# Keysight Technologies

# M9381A PXIe Vector Signal Generator

## 1 MHz to 3 or 6 GHz

## Specifications Guide


KEYSIGHT TECHNOLOGIES

## Notices



## Manual Part Number

M9381-90015

## Edition

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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/m9381a**

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**.

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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 over-voltages 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 )
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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.

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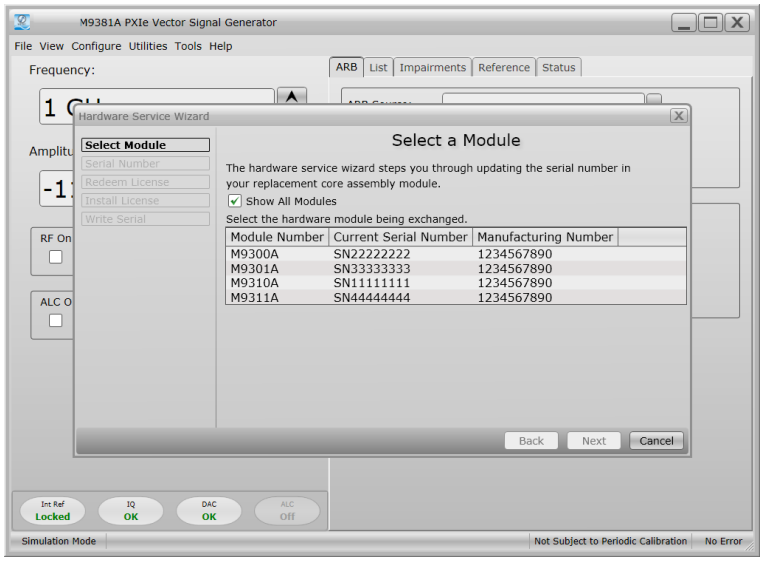
## How to use this document

This document contains technical specifications for all versions of the M9381A PXIe vector signal generator. 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 ≤ 75 °C as reported by the module, and environment temperature of 0 to 55 °C.
- Controlled temperature range = Individual module temperature of ≤ 55 °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.

## Additional information

- Specifications use the normal PLL mode setting, unless otherwise stated. Narrow loop bandwidth refers to specifications using the best wide offset PLL mode setting AGM938X_VAL_SYNTHESIZER_PLL_MODE_BEST_WIDE_OFFSET, available in the M938x Vector Signal Generator/CW Source Instrument Drivers versions 1.2.300 and later.
- Performance described in this document applies for module temperature within ± 5 degrees of IQ alignment, unless otherwise noted.
- When configured for multi-channel, phase coherent operation (shared synthesizer configuration), instrument level warranted specifications only apply to the M9381A which was previously calibrated with the M9301A synthesizer, showing a valid calibration indicator. For all other M9381A channels, specifications revert back to typical performance.
- All graphs contain measured data from one unit and are 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** | |
|---|---|
| Option F03 | 1 MHz to 3 GHz |
| Option F06 | 1 MHz to 6 GHz |
| Resolution | 0.01 Hz |

| **Frequency switching speed** | **Standard, nominal** | **Option UNZ, nominal** | |
|---|---|---|---|
| **List mode switching speed** [1] | | **Normal loop bandwidth** | **Narrow loop bandwidth** |
| Baseband frequency offset change [2] | *≤ 5 ms* | *≤ 10 µs* | *≤ 10 µs* |
| **ALC off** [3] | | | |
| Arbitrary frequency change | *≤ 5 ms* | *≤ 185 µs* | *≤ 240 µs* |
| Frequency change < 100 MHz within a band [4] | *≤ 5 ms* | *≤ 115 µs* | *≤ 120 µs* |
| **ALC on** [3] | | | |
| Arbitrary frequency change | *≤ 5 ms* | *≤ 365 µs* | *≤ 365 µs* |
| Frequency change < 100 MHz within a band [4] | *≤ 5 ms* | *≤ 265 µs* | *≤ 265 µs* |
| **Non-list mode switching speed** [5] | | | |
| Baseband frequency offset change [2] | *≤ 5 ms* | *≤ 250 µs* | *≤ 250 µs* |
| Arbitrary frequency change | *≤ 5 ms* | *≤ 2 ms* | *≤ 2.1 ms* |

| **List mode** | |
|---|---|
| List mode channel parameters | 80 parameters including RF frequency, power, modulation arb and baseband, ALC, power search, triggers |
| Dwell time | 0 to 429 seconds |
| Number of points | 1 to 3201 |
| Triggering | Immediate, external, software, timer |

1. Time from trigger input to frequency and amplitude settled within limits given below with digital modulation on and channel corrections enabled. Specifications are for amplitudes lower than +17 dBm and using an M9036A embedded controller in an M9018A chassis.
2. Baseband offset frequency settled within 100 Hz. Baseband offset can be adjusted ± from carrier frequency within limits determined by RF modulation bandwidth. Synthesizer frequency and amplitude are not changing and ALC off.
3. Carrier frequency settled within 1 ppm or 1 kHz, whichever is greater, and amplitude settled within 0.2 dB (within the controlled temperature range) or within 0.5 dB (at the full temperature range). For frequency changes ≥ 1.6 GHz at carriers ≥ 3.2 GHz nominal frequency settling time within ± 0.05% of final frequency is 125 µs. Simultaneous carrier frequency and amplitude switching.
4. Frequency bands: One (1 to 400 MHz); Two (> 400 to < 750 MHz); Three (≥ 750 to < 1500 MHz); Four (≥ 1500 to < 3000 MHz); Five (≥ 3000 to 6000 MHz).
5. Mean time from IVI command to carrier frequency settled within 1 ppm or 1 kHz whichever is greater and amplitude settled within 0.2 dB. Simultaneous carrier frequency and amplitude switching.

# 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 hour warm-up* | |
| Yearly | < *± 0.1 ppm/year, after 72 hours warm-up* | |
| Total 10 years | < *± 0.6 ppm/10yrs, after 72 hours warm-up* | |
| Achievable initial calibration accuracy (at time of shipment) | ± 5 x $10^{-8}$ | |
| 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

| Output parameters | | |
|---|---|---|
| **Settable range** | **Standard** | **Option 1EA** |
| | +10.7 to –130 dBm | +20 to –130 dBm |
| **Resolution** | | |
| ALC on [6] | *0.02 dB, nominal* | |
| I/Q mode, ALC off [7] | *0.02 dB, nominal* | |
| I/Q mode, ALC off, baseband offset change | *0.001 dB, nominal* | |
| CW mode, ALC off | *0.3 dB, nominal* | |

| Maximum output power - M9310A manufacturing numbers higher than xx5236xxxx | | |
|---|---|---|
| Frequency | Standard | Option 1EA |
| 1 MHz to 5 GHz | +10 dBm | +19 dBm |
| > 5 to 6 GHz | +10 dBm | +18 dBm |
| **Maximum output power - M9310A manufacturing numbers xx5236xxxx and lower** | | |
| Frequency | Standard | Option 1EA |
| 1 MHz to 2.5 GHz | +10 dBm | +19 dBm |
| > 2.5 to 6 GHz | +10 dBm | +18 dBm |

