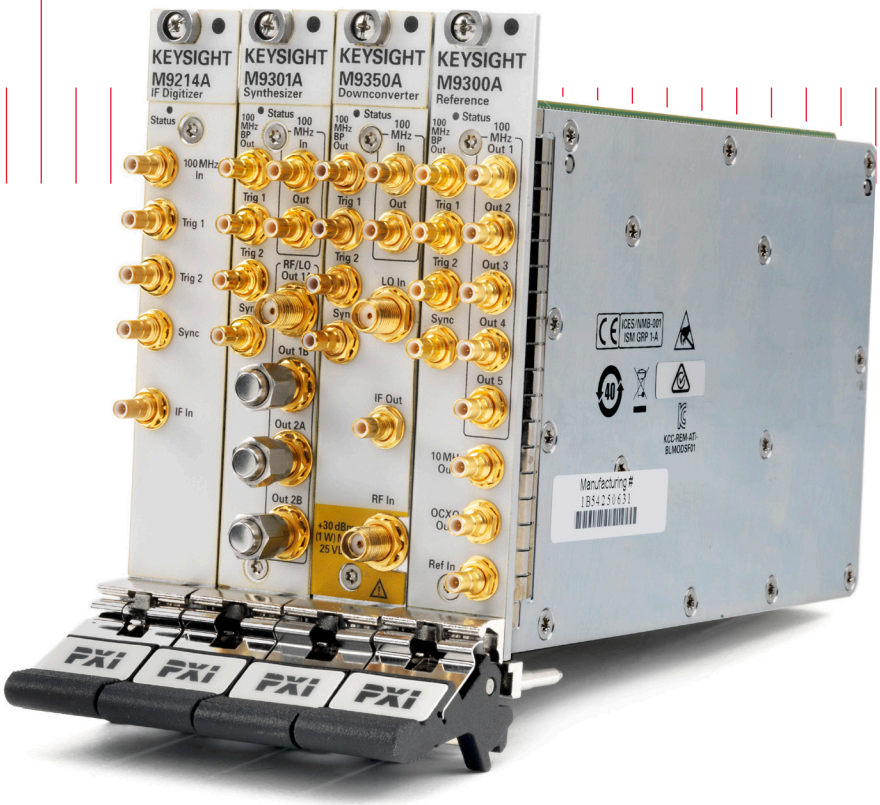
Keysight Technologies

M9391A PXIe Vector Signal Analyzer

1 MHz to 3 or 6 GHz

Specifications Guide



Notices

Manual Part Number

M9391-90015

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Sales and Technical Support

For product specific information and support, and to obtain the latest software and documentation, refer to **www.keysight.com/find/m9391a**.

Worldwide contact information for repair and service can be found at: **www.keysight.com/find/assist.**

Regulatory Compliance

This product has been designed and tested in accordance with accepted industry standards, and has been supplied in a safe condition. To review the Declaration of Conformity, go to: **http://regulations.about.keysight.com**.

Warranty

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Safety Notices

The following safety precautions should be observed before using this product and any associated instrumentation. This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information carefully before using the product.

WARNING

If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protection are intact) only.

The types of product users are:

- Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring operators are adequately trained.
- Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.
- Maintenance personnel perform routine procedures on the product to keep it operating properly (for example, setting the line voltage or replacing consumable materials). Maintenance procedures are described in the user documentation. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

– Service personnel are trained to work on live circuits, perform safe installations, and repair products. Only properly trained service personnel may perform installation and service procedures.

WARNING

Operator is responsible to maintain safe operating conditions. To ensure safe operating conditions, modules should not be operated beyond the full temperature range specified in the Environmental and physical specification. Exceeding safe operating conditions can result in shorter lifespans, improper module performance and user safety issues. When the modules are in use and operation within the specified full temperature range is not maintained, module surface temperatures may exceed safe handling conditions which can cause discomfort or burns if touched. In the event of a module exceeding the full temperature range, always allow the module to cool before touching or removing modules from chassis.

Keysight products are designed for use with electrical signals that are rated Measurement Category I and Measurement Category II, as described in the International Electrotechnical Commission (IEC) Standard IEC 60664. Most measurement, control, and data I/O signals are Measurement Category I and must not be directly connected to mains voltage or to voltage sources with high transient over-voltages. Measurement Category II connections require protection for high transient overvoltages often associated with local AC mains connections. Assume all measurement, control, and data I/O connections are for connection to Category I sources unless otherwise marked or described in the user documentation.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.

Operators of this product must be protected from electric shock at all times.

The responsible body must ensure that operators are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product operators in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000V, no conductive part of the circuit may be exposed.

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance-limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, ensure that the line cord is connected to a properly-grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

When installing equipment where access to the main power cord is restricted, such as rack mounting, a separate main input power disconnect device must be provided in close proximity to the equipment and within easy reach of the operator.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

The instrument and accessories must be used in accordance with its specifications and operating instructions, or the safety of the equipment may be impaired.

Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.
When fuses are used in a product, replace with the same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

CAUTION

A CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits – including the power transformer, test leads, and input jacks – must be purchased from Keysight. Standard fuses with applicable national safety approvals may be used if the rating and type are the same. Other components that are not safety-related may be purchased from other suppliers as long as they are equivalent to the original component (note that selected parts should be purchased only through Keysight to maintain accuracy and functionality of the product). If you are unsure about the applicability of a replacement component, call an Keysight office for information.

WARNING

No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers. For continued protection against fire hazard, replace fuse with same type and rating.

PRODUCT MARKINGS:

The CE mark is a registered trademark of the European Community.

N10149

Australian Communication and Media Authority mark to indicate regulatory compliance as a registered supplier.

ICES/NMB-001
ISM GRP.1 CLASS A

This symbol indicates product compliance with the Canadian Interference-Causing Equipment Standard (ICES-001). It also identifies the product is an Industrial Scientific and Medical Group 1 Class A product (CISPR 11, Clause 4).

KCC-REM-ATi-BLMODSF01

This symbol represents the South Korean Class A EMC Declaration. This equipment is Class A suitable for professional use and is for use in electromagnetic environments outside of the home.

A 급 기기 (업무용 방송통신기자재)
이 기기는 업무용 (A 급) 전자파적합 기기로서 판 매자 또는 사용자는 이 점을 주 의하시기 바라 며 , 가정외의 지역에서 사용하는 것을 목적으 로 합니다.

This symbol indicates separate collection for electrical and electronic equipment, mandated under EU law as of August 13, 2005. All electric and electronic equipment are required to be separated from normal waste for disposal (Reference WEEE Directive, 2002/96/EC).

This symbol indicates the instrument is sensitive to electrostatic discharge (ESD). ESD can damage the highly sensitive components in your instrument. ESD damage is most likely to occur as the module is being installed or when cables are connected or disconnected. Protect the circuits from ESD damage by wearing a grounding strap that provides a high resistance path to ground. Alternatively, ground yourself to discharge any built-up static charge by touching the outer shell of any grounded instrument chassis before touching the port connectors.

This symbol on an instrument means caution risk of danger. You should refer to the operating instructions located in the user documentation in all cases where the symbol is marked on the instrument.

This symbol indicates the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Forty years is the expected useful life of the product.

