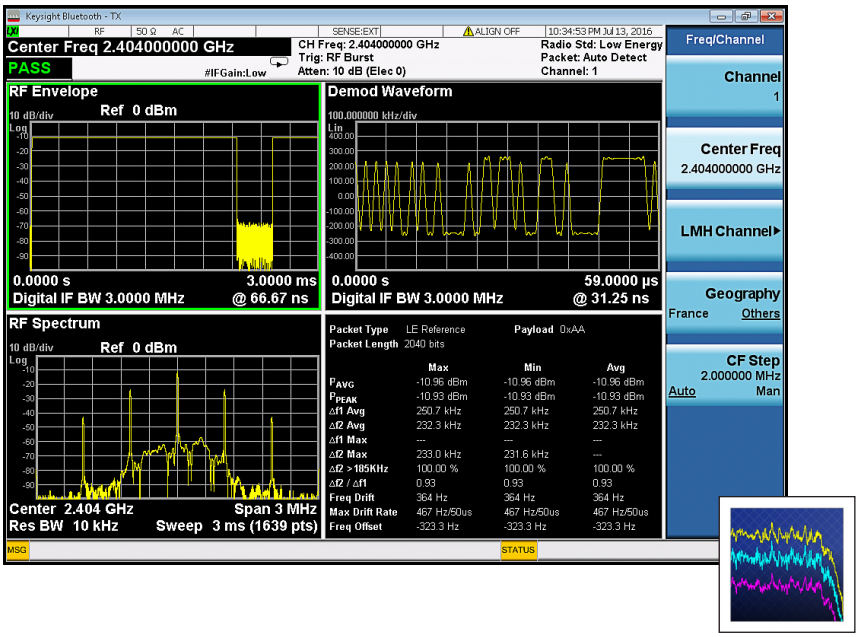
Keysight Technologies
Bluetooth®
X-Series Measurement App, Traditional UI
N9081EM0D

Technical Overview



- Measure *Bluetooth* RF transmitter performance, compliant to *Bluetooth* RF test specifications 2.1+EDR/3.0/3.0+HS and Low Energy (RF-PHY.TS/4.0/4.2/5)
- Perform one-button tests with pass/fail limits per *Bluetooth* RF test specifications
- Use hardkey/softkey manual user interface or SCPI remote user interface
- Leverage built-in context sensitive help
- Flexible licensing provides the option of using perpetual or time based licenses with one or multiple signal analyzers

KEYSIGHT TECHNOLOGIES

Bluetooth Measurement Application

The *Bluetooth* measurement application transforms the X-Series signal analyzers into standard-based *Bluetooth* RF transmitter testers by adding fast, one-button RF conformance measurements to help you design, evaluate, and manufacture your *Bluetooth* devices. The measurement application is standard-compliant to the *Bluetooth* Core Specification to verify your *Bluetooth* design with confidence and support manufacturing with a single application covering basic rate, EDR and low energy technologies for production.

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

All of the *Bluetooth* RF transmitter measurements as defined for basic, EDR and low energy in the test specifications, as well as a wide range of additional measurements and analysis tools, are available with a press of a button (Table 2). These measurements are fully remote controllable via the IEC/IEEE bus or LAN, using SCPI commands.