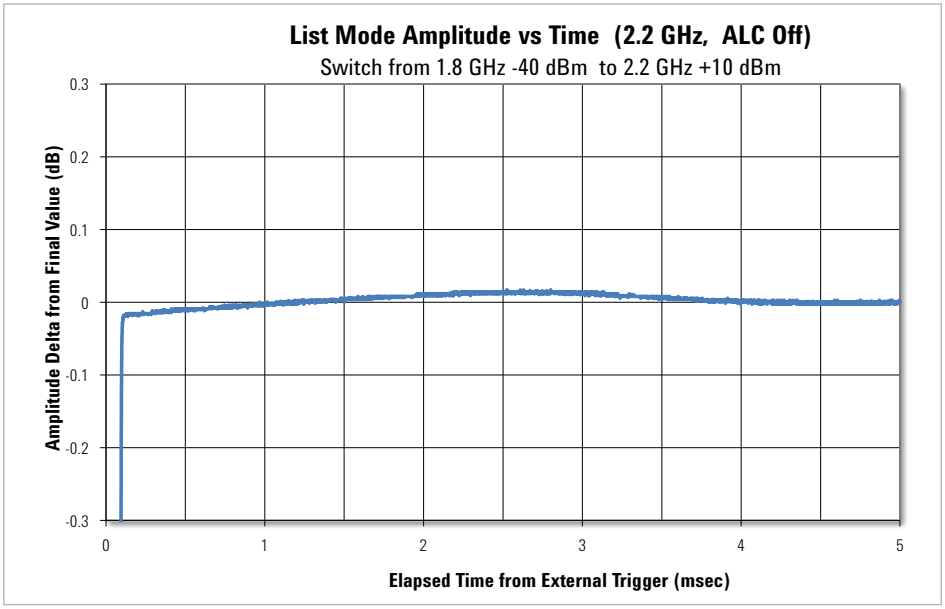



Figure 1. List mode amplitude vs time showing fast settling time to specified level accuracy.

6. Settable to 0.01 dB.
7. After a power search.

# Technical Specifications and Characteristics

## Amplitude (continued)

| Amplitude switching speed | Standard, nominal | Option UNZ, nominal |
|---|---|---|
| **List mode switching speed [8]** | | |
| Baseband power level change [9] | ≤ 5 ms | ≤ 10 µs |
| ALC off | ≤ 5 ms | ≤ 105 µs |
| ALC on | ≤ 5 ms | ≤ 105 µs |
| **Non-list mode switching speed [10]** | | |
| Baseband power level change [9] | ≤ 5 ms | ≤ 250 µs |
| Arbitrary power level change | ≤ 5 ms | ≤ 1.5 ms |

| List mode |
|---|
| See frequency specification section for more detail |

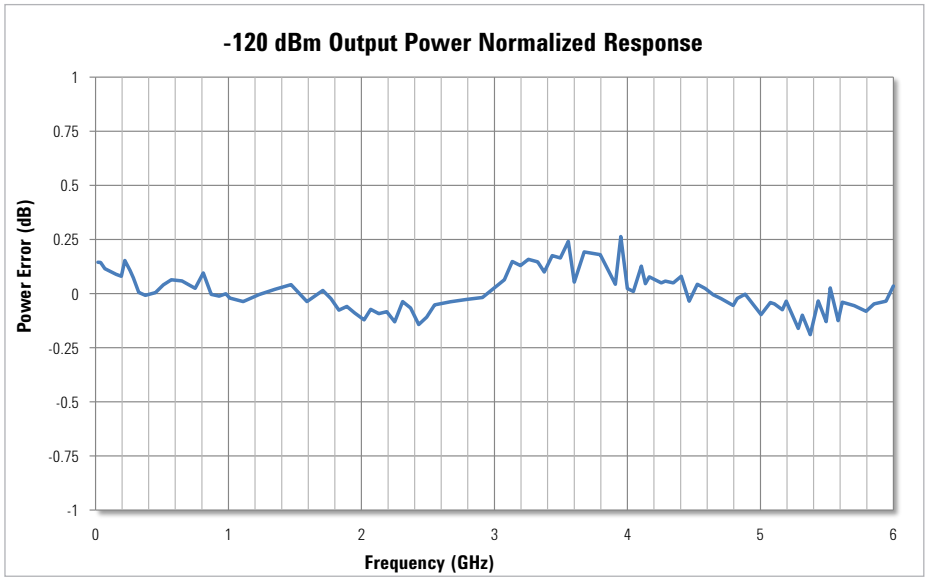



Figure 2. Output power normalized response at –120 dBm.

8. Time from trigger input to amplitude settled within 0.2 dB (within the controlled temperature range) or within 0.5 dB (at the full temperature range). Carrier frequency is not changing. Measurements made with the M9036A embedded controller in an M9018A chassis.
9. Baseband offset amplitude settled within 0.2 dB. Baseband offset can be adjusted from 0 to –20 dB.
10. Mean time from IVI command to amplitude settled within 0.2 dB. Carrier frequency is not changing.

# Technical Specifications and Characteristics

## Amplitude (continued)

| **Absolute level accuracy in CW mode [ALC on] [11] - M9310A manufacturing numbers higher than xx5236xxxx** | | | | |
|---|---|---|---|---|
| **Frequency** | **< Max power to -20 dBm** | **< -20 to -110 dBm** | **< -110 to -120 dBm** | **<-120 to -130 dBm** |
| 1 MHz to 3 GHz | ±0.4 dB<br>*±0.15 dB, typical* | ±0.5 dB<br>*±0.15 dB, typical* | ±0.7 dB<br>*±0.25 dB, typical* | *±0.8 dB, nominal* |
| > 3 to 6 GHz | ±0.5 dB<br>*±0.15 dB, typical* | ±0.6 dB<br>*±0.25 dB, typical* | ±1.0 dB<br>*±0.5 dB, typical* | *±0.8 dB, nominal* |

| **Absolute level accuracy in CW mode [ALC on] [11] - M9310A manufacturing numbers xx5236xxxx and lower** | | | | | |
|---|---|---|---|---|---|
| **Frequency** | **< Max power to -20 dBm** | **< -20 to -90 dBm** | **< -90 to -100 dBm** | **<-100 to -120 dBm** | **<-120 to -130 dBm** |
| 1 to 400 MHz | ±0.5 dB<br>*±0.2 dB, typical* | ±0.55 dB<br>*±0.2 dB, typical* | ±0.62 dB<br>*±0.2 dB, typical* | ±0.85 dB<br>*±0.3 dB, typical* | *±0.8 dB, nominal* |
| > 400 MHz to 3 GHz | ±0.4 dB<br>*±0.2 dB, typical* | ±0.55 dB<br>*±0.2 dB, typical* | ±0.62 dB<br>*±0.2 dB, typical* | ±0.85 dB<br>*±0.25 dB, typical* | *±0.8 dB, nominal* |
| > 3 GHz to 6 GHz | ±0.5 dB<br>*±0.2 dB, typical* | ±0.6 dB<br>*±0.25 dB, typical* | ±0.65 dB<br>*±0.25 dB, typical* | ±1.0 dB<br>*±0.5 dB, typical* | *±0.8 dB, nominal* |

| **Absolute level accuracy (ALC off, relative to ALC on) [12]** | |
|---|---|
| 1 MHz to 5 GHz | *± 0.25 dB, typical* |
| > 5 to 6 GHz | *± 0.62 dB, typical* |
| **Power search [13]** | |
| Time | *< 20 ms, nominal* |
| **Absolute level accuracy in digital I/Q mode (ALC on, relative to CW) [14]** | |
| ≤ 15 dBm | ± 0.7 dB *(± 0.25 dB, nominal)* |
| ≤ 10 dBm | ± 0.2 dB |
| ≤ 0 dBm | ± 0.1 dB |

11. Specifications apply at the controlled temperature range. For temperatures outside this range, absolute level accuracy degrades by ± 0.02 dB/°C.
12. After a power search, with a single sideband signal and with power search blanking on.
13. Power search is an internal alignment routine that improves level accuracy with ALC off.
14. QPSK waveform 4 MSa/s symbol rate. Specifications apply within the controlled temperature range.

