Agilent
N8212A Vector Upconverter
Synthetic Instrument Module
250 kHz to 20 GHz

Data Sheet

The Agilent N8212A is a fully synthesized 20 GHz vector up-converter module that converts a baseband signal to a microwave signal.
The N8212A is fully LXI class A compliant.

Definitions and Conditions

Table of Contents

All specifications and characteristics apply over a 0 to 55 °C range (unless otherwise stated) and apply after a 45 minute warm-up time. Supplemental characteristics, denoted as typical, nominal, or measured, provide additional (non-warranted) information, which may be useful in the application of the product.

Specifications (spec):
Specifications describe the performance of parameters covered by the product warranty and apply over 0 to 55 °C temperature range unless otherwise noted.

Typical (typ):
Represents characteristic performance which is non-warranted. Describes performance that will be met by a minimum of 80% of all products.

Nominal (nom):
Nominal 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. Represents the value of a parameter that is most likely to occur; the expected mean or average.

Measured (meas.):
Measured values represent the value of a parameter measured on an instrument during the design stage. Measured values are non-warranted.

The N8212A Performance Vector Upconverter will meet its specifications when:

- Stored a minimum of two hours within the operating temperature range and turned on for at least 45 minutes.
- The instrument is within its two-year calibration cycle.

Specifications

Frequency

Range[1]		
Option 520	250 kHz to 20 GHz	
Resolution		
CW	0.001 Hz	
All sweep modes	0.01 Hz[2]	
Switching speed[3, 4]	Switching speed using an external arbitrary waveform generator is dependent upon the bandwidth of the AWG.[5] <16 ms (typ) with I/Q modulation off <24 ms (typ) with I/Q modulation on	
Phase offset	Adjustable in nominal 0.1 degree increments	
Frequency bands	Band / Frequency range / N #	
	1 / 250 kHz to 250 MHz / 1/8	
	2 / > 250 to 500 MHz / 1/16	
	3 / > 500 MHz to 1 GHz / 1/8	
	4 / > 1 to 2 GHz / 1/4	
	5 / > 2 to 3.2 GHz / 1/2	
	6 / > 3.2 to 10 GHz / 1	
	7 / > 10 to 20 GHz / 2	
Accuracy	Calibration ± Aging rate ± temperature effects ± line voltage effects (nom)	
Internal timebase reference oscillator	Standard	Option UNX
Aging rate	< ±1 x 10^{-7}/year or < ±4.5 x 10^{-9}/day after 45 days	< ±3 x10^{-8}/year or < ±2.5 x 10^{-10}/day after 30 days
Temperature effects (typ)	Standard	Option UNX
	< ±5 x 10^{-8} 0 to 55 °C	< ±4.5 x 10^{-9} 0 to 55 °C
Line voltage effects (typ)	Standard	Option UNX
	< ±2 x 10^{-9} for +5% –10% change	< ±2 x 10^{-10} for ±10% change
External reference frequency	1, 2, 2.5, 5, 10 MHz	10 MHz only
Lock range	±0.2 ppm	±1.0 ppm
Reference output		
Frequency	10 MHz	
Amplitude	> +4 dBm into 50 Ω load (typ)	
External reference input		
Amplitude	> –3 dBm	
Option UNX	5 dBm ±5 dB[6]	
Input impedance	50 Ω (nom)	

1 Usable, but unspecified, down to 100 kHz.
2 In ramp sweep mode (Option 007), resolution is limited with narrow spans and slow sweep speeds. Refer to ramp sweep specifications for more information.
3 Time from IEEE1588 trigger to within 0.1 ppm of final frequency above 250 MHz or within 100 Hz below 250 MHz.
4 Add 12 ms (typical) when switching from greater than 3.2 GHz to less than 3.2 GHz.
5 Assuming the carrier frequency is fixed.
6 To optimize phase noise 5 dBm ± 2 dB.

Specifications (continued)

Step (digital) sweep

Operating modes	Step sweep of frequency or amplitude or both (start to stop) List sweep of frequency or amplitude or both (arbitrary list)
Sweep range Frequency sweep Amplitude sweep	 Within instrument frequency range Within attenuator hold range (see "Output" section)
Dwell time	1 ms to 60 s
Number of points	2 to 65535 (step sweep) 2 to 1601 per table (list sweep)
Triggering	Auto, external, or single; over LAN, IEEE 1588 time based trigger, or LXI trigger bus
Settling time Frequency Amplitude	 < 8 ms[1] (typ) < 5 ms (typ)

Ramp (analog) sweep (Option 007)[2, 3]

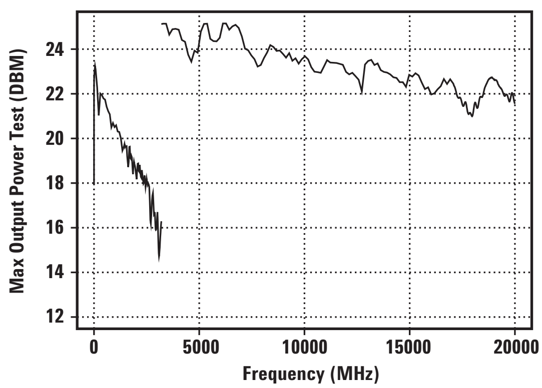
Operating modes	Synthesized frequency sweep (start/stop), (center/span), (swept CW) Power (amplitude) sweep (start/stop) Alternate sweep Alternates successive sweeps between current and stored states		
Sweep span range	Settable from minimum[4] to full range		
Maximum sweep rate	Start frequency	Maximum sweep rate	Max span for 100 ms sweep
	250 kHz to < 0.5 GHz	25 MHz/ms	2.5 GHz
	0.5 to < 1 GHz	50 MHz/ms	5 GHz
	1 to < 2 GHz	100 MHz/ms	10 GHz
	2 to < 3.2 GHz	200 MHz/ms	20 GHz
	≥ 3.2 GHz	400 MHz/ms	20 GHz
Frequency accuracy	±0.05% of span ± timebase (at 100 ms sweep time, for sweep spans less than maximum values given above) Accuracy improves proportionally as sweep time increases[5]		
Sweep time Manual mode Resolution Auto mode	(Forward sweep, not including bandswitch and retrace intervals) Settable 10 ms to 200 seconds 1 ms Set to minimum value determined by maximum sweep rate		
Triggering	Auto, external, or single triggers; using LAN, IEEE 1588 time-based triggering, or the LXI trigger bus		
Markers Display Functions	10 independent continuously variable frequency markers Z-axis intensity or RF amplitude pulse M1 to center, M1/M2 to start/stop, marker delta		

1 19 ms (typ) when stepping from greater than 3.2 GHz to less than 3.2 GHz.
2 During ramp sweep operation, AM, FM, phase modulation, and pulse modulation are usable but not specified; wideband AM and I/Q modulation are not usable.
3 The N8212A does not support operation with swept scalar analyzers, such as the 8757 family.
4 Minimum settable sweep span is proportional to carrier frequency and sweep time. Actual sweep span may be slightly different than desired setting for spans less than [0.00004% of carrier frequency or 140 Hz] x [sweep time in seconds]. Actual span will always be displayed correctly.
5 Typical accuracy for sweep times > 100 ms can be calculated from the equation: [(0.005% of span)/(sweep time in seconds)] ± timebase. Accuracy is not specified for sweep times < 100 ms.