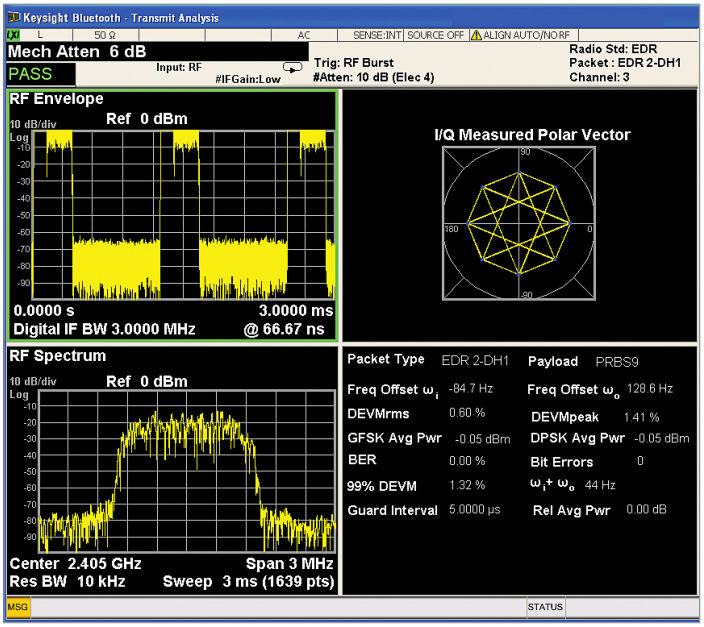


Figure 1. Transmit analysis for EDR signal

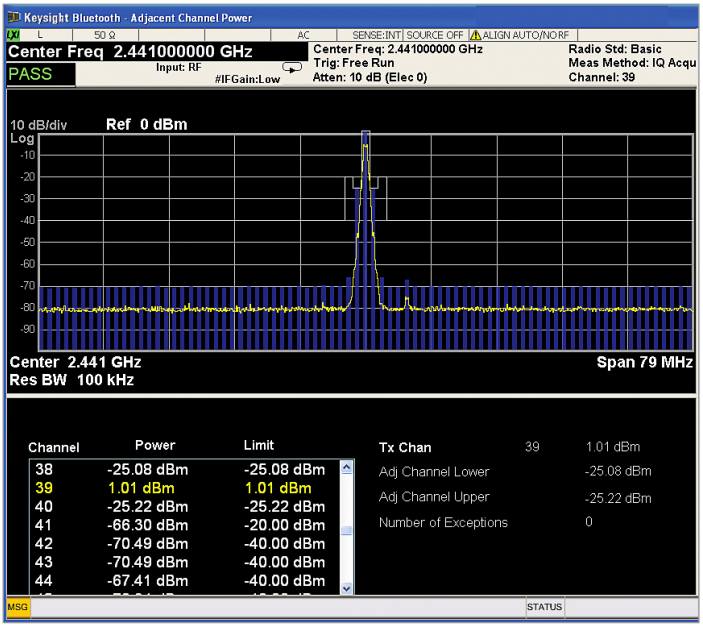


Figure 2. Adjacent channel power for basic rate *Bluetooth* signal

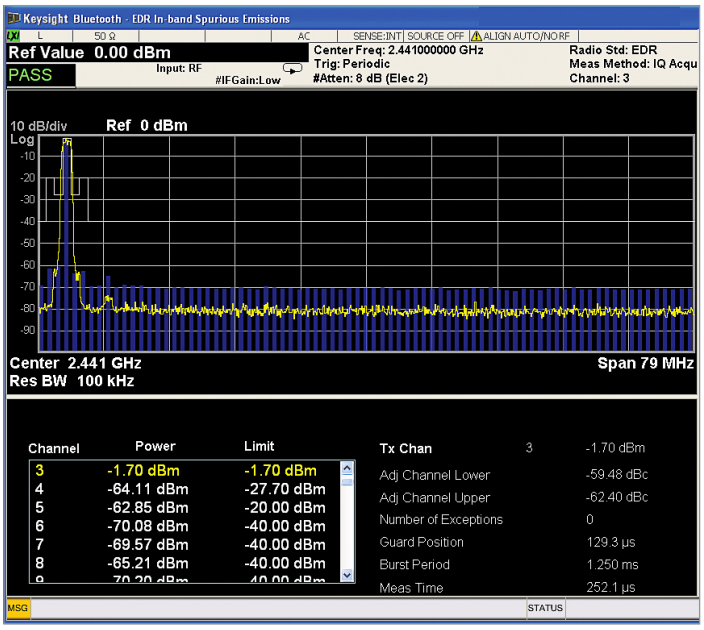


Figure 3. EDR in-band emission

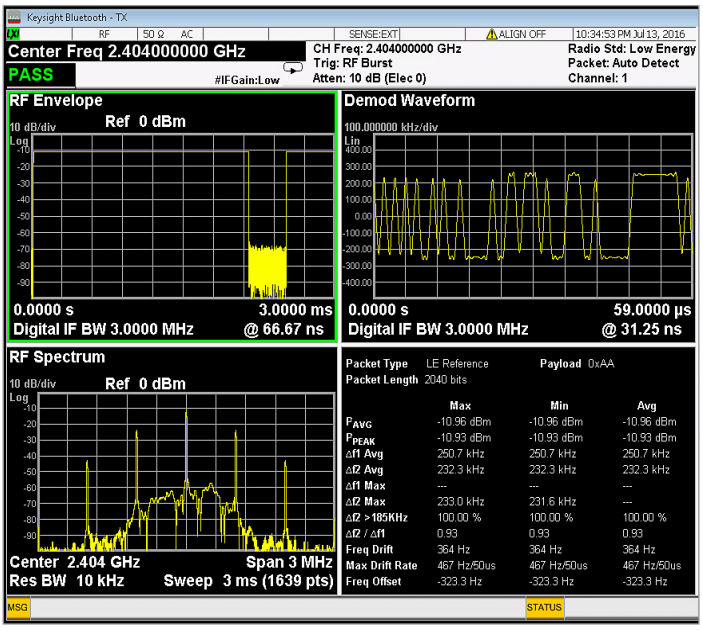


Figure 4. Transmit analysis for low energy (LE) signal

RF Transmitter Tests

With the X-Series signal analyzers and the *Bluetooth* measurement application, you can perform the RF layer test procedure and specification (TSS/TP 4).

Standard-based RF transmitter tests

The *Bluetooth* specifications are developed and licensed by the *Bluetooth* Special Interest Group (SIG). The *Bluetooth* Test Specification document contains the Test Suite Structure (TSS) and Test Purpose (TP) to test the *Bluetooth* RF layer including Basic Rate, Enhanced Data Rate and Low Energy. This specification is a basis for conformance tests of *Bluetooth* devices, giving a high probability of air interface interoperability between different manufacturer's *Bluetooth* devices.

The Keysight X-Series *Bluetooth* measurement application refers to the following *Bluetooth* RF test specifications:

- *Bluetooth* Test Specification 1.2/2.0/2.0+EDR/2.1/2.1+EDR/3.0/3.0+HS
- *Bluetooth* Low Energy RF Test Specifications: RF-PHY.TS/4.0/4.2/5

Table 1 provides a list of tests with their test purpose identifiers and corresponding measurement applications for transmitter tests only.

Table 1. *Bluetooth* RF transmitter measurements and the corresponding measurements in N9081EM0D

***Bluetooth* transmitter tests**	**Identifier[2]**	**N9081EM0D X-Series measurement application**
Basic rate		