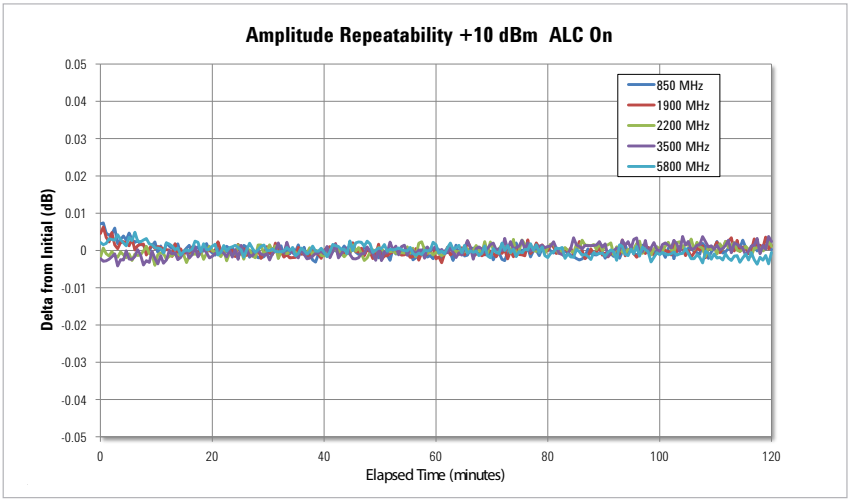



Figure 3. Amplitude repeatability at various carrier frequencies. Repeatability measures the ability of the instrument to return to a given power setting after a random excursion to any other frequency and power setting. It should not be confused with absolute level accuracy.

# Technical Specifications and Characteristics

## Amplitude (continued)

| | |
|---|---|
| **VSWR** | |
| 1 MHz to 6 GHz | *< 1.5:1, nominal* |
| **Maximum reverse power** | |
| 1 MHz to 6 GHz | *1 W, nominal* |
| Max DC voltage | *25 VDC, nominal* |

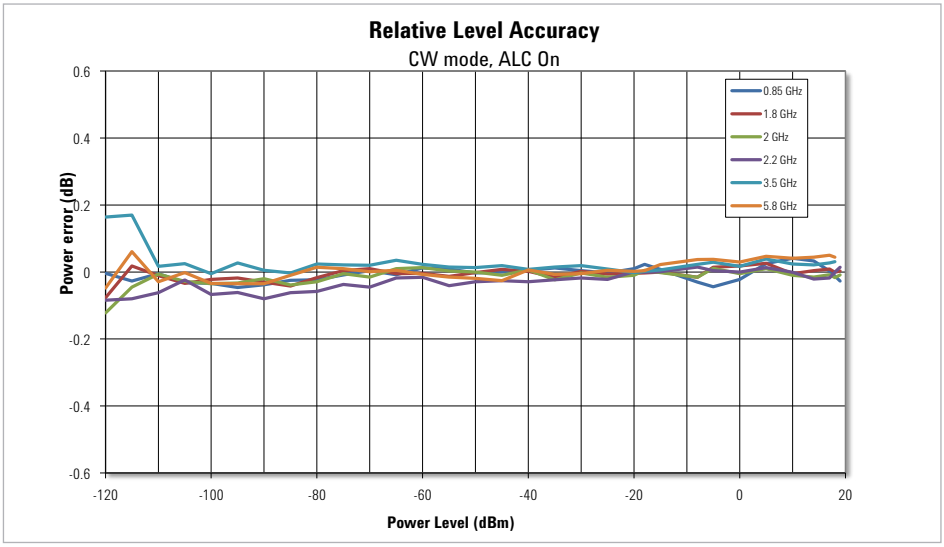



Figure 4. Relative level accuracy at various carrier frequencies.

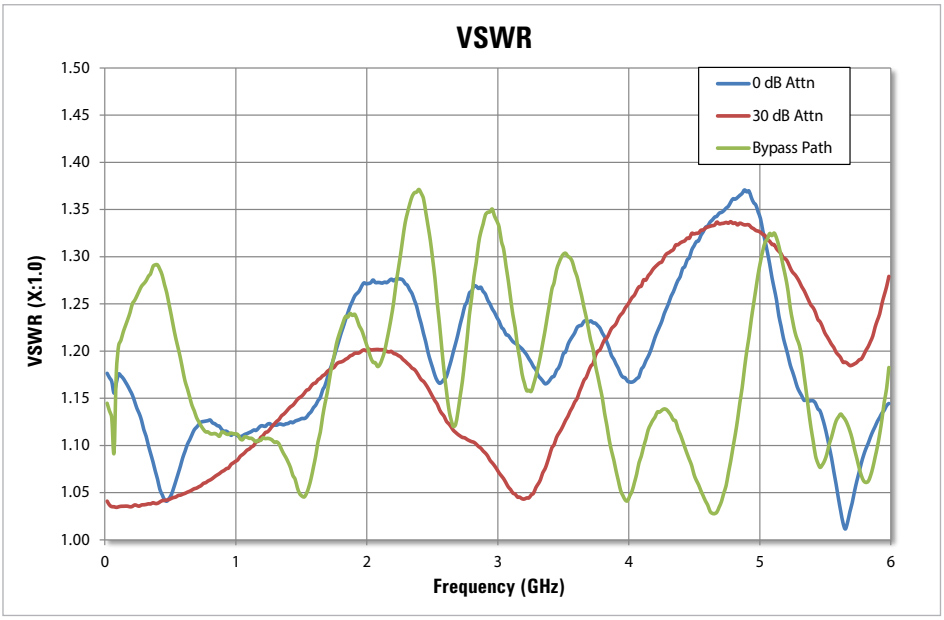



Figure 5. Measured VSWR from 1 MHz to 6 GHz.