Specifications (continued)

Output

Power[1, 2] (dBm)	Frequency range	
Option 520	250 kHz to 3.2 GHz	–130 to +13 (+16)
	250 kHz to 3.2 GHz with Option UNU	–130 to +9 (+16)
	250 kHz to 3.2 GHz with Options UNW	–130 to +9 (+13)
	> 3.2 to 10 GHz	–130 to +18 (+23)[3]
	> 10 to 20 GHz	–130 to +18 (+22)[3]
Step attenuator[4]	0 to 115 dB in 5 dB steps	
Maximum available power in CW mode (measured)	Option 520 output power (measured)	

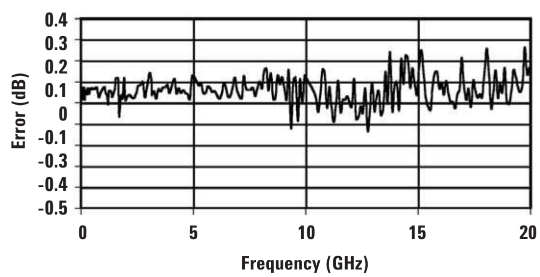


Attenuator hold range minimum	From –15 dBm to maximum specified output power with step attenuator in 0 dB position; can be offset using step attenuator
Amplitude switching speed[5] ALC on or off (without power search)	< 3 ms (typ)

Level accuracy[6] (dB)	Frequency	> +10 dBm	+10 to –10 dBm	–10 to –70 dBm	–70 to –90 dBm
	250 kHz to 2 GHz	±0.6	±0.6	±0.7	±0.8
	> 2 to 20 GHz	±0.8	±0.8	±0.9	±1.0

1 Maximum power specification is warranted from 15 to 35 °C, and is typical from 0 to 15 °C. Maximum power over the 35 to 55 °C range typically degrades less than 2 dB unless otherwise stated.
2 With I/Q modulation on, maximum power specification is typical. With external inputs enabled, $\sqrt{(I^2 + Q^2)} > 0.2\ V_{rms}$.
3 With I/Q modulation on, maximum power specification is typically reduced 3 dB.
4 The step attenuator provides coarse power attenuation to achieve low power levels. Fine power level adjustment is provided by the ALC (Automatic Level Control) within the attenuator hold range.
5 To within 0.1 dB of final amplitude within one attenuator range. Add 10 to 50 ms when using power search.
6 Specifications apply in CW and list/step sweep modes over the 15 to 35 °C temperature range, with attenuator hold off (normal operating mode). Degradation outside this range, for ALC power levels > –5 dBm, is typically < 0.3 dB. In ramp sweep mode (with Option 007), specifications are typical. Specifications do not apply above the maximum specified power.

Output (continued)

CW level accuracy with I/Q modulation	(With PRBS modulated data) (relative to CW)[1]	
With ALC On	QAM or QPSK formats[2]	± 0.2 dB
	Constant-amplitude formats (FSK, GMSK, etc)	± 0.2 dB
With ALC Off[3]	± 0.2 dB (typ)	
Level accuracy (measured)	Option 520 level accuracy at -110 dBm (measured) 	
Resolution	0.01 dB	
Temperature stability	0.01 dB/°C (typ)	
User flatness correction		
Number of points	2 to 1601 points/table	
Number of tables	Up to 10,000 memory limited	
Path loss	Arbitrary, within attenuator range	
Entry modes	Remote power meter[4], remote bus, manual (user edit/view)	
Output impedance	50 Ω (nom)	
SWR (internally leveled)		
250 kHz to 2 GHz	< 1.4:1 (typ)	
> 2 GHz to 20 GHz	< 1.6:1 (typ)	
Leveling modes	Internal leveling, external detector leveling, ALC off	
External detector leveling		
Range	–0.2 mV to –0.5 V (nom) (–36 dBm to +4 dBm using Agilent 33330D/E detector)	
Bandwidth	Selectable 0.1 to 100 kHz (Note: Not intended for pulsed operation)	
Maximum reverse power	1/2 Watt, 0 VDC	

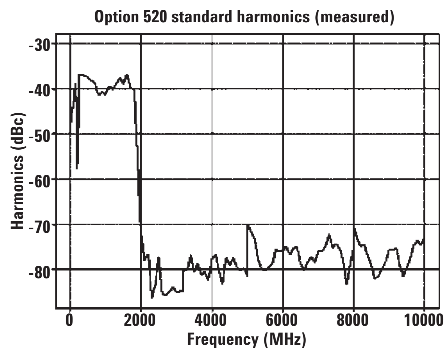
1 If external inputs are used, specification applies with input level $\sqrt{(I^2 + Q^2)} = 0.3\ V_{rms}$ and I/Q modulator attenuation = 10 dB.
2 Measured with symbol rate > 10 kHz and power ≤ 0 dBm.
3 Relative to ALC on, after power search is executed. When applying external I/Q signals with ALC off, output level will vary directly with I/Q input level.
4 Compatible with Agilent N1911A and N1912A peak power meters, and EPM Series (E4418B and E4419B) power meters.

Specifications (continued)

Spectral purity

Harmonics[1]	(at +10 dBm or maximum specified output power, whichever is lower)
< 10 MHz	–28 dBc (typical below 1 MHz)
10 MHz to 2 GHz	–30 dBc[2]
>2 GHz to 20 GHz	–55 dBc

Harmonics (measured)



Sub-harmonics[3]	(at +10 dBm or maximum specified output power, whichever is lower)
250 kHz to 10 GHz	None
> 10 GHz to 20 GHz	< –60 dBc

Non-harmonics[4]

(dBc at +10 dBm or maximum specified output power, whichever is lower, for offsets > 3 KHz [> 300 Hz with Option UNX])

Frequency	Spec	Typical
250 kHz to 250 MHz	–65	–72 for > 10 kHz offsets
> 250 MHz to 1 GHz	–80	–88
> 1 to 2 GHz	–74	–82
> 2 to 3.2 GHz	–68	–76
> 3.2 to 10 GHz	–62	–70
> 10 to 20 GHz	–56	–64

SSB phase noise (CW)[5]

Offset from carrier (dBc/Hz)

Frequency	20 kHz	20 kHz (typ)
250 kHz to 250 MHz[6]	–130	–134
> 250 to 500 MHz[6]	–134	–138
> 500 MHz to 1 GHz[6]	–130	–134
> 1 to 2 GHz[6]	–124	–128
> 2 to 3.2 GHz	–120	–124
> 3.2 to 10 GHz	–110	–113
> 10 to 20 GHz	–104	–108

1 Specifications are typical for harmonics beyond specified frequency range.
2 Typical below 250 MHz if Option 1EH is installed and the filters are off.
3 Sub-harmonics are defined as Carrier Freq / N. Specifications are typical for sub-harmonics beyond specified frequency range.
4 Specifications apply for CW mode, without modulation. In ramp sweep mode (Option 007), performance is typical for offsets > 1 MHz.
5 Phase noise specifications are warranted from 15 to 35 °C.
6 Measured at +10 dBm or maximum specified power, whichever is less.