Output power	TRM/CA/01/C	Transmit analysis
Tx output spectrum –20 dB bandwidth	TRM/CA/05/C	Output spectrum bandwidth
Tx output spectrum – adjacent channel power	TRM/CA/06/C	Adjacent channel power
Modulation characteristics	TRM/CA/07/C	Transmit analysis
Initial carrier frequency tolerance	TRM/CA/08/C	Transmit analysis
Carrier frequency drift	TRM/CA/09/C	Transmit analysis
Enhanced data rate (EDR)		
EDR relative transmit power	TRM/CA/10/C	Transmit analysis
EDR carrier frequency stability and modulation accuracy	TRM/CA/11/C	Transmit analysis
EDR differential phase encoding	TRM/CA/12/C	Transmit analysis
EDR in-band spurious emissions	TRM/CA/13/C	EDR in-band spurious emissions
Low Energy (LE) or Ultra Low Power (ULP)		
Output power at NOC	TRM-LE/CA/01/C	Transmit analysis
Output power at EOC	TRM-LE/CA/02/C	Transmit analysis
In-band emission at NOC	TRM-LE/CA/03/C	LE in-band emission
In-band emission at EOC	TRM-LE/CA/04/C	LE in-band emission
Modulation characteristics	TRM-LE/CA/05/C	Transmit analysis
Carrier frequency offset and drift at NOC	TRM-LE/CA/06/C	Transmit analysis
Carrier frequency offset and drift at EOC	TRM-LE/CA/07/C	Transmit analysis

1. Radio frequency Test Suite Structure (TSS) and Test Purposes (TP) system specifications
2. Identifier format is: (Test)/CA/NN/C, in which
   TRM = Transmitter test
   CA = Capability test (defines the type of testing)
   NN = Test purpose number
   C = Conformance test performed on dedicated *Bluetooth* test system

Measurement Details

Table 2. One-button measurements provided by the N9081EM0D measurement application