CLEANING PRECAUTIONS:

WARNING

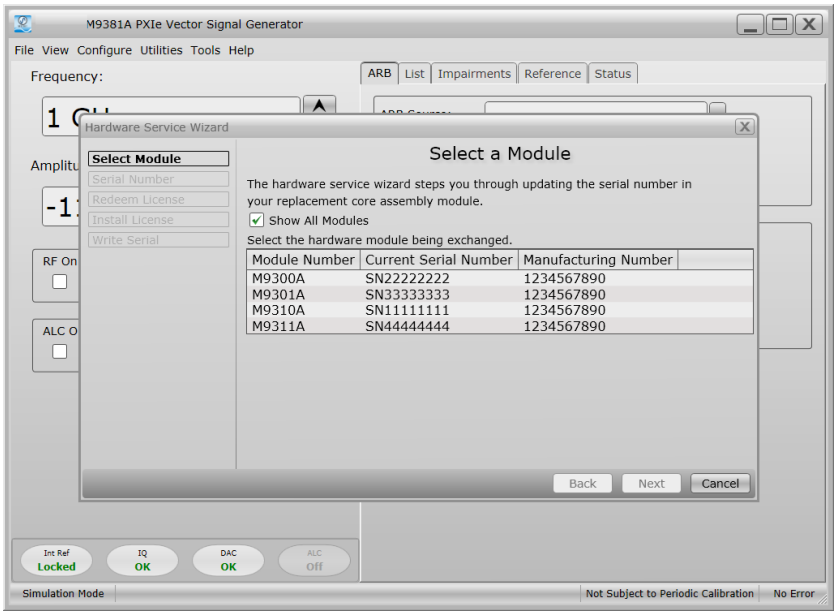
To prevent electrical shock, disconnect the Keysight Technologies instrument from mains before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally. To clean the connectors, use alcohol in a well-ventilated area. Allow all residual alcohol moisture to evaporate, and the fumes to dissipate prior to energizing the instrument.

Table of Contents

How to use this document

This document contains technical specifications for all versions of the M9391A PXIe Vector Signal Analyzer. Specifications published in the datasheet only apply to the current manufacturing version of the equipment. If a specification only applies to a certain manufacturing version of the equipment, it is indicated in this document. Manufacturing numbers can be found on the side of the module, or in the instrument's soft front panel, below.

This screen is accessed by selecting Utilities > Hardware Service Wizard > Show All Modules.



Technical Specifications and Characteristics

Definitions for specifications

Temperatures referred to in this document are defined as follows:

- Full temperature range = Individual module temperature of 25 to 75 °C, as reported by the module, and environment temperature of 0 to 55 °C.
- Controlled temperature range = Individual module temperature of 40 to 51 °C, as reported by the module, and environment temperature of 20 to 30 °C.

Specifications describe the warranted performance of calibrated instruments. Data represented in this document are specifications under the following conditions unless otherwise noted.

- Calibrated instruments have been stored for a minimum of 2 hours within the full temperature range
- 45 minute warm-up time
- Calibration cycle maintained
- When used with Keysight M9300A frequency reference and Keysight interconnect cables

Characteristics describe product performance that is useful in the application of the product, but that is not covered by the product warranty. Characteristics are often referred to as Typical or Nominal values and are italicized.

- ***Typical** describes characteristic performance, which 80% of instruments will meet when operated within the controlled temperature range.*
- ***Nominal** describes representative performance that is useful in the application of the product when operated within the controlled temperature range.*

Recommended best practices in use

- Use slot blockers and EMC filler panels in empty module slots to ensure proper operating temperatures. Keysight chassis and slot blockers optimize module temperature performance and reliability of test.
- Set chassis fan to high at environmental temperatures above 45 °C

Conversion type operating range

Conversion types	Frequency range
Auto	1 MHz to 3 or 6 GHz
Image protect	1 MHz to 3 or 6 GHz
Single high	400 MHz to 3 or 6 GHz
Single low	1.1 GHz to 3 or 6 GHz

Additional information

- Mixer level offset modifies the receiver gain prior to the first mixer of the receiver. A negative setting improves distortion (i.e., TOI) at the cost of noise performance (i.e., DANL). A positive setting improves noise performance at the cost of distortion.
- Performance described in this document applies for module temperature within ± 3 degrees of comprehensive alignment, unless otherwise noted.
- When configured for multi-channel, phase-coherent operation (shared synthesizer configuration), instrument level warranted specifications only apply to the M9391A which was previously calibrated with the M9301A synthesizer, showing a valid calibration indicator. For all other M9391A channels, specifications revert to typical performance.
- All graphs contain measured data from one unit and is representative of product performance within the controlled temperature range unless otherwise noted.
- The specifications contained in this document are subject to change.

Technical Specifications and Characteristics

Frequency

Frequency range and resolution		
Option F03	1 MHz to 3 GHz	
Option F06	1 MHz to 6 GHz	
Tuning resolution	0.001 Hz	
IF frequency		**Nominal**
	15 MHz filter	*326 MHz*
	40 MHz filter	*240 MHz*
	160 MHz filter	*300 MHz*

Analysis bandwidth [1]		
Maximum bandwidth	Option B04	40 MHz
	Option B10	100 MHz
	Option B16	160 MHz

Frequency switching speed [2,3]				
List mode switching speed [4]	**Sample rate**	**Acquisition bandwidth**	**Standard, nominal**	**Option UNZ, nominal**
Baseband frequency offset change [5]	≤ 100 MHz	≤ 80 MHz	*5 ms*	*27 µs*
	> 100 MHz to < 180 MHz	> 80 MHz to < 144 MHz	*5 ms*	*102 µs*
	≥ 180 MHz	≥ 144 MHz	*5 ms*	*15 µs*
Arbitrary frequency change			*5 ms*	*320 µs*
Non-list mode switching speed [6]			**Standard, nominal**	**Option UNZ, nominal**
Baseband frequency offset change [5]			*5 ms*	*310 µs*
Arbitrary frequency change			*5 ms*	*2.3 ms*

1. Instantaneous bandwidth (1 dB bandwidth) available around a center frequency over which the input signal can be digitized for further analysis or processing in the time, frequency or modulation domain.
2. When used with the M9018A PXIe chassis (2-link configuration: 1 x 8 [factory default]) and M9036A PXIe embedded controller.
3. Settled to within 1 kHz or 1 ppm, whichever is greater of final value. Does not include data acquisition or processing time. Amplitude settled to within 0.1 dB. Channel filter set to none. Applies for all conversion types.
4. Time from trigger input to frequency and amplitude settled. Minimum IQ sample rate ≥ 6 MHz. Minimum spectrum acquisition ≥ 4.8 MHz. Minimum power acquisition channel filter bandwidth ≥ 4.8 MHz. For lists with first point < 400 MHz or for frequency changes from > 400 MHz to < 400 MHz, add 40 ms.
5. Baseband offset can be adjusted ± from carrier frequency within limits determined by RF analysis bandwidth and IF filter bandwidth. Synthesizer frequency and amplitude are not changing. Baseband offset settled to within 1 kHz.
6. Mean time from IVI command to carrier frequency settled to within 1 kHz or 1 ppm, whichever is greater. Amplitude settled within 0.1 dB. Simultaneous carrier frequency and amplitude switching. For frequency changes from > 400 MHz to < 400 MHz, add 40 ms.