# Technical Specifications and Characteristics

## Spectral purity

| Phase noise at 20 kHz offset | Normal loop bandwidth |
|---|---|
| 1 GHz | *–122 dBc/Hz, typical* |
| 2 GHz | *–117 dBc/Hz, typical* |
| 3 GHz | *–112 dBc/Hz, typical* |
| 6 GHz | *–108 dBc/Hz, typical* |

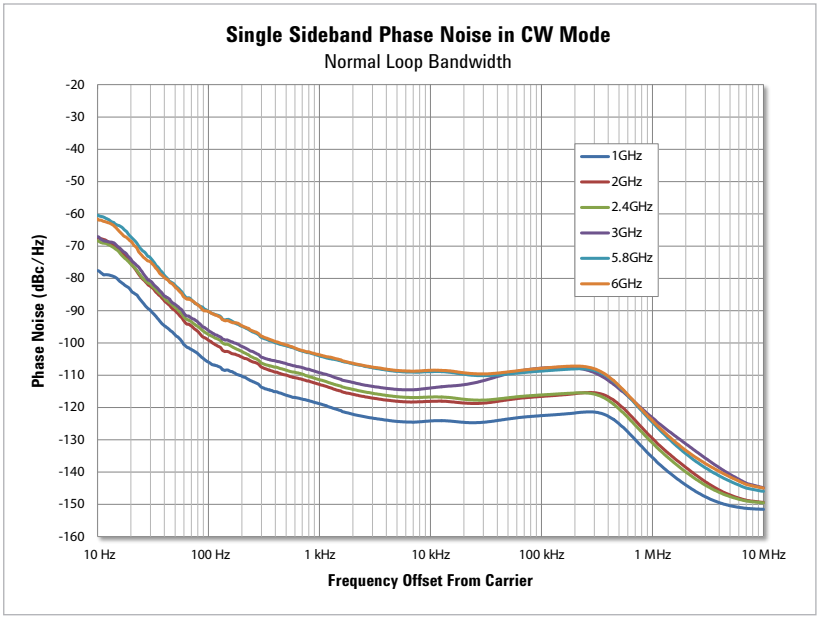



Figure 6. Single sideband phase noise in normal loop bandwidth, CW mode from 10 Hz to 10 MHz, offset at 1, 2, 2.4, 3, 5.8, and 6 GHz.

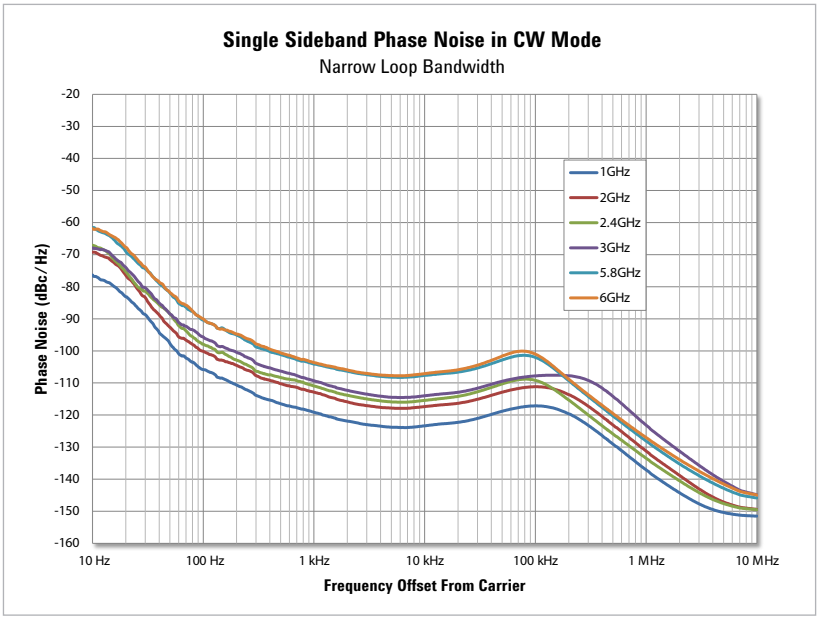



Figure 7. Single sideband phase noise in narrow loop bandwidth, CW mode from 10 Hz to 10 MHz, offset at 1, 2, 2.4, 3, 5.8, and 6 GHz.

# Technical Specifications and Characteristics

## Spectral purity (continued)

| **Broadband noise floor** | |
|---|---|
| **Range** | |
| 1 MHz to 6 GHz | < *–140 dBc/Hz, nominal, at +10 dBm output power level* |

| **Harmonics** | | | | |
|---|---|---|---|---|
| **Range** | **≤ 0 dBm** | | **≤ +10 dBm** | |
| 1 to < 400 MHz | < -43 dBc | *-46 dBc, typical* | < -35 dBc | *-37 dBc, typical* |
| 400 MHz to 1.5 GHz | < -29 dBc | *-31 dBc, typical* | < -27 dBc | *-29 dBc, typical* |
| 1.5 to 3 GHz | < -35 dBc | *-39 dBc, typical* | < -30 dBc | *-33 dBc, typical* |

| **Nonharmonics** [15] | |
|---|---|
| Nonharmonic miscellaneous spurious [16] | < *–70 dBc, nominal* |
| Nonharmonic HET band mixing spurs (0 dBm) | < *–67 dBc, nominal* |
| Nonharmonic Frac–N | < *–66 dBc, nominal* |
| **Subharmonics** | |
| 1 MHz to 6 GHz | none |

15. Non–harmonics include mixing spurs for frequencies below 400 MHz, synthesizer spurs, and other miscellaneous chassis and power supply products, for offsets > 10 kHz.
16. With Keysight M9036A embedded controller.

# Technical Specifications and Characteristics

## Analog modulation

| | |
|---|---|
| **Pulse parameters** | |
| Pulse on/off ratio 1 to 400 MHz | *> 85 dB, typical* |
| Pulse on/off ratio > 400 MHz to 6 GHz | *> 95 dB, typical* |
| Pulse on/off ratio with I/Q modulation | *> 140 dB, nominal* |
| Pulse rise/fall time | *< 10 ns, nominal* |
| **Frequency modulation (Option UNT) [17]** | |
| Maximum deviation | 1.25 MHz |
| Resolution of deviation | 0.1 Hz |
| Maximum rate | 5 MHz |
| **Phase modulation (Option UNT) [17]** | |
| Maximum deviation | 10 radians |
| Resolution of deviation | 0.001 radians |
| Maximum rate | 5 MHz |
| **Amplitude modulation (Option UNT) [17]** | |
| Maximum depth | 100% |
| Resolution of depth | 0.001% |
| Maximum rate | 6.25 MHz |
| **Pulse (Option UNT) [17]** | |
| Rate | 1 Hz to 1 MHz |
| Pulse on time | 200 ns to 2 ms |
| **Multitone (Option UNT) [17]** | |
| Rate (tone separation) | 100 Hz to 1 MHz |
| Number of tones | 2 to 16 |

