	Spectral flatness	OFDM equalized channel frequency resp.
18.3.9.7.4		18.3.9.7.4	Constellation error (EVM rms)	RMS EVM	EVM (rms)
18.3.9.8	17.4.7.9	18.3.9.8	Modulation accuracy test [3]	Modulation analysis	Modulation analysis

1. If 89601B with Option B7R is used with a Keysight spectrum or signal analyzer, these measurements are available as part of the spectrum analyzer mode under the power suite measurements.
2. For the N9077EM0E application, these values are found in the “numeric results” trace under the modulation analysis view. For 89601B with Option B7R, these values are found under the “Syms/Errs” trace.
3. The standard describes the procedure for making this measurement but doesn’t specify test limits.

Table 2. Required 802.11n WLAN transmitter measurements and the corresponding measurements in X-Series measurement application and 89600 VSA software

IEEE 802.11a/j/p	Transmitter test	N/E/W9077EM0E WLAN measurement application	89601B7RC Wireless Connectivity modulation analysis
20.3.20.1	Transmit spectrum mask	Spectrum emission mask	Not available
20.3.20.2	Spectral flatness	Spectral flatness	OFDM equalized channel frequency resp.
20.3.20.3	Transmit power	Channel power	Can be performed using band power marker
20.3.20.4	Transmit center frequency tolerance	Frequency error [1]	Frequency error [1]
20.3.20.6	Symbol clock frequency tolerance	Symbol (chip) clock error [1]	Symbol clock error [1]
20.3.20.7.2	Center frequency leakage	IQ origin offset [1]	IQ offset [1]
20.3.20.7.3	Constellation error (EVM rms)	RMS EVM	EVM (rms)
20.3.20.7.4	Modulation accuracy test [2]	Modulation analysis	Modulation analysis

1. For the N9077EM0E application, these values are found in the "numeric results" trace under the modulation analysis view. For 89601B with Option B7R and Option BHJ, these values are found under the "Syms/Errs" trace.
2. The standard describes the procedure for making this measurement but doesn't specify test limits.

Table 3. Required WLAN 802.11ac/ah/af transmitter measurements and the corresponding measurements available in X-Series measurement application and 89600 VSA software

IEEE 802.11ac (D7.0)	Transmitter test	N/E9077EM1E WLAN measurement application	89601BHXC High Throughput WLAN modulation analysis
22.3.18.1	Transmit spectrum mask	Spectrum emission mask	Not available
22.3.18.2	Spectral flatness	Spectral flatness	Channel freq resp.
22.3.18.3	Transmit center frequency tolerance	Frequency error	Frequency error
22.3.18.3	Symbol clock frequency tolerance	Symbol (chip) clock error	Symbol clock error
22.3.18.4.2	Transmit center frequency leakage	IQ origin offset	IQ offset
22.3.18.4.3	Transmit constellation error (EVM rms)	RMS EVM	EVM (rms)
22.3.18.4.2	Modulation accuracy test [2]	Modulation analysis	Modulation analysis

IEEE 802.11ah(D3.0)	Transmitter test	N/E9077EM1E WLAN measurement application	89601BHXC High Throughput WLAN modulation analysis
24.3.16.1	Transmit spectrum mask	Spectrum emission mask	Not available
24.3.16.2	Spectral flatness	Spectral flatness	Channel freq resp.
24.3.16.3	Transmit center frequency tolerance	Frequency error	Frequency error
24.3.16.4	Symbol clock frequency tolerance	Symbol clock error	Symbol clock error
24.3.16.4.2	Transmit center frequency leakage	IQ origin offset	IQ offset
24.3.16.4.3	Transmit constellation error (EVM rms)	RMS EVM	EVM (rms)
24.3.16.4.4	Modulation accuracy test [2]	Modulation analysis	Modulation analysis

IEEE 802.11af(2013)	Transmitter test	N/E9077EM1EWLAN measurement application	
23.3.18.1	Transmit spectrum mask	Spectrum emission mask	
23.3.18.2	Spectral flatness	Spectral flatness	
23.3.18.3	Transmit center frequency tolerance	Frequency error	
23.3.18.3	Transmit symbol clock tolerance	Symbol clock error	
23.3.18.4.2	Transmit center frequency leakage	I/Q origin offset	
23.3.18.4.3	Transmit constellation error (EVM rms)	RMS EVM	
23.3.18.4.4	Modulation accuracy test	Modulation analysis	

Table 4. Required 802.11ax WLAN transmitter measurements and the corresponding measurements in X-Series measurement Application and 89600 VSA software