Technical Specifications and Characteristics

Frequency (continued)

Frequency reference (M9300A PXIe frequency reference module)		
Reference outputs		
100 MHz Out (Out 1 through Out 5)		
Amplitude	≥ 10 dBm	*13 dBm, typical*
Connectors	5 SMB snap-on	
Impedance	*50 Ω, nominal*	
10 MHz Out		
Amplitude	*9.5 dBm, nominal*	
Connectors	1 SMB snap-on	
Impedance	*50 Ω, nominal*	
OCXO Out		
Amplitude	*11.5 dBm, nominal*	
Connectors	1 SMB snap-on	
Impedance	*50 Ω, nominal*	
Frequency accuracy		
Same as accuracy of internal time base or external reference input		
Internal timebase		
Accuracy	± [(time since last adjustment x aging rate) ± temperature effects ± calibration accuracy]	
Frequency stability		
Aging rate		
Daily	< *±0.5 ppb/day, after 72 hours of warm-up*	
Yearly	< *±0.1 ppm/year, after 72 hours of warm-up*	
Total 10 years	< *±0.6 ppm/10yrs, after 72 hours of warm-up*	
Achievable initial calibration accuracy (at time of shipment)	$\pm 5 \times 10^{-8}$	
Temperature effects		
20 to 30 °C	< *±10 ppb*	
Full temperature range	< *±50 ppb*	
Warm up		
5 minutes over +20 to +30 °C, with respect to 1 hour	< *±0.1 ppm*	
15 minutes over +20 to +30 °C, with respect to 1 hour	< *±0.01 ppm*	
External reference input		
Frequency	1 to 110 MHz, sine wave	
Lock range	*±1 ppm, nominal*	
Amplitude	*0 to 10 dBm, nominal*	
Connector	1 SMB snap-on	
Impedance	*50 Ω, nominal*	

Technical Specifications and Characteristics

Amplitude

Input level		
Max safe average total power	+30 dBm (1 W)	
Max DC voltage	25 Vdc	
Max RF input (specified performance)	1 to 2 MHz	0 dBm
	2 to 4 MHz	+4 dBm
	4 to 100 MHz	+12 dBm
	100 MHz to 6 GHz	+30 dBm

Expected input level setting	
Range	
Pre-amp ON	–170 to 0 dBm
Pre-amp OFF	–170 to +30 dBm
Pre-amp AUTO [7]	–170 to +30 dBm
Resolution	0.1 dB

Absolute amplitude accuracy & total absolute amplitude accuracy

		Full temperature range		**Controlled temperature range**		**@ 46 °C module temp[10], typical**
Conversion type	**Frequency**	**Total absolute amplitude accuracy [8]**	**Absolute amplitude accuracy [9]**	**Total absolute amplitude accuracy [8]**	**Absolute amplitude accuracy [9]**	**Total absolute amplitude accuracy [8]**
40 MHz IF filter		**Module temperature within ± 3 °C of alignment, pre-amp ON & OFF**				
Image protect	≤ 3 GHz	±1.78 dB	±1.72 dB	±1.27 dB	±1.21 dB	*±0.46 dB*
	> 3 GHz	±1.54 dB	±1.48 dB	±1.19 dB	±1.13 dB	*±0.46 dB*
Single	All	±1.47 dB	±1.41 dB	±1.22 dB	±1.17 dB	*±0.45 dB*
160 MHz IF filter		**Module temperature within ±3 °C of alignment, pre-amp OFF [11]**				
Image protect	≤ 3 GHz	±1.46 dB	±1.34 dB	±0.96 dB	±0.85 dB	*±0.33 dB*
	> 3 GHz	±1.54 dB	±1.48 dB	±1.16 dB	±1.09 dB	*±0.45 dB*
Single	All	±1.18 dB	±1.08 dB	±0.94 dB	±0.86 dB	*±0.36 dB*
160 MHz IF filter		**Module temperature within ±3 °C of alignment, pre-amp ON [12]**				
Image protect	≤ 3 GHz	±1.68 dB	±1.60 dB	±1.18 dB	±1.10 dB	*±0.39 dB*
	> 3 GHz	±1.55 dB	±1.49 dB	±1.21 dB	±1.15 dB	*±0.45 dB*
Single	≤ 3 GHz	±1.09 dB	±0.96 dB	±0.85 dB	±0.72 dB	*±0.29 dB*
	> 3 GHz	±1.36 dB	±1.28 dB	±1.04 dB	±0.96 dB	*±0.39 dB*

7. At expected input level ≤ –37 dBm, pre-amp is switched on.
8. Total absolute amplitude accuracy is the total of all amplitude measurement errors. This specification includes the sum of the following individual specifications: linearity, expected input level switching uncertainty, IF bandwidth filter switching uncertainty, absolute amplitude accuracy. The wide range of settings used (i.e., expected input level, etc.) are tested independently. The individual error contributions are calculated as follows: a 99.8 % proportion and 95% confidence are computed for each parameter on a statistically significant number of instruments. The root-sum-square (RSS) of these four independent Gaussian parameters is then taken. To that RSS value, two environmental effects and measurement uncertainty are added. One environmental effect is that of temperature (full and controlled temperature range, as defined above) and the other is the temperature variation of ±3 degrees around a field alignment. Applies over the following subset of settings and conditions: expected input level –50 dBm to +30 dBm; input signals within 60 dB below expected input level; 40 MHz and 160 MHz IF filters; input signal at center frequency over full frequency range.
9. The absolute amplitude accuracy is the amplitude measurement error when only changing frequency. The expected input level, conversion type and IF bandwidth settings remain the same and the error introduced by those parameters are not included. Pre-amp auto/OFF expected input level +10 dBm and –12 dBm. Pre-amp ON expected input level –30 dBm.
10. Typical specifications shown at M9350A downconverter reported module temperature of 46 °C and a corresponding environment temperature of 25 °C.
11. When using pre-amp auto mode, applies for signal level within expected input level >–37 dBm.
12. When using pre-amp auto mode, applies for signal level within expected input level ≤–37 dBm.

Technical Specifications and Characteristics

Amplitude (continued)

Amplitude repeatability and linearity		
	Input signal relative to expected input level setting	**Specification**
Repeatability		*<0.05 dB, nominal*
Linearity [13]	>–35 dB	±0.12 dB *±0.03 dB, nominal*
	≤–35 dB	±0.21 dB *±0.04 dB, nominal*

IF flatness [14, 15]		
Analysis bandwidth	**IF filter**	**Nominal**
40 MHz	40 MHz	*± 0.08 dB*
100 MHz	160 MHz	*± 0.09 dB*
160 MHz	160 MHz	*± 0.10 dB*

IF phase linearity [15]		
Analysis bandwidth	**Conversion type**	**Peak to peak, nominal**
40 MHz	All	*1.0 º*
100 MHz	Single	*0.8 º*
	Image protect	*1.7 º*
160 MHz	Single	*1.4 º*
	Image protect	*1.8 º*

13. Input level 20 dB above the noise floor and dither on, no change in hardware settings, below expected input level.
14. Amplitude deviation from the mean error of the entire bandwidth, all conversion types.
15. Expected input level 0 dBm. Center frequency ≥ 250 MHz.