17. With arbitrary waveforms. Sine, dual–sine, triangle, ramp, and square waveforms supported.

# Technical Specifications and Characteristics

## Vector modulation

| **Residual carrier leakage** | | |
|---|---|---|
| **Frequency** | **Specifications** | **Typical** |
| **M9311A manufacturing serial numbers higher than xx5236xxxx [18]** | | |
| 1 MHz to 5 GHz | < –55 dBc | *< –62 dBc* |
| > 5 to 6 GHz | < –51 dBc | *< –58 dBc* |
| **M9311A manufacturing serial numbers xx5236xxxx and lower [19]** | | |
| 1 to 700 MHz | < –53 dBc | *< –59 dBc* |
| > 700 MHz to 4 GHz | < –55 dBc | *< –62 dBc* |
| > 4 to 6 GHz | < –49 dBc | *< –53 dBc* |
| **I/Q image suppression** | | |
| **Frequency** | **Specifications** | **Typical** |
| **M9311A manufacturing serial numbers higher than xx5236xxxx [18]** | | |
| 1 to 850 MHz | < –43 dBc | *< –54 dBc* |
| > 850 MHz to 5 GHz | < –52 dBc | *< –61 dBc* |
| > 5 to 6 GHz | < –45 dBc | *< –54 dBc* |
| **M9311A manufacturing serial numbers xx5236xxxx and lower [19]** | | |
| 1 to 700 MHz | < –46 dBc | *< –55 dBc* |
| > 700 to 850 MHz | < –46 dBc | *< –57 dBc* |
| > 850 MHz to 4 GHz | < –54 dBc | *< –62 dBc* |
| > 4 to 5 GHz | < –49 dBc | *< –54 dBc* |
| > 5 to 6 GHz | < –48 dBc | *< –54 dBc* |
| **I/Q baseband feed-through [18]** | | |
| **Frequency** | **Specifications** | |
| 1 to 400 MHz | *< –65 dBc, typical* | |
| > 400 MHz to 3 GHz | *< –80 dBc, typical* | |
| > 3 GHz | *< –90 dBc, typical* | |
| **RF modulation bandwidth with internal ARB** | | |
| Option B04 (standard) | 40 MHz | |
| Option B10 | 100 MHz | |
| Option B16 | 160 MHz | |
| **RF I/Q channel flatness** | | |
| **Bandwidth** | **1 MHz to 5.5 GHz** | **> 5.5 to 6 GHz** |
| 40 MHz BW | *< ± 0.1 dB, typical* | *< ± 0.2 dB, typical* |
| 100 MHz BW | *< ± 0.2 dB, typical* | *< ± 0.3 dB, typical* |
| 160 MHz BW | *< ± 0.3 dB, typical* | *< ± 0.5 dB, typical* |

18. Measured with an SSB waveform with an I/Q scale factor of 0.25 for offsets ≤ 50 MHz, after executing IQ alignment. Specifications apply at 625 kHz and 50 MHz offsets.

19. Measured with an SSB waveform with an I/Q scale factor of 0.5 for offsets ≤ 50 MHz. Specifications apply at 625 kHz and 50 MHz offsets.

# Technical Specifications and Characteristics

## Vector modulation (continued)

| **Corrected phase error** | | |
|---|---|---|
| **Bandwidth** | **1 GHz** | **3 GHz** |
| 40 MHz BW | *± 0.25 °C, nominal* | *± 1.25 °C, nominal* |
| 100 MHz BW | *± 0.65 °C, nominal* | *± 2.5 °C, nominal* |
| 160 MHz BW | *± 0.9 °C, nominal* | *± 3.0 °C, nominal* |
| **Arbitrary waveform memory maximum playback capacity** | | |
| Option M01 (standard) | 32 MSa | |
| Option M05 | 512 MSa | |
| Option M10 | 1024 MSa | |

| **Channel-to-channel synchronization** [20] | | |
|---|---|---|
| | **Timing** | **Phase** |
| Skew | *≤ 500 ps, nominal* | -- |
| Jitter [21] | *≤ 45 ps, nominal* | *≤ 1 °, nominal* |
| Repeatability [22] | *≤ 70 ps, nominal* | *≤ 1.5 °, nominal* |
| Adjustment resolution | 50 ps | 0.05 ° |
| Drift per 5 °C | *10 ps, nominal* | *0.5 °, nominal* |
| Drift over 12 hours | *20 ps, nominal* | *0.5 °, nominal* |

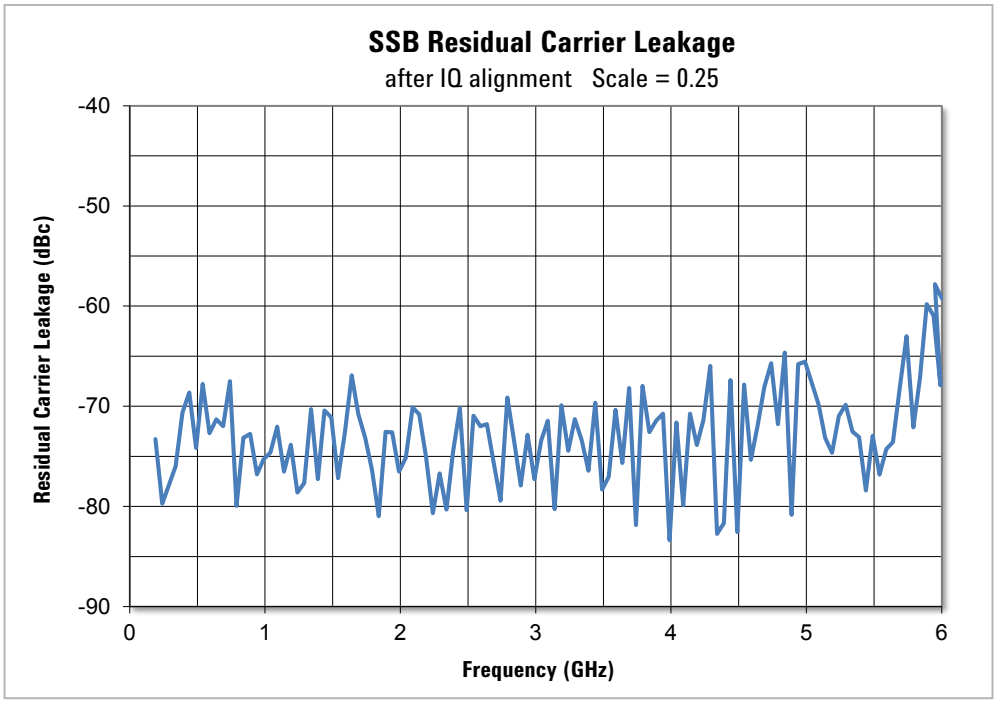



Figure 8. SSB residual carrier leakage.

20. 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.
21. Jitter indicates measurement-to-measurement variation and applies over short time interval at room temperature without resetting or reinitializing a driver session.
22. Repeatability indicates stability of alignment between channels across power cycles and IVI sessions, with identical cabling and hardware settings (frequency, span, sample rate, etc.)

# Technical Specifications and Characteristics

## Vector modulation (continued)

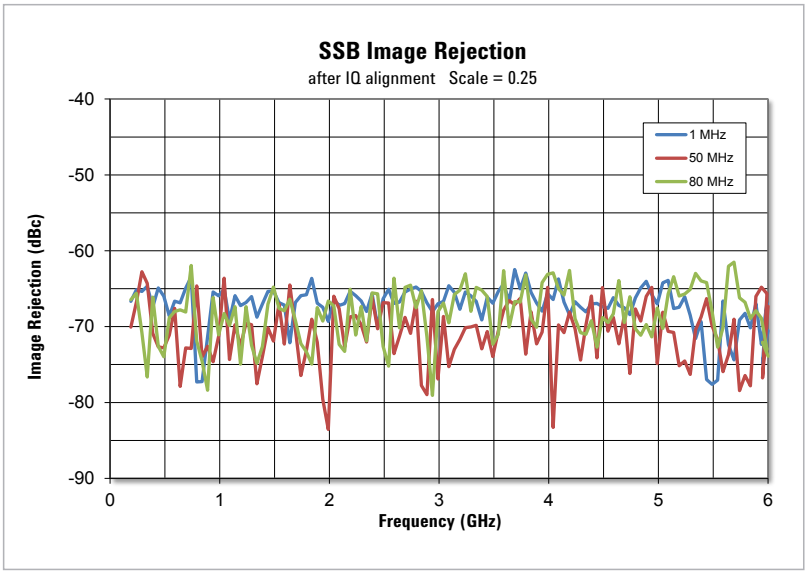



Figure 9. SSB image rejection at 1, 50, and 80 MHz offsets.