***Bluetooth* Technology**			
Transmit analysis	**Basic data rate**	**Enhanced data rate**	**Low energy**
Output power (in time domain)			
Peak power	•		•
Average power	•		•
Modulation characteristics			
ΔF1 avg (11110000)	•		•
ΔF2 avg (10101010)	•		•
Min Δf1/ Δf2 max,	•		•
Max ΔF1/ ΔF2 max,	•		•
ΔF2 > 115 kHz	•		•
ΔF2/ΔF1 ratio			
Initial carrier frequency tolerance (ICFT)	•		
Frequency offset			•
Carrier frequency drift			
Frequency drift	•		•
Max drift rate	•		•
Adjacent channel power	•		
Output power – 20 dB bandwidth	•		
EDR transmit analysis			
Relative transmit power			
GFSK average power		•	
DPSK average power		•	
Relative power		•	
Frequency stability and modulation accuracy			
Freq offset □i/□0, □i+□0		•	
RMS DEVM (differential DVM)		•	
Peak DEVM		•	
Differential phase decoding			
BER		•	
Bit error		•	
99% DEVM		•	
EDR in-band spurious emissions		•	
LE in-band emissions			•

Key Specifications

Definitions

- Specifications describe the performance of parameters covered by the product warranty.
- 95th percentile values indicate the breadth of the population (≈2□) of performance tolerances expected to be met in 95% of cases with a 95% confidence. These values are not covered by the product warranty.
- Typical values are designated with the abbreviation “typ.” These are performance beyond specification that 80% of the units exhibit with a 95% confidence. These values are not covered by the product warranty.
- Nominal values are designated with the abbreviation “nom.” These values indicate expected performance, or describe product performance that is useful in the application of the product, but is not covered by the product warranty.

Note: Data subject to change

Supported devices and standard version

Device type	***Bluetooth* devices**
Standard version	*Bluetooth* radio frequency system specification 1.2/2.0/2.0+EDR/2.1/2.1+EDR revision 2.1.E.0 – basic rate – enhanced data rate *Bluetooth* Low Energy RF PHY test specification (LE RF-PHY.TS/4.0/4.2/5)
Power classes	Class 1, class 2 and class 3
Radio band	*Bluetooth* basic rate and EDR system: 2.400 to 2.4835 GHz (f = 2402 +k MHz, k = 0, ...,78) *Bluetooth* low energy system: 2.400 to 2.4835 GHz (f = 2402 +kx2 MHz, k = 0, ...,39)

For a complete list of specifications refer to the appropriate specifications guide.
Benchtop
PXA: **www.keysight.com/find/pxa_specifications**
MXA: **www.keysight.com/find/mxa_specifications**
EXA: **www.keysight.com/find/exa_specifications**
CXA: **www.keysight.com/find/cxa_specifications**

PXIe:
VSA up to 6 GHz: **www.keysight.com/find/m9391a**
VSA up to 50 GHz: **www.keysight.com/find/m9393a**
VXT: **www.keysight.com/find/vxt**
CXA-m: **www.keysight.com/find/cxa-m**

Key Specifications

Supported standards	
Bluetooth basic rate	Revision 2.1.E.0
Bluetooth Enhanced Data Rate	Revision 2.1.E.0/3.0/3.0+HS
Bluetooth Low Energy	LE. RF-PHY.TS/4.0/4.2/5