Technical Specifications and Characteristics

Amplitude (continued)

IF bandwidth filter switching uncertainty [16]	Specification	Typical	Nominal
	±0.4 dB	*±0.15 dB*	*±0.09 dB*

Expected input level switching uncertainty	Specification	Typical	Nominal
Pre-amp Auto/OFF			
Max input to +5 dBm	±0.45 dB	*±0.14 dB*	*±0.10 dB*
Crossing +5 dBm	±0.63 dB	*±0.24 dB*	*±0.17 dB*
Pre-amp OFF			
+5 to –50 dBm	±0.41 dB	*±0.16 dB*	*±0.11 dB*
Pre-amp ON			
+0 to –50 dBm	±0.64 dB	*±0.27 dB*	*±0.21 dB*
Pre-amp AUTO			
Crossing –37 dBm	±0.95 dB	*±0.19 dB*	*±0.12 dB*

Amplitude switching speed		
Arbitrary amplitude change	**Standard, nominal**	**Option UNZ, nominal**
List mode switching speed [17]	*≤ 5 ms*	*≤ 136 µs*
Non-list mode switching speed [18]	*≤ 5 ms*	*≤ 1.5 ms*

Input voltage standing wave ratio (VSWR)	Nominal
< 10 MHz	*1.7:1*
10 MHz to 2.5 GHz	*1.4:1*
> 2.5 GHz	*1.7:1*

16. Amplitude error relative to the reference IF bandwidth filter of 40 MHz.
17. Settled to within 0.1 dB of final value. Does not include data acquisition or processing time.
    When used with the M9018A PXIe chassis (2-link configuration: 1 x 8 [factory default]) and the M9036A PXIe embedded controller.
18. Mean time from IVI command to amplitude settled.

Technical Specifications and Characteristics

Dynamic range

Displayed average noise level (DANL) [19]			
Conversion type	**Frequency**	**Specification**	**Nominal**
Pre–amp OFF			
Image protect	< 100 MHz		*–145 dBm/Hz*
	100 to < 700 MHz	–137 dBm/Hz	*–147 dBm/Hz*
	700 MHz to < 5.75 GHz	–140 dBm/Hz	*–148 dBm/Hz*
	5.75 to 6 GHz	–129 dBm/Hz	*–146 dBm/Hz*
Single	<1.2 GHz	–148 dBm/Hz	*–154 dBm/Hz*
	1.2 to 3.1 GHz	–143 dBm/Hz	*–152 dBm/Hz*
	> 3.1 to < 5.4 GHz	–138 dBm/Hz	*–149 dBm/Hz*
	5.4 to 6 GHz	–133 dBm/Hz	*–148 dBm/Hz*
Pre–amp ON			
Image protect	< 100 MHz		*–162 dBm/Hz*
	100 MHz to < 2.7 GHz	–156 dBm/Hz	*–161 dBm/Hz*
	2.7 to 4.4 GHz	–155 dBm/Hz	*–160 dBm/Hz*
	> 4.4 to < 5.6 GHz	–152 dBm/Hz	*–157 dBm/Hz*
	5.6 to 6 GHz	–141 dBm/Hz	*–154 dBm/Hz*
Single	<1.1 GHz	–157 dBm/Hz	*–161 dBm/Hz*
	1.1 to < 3.6 GHz	–154 dBm/Hz	*–158 dBm/Hz*
	3.6 to 5 GHz	–151 dBm/Hz	*–156 dBm/Hz*
	> 5 to 6 GHz	–146 dBm/Hz	*–153 dBm/Hz*

Third order intermodulation distortion (TOI) [20]		**TOI**[23]		**Distortion**[24]
Conversion type: auto	**Frequency**	**Specification**	**Typical**	**Specification**
Pre–amp OFF [21]	≤ 400 MHz	+15 dBm	+20.5 dBm	–52 dBc
	> 400 MHz to 3 GHz	+18 dBm	+23 dBm	–52 dBc
	> 3 GHz	+20 dBm	+23.5 dBm	–52 dBc
Pre–amp ON [22]	≤ 100 MHz	–9.9 dBm	–2.5 dBm	–56 dBc
	> 100 to 850 MHz	–7.9 dBm	+2 dBm	–58 dBc
	> 850 MHz to 2 GHz	–4.3 dBm	+5 dBm	–47 dBc
	> 2 to 3 GHz	–0.9 dBm	+7 dBm	–41 dBc
	> 3 to 6 GHz	+1 dBm	+5 dBm	–32 dBc

19. Expected input level of –50 dBm. Mixer level offset +10 dB.
20. Two tone, 100 kHz tone spacing.
21. Expected input level –5 dBm. Mixer level offset +10 dB.
22. Expected input level –25 dBm. Mixer level offset +15 dB.
23. TOI = third order intercept. The TOI is given by the input tone level (in dBm) minus (distortion/2) where distortion is the relative level of the distortion tones in dBc.
24. Expected input level -10 dBm with preamp off and -30 dBm with preamp on.

Technical Specifications and Characteristics

Dynamic range (continued)

Second harmonic distortion (SHI)			
Conversion type: image protect	**Frequency**	**SHI, nominal[26]**	**Distortion, nominal[27]**
Pre-amp OFF [25]	≤ 1.35 GHz	*+35 dBm*	*– 45 dBc*
	> 1.35 GHz	*+95 dBm*	*–105 dBc*

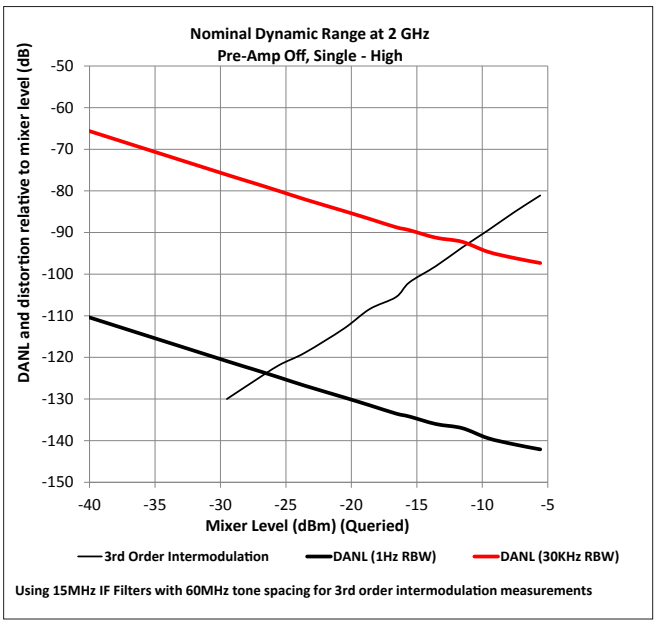


Figure 1. Dynamic range at 2 GHz, pre-amp OFF, single-high conversion type.

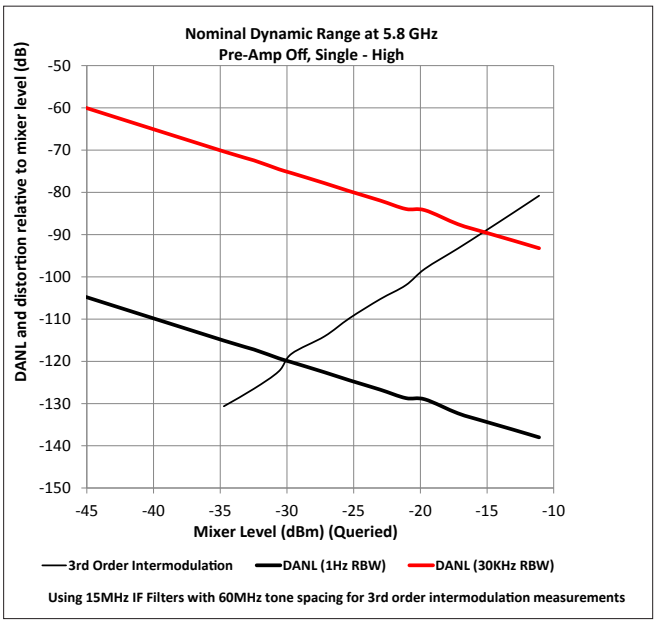


Figure 2. Dynamic range at 5.8 GHz, pre-amp OFF, single-high conversion type.