IEEE 802.11ax(D5.0)	Transmitter test	N/E9077EM1E WLAN measurement application	89601BHXC High throughput WLAN modulation analysis
26.3.14.1	Transmit spectrum mask	Spectrum emission mask	Not available
26.3.14.2	Spectral flatness	Spectral flatness	Channel freq resp.
26.3.14.3	Transmit center frequency tolerance	Frequency error	Frequency error [1]
26.3.14.3	Symbol clock frequency tolerance	Symbol (chip) clock error	Symbol clock error [1]
26.3.14.4.2	Transmit center frequency leakage	IQ origin offset	IQ offset1
26.3.14.4.3	Transmit constellation error (EVM rms)	RMS EVM	EVM (rms)
26.3.14.4	Modulation accuracy test2	Modulation analysis	Modulation analysis

Table 5. Required 802.11be WLAN transmitter measurements and the corresponding measurements in X-Series measurement application and 89600 VSA software

IEEE 802.11be (D1.0)	Transmitter test	N/E9077EM2E WLAN measurement application	89601BHXC High Throughput WLAN modulation analysis
36.3.18.1	Transmit spectrum mask	Spectrum emission mask	Not available
36.3.18.2	Spectral flatness	Spectral flatness	Channel frequency response
36.3.18.3	Transmitter center frequency tolerance	Frequency error	Frequency error
36.3.18.3	Symbol clock frequency tolerance	Symbol (chip) clock error	Symbol clock error
36.3.18.4.2	Transmit center frequency leakage	IQ origin offset	IQ offset
36.3.18.4.3	Transmit constellation error (EVM rms)	RMS EVM	EVM (rms)
36.3.18.4.4	Modulation accuracy (EVM) test	Modulation analysis	Modulation analysis

IEEE 802.11be (D0.2)	Transmitter test	N/E9077EM2E WLAN measurement application	89601BHXC High Throughput WLAN modulation analysis
38.3.24.1	Transmit spectrum mask	Spectrum emission mask	Not available
38.3.24.2	Spectral flatness	Spectral flatness	Channel frequency response
38.3.24.3	Transmitter center frequency and symbol clock frequency tolerance	Frequency error Symbol (chip) clock error	Frequency error Symbol clock error
38.3.24.4.2	Transmit center frequency leakage	IQ origin offset	IQ offset
38.3.24.4.3	Transmitter modulation accuracy (EVM) test	RMS EVM	EVM (rms)

Measurement Details

All of the RF transmitter measurements as defined in the IEEE standard, as well as a widerange of additional measurements and analysis tools, are available with the press of a button. These measurements are fully remote controllable via the IEC/IEEE bus or LAN, using SCPI commands. A detailed list of supported measurements is shown in Table 5.

Table 6. List of one-button measurements provided by the WLAN measurement application

Technology	IEEE 802.11b/g (DSSS/CCK/PBCC)	IEEE 802.11a/g (ERP-OFDM, DSSS- OFDM), 802.11j, 802.11p	IEEE 802.11n (20 MHz, 40 MHz), 802.11ac (20/40/80/160,80+80 MHz [1], 802.11ah (1/2/4/8/16 MHz), 802.11af (6/7/8 MHz)	IEEE 802.11ax/be/bn (20/40/80/160/320, 80+80 MHz) [1]
Modulation analysis				
RMS EVM	● [2]	●	●	●
Peak EVM		●	●	●
Pilot EVM		●	●	●
Data EVM		●	●	●
cross-correlated EVM (ccEVM)	●	●	●	●
IQ Noise Correction (IQ-NC)	●	●	●	●
1K chips EVM	●			
RMS magnitude error	●			
Peak magnitude error	●			
RMS phase error	●			
Peak phase error	●			
Frequency error	●	●	●	●
Common pilot error			●	
Chip clock error	●			
Symbol clock error				
I/Q origin offset (CFL)	●	●	●	●
Quadrature skew	●	●	●	●
I/Q gain imbalance	●	●	●	●
Carrier suppression	●	●	●	●
Average burst power	●	●	●	●
Peak burst power	●	●	●	●
Pk-to-avg power ratio	●	●	●	●
Duty (On, Off, Cycle)	●	●	●	●
RMS Common Pilot Error (Max, Avg0	●	●	●	●
Modulation format	●	●	●	●
Bit rate	●	●	●	●
Preamble frequency error			●	●
Burst & Sig Info			●	●
User info				●
HE or EHT SIG-B (common & user field)				●
UHR-SIG User Field				● [4]
UHR-SIG Common Field				● [4]
Unused Tone Error & Metrics				●
4096QAM				●