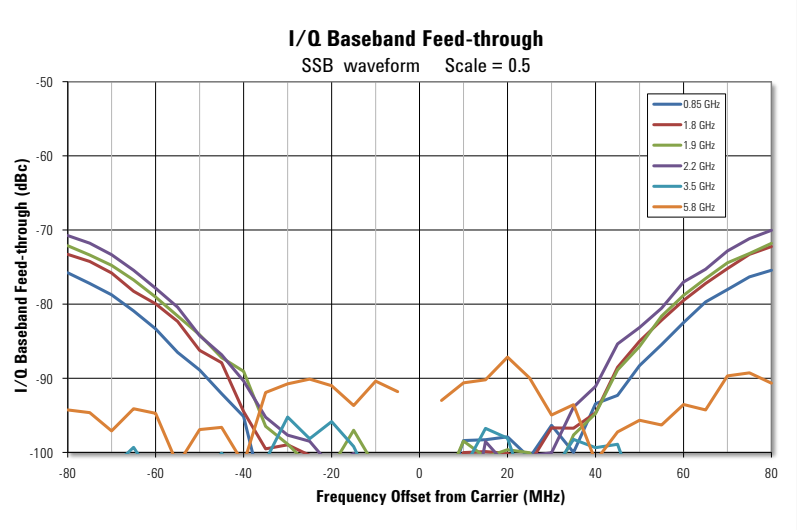



Figure 10. I/Q baseband feed-through at various carrier frequencies.

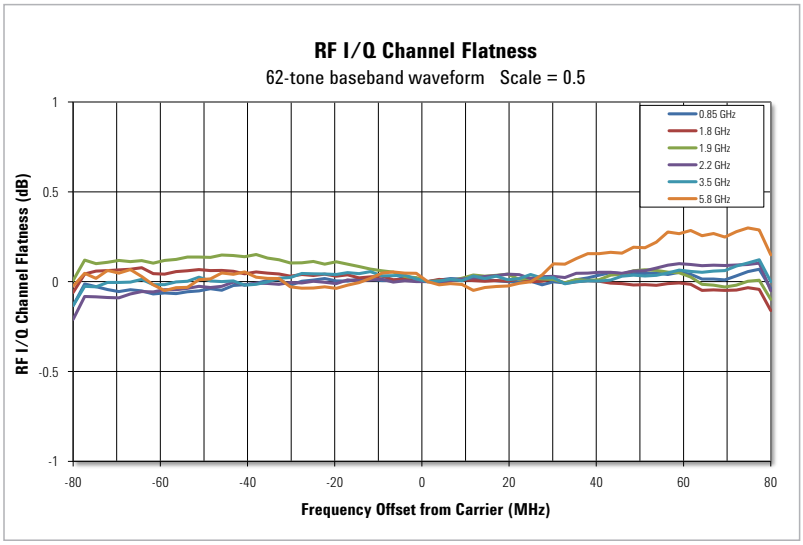



Figure 11. RF I/Q channel flatness at various carrier frequencies.

# Technical Specifications and Characteristics

## Format specific modulation data

| **3GPP W-CDMA performance data [23]** | | | | | | |
|---|---|---|---|---|---|---|
| Modulation type | QPSK | | | | | |
| EVM (2 GHz, 1 DPCH, ≤ 5 dBm) | *0.57% rms, typical* | | | | | |
| **Channel distortion [24]** | **ACLR** | | | | | |
| | **Power level** | | **0 dBm** | | **5 dBm** | |
| **Offset** | **Configuration** | **Frequency** | **Spec (dBc)** | **Typical (dBc)** | **Spec (dBc)** | **Typical (dBc)** |
| **M9311A manufacturing serial numbers higher than xx5236xxxx** | | | | | | |
| Adjacent 5 MHz | 1 DPCH 1 carrier | 900 MHz | –70 | *–72* | *–71* | *–72* |
| Alternate 10 MHz | | | –71 | *–73* | *–72* | *–74* |
| Adjacent 5 MHz | | 1800 to 2200 MHz | –70 | *–72* | *–70* | *–71* |
| Alternate 10 MHz | | | –71 | *–73* | *–72* | *–73* |
| Adjacent 5 MHz | 64 DPCH 1 carrier | 900 MHz | –69 | *–71* | *–69* | *–72* |
| Alternate 10 MHz | | | –71 | *–72* | *–71* | *–73* |
| Adjacent 5 MHz | | 1800 to 2200 MHz | –68 | *–70* | *–68* | *–70* |
| Alternate 10 MHz | | | –70 | *–72* | *–71* | *–73* |
| **M9311A manufacturing serial numbers xx5236xxxx and lower** | | | | | | |
| Adjacent 5 MHz | 1 DPCH 1 carrier | 900 MHz | –70 | *–71* | *–71* | *–72* |
| Adjacent 10 MHz | | | –71 | *–73* | *–72* | *–74* |
| Adjacent 5 MHz | | 1800 to 2200 MHz | –70 | *–71* | *–70* | *–71* |
| Adjacent 10 MHz | | | –71 | *–73* | *–72* | *–73* |
| Adjacent 5 MHz | 64 DPCH 1 carrier | 900 MHz | –69 | *–70* | *–67* | *–69* |
| Adjacent 10 MHz | | | –71 | *–72* | *–71* | *–73* |
| Adjacent 5 MHz | | 1800 to 2200 MHz | –68 | *–70* | *–67* | *–70* |
| Adjacent 10 MHz | | | –70 | *–72* | *–71* | *–73* |

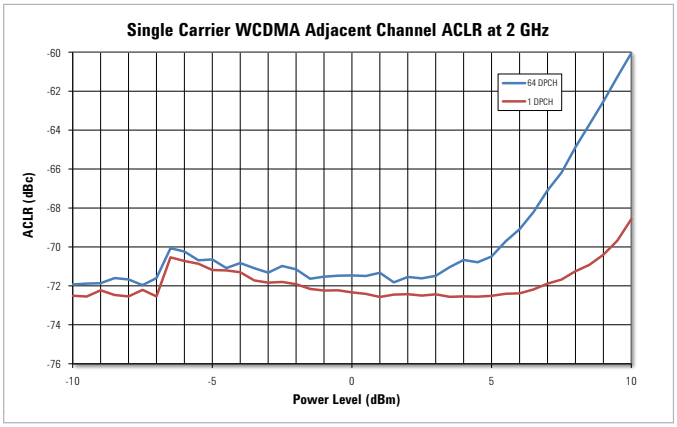



Figure 12. Single carrier W-CDMA adjacent channel ACLR versus power level at 2 GHz.

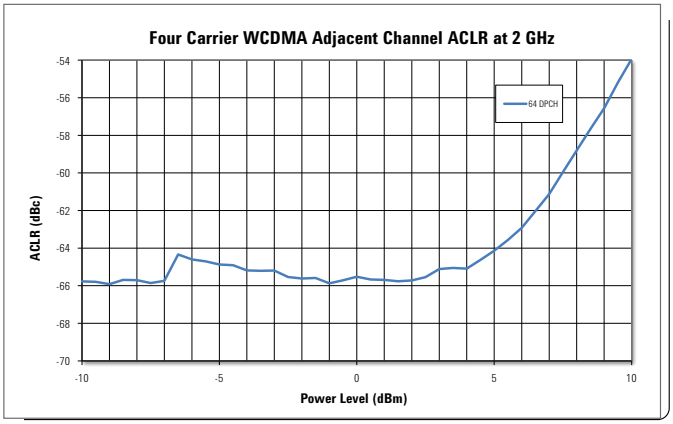



Figure 13. Four carrier W-CDMA adjacent channel ACLR versus power level at 2 GHz.