25. Expected input level -10 dBm. Mixer level offset +10 dB.
26. SHI = second harmonic intercept. The SHI is given by the input power in dBm minus the second harmonic distortion level relative to the input signal in dBc.
27. For 0 dBm input signal.

Technical Specifications and Characteristics

Dynamic range (continued)

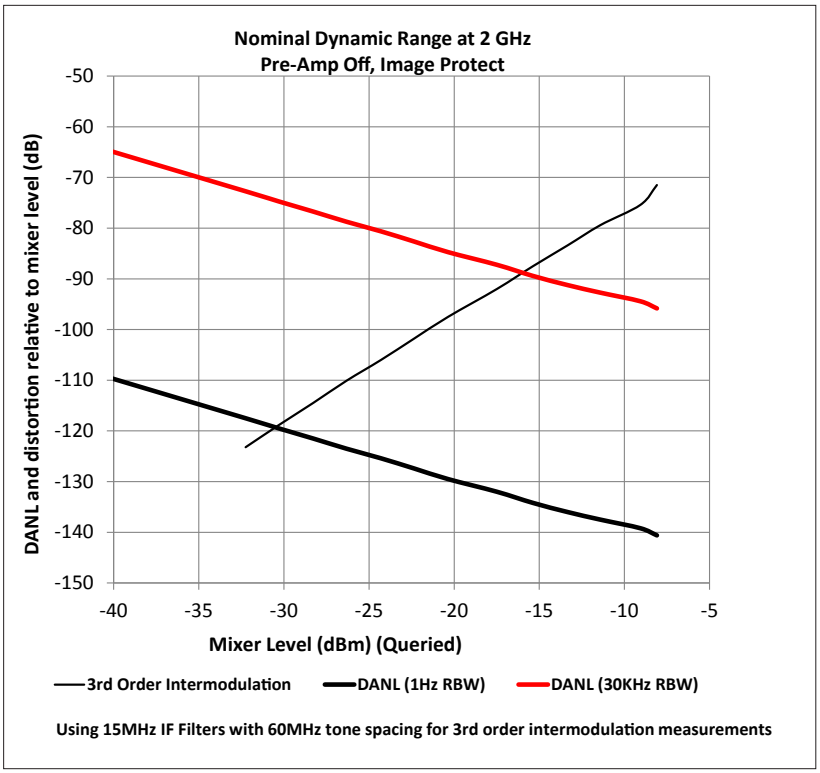


Figure 3. Dynamic range at 2 GHz, pre-amp OFF, image protect conversion type.

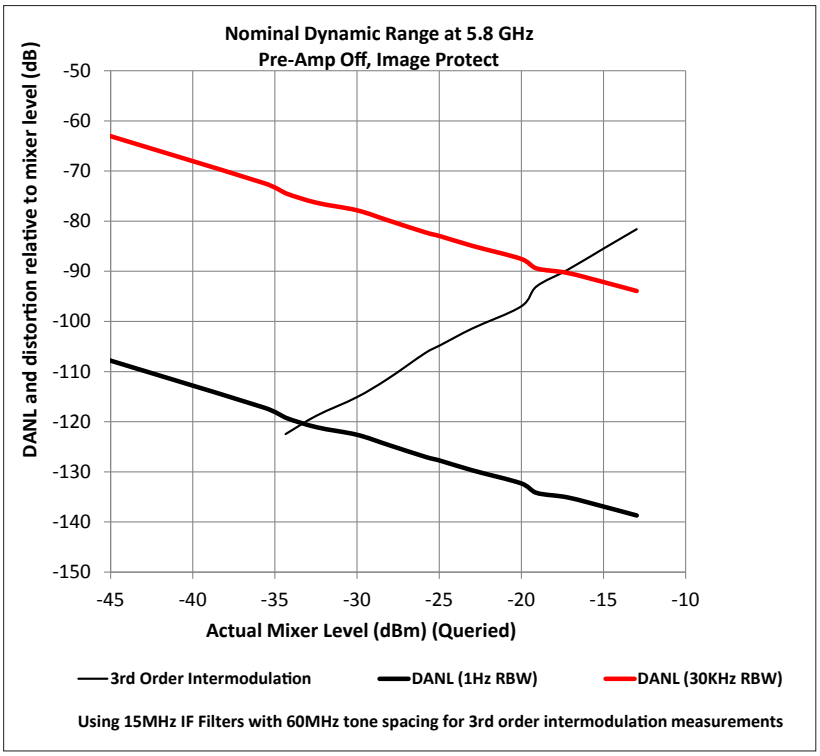


Figure 4. Dynamic range at 5.8 GHz, pre-amp OFF, image protect conversion type.

Technical Specifications and Characteristics

Spectral purity

Phase noise [28]			
Conversion type	**Center frequency**	**Offset**	**Nominal**
Single low	1.1 GHz	10 kHz	*–120 dBc/Hz*
Single high	1 GHz	10 kHz	*–119 dBc/Hz*

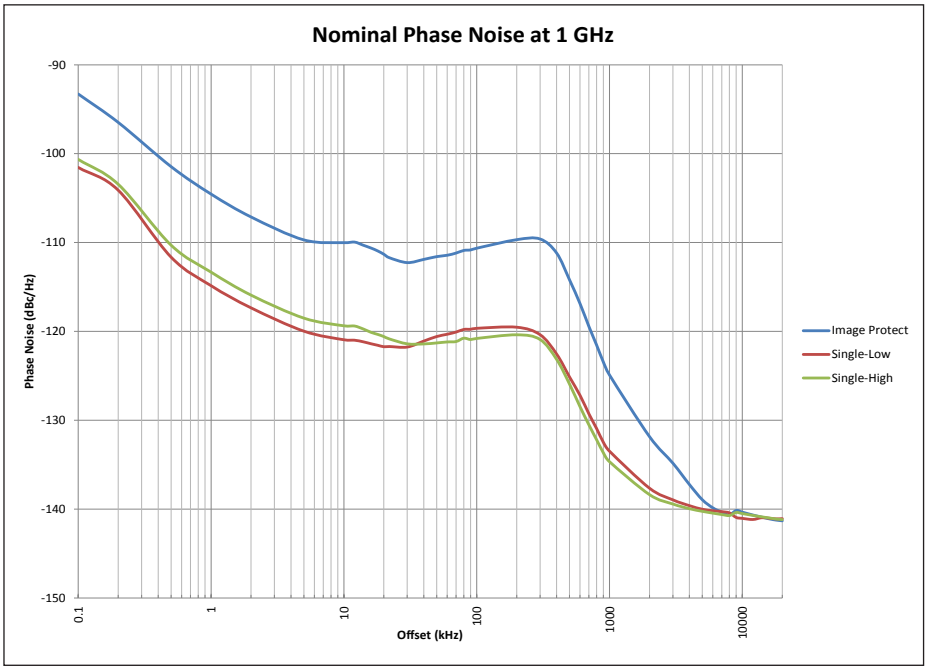


Figure 5. Phase noise at 1 GHz
(1.1 GHz for single-low conversion type).