Description	**PXA**	**MXA**	**EXA**	**CXA**
Basic rate or Low energy measurements				
Output power				
Packet type		DH1, DH3, DH5, HV3		
Payload		PRBS9, BS00, BSFF, BS0F, BS55		
Synchronization		RF Burst or Preamble		
Trigger		External, RF Burst, Periodic Timer, Free Run, Video		
Supported measurements		Average power, peak power		
Range		+30 dBm to –70 dBm		
Absolute power accuracy	± 0.20 dB (95%)	± 0.25 dB (95%)	± 0.29 dB (95%)	± 0.61 dB (95%)
Measurement floor		–70 dBm (nom)		
Modulation characteristics				
Packet type		DH1, DH3, DH5, HV3 (for Basic), Reference packet (for LE)		
Payload		BS0F, BS55		
Synchronization		Preamble		
Trigger		External, RF Burst, Periodic Timer, Free Run, Video		
Supported measurements		Min/max Δf1avg, min Δf2max (kHz), total Δf2max > Δf2max lower limit (%), min of min Δf2avg/max Δf1avg, pseudo frequency deviation (Δf1and Δf2)		
RF input level range		+30 dBm to –70 dBm		
Deviation range		± 250 kHz (nom)		
Deviation resolution		100 Hz (nom)		
Measurement accuracy		± 100 Hz + tfa[1] (nom)		
Initial carrier frequency tolerance				
Packet type		DH1, DH3, DH5, HV3 (for Basic), Reference packet (for LE)		
Payload		PRBS9, BS00, BSFF, BS0F, BS55		
Synchronization		Preamble		
Trigger		External, RF Burst, Periodic Timer, Free Run, Video		
RF input level range		+30 dBm to –70 dBm		
Measurement range		Nominal channel freq ± 100 kHz (nom)		
Measurement accuracy		± 100 Hz + tfa[1] (nom)		
Carrier frequency drift				
Packet type		DH1, DH3, DH5, HV3 (for Basic), Reference packet (for LE)		
Payload		PRBS9, BS00, BSFF, BS0F, BS55		
Synchronization		Preamble		
Trigger		External, RF Burst, Periodic Timer, Free Run, Video		
RF input level range		+30 dBm to –70 dBm		
Measurement range		± 100 kHz (nom)		
Measurement accuracy		± 100 Hz + tfa[1] (nom)		
Adjacent channel power[2] (Basic Rate)				
Packet type		DH1, DH3, DH5, HV3		
Payload		PRBS9, BS00, BSFF, BS0F, BS55		
Synchronization		None		
Trigger		External, RF Burst, Periodic Timer, Free Run, Video		
Absolute power accuracy		Dominated by the variance of measurements[4]		
Packet type		Reference packet		
Payload		PRBS9, BS00, BSFF, BS0F, BS55		
Packet length		Up to 255 octets (*Bluetooth* 4.2)		
Trigger		External, RF Burst, Periodic Timer, Free Run, Video		
Absolute power accuracy		Dominated by the variance of measurements[4]		

Key Specifications (continued)

Description	PXA	MXA	EXA	CXA
Enhanced data rate (EDR) measurements				
EDR relative transmit power				
Packet type	2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3, 3-DH5			
Payload	PRBS9, BS00, BSFF, BS0F, BS55			
Synchronization	DPSK synchronization sequence			
Trigger	External, RF Burst, Periodic Timer, Free Run, Video			
Supported measurements	Power in GFSK header, power in PSK payload, relative power between GFSK header and PSK payload			
RF input level range	+30 dBm to –70 dBm			
Absolute power accuracy	± 0.20 dB (95%)	± 0.25 dB (95%)	± 0.29 dB (95%)	± 0.61 dB (95%)
Measurement floor	–70 dBm (nom)			
EDR modulation accuracy				
Packet type	2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3, 3-DH5			
Payload	PRBS9, BS00, BSFF, BS55			
Synchronization	DPSK synchronization sequence			
Trigger	External, RF Burst, Periodic Timer, Free Run, Video			
Supported measurements	rms DEVM, peak DEVM, 99% DEVM			
RF input level range	+30 dBm to –70 dBm			
Range (rms DEVM)	0 to 12%			0 to 12% (nom)
Floor	1.5%			1.6% (nom)
Accuracy	± 1.2%[5]			
EDR carrier frequency stability				
Packet type	2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3, 3-DH5			
Payload	PRBS9, BS00, BSFF, BS55			
Synchronization	DPSK synchronization sequence			
Trigger	External, RF Burst, Periodic Timer, Free Run, Video			
Supported measurements	Worst case initial frequency error(☐i) for all packets (carrier frequency stability), worst case frequency error for all blocks (☐o),(☐o + ☐i) for all blocks			
RF input level range	+30 dBm to –70 dBm			
Carrier frequency stability and frequency error	± 100 Hz + tfa[1] (nom)			
EDR in-band spurious emissions				
Packet type	2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3, 3-DH5			
Payload	PRBS9, BS00, BSFF, BS55			
Synchronization	DPSK synchronization sequence			
Trigger	External, RF Burst, Periodic Timer, Free Run, Video			
Measurement accuracy				
offset freq = 1 MHz to 1.5 MHz	Dominated by the ambiguity of the measurement standards[6]			
offset freq = other offset (2 MHz to 78 MHz)	Dominated by the variance of measurements[4]			