Specifications (continued)

Spectral purity (continued)

Option UNX: Absolute SSB phase noise (dBc/Hz) (CW)[1]

Offset from carrier

Frequency	1 Hz spec (typical)	10 Hz spec (typical)	100 Hz spec (typical)
250 kHz to 250 MHz[2]	–58 (–66)	–87 (–94)	–104 (–120)
> 250 to 500 MHz[2]	–61 (–72)	–88 (–98)	–108 (–118)
> 500 MHz to 1 GHz[2]	–57 (–65)	–84 (–93)	–101 (–111)
> 1 to 2 GHz[2]	–51 (–58)	–79 (–86)	–96 (–106)
> 2 to 3.2 GHz	–46 (–54)	–74 (–82)	–92 (–102)
> 3.2 to 10 GHz	–37 (–44)	–65 (–72)	–81 (–92)
> 10 to 20 GHz	–31 (–38)	–59 (–66)	–75 (–87)

Frequency	1 kHz spec (typical)	10 kHz spec (typical)	100 kHz spec (typical)
250 kHz to 250 MHz[2]	–121 (–128)	–128 (–132)	–130 (–133)
> 250 to 500 MHz[2]	–126 (–132)	–132 (–136)	–136 (–141)
> 500 MHz to 1 GHz[2]	–121 (–130)	–130 (–134)	–130 (–135)
> 1 to 2 GHz[2]	–115 (–124)	–124 (–129)	–124 (–129)
> 2 to 3.2 GHz	–111 (–120)	–120 (–124)	–120 (–124)
> 3.2 to 10 GHz	–101 (–109)	–110 (–114)	–110 (–115)
> 10 to 20 GHz	–95 (–106)	–104 (–107)	–104 (–109)

Option UNX: Residual SSB phase noise (dBc/Hz) (CW)[1]

Offset from carrier

Frequency	1 Hz spec (typical)	10 Hz spec (typical)	100 Hz spec (typical)
250 kHz to 250 MHz[2]	(–94)	–100 (–107)	–110 (–118)
> 250 to 500 MHz[2]	(–101)	–105 (–112)	–115 (–122)
> 500 MHz to 1 GHz[2]	(–94)	–100 (–107)	–110 (–118)
> 1 to 2 GHz[2]	(–89)	–96 (–101)	–104 (–112)
> 2 to 3.2 GHz	(–85)	–92 (–97)	–100 (–108)
> 3.2 to 10 GHz	(–74)	(–87)	(–98)

Frequency	1 kHz spec (typical)	10 kHz spec (typical)	100 kHz spec (typical)
250 kHz to 250 MHz[2]	–120 (–126)	–128 (–132)	–130 (–133)
> 250 to 500 MHz[2]	–124 (–131)	–132 (–136)	–136 (–141)
> 500 MHz to 1 GHz[2]	–120 (–126)	–130 (–134)	–130 (–134)
> 1 to 2 GHz[2]	–114 (–120)	–124 (–129)	–124 (–129)
> 2 to 3.2 GHz	–110 (–116)	–120 (–124)	–120 (–124)
> 3.2 to 10 GHz	(–106)	(–114)	(–115)

Residual FM	(rms, 50 Hz to 15 kHz bandwidth)
CW mode	< N x 8 Hz (typ)
Option UNX	< N x 4 Hz (typ)
Ramp sweep mode	< N x 1 kHz (typ)
Broadband noise	(CW mode at +10 dBm or maximum specified output power, whichever is lower, for offsets > 10 MHz)
> 2.4 to 20 GHz	< –148 dBc/Hz (typ)

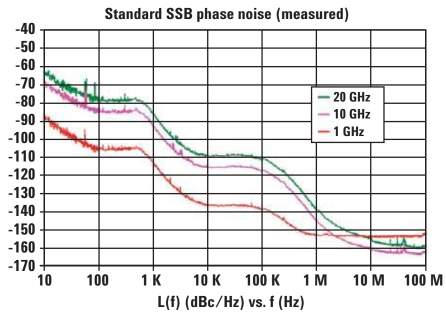
1 Phase noise specifications are warranted from 15 to 35 °C.
2 Measured at +10 dBm or maximum specified power, whichever is less.

Specifications (continued)

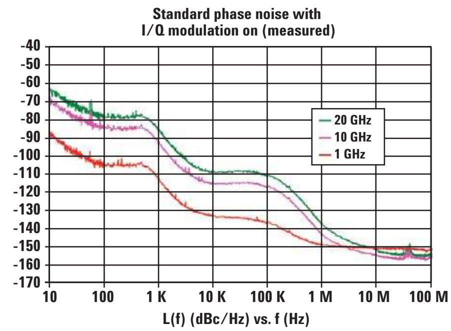
Spectral purity (continued)

Measured phase noise with E5500 and plotted without spurs

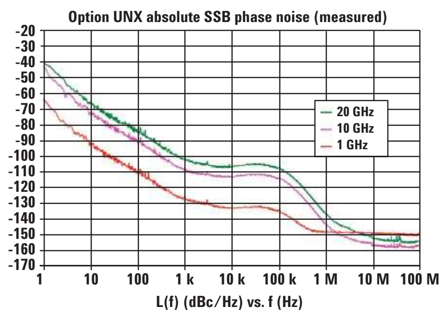
Standard phase noise



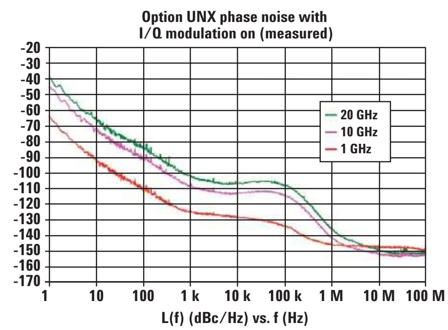
Standard phase noise performance with I/Q modulation on[1]



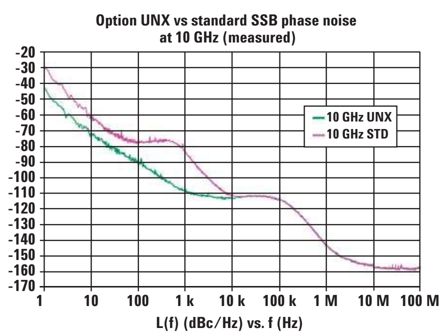
Option UNX phase noise



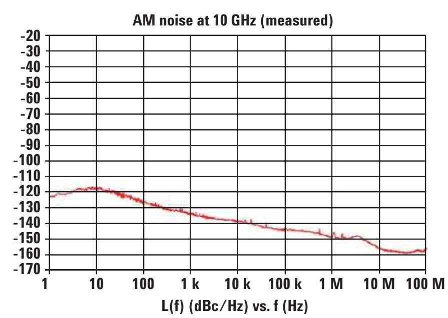
Option UNX phase noise with I/Q modulation on[1]