Figure 6. Phase noise at 5.8 GHz.

28. Mixer level offset +20 dB.

Technical Specifications and Characteristics

Spectral purity (continued)

Residuals, images & spurious responses **Non-input related spurs** [29] **Expected input level** Pre-amp ON	**Conversion type**	**Frequency**	**Nominal**
≤ 0 dBm (measured at –50 dBm)	Single	All	*< –120 dBm*
	Image protect	All [30]	*< –120 dBm*
Pre-amp OFF			
< +5 dBm (measured at –50 dBm)	Single	≤ 3 GHz	*< –120 dBm*
		> 3 GHz	*< –116 dBm*
	Image protect	All [31]	*< –105 dBm*
≥ +5 dBm (measured at +6 dBm)	Single	All	*< –98 dBm*
	Image protect	All [32]	*< –90 dBm*
LO related spurs [33]	**Offsets from carrier**	**Frequency**	**Nominal**
	200 to 10 kHz	All	*– 82 dBc*
	10 kHz to 10 MHz	All	*– 55 dBc*
First order RF spurious responses [34]	**Offsets from carrier**	**Frequency**	**Nominal**
	≥ 10 MHz	≥ 200 MHz to 6 GHz	*–60 dBc*
Higher order RF spurious responses [34]	**Offsets from carrier**	**Frequency**	**Nominal**
	≥ 10 MHz	≥ 200 MHz to 6 GHz	*–60 dBc*
Image responses [35]	**Conversion type**	**Frequency**	**Nominal**
	Image protect	All	*< –68 dBc*
IF rejection [36]	**IF bandwidth filter**	**Frequency**	**Nominal**
	15 MHz	≤ 400 MHz	*< –57 dBc*
		> 400 MHz	*< –105 dBc*
	40 MHz	≤ 450 MHz	*< –57 dBc*
		> 450 MHz	*< –98 dBc*
	160 MHz	All	*< –85 dBc*
LO emission [37]	**Conversion type**	**Frequency**	**Nominal**
	Single	≤ 3 GHz	*–72 dBm*
		> 3 GHz	*–62 dBm*
	Image protect	All	*–88 dBm*

29. Mixer level offset at 10 dB, input terminated, with 50Ω load.
30. From 4.72 to 4.88 GHz, specification at <-108 dBm, nominal.
31. From 4.72 to 4.88 GHz, specification at <-96 dBm, nominal.
32. From 4.72 to 4.88 GHz, specification at <-80 dBm, nominal.
33. Expected input level 0 dBm. Mixer offset level -10 dB.
34. Conversion type: image protect, pre-amp OFF, expected input level -20 dBm and mixer level offset 0 dB.
35. Excitation frequency: [F=2*Final IF] MHz, expected input level -20 dBm, mixer level offset -30 dB.
36. Suppression of signal at IF frequencies when tuned at least 2 x IF BW away. All input paths, image protect, expected input level -30 dBm. Input signal at -30 dBm and mixer level offset 0 dB.
37. Expected input level -50 dBm. Mixer level offset +10 dB.

Technical Specifications and Characteristics

Data acquisition

Maximum capture memory	**Non-list mode**	**List mode**
Option M01	128 MSample (512 MB)	128 MSample (512 MB)
Option M05	512 MSample (2 GB)	512 MSample (2 GB)
Option M10	1 GSample (4 GB) [38]	512 MSample (2 GB) to ~ 1 GSample (3.999 GB) [39]

Segments	
Minimum length	1 sample [40]
Maximum length	Full capture memory [38]
Maximum sample rate	
Option B04 / 40 MHz	50 MS/s complex, 100 MS/s real
Option B10 / 100 MHz	125 MS/s complex, 250 MS/s real
Option B16 / 160 MHz	200 MS/s complex, 400 MS/s real
List mode	
Maximum number of segments	3201
Trigger sources	External, magnitude
Trigger modes	Per acquisition, interval timer trigger
Triggering	
Delay range [41]	–500 ms to +500 ms, nominal
Delay resolution	1 sample, nominal
External trigger signal frequency range	10 to 30 MHz for pulse
External trigger signal level	TTL
External trigger signal duty cycle range	20% to 80%
External trigger signal waveform	Sine, pulse/square, ramp (symmetry 0% to 100%)

Channel-to-channel synchronization [42]		
	Timing	**Phase**
Skew	*≤ 400 ps, nominal*	–
Jitter [43]	*≤ 50 ps, nominal*	*≤0.3 °, nominal*
Repeatability [44]	*≤ 80 ps, nominal*	-
Adjustment resolution [45]	50 ps	0.05 °
Drift per 5 °C	*10 ps, nominal*	*0.5 °, nominal*
Drift over 12 hours	*20 ps, nominal*	*0.5 °, nominal*

38. The default mode for allocation of capture memory is AgM9391MemoryModeNormal, where the digitizer's memory is shared by both the default single acquisition (capture ID = 0) and all the other acquisitions with non-zero capture IDs. In particular, the memory for the default single acquisition is allocated from the area unused by the list acquisitions. If the available memory is not sufficient for the single acquisition, the user must release memory allocated for the non-zero capture ID acquisitions manually, thus increasing free space. Total memory usage is limited according to the memory option. Note that the maximum size of acquisition is 2 GB in this mode. To perform the default single acquisition with memory size larger than 2 GB, AgM9391MemoryModeLargeAcquisition must be selected. The non-zero capture ID acquisitions cannot be performed in this mode. All data acquired with AGM9391MemoryMode Normal will be invalidated.
39. The maximum size for a single list point capture is limited to 512 MSamples (2 GB). However, with option M10, total capture of up to 3.999 GB is available across all list mode captures.
40. 64-bit mode, 2 samples for 32-bit mode.
41. Negative trigger delay limited to capture size.
42. Multi-channel capability only supported with up to 4-channels when configured with a Keysight M9018A PXIe chassis with FPGA version 1.05 or greater. Characteristics measured at 400, 900, 2400, 5800 MHz and apply in auto conversion mode at frequencies ≥ 400 MHz with IF filter = 160 MHz.
43. Jitter indicates measurement-to-measurement variation and applies over short time interval at room temperature without resetting or reinitializing a driver session.
44. Repeatability indicates stability of alignment between channels across power cycles and IVI sessions, with identical cabling and hardware settings (frequency, span, sample rate, etc.)
45. Channel time and phase offsets can be adjusted using OffsetDelay and OffsetPhase properties respectively.