1. tfa = transmitter frequency × frequency reference accuracy.
2. The accuracy is for absolute power measured at 2.0 MHz offset and other offsets (offset = K MHz, K= 3,...,78).
3. The accuracy is for absolute power measured at 2.0 MHz offset and other offsets (offset = 2 MHz * K, K = 2,...,39).
4. The measurement at these offsets is usually the measurement of noise-like signals and therefore has considerable variance. For example, with 100 ms sweeping time, the standard deviation of the measurement is about 0.5 dB. In comparison, the computed uncertainties of the measurement for the case with CW interference is only ± 0.20 dB (PXA), ± 0.25 dB (MXA), ± 0.29 dB (EXA), ± 0.61 dB (CXA) (95th percentile).
5. The accuracy specification applies when the EVM to be measured is well above the measurement floor. Please refer to *Bluetooth* specification guide for N9081A or W9081A for more detail explanation.
6. The measurement standards call for averaging the signal across 3.5 µs apertures and reporting the highest result. For common impulsive power at these offsets, this gives a variation of result with the time location of that interference that is 0.8 dB peak-to-peak and changes with a scallop shape with a 3.5 µs period. Uncertainties in the accuracy of measuring CW-like relative power at these offsets are nominally only ± 0.03 dB (PXA), ± 0.07 dB (MXA), ± 0.09 dB (EXA), ± 0.11 dB (CXA), but observed variations of the measurement algorithm used with impulsive interference are similar to the scalloping error.

Ordering Information

Flexible licensing and configuration

- **Perpetual:** License can be used in perpetuity.
- **Time-based:** 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

You Can Upgrade!

All of our X-Series application options are license-key upgradeable.

UP GRADE

Bluetooth® measurement application (N9081EM0D)

Model	Software License Type	Support Contract	Support Subscription (12-month) [2]
N9081EM0D-1FP	Node-locked perpetual	R-Y5C-001-A[2]	R-Y6C-001-L[2]
N9081EM0D-1FL	Node-locked 12-month	R-Y4C-001-L[1]	Included
N9081EM0D-1TP	Transportable perpetual	R-Y5C-004-D[2]	R-Y6C-004-L[2]
N9081EM0D-1TL	Transportable 12-month	R-Y4C-004-L[1]	Included
N9081EM0D-1NP	Floating perpetual	R-Y5C-002-B[2]	R-Y6C-002-L[2]
N9081EM0D-1NL	Floating 12-month	R-Y4C-002-L[1]	Included
N9081EM0D-1UP	USB portable perpetual	R-Y5C-005-E[2]	R-Y6C-005-L[2]
N9081EM0D-1UL	USB portable 12-month	R-Y4C-005-L[1]	Included

One month software support subscription extensions [3]

Model	Description
R-Y6C-501[3]	1-month of software support subscription for node-locked license
R-Y6C-502[3]	1-month of software support subscription for floating license
R-Y6C-504[3]	1-month of software support subscription for transportable license
R-Y6C-505[3]	1-month of software support subscription for USB portable license

1. All time-based X-Series measurement application licenses includes a 12-month support contract which also includes the 12-month software support subscription as same duration.
2. Support contract must bundle software support subscription for all perpetual licenses in the first year. All software upgrades and Keysight support are provided for software licenses with valid support subscription.
3. After the first year, software support subscription may be extended with annual or monthly software support subscription extension.

Try Before You Buy!

Evaluate a full-featured version of our X-Series measurement application with our ***FREE*** trial. Redeem one 30-day trial license of each measurement application online at: www.keysight.com/find/X-Series_apps_trial

Hardware Configurations

To learn more about compatible platforms and required configurations, please visit: **www.keysight.com/find/X-Series_apps_platform**

Software Models & Options

To learn more about X-Series measurement application licensing, model numbers and options, please visit: **www.keysight.com/find/X-Series_apps_model**

Hardware Configuration

For optimizing the *Bluetooth* measurement application, Keysight recommends a minimum level of instrument hardware functionality at each instrument performance point. Supported instruments include:

Benchtop:

- PXA N9030A
- MXA N9020A
- EXA N9010A
- CXA N9000A

PXIe:

- VSA (6 GHz) M9391A
- VSA (50 GHz) M9393A
- VXT M9420/21A
- CXA-m M9290A

N90x0A X-Series signal analyzer

Capability	Instrument Option	Benefit
Analysis bandwidth	10 or 25 MHz as default or higher	**Required** [1]: Wider analysis bandwidth options such as 25/40/85/160 MHz can be selected depending on the specified signal analyzer model
Precision frequency reference	-PFR	**Recommended**: For enhanced frequency accuracy and repeatability for lower measurement uncertainty
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	**Recommended**: For maximizing the measurement sensitivity
Fine resolution step attenuator	-FSA	**Recommended**: Useful for maximizing useable dynamic range to see signals
Analog baseband I/Q inputs	-BBA on PXA and MXA only	**Optional**: To extend measurements at baseband if required by device under test