Channel power	●	●	●	●
Occupied bandwidth	●	●	●	●
CCDF	●	●	●	●
Spectrum emission mask (SEM)	●	●	●	● [3]
Spurious emissions	●	●	●	●
Power vs. time	●	●	●	●
Spectral flatness	●	●	●	● [3]
Monitor spectrum	●	●	●	●
I/Q waveform	●	●	●	●

1. 802.11ac/ax/be is not supported on the CXA.
2. You can choose the 802.11b EVM result by standard 1997, 2007 or 2016.
3. 802.11be supports this measurement with X-apps 2022 release (A.30.0x).
4. 802.11bn support this measurement with X-apps 2025 Update 1.0 (A.41.0x)

Key Specifications

Description	UXA (N9040B)	PXA (N9030B)	MXA (N9020B)	EXA (N9010B)	CXA (N9000B)
Supported standards	802.11a, 802.11g ERP-OFDM, 802.11g DSSS-OFDM, 802.11b/g DSSS/CCK/PBCC, 802.11j, 802.11p, 802.11-a turbo mode				
	802.11n (20 MHz5, 40 MHz) HT Mixed, HT Greenfield, Non-HT 802.11ac 205/406/807/1608 MHz, 80+80 MHz7, MCS=0-13 802.11af 6/7/8 MHz 802.11ah 1/2/4/8/16 MHz, MCS0-10 802.11ax 205/406/807/1608 MHz, 80+80 MHz7, MCS=0-13 802.11be 205/406/807/1608 MHz, 80+80 MHz7, MCS=0-13, 15 802.11bn 205/406/807/1608 MHz, 80+80 MHz7, MCS=0-13, 15, four new MCS (17,19, 20,23)				
Modulation formats	BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM, 4096QAM				
Modulation accuracy (nominal) Center frequency in 2.4 GHz band [1] 802.11a/g/j/p (OFDM), 802.11g (DSSS-OFDM), 802.11n (20 MHz); Code rate: 3/4; Equalizer training = channel est. seq. only, Track phase: On; RF input level = –10 dBm, Attenuation = 10 dB					
EVM floor		–53 dB (0.23%)	–52 dB (0.25%) [9]	–49 dB (0.36%)	–44 dB (0.63%)
802.11n (40 MHz); Code rate: 3/4; Equalizer training = channel est. seq. only, Track phase: On; RF input level = –10 dBm, Attenuation = 10 dB					
EVM floor		–50 dB (0.32%)	–50 dB (0.32%) [9]	–46 dB (0.47%)	Not Applicable [3]
Center frequency in 5.0 GHz band [2] 802.11a/g/j/p (OFDM), 802.11n (20 MHz), 802.11ac (20 MHz); Code rate: 3/4; Equalizer training = channel est. seq. only, Track phase: On; RF input level = –10 dBm, Attenuation = 10 dB					
EVM floor		–50 dB (0.29%)	–49 dB (0.34%) [8]	–47 dB (0.45%)	–40 dB (0.95%)
802.11n (40 MHz), 802.11ac (40 MHz); Code rate: 3 4; Equalizer training = channel est. seq. only, Track phase: On; RF input level = –10 dBm, Attenuation = 10 dB					
EVM floor		–48 dB (0.40%)	–47 dB (0.42%)8	–45 dB (0.53%)	Not Applicable [3]
802.11ac (80 MHz); Code rate: 3/4; Equalizer training = channel est. seq. only, Track phase: On; RF input level = –10 dBm, Attenuation = 6 dB					
EVM floor		–47 dB (-0.45%)	–46 dB (0.50%) [9]	Not Applicable [3]	Not Applicable [3]
802.11ax (80 MHz); MCS 11, Equalizer training = channel est.seq.only, Frequency sync = Preamble, pilot & data Track phase: On; Track amp: Off; Track timing: On; RF input level= -10 dBm, Attenuation = 6 dB					
EVM floor (2.4 GHz band) EVM floor (5 GHz band)		–52.0 dB (0.25%) –50.5 dB (0.30%)	–51.7 dB (0.30%) –47.5 dB (0.30%)	–50.3 dB (0.31%) [10] –50.3 dB (0.31%) [10]	Not Applicable [3] Not Applicable [3]
802.11ax (160 MHz); MCS 11, Equalizer training = channel est.seq.only, Frequency sync = Preamble, pilot & data Track phase: On; Track amp: Off; Track Timing: On; RF input level= -10 dBm, Attenuation = 6 dB					
EVM floor (2.4 GHz band) EVM floor (5 GHz band)	–47.8 dB (0.41%) –47.0 dB (0.45%)	–47.5 dB (0.42%) –47.0 dB (0.45%)	–47.3 dB (0.43%) [10] –47.0 dB (0.44%) [10]	Not Applicable [3] Not Applicable [3]	Not Applicable [3] Not Applicable [3]
802.11ac (160 MHz); Code rate: 3/4; Equalizer training = channel est. seq. only, Track phase: On; RF input level = –10 dBm, Attenuation = 8 dB					
EVM floor		–46 dB (0.50%)	–45 dB (0.56%) 9	Not Applicable [3]	Not Applicable [3]
802.11ah (1 MHz); Code Rate: 3/4; Equalizer training = channel est. seq only, Track phase:ON; RF input level = -10 dBm, Atten=10 dB Center frequency in Sub GHz band					
EVM floor 1 [1]		–58 dB (0.13%)	–54 dB (0.19%)	–53 dB (0.22%)	–46 dB (0.46%)
Accuracy (EVM range: 0 to 8%)		± 0.30%			
Frequency error accuracy		± 10 Hz+tfa9			
802.11b/g (DSSS/CCK/PBCC); Reference filter: Gaussian; RF input level = –10 dBm, Attenuation = 10 dB Center frequency in 2.4 GHz band [4]					
EVM floor (Equalizer off)		–41 dB (0.80%)	–40 dB (1.00%)	–39 dB (1.03%)	–36 dB (1.49%)
EVM floor (Equalizer on)		–54 dB (0.20%)	–46 dB (0.50%)	–46 dB (0.50%)	–44 dB (0.60%)
Accuracy (EVM range: 0 to 2%)		± 0.90%			
Accuracy (EVM range: 2 to 20%)		± 0.40%			