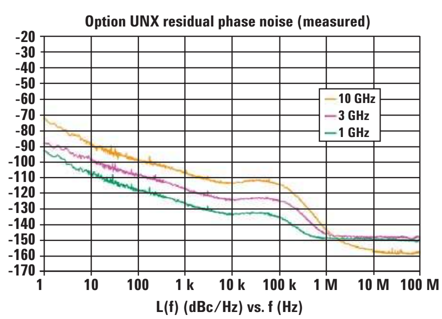
Standard vs. Option UNX phase noise



AM noise at 10 GHz



Option UNX phase noise



1 External I/Q input level $\sqrt{(I^2 + Q^2)} = 250\ mV_{rms}$, I/Q modulator attenuator set to auto.

Spectral purity (continued)

Measured RMS jitter[1]

	Carrier frequency	SONET/SDH data rates	RMS jitter bandwidth	Unit intervals (µUI)	Time (fs)
Standard	155 MHz	155 MB/s	100 Hz to 1.5 MHz	25	158
	622 MHz	622 MB/s	1 kHz to 5 MHz	21	34
	2.488 GHz	2488 MB/s	5 kHz to 20 MHz	57	23
	9.953 GHz	9953 MB/s	10 kHz to 80 MHz	152	15

	Carrier frequency	SONET/SDH data rates	RMS jitter bandwidth	Unit intervals (µUI)	Time (fs)
Option UNX	155 MHz	155 MB/s	100 Hz to 1.5 MHz	23	151
	622 MHz	622 MB/s	1 kHz to 5 MHz	19	30
	2.488 GHz	2488 MB/s	5 kHz to 20 MHz	56	22
	9.953 GHz	9953 MB/s	10 kHz to 80 MHz	152	15

Frequency modulation (Option UNT)

Maximum deviation[2]

Frequency	Maximum deviation
250 kHz to 250 MHz	2 MHz
> 250 to 500 MHz	1 MHz
> 500 MHz to 1 GHz	2 MHz
> 1 GHz to 2 GHz	4 MHz
> 2 GHz to 3.2 GHz	8 MHz
> 3.2 GHz to 10 GHz	16 MHz
> 10 GHz to 20 GHz	32 MHz

Resolution	0.1% of deviation or 1 Hz, whichever is greater
Deviation accuracy	< ± 3.5% of FM deviation + 20 Hz (1 kHz rate, deviations < N x 800 kHz)

Modulation frequency response[3] (at 100 kHz deviation)

Path [coupling]	1 dB bandwidth	3 dB bandwidth (typ)
FM path 1 [DC]	DC to 100 kHz	DC to 10 MHz
FM path 2 [DC]	DC to 100 kHz	DC to 1 MHz
FM path 1 [AC]	20 Hz to 100 kHz	5 Hz to 10 MHz
FM path 2 [AC]	20 Hz to 100 kHz	5 Hz to 1 MHz

DC FM[4] carrier offset	±0.1% of set deviation + (N x 8 Hz)
Distortion	< 1% (1 kHz rate, deviations < N x 800 kHz)
Sensitivity	±1 V_{peak} for indicated deviation
Paths	FM1 and FM2 are summed internally for composite modulation. Either path may be switched to any one of the modulation sources: Ext1, Ext2, internal1, internal2. The FM2 path is limited to a maximum rate of 1 MHz. The FM2 path must be set to a deviation less than FM1.

1 Calculated from phase noise performance in CW mode only at +10 dBm.
2 Through any combination of path1, path2, or path1 + path2.
3 Specifications apply in CW and list/step sweep modes. During ramp sweep operation (Option 007), 3 dB bandwidth is typically 50 kHz to 10 MHz (FM1 path), and 50 kHz to 1 MHz (FM2 path).
4 At the calibrated deviation and carrier frequency, within 5 °C of ambient temperature at time of user calibration.

Specifications (continued)

Phase modulation (Option UNT)

Maximum deviation[1]	Frequency	Normal BW mode	High BW mode
	250 kHz to 250 MHz > 250 to 500 MHz > 500 MHz to 1 GHz > 1 GHz to 2 GHz > 2 GHz to 3.2 GHz > 3.2 GHz to 10 GHz > 10 GHz to 20 GHz	20 rad 10 rad 20 rad 40 rad 80 rad 160 rad 320 rad	2 rad 1 rad 2 rad 4 rad 8 rad 16 rad 32 rad
Resolution	0.1% of set deviation		
Deviation accuracy	< ±5% of deviation + 0.01 radians (1 kHz rate, normal BW mode)		
Modulation frequency response[2]	Normal BW mode	High BW mode	
Rates (3 dB BW)	DC to 100 kHz	DC to 1MHz (typical)[3]	
Distortion	< 1 % (1 kHz rate, Total Harmonic Distortion (THD), dev < N x 80 rad, normal BW mode)		
Sensitivity	±1 V_{peak} for indicated deviation		
Paths	ΦM1 and ΦM2 are summed internally for composite modulation. Either path may be switched to any one of the modulation sources: Ext1, Ext2, internal1, internal2. The ΦM2 path must be set to a deviation less than ΦM1.		

1 Through any combination of path1, path2, or path1 + path2.
2 Specifications apply in CW and list/step sweep modes. During ramp sweep operation (Option 007), 3 dB bandwidth is typically 50 kHz to 1 MHz (high BW mode).
3 Path 1 is usable to 4 MHz for external inputs less than 0.3 V peak.

Amplitude modulation[1] (Option UNT) (typ)

Depth	Linear mode	Exponential (log) mode (downward modulation only)
Maximum		
ALC on	> 90%	> 20 dB
ALC Off with power search[2] or ALC On with Deep AM[4]	> 95%	> 40 dB[3]
Settable	0 to 100 % (0 to 100%/volt sensitivity)	0 to 40 dB (0 to 40 dB/volt sensitivity)
Resolution	0.1%	0.01 dB
Accuracy (1 kHz rate)	< ±(6% of setting + 1%)	< ±(2% of setting + 0.2 dB)
Ext sensitivity	Linear mode	Exponential (log) mode (downward modulation only)
	±1 V_{peak} for indicated depth	–1 V_{peak} for indicated depth
Rates (3 dB bandwidth, 30% depth)		
DC coupled	0 to 100 kHz	
AC coupled	10 Hz to 100 kHz (usable to 1 MHz)	
Distortion (1 kHz rate, linear mode, Total Harmonic Distortion (THD))		
30% AM	< 1.5%	
60% AM	< 2%	
Paths	AM1 and AM2 are summed internally for composite modulation. Either path may be switched to any one of the modulation sources: Ext1, Ext2, internal1, internal2.	

External modulation inputs (Ext1 & Ext2) (Option UNT)

Modulation types	AM, FM, and ΦM
Input impedance	50 or 600 Ω (nom) switched
High/low indicator (100 Hz to 10 MHz BW, ac coupled inputs only)	Activated when input level error exceeds 3% (nom)

1 AM specifications are typical. For carrier frequencies below 2 MHz, AM is usable but not specified. Unless otherwise stated, specifications apply with ALC on, Deep AM off, and envelope peaks within ALC operating range (–15 dBm to maximum specified power, excluding step-attenuator setting).
2 ALC Off is used for narrow pulse modulation and/or high AM depths, with envelope peaks below ALC operating range. Carrier power level will be accurate after a power search is executed.
3 To achieve > 40 dB depth, less than –1 V external input may be required.
4 ALC On with Deep AM provides high AM depths together with closed-loop internal leveling. This mode can be used with a repetitive AM waveform (frequency > 10 Hz) with peaks > –5 dBm (nominal, excluding step-attenuator setting).