M9391/93A PXIe VSA vector signal analyzer

Description	Model-Option	Additional information
Frequency range 3 or 6 GHz	M9391A-F03, or F06	One required for M9391A
Frequency range 8.4, 14, 18, or 27 GHz Frequency extension to 43.5 or 50 GHz	M9393A-F08, F14, F18, or F27 M9393A-FRZ or FRX	One required for M9393A Optional (requires M9393A-F27)
Analysis bandwidth 40, 100 or 160 MHz	M9391A/M9393A-B04, B10 or B16	One required[1]
Memory 128, 512 or 1024 MSa	M9391A/M9393A-M01, M05 or M10	One required
Frequency reference 10 MHz and 100 MHz	M9391A/M9393A-300	One required

M9420/21A PXIe VXT vector transceiver

Description	Model-Option	Additional information
Frequency range 3.8 or 6 GHz	M9420A/M9421A-504, or 506	One required
Analysis bandwidth 40, 80 or 160 MHz	M9420A/M9421A-B40/B80/B1X	One required[1]
Memory 256 or 512 MSa	M9420A/M9421A-M02/M05	One required
Half duplex port	M9420A/M9421A-HDX	Optional
High output power	M9420A/M9421A-1EA	Optional

M9290A CXA-m PXIe signal analyzer

Description	Model-Option	Additional information
Frequency range 3, 7.5, 13.6 or 26.5 GHz	M9290A-F03, F07, F13, or F26	One required
Analysis bandwidth 25 MHz	M9290A-B25	Optional
Preamplifier, 3, 7.5, 13.6 or 26.5 GHz	M9290A-P03, P07, P13 or P26	One required
Fine resolution step attenuator	M9290A-FSA	Optional

1. EDR In-band spur emission with FFT mode requires 80 MHz analysis bandwidth or wider. Not available on CXA, EXA and PXIe CXA-m.)

Related Literature

N9081A & W9081A Bluetooth, Self-Guide Demonstration,
Literature Number 5990-6161EN

Bluetooth Measurement Fundamentals, Application Note,
Literature Number 5988-3760EN

Verifying Bluetooth Baseband Signals using Mixed Signal Oscilloscopes, Application Note AN 1333-3, Literature Number 5988-2181EN

Keysight E4438C Signal Studio for Bluetooth, Application Note 1421,
Literature Number 5988-5417EN

Keysight Innovative Solution for Testing Bluetooth Enhanced Data Rate Products, Product Overview, Literature Number 5989-3055EN

User's and Programmer's Reference Guide is available in the library section of the N9081EM0D product pages.

Web

Bluetooth X-Series measurement app, traditional UI product webpage:
www.keysight.com/find/N9081D

X-Series measurement applications:
www.keysight.com/find/X-Series_Apps

X-Series signal analyzers:
www.keysight.com/find/X-Series

Application pages:
www.keysight.com/find/bluetooth

Industry pages:
www.keysight.com/find/IoT

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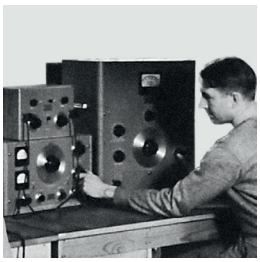
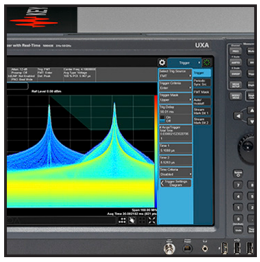
From Hewlett-Packard to Agilent to Keysight.





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Register your products to get up-to-date product information and find warranty information.

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Keysight Services

www.keysight.com/find/service
Keysight Services can help from acquisition to renewal across your instrument's lifecycle. Our comprehensive service offerings—one-stop calibration, repair, asset management, technology refresh, consulting, training and more—helps you improve product quality and lower costs.

CALIBRATION UP TO 10 YEARS WARRANTY
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www.keysight.com/find/AssurancePlans
Up to ten years of protection and no budgetary surprises to ensure your instruments are operating to specification, so you can rely on accurate measurements.

Keysight Channel Partners

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

www.keysight.com/find/X-Series_apps
www.keysight.com/find/n9081d

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

Americas

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Mexico	001 800 254 2440
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