Frequency error accuracy		± 10 Hz+tfa [9]			

1. GHz band for radio standard 802.11a/g (OFDM), 802.11 (DSSS-OFDM), 802.11n (20 MHz or 40 MHz) is applied channel center frequency = 2407 MHz + 5xk MHz (k = 1.....13)
2. 5.0 GHz band for radio standard 802.11a/g (OFDM), 802.11g (DSSS-OFDM), 802.11n (20 MHz or 40 MHz), 802.11ac (20 MHz, 40 MHz, 80 MHz, 160 MHz, 80 + 80 MHz) is applied channel center frequency = 5000 MHz + 5xk MHz (k = 0,1,2,...200)
3. The CXA with Option B25 can only support the bandwidth of 25 MHz. EXA with Option B40 can only support 40 MHz bandwidth.
4. GHz band for radio standard 802.11b/g (DSS/CCK/PBCC) is applied channel center frequency = 2407 MHz + 5xk MHz (k = 1.....13)
5. Requires N90x0B-B25 25 MHz analysis bandwidth option or higher
6. Requires N90x0B-B40 40 MHz analysis bandwidth option or higher
7. Requires N90x0B-B85 85 MHz analysis bandwidth option or higher
8. Requires N90x0B-B1X 160 MHz analysis bandwidth option
9. tfa = transmitter frequency × frequency reference accuracy
10. MXA with -EP2 option (S/N prefix≥MY/SG/US5233, ship standard with N9020B-EP2)