Internal modulation source (Option UNT)

Dual function generators provide two independent signals (internal1 and internal2) for use with AM, FM, ΦM, or LF Out.	
Waveforms	Sine, square, positive ramp, negative ramp, triangle, Gaussian noise, uniform noise, swept sine, dual sine[1]
Rate range	
Sine	0.5 Hz to 1 MHz
Square, ramp, triangle	0.5 Hz to 100 kHz
Resolution	0.5 Hz
Accuracy	Same as timebase
LF Out	
Output	Internal1 or internal2; also provides monitoring of internal1 or internal2 when used for AM, FM, or ΦM
Amplitude	0 to 3 V_{peak}, into 50 Ω (nom)
Output impedance	50 Ω (nom)
Swept sine mode (frequency, phase continuous)	
Operating modes	Triggered or continuous sweeps
Frequency range	1 Hz to 1 MHz
Sweep rate	0.5 Hz to 100 kHz sweep/s, equivalent to sweep times 10 µs to 2 s
Resolution	0.5 Hz (0.5 sweep/s)

Wideband AM

Rate (typical 1 dB bandwidth)	
ALC on	1 kHz to 80 MHz
ALC off	DC to 80 MHz
External I input	
Sensitivity	0.5 V = 100%
Input impedance	50 Ω (nom)

1 Internal2 is not available when using swept sine or dual sine modes.

Specifications (continued)

Pulse modulation[1, 2] (Option UNU)	**500 MHz to 3.2 GHz**	**Above 3.2 GHz**
On/Off ratio	80 dB (typ)	80 dB
Rise/Fall times (Tr, Tf)	100 ns (typ)	6 ns (typ)
Minimum pulse width Internally leveled Level hold (ALC off with power search)	 2 μs 0.5 μs	 1 μs 0.15 μs
Repetition frequency Internally leveled Level hold (ALC off with power search)	 10 Hz to 250 kHz DC to 1 MHz	 10 Hz to 500 kHz DC to 3 MHz
Level accuracy (relative to CW) Internally leveled Level hold (ALC off with power search)	 ±0.5 dB ±0.5 dB (typ)	 ±0.5 dB ±0.5 dB (typ)
Width compression (RF width relative to video out)	±50 ns (typ)	±5 ns (typ)
Video feed-through[3]	< 200 mv (typ)	< 2 mv (typ)
Video delay (ext input to video)	50 ns (nom)	50 ns (nom)
RF delay (video to RF output)	270 ns (nom)	35 ns (nom)
Pulse overshoot	< 10% (typ)	< 10% (typ)
Input level	+1 V_{peak} = RF On	+1 V_{peak} = RF On
Input impedance	50 ohms (nom)	50 ohms (nom)

1 With ALC off, specs apply after the execution of power search. Specifications apply with Atten Hold Off (default mode for instruments with attenuator), or ALC level between –5 and +10 dBm or maximum specified power, whichever is lower.

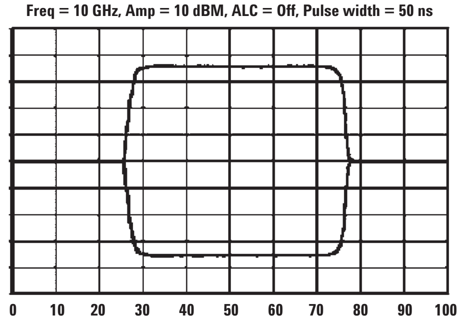
2 Power search is a calibration routine that improves level accuracy with ALC off. The instrument microprocessor momentarily closes the ALC loop to find the modulator drive setting necessary to make the quiescent RF level equal to an entered value, then opens the ALC loop while maintaining that modulator drive setting. When executing power search, RF power will be present for typically 10-50 ms; the step attenuator can be set to automatically switch to maximum attenuation to protect sensitive devices. Power search can be configured to operate either automatically or manually at the carrier frequency, or over a user-definable frequency range.

3 With attenuator in 0 dB position. Video feed-through decreases with attenuator setting.

Specifications (continued)

Narrow pulse modulation[1, 2] (Option UNW)	**10 MHz to 3.2 GHz**	**Above 3.2 GHz**
On/Off ratio	80 dB	80 dB
Rise/Fall times (Tr, Tf)	10 ns (8 ns typ)	10 ns (6 ns typ)
Minimum pulse width		
Internally leveled	1 μs	1 μs
Level hold (ALC off with power search)	20 ns	20 ns
Repetition frequency		
Internally leveled	10 Hz to 500 kHz	10 Hz to 500 kHz
Level hold (ALC off with power search)	DC to 5 MHz	DC to 10 MHz
Level accuracy (relative to CW)		
Internally leveled	±0.5 dB	±0.5 dB (±0.15 dB typ)
Level hold (ALC off with power search)	±1.3 dB (typ)	±0.5 dB (typ)
Width compression (RF width relative to video out)	±5 ns (typ)	±5 ns (typ)
Video feed-through[3]	< 125 mv (typ)	< 2 mv (typ)
Video delay (ext input to video)	50 ns (nom)	50 ns (nom)
RF delay (video to RF output)	45 ns (nom)	35 ns (nom)
Pulse overshoot	< 15% (typ)	< 10% (typ)
Input level	+1 V_{peak} = RF On	+1 V_{peak} = RF On
Input impedance	50 Ω (nom)	50 Ω (nom)

Measured pulse modulation envelope
Freq = 10 GHz, Amp = 10 dBM, ALC = Off, Pulse width = 50 ns



1 With ALC off, specs apply after the execution of power search. Specifications apply with Atten Hold Off (default mode for instruments with attenuator), or ALC level between –5 and +10 dBm or maximum specified power, whichever is lower.

2 Power search is a calibration routine that improves level accuracy with ALC off. The instrument microprocessor momentarily closes the ALC loop to find the modulator drive setting necessary to make the quiescent RF level equal to an entered value, then opens the ALC loop while maintaining that modulator drive setting. When executing power search, RF power will be present for typically 10-50 ms; the step attenuator can be set to automatically switch to maximum attenuation to protect sensitive devices. Power search can be configured to operate either automatically or manually at the carrier frequency, or over a user-definable frequency range.

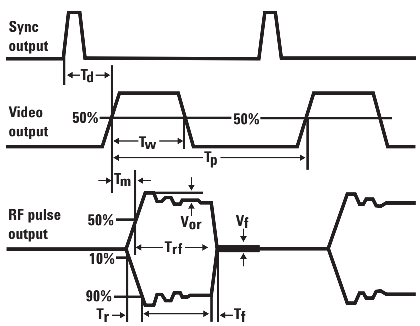
3 With attenuator in 0 dB position. Video feed-through decreases with attenuator setting.