23. W-CDMA characteristics apply at 900 MHz and between 1.8 to 2.2 GHz, 3.84 Mcps rate.
24. Specifications apply within the controlled temperature range.

# Technical Specifications and Characteristics

## Format specific modulation data (continued)

| **GSM/EDGE performance data** [25] | | |
|---|---|---|
| | **GSM** | **EDGE** |
| Modulation type | GMSK bursted | 3pi/8-8PSK bursted |
| Modulation rate | 270.833 ksps | 70.833 ksps |
| EVM [ALC off] | *±0.15 ° rms global phase error, typical* | *0.3%, typical* |
| EVM [ALC on] | *±0.15 ° rms, global phase error, typical* | *0.6%, typical* |
| **Output RF spectrum (ORFS)** | **GSM, *typical*** | **EDGE, *typical*** |
| **M9311A manufacturing serial numbers higher than xx5236xxxx** | | |
| **Offset** | **Narrow loop bandwidth** [26] | **Narrow loop bandwidth** [26] |
| 200 kHz | *–37 dBc* | *–39 dBc* |
| 400 kHz | *–66 dBc* | *–66 dBc* |
| 600 kHz | *–71 dBc* | *–71 dBc* |
| 800 kHz | *–76 dBc* | *–76 dBc* |
| 1200 kHz | *–81 dBc* | *–81 dBc* |
| 1800 kHz | *–80 dBc* | *–79 dBc* |
| **M9311A manufacturing serial numbers xx5236xxxx and lower** | | |
| **Offset** | **Normal loop bandwidth** | **Normal loop bandwidth** |
| 200 kHz | *–36 dBc* | *–39 dBc* |
| 400 kHz | *–64 dBc* | *–64 dBc* |
| 600 kHz | *–68 dBc* | *–68 dBc* |
| 800 kHz | *–75 dBc* | *–75 dBc* |
| 1200 kHz | *–80 dBc* | *–80 dBc* |
| 1800 kHz | *–80 dBc* | *–79 dBc* |

25. GSM/EDGE characteristics apply 800 to 900 MHz, and 1800 to 1900 MHz, with 1 timeslot channel configuration.
26. Narrow loop bandwidth is not available in M938x vector signal generator/CW source instrument drivers version 1.1.199.3 and earlier.

# Technical Specifications and Characteristics

## Format specific modulation data (continued)

| **WLAN 802.11 performance data – single channel** | **EVM** | | | | | |
|---|---|---|---|---|---|---|
| **M9311A manufacturing serial numbers higher than xx5236xxxx** | | | | | | |
| | **Preamble only – narrow loop bandwidth [27]** | | | | | |
| **Power level** | **–7 dBm** | | **0 dBm** | | **+5 dBm** | |
| | *Typical* | *Nominal* | *Typical* | *Nominal* | *Typical* | *Nominal* |
| 802.11n, 20 MHz, 64 QAM | | | | | | |
| 2.4 GHz | *–52.5 dB* | *–53.2 dB* | *–52.7 dB* | *–53.4 dB* | *–51.3 dB* | *–52.1 dB* |
| 5.8 GHz | *–44.6 dB* | *–45.8 dB* | *–45.2 dB* | *–45.8 dB* | *–41.3 dB* | *–42.8 dB* |
| 802.11n, 40 MHz, 64 QAM | | | | | | |
| 2.4 GHz | *–48.5 dB* | *–49.5 dB* | *–48.6 dB* | *–49.7 dB* | *–47.8 dB* | *–49.2 dB* |
| 5.8 GHz | *–44.1 dB* | *–44.5 dB* | *–44.1 dB* | *–44.7 dB* | *–40.1 dB* | *–41.7 dB* |
| 802.11ac, 80 MHz, 256 QAM | | | | | | |
| 5.8 GHz | *–42.2 dB* | *–45.6 dB* | *–42.8 dB* | *–46.1 dB* | *–40.6 dB* | *–42.8 dB* |
| 802.11ac, 160 MHz, 256 QAM | | | | | | |
| 5.8 GHz | *–42.5 dB* | *–43.7 dB* | *–42.7 dB* | *–44.1 dB* | *–39.8 dB* | *–40.6 dB* |

| | **Preamble, pilots & data - narrow loop bandwidth [27]** | | |
|---|---|---|---|
| **Power level** | **–7 dBm, *nominal*** | **0 dBm, *nominal*** | **+5 dBm, *nominal*** |
| 802.11n, 20 MHz, 64 QAM | | | |
| 2.4 GHz | *–54.4 dB* | *–54.7 dB* | *–54.5 dB* |
| 5.8 GHz | *–46.5 dB* | *–46.9 dB* | *–43.7 dB* |
| 802.11n, 40 MHz, 64 QAM | | | |
| 2.4 GHz | *–52.8 dB* | *–53.3 dB* | *–52.9 dB* |
| 5.8 GHz | *–47.2 dB* | *–47.6 dB* | *–44.0 dB* |
| 802.11ac, 80 MHz, 256 QAM | | | |
| 5.8 GHz | *–48.7 dB* | *–48.9 dB* | *–45.2 dB* |
| 802.11ac, 160 MHz, 256 QAM | | | |
| 5.8 GHz | *–47.2 dB* | *–47.8 dB* | *–43.9 dB* |

| **WLAN 802.11 performance data – single channel** | **EVM, nominal** | | | |
|---|---|---|---|---|
| **Normal loop bandwidth – M9311A manufacturing numbers xx5236xxxx and lower** | | | | |
| | **Preamble only** | | | |
| **Frequency** | **2.4 GHz** | | **5.8 GHz** | |
| **Power level** | **5 dBm** | **15 dBm** | **1 dBm** | **11 dBm** |
| 802.11a/g, 20 MHz, 64 QAM | *–49.6 dB* | *–39.4 dB* | *–44.0 dB* | *–34.2 dB* |
| 802.11n, 40 MHz, 64 QAM | *–47.8 dB* | *–40.4 dB* | *–43.0 dB* | *–33.3 dB* |
| 802.11ac, 80 MHz, 64 QAM | *–46.8 dB* | *–38.0 dB* | *–42.1 dB* | *–31.7 dB* |
| 802.11ac, 80 MHz, 256 QAM | *–46.1 dB* | *–38.6 dB* | *–42.1 dB* | *–32.3 dB* |
| 802.11ac, 160 MHz, 64 QAM | *–46.0 dB* | *–38.2 dB* | *–40.6 dB* | *–32.1 dB* |

27. Narrow loop bandwidth is not available in M938x vector signal generator/CW source instrument drivers version 1.1.199.3 and earlier.