Description	PXA (N9030B)	MXA (N9020B)	EXA (N9010B)	CXA (N9000B)
Channel power				
Minimum power at RF input	–50 dBm (nominal)			
Center frequency in 2.4 GHz band 802.11b/g (DSSS/CCK/PBCC); Integration bandwidth = 22 MHz				
Absolute power accuracy	± 0.19 dB (95th percentile)	± 0.23 dB (95th percentile)	± 0.27 dB (95th percentile)	± 0.61 dB (95th percentile)
Measurement floor	–78.3 dBm (typical)	–76.3 dBm (typical)	–72.3 dBm (typical)	–71.3 dBm (typical)
802.11a/g/j/p (OFDM), 802.11g (DSSS-OFDM), 802.11n (20 MHz), 802.11ac (20 MHz); Integration bandwidth = 20 MHz				
Absolute power accuracy	± 0.19 dB (95th percentile)	± 0.23 dB (95th percentile)	± 0.27 dB (95th percentile)	± 0.61 dB (95th percentile)
Measurement floor	–78.7 dBm (typical)	–76.7 dBm (typical)	–72.7 dBm (typical)	–71.7 dBm (typical)
802.11n (40 MHz), Integration bandwidth= 40 MHz				
Absolute power accuracy	± 0.19 dB (95th percentile)	± 0.23 dB (95th percentile)	± 0.27 dB (95th percentile)	± 0.61 dB (95th percentile)
Measurement floor	–75.7 dBm (typical)	–73.7 dBm (typical)	–69.7 dBm (typical)	–68.7 dBm (typical)
Center frequency in 5.0 GHz band 802.11a/g/j/p (OFDM), 802.11n (20 MHz), 802.11ac (20 MHz); Integration bandwidth= 20 MHz				
Absolute power accuracy	± 0.41 dB (95th percentile)	± 0.50 dB (95th percentile)	± 0.50 dB (95th percentile)	± 1.24 dB (95th percentile)
Measurement floor	–76.7 dBm (typical)	–76.7 dBm (typical)	–72.7 dBm (typical)	–64.7 dBm (typical)
802.11n (40 MHz), 802.11ac (40 MHz); Integration bandwidth = 40 MHz				
Absolute power accuracy	± 0.41 dB (95th percentile)	± 0.50 dB (95th percentile)	± 0.50 dB (95th percentile)	± 1.24 dB (95th percentile)
Measurement floor	–73.7 dBm (typical)	–73.7 dBm (typical)	–69.7 dBm (typical)	–61.7 dBm (typical)
802.11ac (80 MHz); Integration bandwidth = 80 MHz				
Absolute power accuracy	± 0.41 dB (95th percentile)	± 0.50 dB (95th percentile)	± 0.50 dB (95th percentile)	± 1.24 dB (95th percentile)
Measurement floor	–70.7 dBm (typical)	–70.7 dBm (typical)	–66.7 dBm (typical)	–58.7 dBm (typical)
802.11ac (160 MHz); Integration bandwidth = 160 MHz				
Absolute power accuracy	± 0.41 dB (95th percentile)	± 0.50 dB (95th percentile)	± 0.50 dB (95th percentile)	± 1.24 dB (95th percentile)
Measurement floor	–67.7 dBm (typical)	–67.7 dBm (typical)	–63.7 dBm (typical)	–55.7 dBm (typical)
802.11ax (80 MHz); Integration bandwidth = 80 MHz				
Measurement floor	–72.7 dBm (typical)	–70.1 dBm (typical)		
802.11ax (160 MHz); Integration bandwidth = 160 MHz				
Measurement floor	–67.7 dBm (typical)	– 67.7 dBm (typical)		
802.11ah (1 MHz); Integration bandwidth = 1 MHz				
Absolute power accuracy	± 0.19 (95th percentile)	± 0.23 (95th percentile)	± 0.27 (95th percentile)	± 0.61 (95th percentile)
Measurement floor	–91.7 dBm (typical)	–89.7 dBm	–86.7 dBm	–84.7 dBm
Power versus Time (nominal)				