Specifications (continued)

Internal pulse generator(Option UNU or UNW)

Modes	Free-run, triggered, triggered with delay, doublet, and gated. Triggered with delay, doublet, and gated require external trigger source.
Period (PRI) (Tp)	70 ns to 42 s (Repetition frequency: 0.024 Hz to 14.28 MHz)
Pulse width (Tw)	10 ns to 42 s
Delay (Td) Free-run mode Triggered with delay and doublet modes	 0 to ±42 s 75 ns to 42 s with ±10 ns jitter
Resolution	10 ns (width, delay, and PRI)

T_d – video delay (variable)
T_w – video pulse width (variable)
T_p – pulse period (variable)
T_m – RF delay
T_{rf} – RF pulse width
T_f – RF pulse fall time
T_r – RF rise time
V_{or} – pulse overshoot
V_f – video feedthrough



Simultaneous modulation

All modulation types (FM, AM, ΦM, and I/Q) may be simultaneously enabled except: FM with ΦM, and linear AM with exponential AM, and wideband AM with I/Q. AM, FM, and ΦM can sum simultaneous inputs from any two sources (Ext1, Ext2, internal1, or internal2). Any given source (Ext1, Ext2, internal1, or internal2) may be routed to only one activated modulation type.

Vector modulation[1]

External I/Q inputs Input impedance Input range[2]	 50 Ω (nom) Minimum 0.1 V_{rms}, maximum 1 V_{peak}

1 With Option 007, vector modulation is not usable in ramp sweep mode.

2 For optimum signal quality, the I and Q inputs should be 0.7 V_{peak}, with $\sqrt{(I^2 + Q^2)}$ + 150 mV_{rms}. Different RMS levels are accommodated by adjusting the internal I/Q modulator attenuator, which may be either manually or automatically set. The minimum input level required to maintain RF level accuracy is $\sqrt{(I^2 + Q^2)}$ = 0.1 V_{rms}.

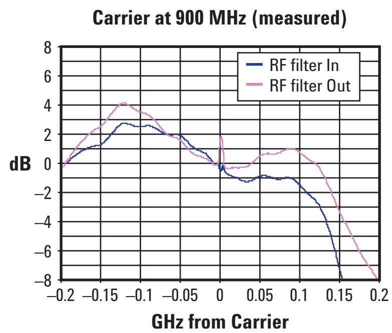
Specifications (continued)

Vector modulation[1] (continued)

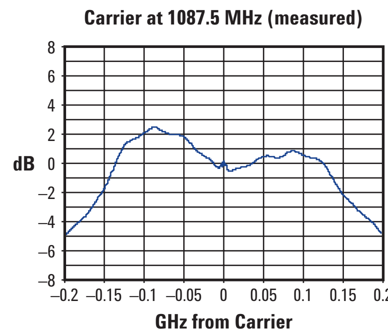
Wideband external I/Q inputs		
RF output frequency range	250 kHz to 3.2 GHz	3.2 to 20 GHz
Input		
Input (baseband) frequency	DC to 130 MHz (nom)	DC to > 1.0 GHz
Input impedance	50 Ω (nom)	50 Ω (nom)
Recommended input level[2]	–1 dBm	–1 dBm
Maximum DC input voltage	±1 VDC	±1 VDC
Maximum input RF power	+15 dBm	+15 dBm
I/Q offset adjustment	±50%	±50%
I/Q quadrature skew	±10 degrees (nom)	±10 degrees (nom)

I/Q frequency response[3] for frequencies < 3.2 GHz (measured)

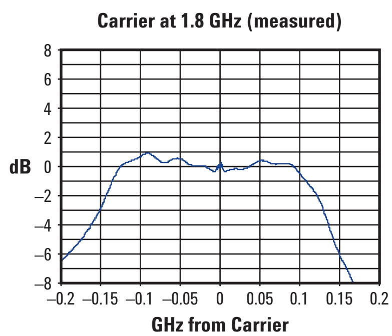
900 MHz



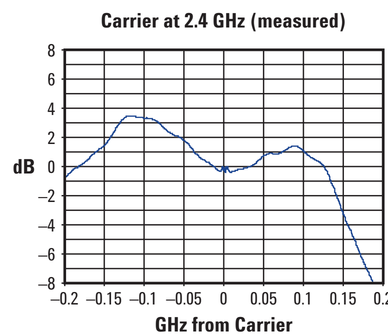
1087.5 MHz



1.8 GHz



2.4 GHz

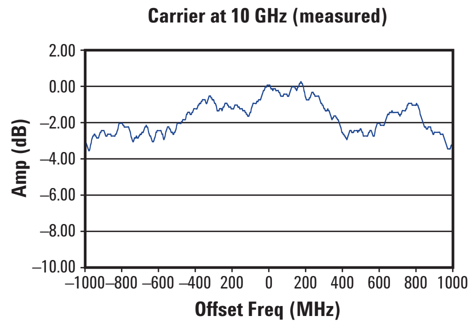


1 With Option 007, vector modulation is not usable in ramp sweep mode.
2 For optimal signal quality, I and Q inputs as determined by $\sqrt{(I\text{-}I)^2 + (Q\text{-}Q)^2}$ should be approximately 270 mV_{rms}; or I-I and Q-Q should equal 190 mV each.
3 Sine wave response, measured with input level = 100 mV_{rms} on one channel, and ALC off. For carrier frequencies below 1.5 GHz, modulation frequency response within ±150 MHz of carrier may be limited by RF chain filtering.

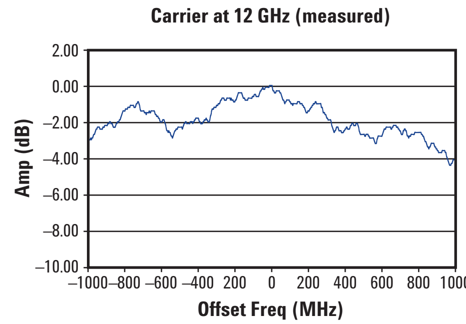
Vector modulation[1] (continued)

I/Q frequency response for frequencies > 3.2 GHz (measured)

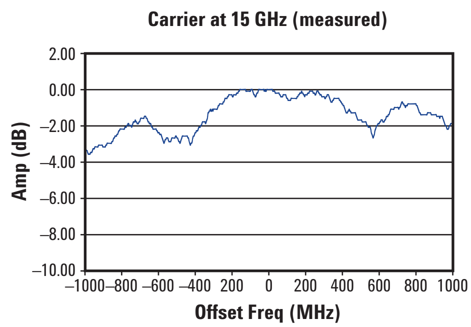
10 GHz



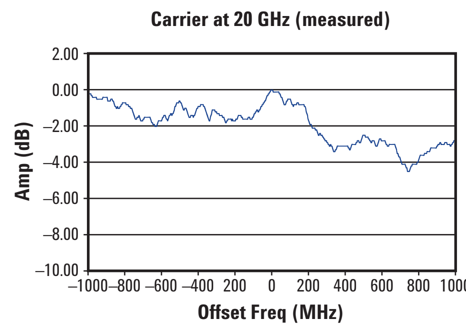
12 GHz



15 GHz



20 GHz



RF path filters[2]

Carrier frequency	Nominal filter cutoff frequencies
≤ 250 MHz	300 MHz low-pass filter
> 250 to 396 MHz	200 to 420 MHz bandpass filter
> 396 to 628 MHz	350 to 650 MHz bandpass filter
> 628 to 1000 MHz	1040 MHz low-pass filter
> 1.0 to 1.5 GHz	1.6 GHz low-pass filter
> 3.2 GHz to 5 GHz	5.5 GHz low-pass filter
> 5 GHz to 8 GHz	8.9 GHz low-pass filter
> 8 GHz to 12.8 GHz	13.9 GHz low-pass filter
> 12.8 GHz to 20 GHz	22.5 GHz low-pass filter

1 With Option 007, vector modulation is not usable in ramp sweep mode.
2 Modulation frequency response within ±1 GHz of the carrier frequency may be limited by the RF chain cutoff frequencies. For operation near a filter edge, filters can be bypassed using software commands to increase modulation bandwidth.