Technical Specifications and Characteristics

Measurement speed[46]

IQ data capture [47]	Nominal	
Large block (50 MSamples)	*1.5 s*	Transferred in 100 kSa or 1 MSa blocks
Small block (100 captures, 100 ksamples each)	*292 ms*	Transferred in 10 kSa blocks
Adjust level, freq (10 ksamples)	*1.7 ms*	Transferred in 10 kSa blocks

Power measurements [48]			
Channel power settings & filter bandwidth	**Acquisition Time**	**Averages**	**Nominal**
3.84 MHz	400 µs	None	*1.8 ms*
		10	*7.6 ms*
	100 µs	None	*1.3 ms*
		10	*4.1 ms*
	50 µs	None	*1.3 ms*
		10	*3.4 ms*
30 kHz	100 µs	None	*3.9 ms*
		10	*30.4 ms*

Format specific measurement data

GSM [49, 50]		
	Parameters	**Nominal**
Global phase error	0.9, 1.8, 1.9, 2.0, 2.1, 2.2 GHz	*0.17 °*
ORFS dynamic range	200 kHz offset	*–36 dBc*
	250 kHz offset	*–41 dBc*
	400 kHz offset	*–69 dBc*
	600 kHz offset	*–73 dBc*
	800 kHz offset	*–77 dBc*
	1200 kHz offset	*–80 dBc*
	1800 kHz offset	*–78 dBc*

EDGE [49, 50]		
	Parameters	**Nominal**
Residual EVM	0.9, 1.8, 1.9, 2.0, 2.1, 2.2 GHz	*0.23% rms*
ORFS dynamic range	200 kHz offset	*–37 dBc*
	250 kHz offset	*–42 dBc*
	400 kHz offset	*–69 dBc*
	600 kHz offset	*–73 dBc*
	800 kHz offset	*–77 dBc*
	1200 kHz offset	*–80 dBc*
	1800 kHz offset	*–77 dBc*

46. EVM, ACPR and servo loop test times for the RF power amplifier test, reference solution are included in the solution brochure 5991-4104EN.
47. Capture block, transfer to host memory, 160 MHz BW, excludes frequency transitions below 400 MHz, with M9037A embedded controller (2-link configuration: 1 x 8 [factory default]).
48. Transfer to host memory, 160 MHz IF bandwidth filter, excludes frequency transitions below 400 MHz, with M9037A embedded controller (2-link configuration: 1 x 8 [factory default]).
49. Synthesizer PLL mode set to PLL mode best wide offset.
50. Expected input level 0 dBm, input signal (total power) 0 dBm, mixer level offset +10 dB, conversion type: Auto, PeakToAverage set per signal peak to average.

Technical Specifications and Characteristics

Format Specific measurement (continued)

W–CDMA [51, 52]	**Parameters**		**Typical**	**Nominal**
Residual EVM	2 GHz, 1 DPCH, 1 carrier			*0.5%*
ACLR dynamic range	2 GHz, 1 DPCH, 1 carrier (power mode)	Adjacent	*–68.1 dBc*	*–69.8 dBc*
		Alternate	*–70.7 dBc*	*–71.7 dBc*

802.11g [51, 52, 56]	**Parameters**	**Nominal**
EVM	2.4 GHz, 20 MHz BW	*–52.8 dB*

802.11a [51, 52, 56]	**Parameters**	**Nominal**
EVM	5.8 GHz, 20 MHz BW	*–48.1 dB*

802.11n [51, 52, 56]	**Parameters**	**Nominal**			
		1-channel	**2-channel** [54]	**3-channel** [54]	**4-channel** [54]
EVM	2.4 GHz, 40 MHz BW	*–52.0 dB*	*–51.6 dB*	*–50.6 dB*	*–50.9 dB*
	5.8 GHz, 40 MHz BW	*–48.6 dB*	*–46.6 dB*	*–45.3 dB*	*–46.0 dB*

802.11ac [51, 52]	**Parameters**	**Nominal**			
		1-channel	**2-channel** [54]	**3-channel** [54]	**4-channel** [54]
				Preamble only	
EVM [55]	5.8 GHz, 80 MHz BW	*–46.5 dB*	*–44.3 dB*	*–43.0 dB*	*–43.6 dB*
	5.8 GHz, 160 MHz BW	*–44.7 dB*	*–43.4 dB*	*–41.7 dB*	*–43.3 dB*
				Preamble, pilots & data	
EVM [55]	5.8 GHz, 80 MHz BW	*–49.4 dB*	*–48.6 dB*	*–47.3 dB*	*–46.4 dB*
	5.8 GHz, 160 MHz BW	*–47.5 dB*	*–47.5 dB*	*–44.7 dB*	*–45.1 dB*
SEM	5.8 GHz, 80 MHz BW	see Figure 10			

802.11a/g [54, 52]	**Parameters**	
SEM	2.4 GHz	see Figure 11
	5.5 GHz	see Figure 12

802.11e [54, 52, 57]	**Parameters**	
OFDMA WiMAX™ EVM	2.5, 3.5, & 5.8 GHz	*–48.3 dB, nominal*

51. Synthesizer PLL mode set to PLL mode best wide offset.
52. Expected input level 0 dBm, input signal (total power) 0 dBm, conversion type: Auto. PeakToAverage set per signal peak to average.
53. Synthesizer PLL mode set to PLL mode normal.
54. 2-channel, 3-channel and 4-channel configurations require M9391A instrument driver version 1.1 or greater, with each channel configured with its own independent synthesizer. Sharing a single synthesizer will degrade EVM performance approximately 1 dB.
55. Mixer level offset = +5 dB
56. Mixer level offset = +10 dB
57. Mixer level offset = +15 dB

Technical Specifications and Characteristics

Format specific measurement (continued)

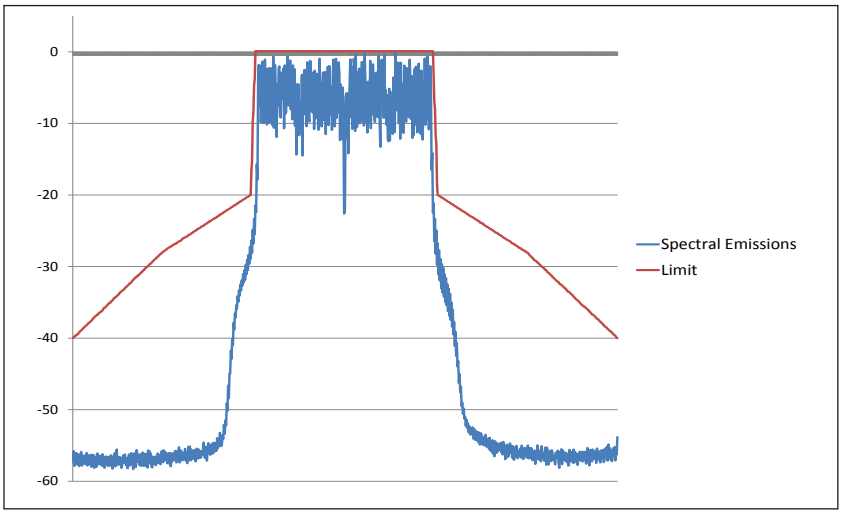


Figure 7. WLAN 802.11ac SEM at 5.8 GHz, 80 MHz bandwidth.

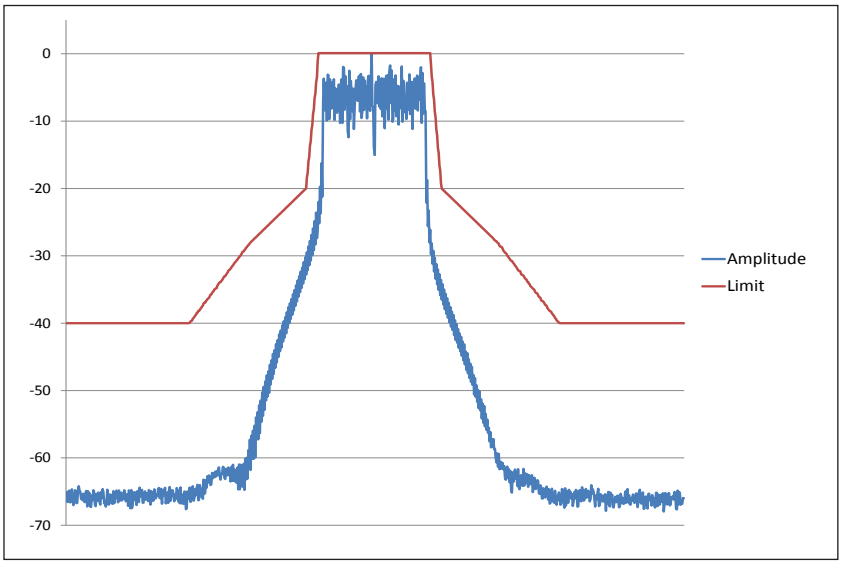


Figure 8. WLAN 802.11a/g SEM at 2.4 GHz, 20 MHz bandwidth.