802.11b/g (DSSS/CCK/PBCC) **Center frequency in 2.4 GHz band**				
Measurement results type	Min, Max, Mean			
Measurement time	Up to 88 ms			
Dynamic range	64.0 dB	62.0 dB	58.0 dB	57.0 dB
Spectrum emission mask **802.11a/g/j/p (OFDM), 802.11g (DSSS-OFDM), 802.11n (20 MHz); Integration bandwidth = 18 MHz, RBW = 100.0 kHz, 11.0 MHz offset** **Center frequency in 2.4 GHz band**				
Dynamic range, relative	87.3 dB (typical)	84.3 dB (typical)	79.9 dB (typical)	79.8 dB (typical)
Sensitivity, absolute	–101.5 dBm (typical)	–99.5 dBm (typical)	–95.5 dBm (typical)	–94.5 dBm (typical)
Accuracy, relative	± 0.05 dB	± 0.12 dB	± 0.12 dB	± 0.12 dB
Accuracy, absolute	± 0.20 dB (95th percentile)	± 0.27 dB (95th percentile)	± 0.31 dB (95th percentile)	± 0.64 dB (95th percentile)
802.11a/g (OFDM), 802.11n (20 MHz), 802.11ac (20 MHz); Integration bandwidth = 18 MHz, RBW = 100.0 kHz, 11.0 MHz offset **Center frequency in 5.0 GHz band**				
Dynamic range, relative	85.3 dB (typical)	84.3 dB (typical)	79.9 dB (typical)	73.2 dB (typical)
Sensitivity, absolute	–99.5 dBm (typical)	–99.5 dBm (typical)	–95.5 dBm (typical)	–87.5 dBm (typical)
Accuracy, relative	± 0.05 dB	± 0.12 dB	± 0.12 dB	± 0.11 dB
Accuracy, absolute	± 0.41 dB (95th percentile)	± 0.54 dB (95th percentile)	±0.54 dB (95th percentile)	±1.28 dB (95th percentile)
802.11n (40 MHz), 802.11ac (40 MHz) @ 5 GHz only; Integration bandwidth = 38 MHz, RBW = 100.0 kHz, 21.0 MHz offset **Center frequency in 2.4 GHz band**				
Dynamic range, relative	87.3 dB (typical)	84.5 dB (typical)	80.2 dB (typical)	80.0 dB (typical)
Sensitivity, absolute	–101.5 dBm (typical)	–99.5 dBm (typical)	–95.5 dBm (typical)	–94.5 dBm (typical)
Accuracy, relative	± 0.05 dB	± 0.12 dB	± 0.12 dB	± 0.12 dB
Accuracy, absolute	± 0.20 dB (95th percentile)	± 0.27 dB (95th percentile)	± 0.31 dB (95th percentile)	± 0.64 dB (95th percentile)
802.11n (40 MHz), 802.11ac (40 MHz) @ 5 GHz only; Integration bandwidth = 38 MHz, RBW = 100.0 kHz, 21.0 MHz offset **Center frequency in 2.4 GHz band**				
Dynamic range, relative	87.3 dB (typical)	84.5 dB (typical)	80.2 dB (typical)	80.0 dB (typical)
Sensitivity, absolute	–101.5 dBm (typical)	–99.5 dBm (typical)	–95.5 dBm (typical)	–94.5 dBm (typical)
Accuracy, relative	± 0.05 dB	± 0.12 dB	± 0.12 dB	± 0.12 dB
Accuracy, absolute	± 0.20 dB (95th percentile)	± 0.27 dB (95th percentile)	± 0.31 dB (95th percentile)	± 0.64 dB (95th percentile)
Center frequency in 5.0 GHz band				
Dynamic range, relative	85.4 dB (typical)	84.5 dB (typical)	80.2 dB (typical)	73.3. dB (typical)
Sensitivity, absolute	–99.5 dBm (typical)	–99.5 dBm (typical)	–95.5 dBm (typical)	–87.5 dBm (typical)
Accuracy, relative	± 0.05 dB	± 0.12 dB	± 0.12 dB	± 0.11 dB
Accuracy, absolute	± 0.41 dB (95th percentile)	± 0.54 dB (95th percentile)	± 0.54 dB (95th percentile)	± 1.28 dB (95th percentile)
802.11b/g (DSSS/CCK/PBCC); Integration bandwidth = 22 MHz, RBW = 100.0 kHz, 11.0 MHz offset **Center frequency in 2.4 GHz band**				
Dynamic range, relative	87.3 dB (typical)	84.3 dB (typical)	80.0 dB (typical)	79.9 dB (typical)
Sensitivity, absolute	–101.5 dBm (typical)	–99.5 dBm (typical)	–95.5 dBm (typical)	–94.5 dBm (typical)
Accuracy, relative	± 0.05 dB	± 0.12 dB	± 0.12 dB	± 0.12 dB
Accuracy, absolute	± 0.20 dB (95th percentile)	± 0.27 dB (95th percentile)	± 0.31 dB (95th percentile)	± 0.64 dB (95th percentile)
802.11ac (80 MHz); Integration bandwidth = 78 MHz, RBW = 100.0 kHz, 41.0 MHz offset **Center frequency in 5.0 GHz band**				
Dynamic range, relative	85.4 dB (typical)	84.6 dB (typical)	80.4 dB (typical)	73.4 dB (typical)
Sensitivity, absolute	–99.5 dBm (typical)	–99.5 dBm (typical)	–95.5 dBm (typical)	–87.5 dBm (typical)
Accuracy, relative	± 0.05 dB	± 0.12 dB	± 0.12 dB	± 0.11 dB
Accuracy, absolute	± 0.41 dB (95th percentile)	± 0.54 dB (95th percentile)	± 0.54 dB (95th percentile)	± 1.28 dB (95th percentile)
802.11ac (160 MHz); Integration bandwidth = 158 MHz, RBW = 100.0 kHz, 81.0 MHz offset **Center frequency in 5.0 GHz band**				
Dynamic range, relative	85.4 dB (typical)	84.7 dB (typical)	80.4 dB (typical)	73.4 dB (typical)
Sensitivity, absolute	–99.5 dBm (typical)	–99.5 dBm (typical)	–95.5 dBm (typical)	–87.5 dBm (typical)
Accuracy, relative	± 0.05 dB	± 0.12 dB	± 0.12 dB	± 0.11 dB