# Technical Specifications and Characteristics

## Format specific modulation data (continued)

| **WLAN 802.11 performance data – multi-channel [28]** | **EVM** | | |
|---|---|---|---|
| | **Preamble only – narrow loop bandwidth, 0 dBm** | | |
| | ***2-channel, nominal*** | ***3-channel, nominal*** | ***4-channel, nominal*** |
| 802.11n, 20 MHz, 64 QAM | | | |
| 2.4 GHz | *–52.4 dB* | *–50.8 dB* | *–50.9 dB* |
| 5.8 GHz | *–45.6 dB* | *–44.3 dB* | *–45.1 dB* |
| 802.11n, 40 MHz, 64 QAM | | | |
| 2.4 GHz | *–49.2 dB* | *–48.3 dB* | *–48.8 dB* |
| 5.8 GHz | *–44.2 dB* | *–42.7 dB* | *–43.3 dB* |
| 802.11ac, 80 MHz, 256 QAM | | | |
| 5.8 GHz | *–43.3 dB* | *–42.0 dB* | *–42.9 dB* |
| 802.11ac, 160 MHz, 256 QAM | | | |
| 5.8 GHz | *–42.1 dB* | *–40.3 dB* | *–41.7 dB* |
| | **Preamble, pilots & data – narrow loop bandwidth, 0 dBm** | | |
| | ***2-channel, nominal*** | ***3-channel, nominal*** | ***4-channel, nominal*** |
| 802.11n, 20 MHz, 64 QAM | | | |
| 2.4 GHz | *–54.2 dB* | *–54.2 dB* | *–52.9 dB* |
| 5.8 GHz | *–46.4 dB* | *–45.6 dB* | *–45.7 dB* |
| 802.11n, 40 MHz, 64 QAM | | | |
| 2.4 GHz | *–52.8 dB* | *–52.7 dB* | *–51.7 dB* |
| 5.8 GHz | *–47.1 dB* | *–46.1 dB* | *–45.3 dB* |
| 802.11ac, 80 MHz, 256 QAM | | | |
| 5.8 GHz | *–46.8 dB* | *–45.4 dB* | *–44.7 dB* |
| 802.11ac, 160 MHz, 256 QAM | | | |
| 5.8 GHz | *–45.4 dB* | *–43.0 dB* | *–43.3 dB* |

| **LTE FDD performance data – single channel [29]** | | |
|---|---|---|
| **EVM** | | |
| 900 MHz | *–52.0 dB (0.25%), nominal* | |
| 2 GHz | *–50.0 dB (0.32%), nominal* | |
| ACPR [23] | Adjacent (< 5 dBm) | Alternate (< 5 dBm) |
| 900 MHz | *–68 dBc, nominal* | *–70 dBc, nominal* |
| 2 GHz | *–67 dBc, nominal* | *–70 dBc, nominal* |
| **LTE FDD & LTE TDD performance data – multi-channel [30]** | | |
| **LTE FDD – EVM** | **2x2 MIMO** | **4x4 MIMO** |
| 900 MHz | *–50.5 dB (0.30%), nominal* | *–51.5 dB (0.27%), nominal* |
| 2 GHz | *–50.0 dB (0.32%), nominal* | *–50.5 dB (0.30%), nominal* |
| **LTE TDD – EVM** | **2x2 MIMO** | **4x4 MIMO** |
| 900 MHz | *–51.0 dB (0.28%), nominal* | *–50.7 dB (0.29%), nominal* |
| 2 GHz | *–49.8 dB (0.32%), nominal* | *–49.7 dB (0.33%), nominal* |

28. Multi-channel performance data applies when each channel is configured with its own independent synthesizer. Sharing a single synthesizer will degrade EVM performance approximately 1 dB.

29. LTE FDD E-TM 1.1 and E-TM 3.1, 10 MHz, 64 QAM PDSCH, full resource block, ≤ +6 dBm.

30. LTE FDD/TDD MIMO R9 downlink, full filled 64 QAM 10 MHz (50 RB), at 0 dBm, open-loop spatial multiplexing transmission mode. MIMO performance data applies when each channel is configured with its own independent synthesizer. Sharing a single synthesizer will degrade EVM performance approximately 1 dB.

# Technical Specifications and Characteristics

| **Environmental and physical specifications** | | | | |
|---|---|---|---|---|
| Temperature | Operating<br>Non-operating (storage) | | 0 to 55 °C<br>–40 to +70 °C | |
| Humidity [31] | | | Type tested at 95%, +40 °C (non-condensing) | |
| Shock/vibration [31] | Operating random vibration<br>Survival random vibration<br>Functional shock<br>Bench handling | | Type tested at 5 to 500 Hz, 0.21 g rms<br>Type tested at 5 to 500 Hz, 2.09 g rms<br>Type tested at half-sine, 30 g, 11 ms<br>Type tested per MIL-PRF-28800F | |
| Altitude | | | Up to 15,000 feet (4,572 meters) | |
| Connectors | RF OUT | | SMA female | |
| EMC | | | Complies with European EMC Directive 2004/108/EC<br>– IEC/EN 61326-2-1<br>– CISPR Pub 11 Group 1, class A<br>– AS/NZS CISPR 11<br>– ICES/NMB-001<br>This ISM device complies with Canadian ICES-001.<br>Cet appareil ISM est conforme a la norme NMB-001 du Canada. | |
| Warm-up time | | | 45 minutes | |
| Size | M9300A<br>M9301A<br>M9310A<br>M9311A | | 1 PXIe slot<br>1 PXIe slot<br>1 PXIe slot<br>2 PXIe slots | |
| Dimensions | Module | Length | Width | Height |
| | M9300A | 210 mm | 22 mm | 130 mm |
| | M9301A | 210 mm | 22 mm | 130 mm |
| | M9310A | 210 mm | 22 mm | 130 mm |
| | M9311A | 210 mm | 42 mm | 130 mm |
| Weight | M9300A<br>M9301A<br>M9310A<br>M9311A | | 0.551 kg (1.215 lbs)<br>0.535 kg (1.179 lbs)<br>0.551 kg (1.215 lbs)<br>0.901 kg (1.986 lbs) | |
| Power drawn from chassis | M9300A<br>M9301A<br>M9310A<br>M9311A | | ≤ 18 W<br>≤ 25 W<br>≤ 28 W<br>≤ 45 W | |

31. 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.

# Technical Specifications and Characteristics

| | |
|---|---|
| **System requirements** | |
| Operating systems | Windows 7 (32-bit and 64-bit) |
| Processor speed | 1 GHz 32-bit (x86), 1 GHz 64-bit (x64)<br>(no support for Itanium 64) |
| Available memory | 4 GB minimum<br>8 GB or greater recommended |
| Available disk space [32] | 1.5 GB available hard disk space, includes:<br>1 GB available for Microsoft .NET framework 3.5 SP1 [33]<br>100 MB for Keysight IO libraries suite |
| Video | Support for DirectX 9 graphics with 128 MB graphics memory recommended<br>(Super VGA graphics is supported) |
| Browser | Microsoft Internet Explorer 7 or greater |
| **M938x vector signal generator/CW source instrument drivers** | |
| Keysight IO libraries | Version 16.3.16603.3 or later |
| Narrow loop bandwidth | Narrow loop bandwidth using the best wide offset PLL mode setting AGM938X_VAL_SYNTHESIZER_PLL_MODE_BEST_WIDE_OFFSET requires instrument drivers version 1.2.300.0 or later |

32. Because of the installation procedure, less disk space may be required for operation than is required for installation.

33. NET framework runtime components are installed by default with Windows 7. Therefore, you may not need this amount of available disk space.

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