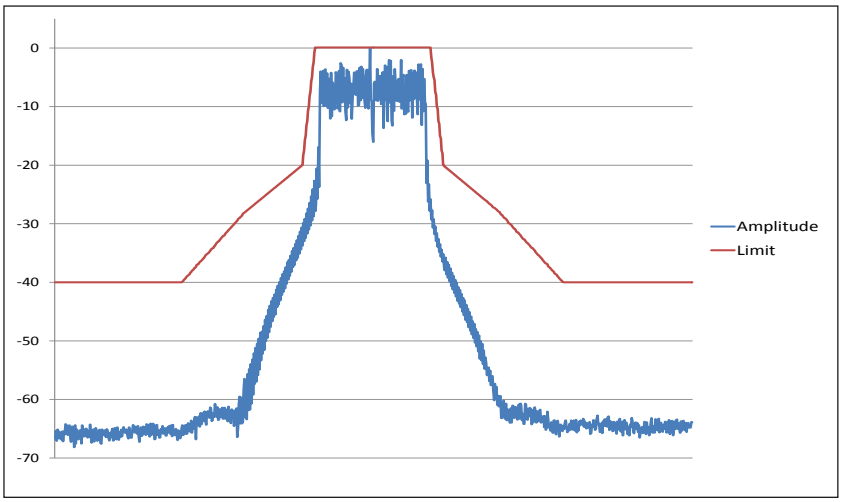


Figure 9. WLAN 802.11a/g SEM at 5.5 GHz, 20 MHz bandwidth.

Technical Specifications and Characteristics

Format specific measurement (continued)

LTE FDD - single channel [58, 59]	**Parameters**		**1-channel, nominal**
10 MHz BW EVM, E–TM 3.1 [61, 62]	0.7, 0.9 GHz		*–52.2 dB (0.25%)*
	1.8, 1.9, 2.0, 2.1, 2.2 GHz		*–51.0 dB (0.28%)*
10 MHz BW ACLR, E–TM 1.1 [63]	0.7, 0.9, 1.8, 1.9, 2.0, 2.1, 2.2 GHz (power mode)	Adjacent	*–64.2 dBc*
		Alternate	*–65.5 dBc*

LTE FDD - MIMO [58, 59, 60]	**Parameters**	**2-channel, nominal**	**4-channel, nominal**
10 MHz BW EVM, R9 downlink, 64 QAM, open loop spacial multiplexing	0.9 GHz	*–49.8 dB (0.32%)*	*–50.1 dB (0.31%)*
	2.0 GHz	*–49.2 dB (0.35%)*	*–49.3 dB (0.34%)*

LTE TDD - MIMO [58, 59, 60]	**Parameters**	**2-channel, nominal**	**4-channel, nominal**
10 MHz BW EVM, R9 downlink, 64 QAM, open loop spacial multiplexing	0.9 GHz	*–50.7 dB (0.29%)*	*–50.3 dB (0.31%)*
	2.0 GHz	*–49.0 dB (0.36%)*	*–49.0 dB (0.36%)*

58. Expected input level 0 dBm, input signal (total power) 0 dBm, conversion type: Auto. PeakToAverage set per signal peak to average.
59. Synthesizer PLL mode set to PLL mode normal.
60. MIMO configurations require M9391A instrument driver version 1.1 or greater, with each channel configured with its own independent synthesizer. Sharing a single synthesizer will degrade EVM performance approximately 1 dB.
61. PDCCH power boost = 1.065 dB
62. Mixer level offset = +10 dB
63. Mixer level offset = +15 dB

Technical Specifications and Characteristics

Environmental and physical specifications				
Temperature	Operating		Individual module temp 25 to 75 °C as reported by the module and environment temp of 0 to 55 °C	
	Non-operating (storage)		Environment temp of –40 to +70 °C	
Humidity[64]			Type tested at 95%, +40 °C (non-condensing)	
Shock/vibration[64]	Operating random vibration Survival random vibration Functional shock Bench handling		Type tested at 5 to 500 Hz, 0.21 g rms Type tested at 5 to 500 Hz, 2.09 g rms Type tested at half-sine, 30 g, 11 ms Type tested per MIL-PRF-28800F	
Altitude			Up to 15,000 feet (4,572 meters)[65]	
Connectors	RF In		SMA female	
EMC			Complies with European EMC Directive 2004/108/EC – IEC/EN 61326-2-1 – CISPR Pub 11 Group 1, class A – AS/NZS CISPR 11 – ICES/NMB-001 This ISM device complies with Canadian ICES-001. Cet appareil ISM est conforme a la norme NMB-001 du Canada.	
Warm-up time			45 minutes	
Size	M9300A M9301A M9350A M9214A		1 PXIe slot 1 PXIe slot 1 PXIe slot 1 PXIe slot	
Dimensions	Module	Length	Width	Height
	M9300A	210 mm	22 mm	130 mm
	M9301A	210 mm	22 mm	130 mm
	M9350A	210 mm	22 mm	130 mm
	M9214A	210 mm	22 mm	130 mm
Weight	M9300A M9301A M9350A M9214A		0.55 kg (1.21 lbs) 0.54 kg (1.19 lbs) 0.56 kg (1.23 lbs) 0.36 kg (0.79 lbs)	
Power drawn from chassis	M9300A M9301A M9350A M9214A		≤ 18 W ≤ 25 W ≤ 30 W ≤ 35 W	

64. Samples of this product have been type tested in accordance with the Keysight Environmental Test Manual and verified to be robust against the environmental stresses of storage, transportation and end-use--those stresses include but are not limited to temperature, humidity, shock, vibration, altitude and power-line conditions. Test methods are aligned with IEC 60068-2 and levels are similar to MIL-PRF-28800F Class 3.
65. At 15,000 feet, the maximum environmental temperature is de-rated to 52 °C.

Technical Specifications and Characteristics

System requirements	
Topic	**Windows 7 requirements**
Operating systems	Windows 7 (32-bit and 64-bit)
Processor speed	1 GHz 32-bit (x86), 1 GHz 64-bit (x64) (no support for Itanium 64)
Available memory	4 GB minimum 8 GB or greater recommended
Available disk space [66]	1.5 GB available hard disk space, includes: 1 GB available for Microsoft .NET Framework 3.5 SP1 [67] 100 MB for Keysight IO Libraries Suite
Video	Support for DirectX 9 graphics with 128 MB graphics memory recommended (Super VGA graphics is supported)
Browser	Microsoft Internet Explorer 7 or greater
M9391A vector signal analyzer instrument drivers	
Keysight IO libraries	Version 16.3 or greater
M9391A instrument driver	Version 1.1 or greater

66. Because of the installation procedure, less disk space may be required for operation than is required for installation.
67. NET Framework Runtime Components are installed by default with Windows Vista and Windows 7. Therefore, you may not need this amount of available disk space.

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