Accuracy, absolute	± 0.41 dB (95th percentile)	± 0.54 dB (95th percentile)	± 0.54 dB (95th percentile)	± 1.28 dB (95th percentile)
802.11ax (80 MHz); Integration bandwidth = 79 MHz, RBW = 100.0 kHz, 40.5 MHz offset Center frequency in 2.4 GHz band				
Dynamic range, relative	87.4 dB (typical)	85.1 dB (typical)		
Sensitivity, absolute	–101.5 dBm (typical)	–99.5 dBm (typical)		
Accuracy, relative	± 0.15 dB	± 0.26 dB		
Accuracy, absolute	± 0.22 dB (95th percentile)	± 0.28 dB (95th percentile)		
Center frequency in 5.0 GHz band				
Dynamic range, relative	85.4 dB (typical)	85.1 dB (typical)		
Sensitivity, absolute	–99.5 dBm (typical)	–99.5 dBm (typical)		
Accuracy, relative	± 0.60 dB	± 0.67 dB		
Accuracy, absolute	± 0.42 dB (95th percentile)	± 0.54 dB (95th percentile)		
802.11ax (160 MHz); Integration bandwidth = 159 MHz, RBW = 100.0 kHz, 80.5 MHz offset Center frequency in 2.4 GHz band				
Dynamic range, relative	87.4 dB (typical)	85.2 dB (typical)		
Sensitivity, absolute	–101.5 dBm (typical)	–99.5 dBm (typical)		
Accuracy, relative	± 0.18 dB	± 0.23 dB		
Accuracy, absolute	± 0.22 dB (95th percentile)	± 0.28 dB (95th percentile)		
Center frequency in 5.0 GHz band				
Dynamic range, relative	85.4 dB (typical)	85.2 dB (typical)		
Sensitivity, absolute	–99.5 dBm (typical)	–99.5 dBm (typical)		
Accuracy, relative	± 0.75 dB	± 0.82 dB		
Accuracy, absolute	± 0.42 dB (95th percentile)	± 0.54 dB (95th percentile)		
802.11ah (1 MHz); Integration bandwidth=0.9 MHz, RBW=10.0 kHz,0.6 MHz offset Center frequency in Sub GHz band				
Dynamic range, relative	90.1 dB (typical)	89.9 dB (typical)	87.9 dB (typical)	78.7 dB (typical)
Sensitivity, absolute	–111.5 dBm (typical)	–109.5 dBm (typical)	–106.5 dBm (typical)	–104.5 dBm (typical)
Accuracy, relative	± 0.06 dB	± 0.13 dB	± 0.13 dB	± 0.14 dB
Accuracy, absolute	± 0.21 dB (95th percentile)	± 0.27 dB (95th percentile)	± 0.31 dB (95th percentile)	± 0.65 dB (95th percentile)

Ordering Information

Licenses ordering information

Option	Title
N9077EM0E [1] **E9077EM0E** [1] **W9077EM0E** [1]	WLAN 802.11a/b/g/j/p/n/af/ah measurement application
N9077EM1E [1] **E9077EM1E** [1]	WLAN 802.11ac/ax measurement application
N9077EM2E [1] **E9077EM2E** [1]	WLAN 802.11be/bn measurement application

1. Keysight supports tiered X-app models with N-models for UXA/PXA/PXE, E-models for MXA/EXA/MXE/VXT. The higher tiered X-app models can run at the lower platforms, which means N-models can run on all platforms, E-models can only run on MXA/EXA/MXE/VXT, and CXA, and W-models can only run on CXA

Flexible licensing and configuration

- Perpetual: License can be used in perpetuity.
- Subscription: License is time limited to a defined period, such as 12-months.
- Node-locked: Allows you to use the license on one specified instrument/computer.
- Transportable: Allows you to use the license on one instrument/computer at a time. This license may be transferred to another instrument/computer using Keysight's online tool.
- Floating: Allows you to access the license on networked instruments/computers from a server, one at a time. For concurrent access, multiple licenses may be purchased.
- USB portable: Allows you to move the license from one instrument/computer to another by end-user only with certified USB dongle, purchased separately.
- Software support subscription: Allows the license holder access to Keysight technical support and all software upgrades