Remote programming

Interfaces	LXI, IEEE-1588, and 10/100 BaseT LAN interface
Control languages	Interchangeable Virtual Instrument Common Object Model (IVI-COM) Interchangeable Virtual Instrument-C (IVI-C)

General specifications

Power requirements	100-240 V, 50/60 Hz (automatically selected)
Power consumption	< 300 watts (typical), < 400 watts (maximum) Standby: 15-25 watts (typical)

Environmental

Samples of this product have been type tested in accordance with the Agilent 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.

Operating temperature range	0 to 55 °C
Storage temperature range[1]	–40 to +70 °C
Relative humidity	Type tested: 0% to 95% at 40 °C, (non-condensing)
Altitude	Type tested: 0 m to 4600 m above mean sea level
Audio noise	L_{NPE} < 70 dB(A), tested according to ISO 7779

Shock and vibration

Operating random vibration	Type tested: 5 to 500 Hz, 0.21 g_{rms}
Survival random vibration	Type tested: 5 to 500 Hz, 2.09 g_{rms}
Survival swept sine vibration	Type tested: 5 to 500 Hz, 0.5 g_{peak}
End use handling shock	Type tested: Half sine, 60 in/sec ΔV, 2-3 msec duration
Transportation shock	Type tested: Trapezoidal, 50 g, 337 in/sec ΔV
Functional shock	Type tested: Half-sine, 30 g, 11 ms
Bench drop test	Type tested: Per MIL-PRF28800F

1 Storage below –20 °C, instrument states may be lost.

Specifications (continued)

Electromagnetic compatibility (EMC)

Complies with European EMC Directive 89/336/EEC, amended by 93/68/EEC	IEC/EN 61326 CISPR Pub 11 Group 1, Class A AS/NZS CISPR 11:2002 ICES/NMB-001

Safety

Complies with European Low Voltage Directive 73/23/EEC, amended by 93/68/EEC	IEC/EN 61010 Canada: CSA C22.2 No. 61010 USA: UL 61010B

Weight

Net weight	19.1 kg (42 lbs) (nominal)

Dimensions

4U, 1/2 rack width LXI module	
Height	17.8 cm (7.0 in)
Width	21.3 cm (8.375 in)
Length	64.0 cm (25.2 in)

Recommended calibration cycle

The recommended calibration cycle is 24 months. Calibration services are available through Agilent service centers.

ISO compliance

This product is manufactured in an ISO-9001 registered facility in concurrence with Agilent Technologies, Inc. commitment to quality.

Warranty

This Agilent Technologies product is warranted against defects in materials and workmanship for a period of one year from date of shipment. During the warranty period, Agilent Technologies will, at its option, either repair or replace products that are defective.

Input/Output Descriptions

Front panel connectors (all connectors are SMB male unless otherwise noted)	
RF output	RF/microwave output signal from the N8212A; nominal output impedance 50 Ω
Option 520	Precision APC-3.5 male
References	
1 GHz Out	Outputs 1 GHz internal reference signal, only when equipped with option UNX. Connector is SMA female; when not in use, connector should be terminated with a 50 Ω load.
10 MHz Out	Outputs internal or external reference signal. Nominal output impedance 50 Ω. Nominal output power +8 dBm.
10 MHz In	Accepts an external reference (timebase) input (at 1, 2, 2.5, 5, 10 MHz for standard and 10 MHz only for option UNX). Nominal input impedance 50 Ω.
10 MHz EFC	(Option UNX only.) Accepts an external DC voltage, ranging from –5 V to +5 V, for electronic frequency control (EFC) of the internal 10 MHz reference oscillator. This voltage inversely tunes the oscillator about its center frequency approximately –0.07 ppm/V. The nominal input impedance is greater than 1 MΩ. Note: A short or 50 Ω termination should be attached to this input connector whenever the EFC port is not used.
Step Sweep	
Settled	Provides an output trigger that indicates when the signal generator has settled to a new frequency or power level. High indicates source not settled; low indicates source settled.
Trig out	Outputs a TTL signal. High at start of dwell, or when waiting for point trigger; low when dwell is over or point trigger is received. In ramp sweep mode, provides 1601 equally-spaced 1 μs pulses (nom) across a ramp sweep. When using LF Out, provides 2 μs pulse at start of LF sweep.
Trig in	Accepts TTL signal for triggering point-to-point in manual sweep mode, or to trigger start of LF sweep. Damage levels ≥ +10 V or ≤ –4 V.
Analog Sweep	
Z/Mkrs	During ramp sweep, supplies +5 V (nom) level during retrace and bandswitch intervals. Supplies –5 V (nom) level when the RF frequency is at a marker frequency.
Stop Swp	Open collector, TTL-compatible input/output. In ramp sweep operation, provides low level (nominally 0 V) during sweep retrace and bandcross intervals, and high level during the forward portion of the sweep. Sweep will stop when grounded externally, sweep will resume when allowed to go high.
Sweep Out	Supplies a voltage proportional to the RF power or frequency sweep ranging from 0 V at the start of sweep to +10 V (nominal) at the end of sweep, regardless of sweep width. During CW operation, supplies a voltage proportional to the output frequency, +10 V (nom) corresponding to the maximum specified frequency. Output impedance: < 1 Ω (nominal), can drive 2000 Ω.
LF Output	LF output (Option UNT) is an internal modulation drive and function generator for AM, FM, PM and pulse modulation. Nominal output impedance 50 Ω.