Software license type	Software license	Support subscription
Node-locked perpetual	SW1000-LIC-01	SW1000-SUP-01
Node-locked time-based	SW1000-SUB-01	Included
Transportable perpetual	SW1000-LIC-01	SW1000-SUP-01
Transportable time-based	SW1000-SUB-01	Included
Floating perpetual (single site)	SW1000-LIC-01	SW1000-SUP-01
Floating time-based (single site)	SW1000-SUB-01	Included
Floating perpetual (regional)	SW1000-LIC-01	SW1000-SUP-01
Floating time-based (regional)	SW1000-SUB-01	Included
Floating perpetual (worldwide)	SW1000-LIC-01	SW1000-SUP-01
Floating time-based (worldwide)	SW1000-SUB-01	Included
USB portable perpetual	SW1000-LIC-01	SW1000-SUP-01
USB portable time-based	SW1000-SUB-01	Included

For time-based licenses, KeysightCare support is included. For perpetual licenses, KeysightCare support subscription may be purchased using the following model numbers. For example, a one-month

Software support subscription extensions

Support subscription	Description
SW1000-SUP-01	Perpetual KeysightCare support (1 month to 60 months)
SW1000-B2S	Back to KeysightCare support fee (Perpetual support only, one time fee) Minimum of 12 months required for a renewal

Hardware Configuration

For optimizing WLAN measurement applications, Keysight recommends a minimum level of X-Series multi-touch instrument hardware functionality at each instrument performance point. Supported instruments include:

Hardware		PXIe
• UXA N9042B • UXA: N9040B+V3080A • UXAN9041B[1] • UXA N9040B • PXA N9030B • PXA N9032B	• MXA N9021B • MXA N9020B • EXA N9010B • CXA N9000B	• VSA up to 6 GHz M9391A • VSA up to 50 GHz M9393A • VXT M9421A • VXT M9410A/M9411A • VXT M9415A/M9416A • Radio Test M8920A/M8920B

N90x0B X-Series signal analyzer

Capability	Instrument option	Benefit
Analysis bandwidth	25 MHz minimum (-B25) or wider.	Required: based on bandwidth of WLAN signal under test
Electronic attenuator	-EA3	Recommended: fast and reliable attenuation changes ideal for manufacturing without the wear associated with mechanical attenuators up to 3.6 GHz in 1 dB steps
Pre-amplifier	3.6 GHz (-P03) or higher up to instrument maximum RF frequency as available	Recommended: for maximizing the measurement sensitivity
Microwave preselector bypass option	-MPB	Required: for measurements > 3.6 GHz
Real-time spectrum analysis	-RT1 or -RT2	Required: for real-time spectrum analysis; maximum bandwidth varies by instrument

Note 1: Currently pulse analysis measurement application has only been qualified for UXA N9041B Input 1 Port.

M9415A/M9416A PXIe VXT vector transceiver

Capability	Instrument option	Benefit
Frequency range 6, 8 or 12 GHz	M9415A/M9416A-F06/F08/F12	One required
Analysis bandwidth 400, 800 MHz or 1.2 GHz	M9415A/M9416A-B4X/B8X/B12	One required
Memory 256 or 512 MSa	M9415A/M9416A-M02/M05	One required
Half duplex port	M9415A/M9416A-HDX	Optional
High output power	M9415A/M9416A-1EA	Optional

M9410A/M9411A PXIe VXT vector transceiver

Capability	Instrument option	Benefit
Frequency range 6 GHz	M9410A/M9411A-001	One required
Analysis bandwidth 300, 600 or 1200 MHz	M9410A/M9411A-B3X/B6X/B12	One required
Memory 256 or 512 MSa	M9410A/M9411A-M02/M05	One required
Half duplex port	M9410A/M9411A-HDX	Optional
High output power	M9410A/M9411A-1EA	Optional

Additional Resources

Literature

- IEEE 802.11 Physical Layer Operation and Measurement, Application note: 5988-5411EN
- RF Testing of WLAN Products, Application note: 5988-3762EN
- Testing New-Generation WLAN 802.11ac, Application note: 5990-8856EN
- MIMO Wireless LAN PHY Layer Operation and Measurement, Application note: 5989-3443EN

Web

- WLAN 802.11a/b/g/j/p/n/af/ah X-Series measurement app, multi-touch UI product webpage
  - www.keysight.com/find/N9077EM0E
- WLAN 802.11ac/ax X-Series measurement app, multi-touch UI product webpage
  - www.keysight.com/find/N9077EM1E
- WLAN 802.11be X-Series measurement app, multi-touch UI product webpage
  - www.keysight.com/find/N9077EM2E
- X-Series measurement applications: www.keysight.com/find/X-Series_Apps
- X-Series signal analyzers: www.keysight.com/find/X-Series
- Compatible Instruments for X-Series Measurement Applications: www.keysight.com/find/X-Series_apps_platform
- Application pages: www.keysight.com/find/WLAN
- Internet of Things pages: www.keysight.com/find/IoT