Input/Output Descriptions (continued)

Front panel connectors (all connectors are SMB male unless otherwise noted) (continued)

Pulse Modulation	
Pulse In	Accepts input signal for external fast pulse modulation. Also accepts external trigger pulse input for internal pulse modulation. Nominal impedance 50 Ω. Damage levels are 5 V_{rms} and 10 V_{peak}.
Sync Out	Outputs a synchronizing pulse, nominally 50 ns width, during internal and triggered pulse modulation. TTL-level compatible, nominal source impedance 50 Ω.
Video Out	Outputs a signal that follows the RF output in all pulse modes. TTL-level compatible, nominal source impedance 50 Ω.
Vector I/Q Inputs	The I, I-bar, Q, and Q-bar inputs are used to provide vector modulation to the N8212A vector upconverter module. The I-input is an in-phase input, and the Q-input is a quadrature input. For single-ended sources, only the I and Q inputs are used for inputting vector modulation to the N8212A. For differential input signals, the I and I-bar inputs are for the differential in-phase modulation component, and the Q and Q-bar inputs are for the differential quadrature-phase modulation component.
I	Accepts an "I" input either for I/Q modulation or for wideband AM. Nominal input impedance is 50 Ω. Damage levels are ±4 VDC or +20 dBm. Connector type is SMA-female.
I-bar	Accepts an "I-bar" input either for I/Q modulation or for wideband AM. Nominal input impedance is 50 Ω. Damage levels are ±4 VDC or +20 dBm. Connector type is SMA-female.
Q	Accepts a "Q" input for I/Q modulation. Nominal input impedance is 50 Ω. Damage levels are ±4 VDC or +20 dBm. Connector type is SMA-female.
Q-bar	Accepts a "Q-bar" input for I/Q modulation. Nominal input impedance is 50 Ω. Damage levels are ±4 VDC or +20 dBm. Connector type is SMA-female.
Analog Inputs	
Ext 1	Drives either AM, FM, or ΦM. Nominal input impedance 50 or 600 Ω, damage levels are 5 V_{rms} and 10 V_{peak}.
Ext 2	Drives either AM, FM, or ΦM. Nominal input impedance 50 or 600 Ω, damage levels are 5 V_{rms} and 10 V_{peak}.
Automatic Leveling Control (ALC)	
ALC Input	Used for negative external detector leveling. Nominal input impedance 120 kΩ, damage level 12 to +0.5 V. Connector type is BNC-female.
ALC Hold	Allows the user to enable or disable the Automatic Leveling Control (ALC) function of the upconverter. A TTL logic '1' signal enables the ALC function, and a TTL logic level '0' signal disables the ALC function of the upconverter. The ALC hold function is useful when pulse modulating the source, so that the ALC circuit does not try to react to the pulsed signal. Typically a marker signal from an external arbitrary waveform generator (AWG) is used to drive the ALC hold. When this port is unused, do not place a termination or short on this connector.

Input/Output Descriptions (continued)

Front panel connectors (all connectors are SMB male unless otherwise noted) (continued)

Coherent Carriers[1]	The coherent carrier In/Out ports are used to allow multiple upconverters to be phase coherent. A common LO signal can be sent to two or more different upconverters, thus allowing their output signals to be phase coherent. In the upconverter, there is a low-band LO, and a high-band LO, thus requiring two different LOs to operate over the entire frequency range of the upconverter. To make the upconverter coherent over its entire frequency range requires having both a low-band and high-band coherent LO signal. When not using the coherent carriers ports for tying multiple upconverter LOs together to make them phase coherent, the supplied jumper cables are required. A jumper cable from 0.25 to 3.2 GHz Out connector to 0.25 to 3.2 GHz In connector, and from 3.2 to 10 GHz Out connector to 3.2-10 GHz In connector is required for operation.
0.25 to 3.2 GHz In	Input port for a reference LO signal for the low-band of operation. This port is used when it is desired to make the upconverter phase coherent over the low-band (0.25 to 3.2 GHz) of operation of the upconverter. Connector is SMA female.
3.2 to 10 GHz In	Input port for a reference LO signal for the high-band of operation. This port is used when it is desired to make the upconverter phase coherent over the high-band (3.2 to 20 GHz) of operation of the upconverter. The LO signal needs to tune over the range of 3.2 to 10 GHz. There is a frequency doubler to get the upconverter’s output signal to 20 GHz. Connector is SMA female.
0.25 to 3.2 GHz Out	Output port for the low-band reference LO. Normally this signal is routed back in to the 0.25 to 3.2 GHz In port on the upconverter. If multiple coherent upconverter operation is desired, this output signal can be split into multiple signals, and then routed to several different upconverters to provide a low-band (0.25 to 3.2 GHz) coherent LO signal. Connector is SMA female.
3.2 to 10 GHz Out	Output port for the high-band reference LO. Normally this signal is routed back in to the 3.2 to 10 GHz In port on the upconverter. If multiple coherent upconverter operation is desired, this output signal can be split into multiple signals, and then routed to several different upconverters to provide a high-band (3.2 to 10 GHz) coherent LO signal. The high-band LO must tune over the range 3.2 to 10 GHz; there is a doubler to get the upconverter’s output signal up to 20 GHz. Connector is SMA female.

1 By design, the coherent carriers will not lock below 250 MHz.

Front panel indicator lights

PWR	Indicates when the power switch on the unit is turned to the 'ON' position
LAN	Indicates LAN connection status
1588	Indicates the clock status of the IEEE 1588 time-based trigger
LAN RST	Front panel access hole to reset the LAN to a known default state

Rear panel connectors

Power requirements	100-240 V, 50/60 Hz (automatically selected)
Power consumption	< 300 watts (typical), < 400 watts (maximum) Standby: 15-25 watts (typical)
LAN	Standard LAN connector for 10/100 BaseT LAN communication
LXI trigger bus in	Input for the LXI trigger-bus signals. 25-pin subminiature female connector.
LXI trigger bus out	Output for the LXI trigger-bus signals. 25-pin subminiature female connector.
Diagnostics port (25-pin parallel port)	Used for internal testing of the instrument in the factory. 25-pin D-subminiature female connector.
Diagnositcs port (9-pin serial port)	For internal testing of the instrument in the factory. 9-pin D-subminiature male connector.

Ordering Information and Options

Model/Option	Description
N8212A	20 GHz vector upconverter synthetic instrument module
N8212A-520	Frequency range from 250 kHz to 20 GHz
N8212-007	Analog ramp sweep interface
N8212A-016	Wideband, single and differential I/Q modulation inputs
N8212A-UNT	AM/FM/ΦM modulation
N8212A-UNU	Standard pulse modulation
N8212A-UNW	Narrow pulse modulation
N8212A-UNX	Enhanced close in phase noise performance (<1 kHz)

Resources

Abbreviations used in this data sheet

GS/s	Giga-sample per second
LAN	Local Area Network
MS/s	Mega-sample per second
k	kilo, or 1000
SMB	Sub-miniature bayonet
ps	Pico-seconds
AC	Alternating Current
DC	Direct Current
s	seconds
NA	Not Applicable

Web Resources

For additional information, visit:
www.agilent.com/find/synthetic

For information about renting, leasing, or financing Agilent's latest technology, visit:
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Related Literature

Publication Title	Publication Type	Publication Number
N8211A Vector Up-converter Synthetic Instrument Module	Data Sheet	5989-2592EN
N8241A 15-bit Arbitrary Waveform Generator Synthetic Instrument Module	Data Sheet	5989-2595EN
N8242A 10-bit Arbitrary Waveform Generator Synthetic Instrument Module	Data Sheet	5989-5010EN
PSG Signal Generator	Brochure	5989-1324EN
E8257D PSG Analog Signal Generator	Data Sheet	5989-0698EN
E8267D PSG Vector Signal Generator	Data Sheet	5989-0697EN
PSG Self Guided Demo	Application Note	5988-2414EN
E8257D PSG CW and Analog Signal Generators	Configuration Guide	5989-1325EN
E8267D PSG Vector Signal Generator	Configuration Guide	5989-1326EN

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