Keysight X-Series Signal Analyzers

This manual provides documentation
for the following Analyzer:

N9040B UXA Signal Analyzer

KEYSIGHT

SPECIFICATIONS GUIDE

Notices

Trademark Acknowledgments

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Contents

1 UXA Signal Analyzer

This chapter contains the specifications for the core signal analyzer. The specifications and characteristics for the measurement applications and options are covered in the chapters that follow.

Definitions and Requirements

This book contains signal analyzer specifications and supplemental information. The distinction among specifications, typical performance, and nominal values are described as follows.

Definitions

- Specifications describe the performance of parameters covered by the product warranty (temperature = 0 to 55°C also referred to as "Full temperature range" or "Full range", unless otherwise noted).
- 95th percentile values indicate the breadth of the population (≈2σ) of performance tolerances expected to be met in 95% of the cases with a 95% confidence, for any ambient temperature in the range of 20 to 30°C. In addition to the statistical observations of a sample of instruments, these values include the effects of the uncertainties of external calibration references. These values are not warranted. These values are updated occasionally if a significant change in the statistically observed behavior of production instruments is observed.
- Typical describes additional product performance information that is not covered by the product warranty. It is performance beyond specification that 80% of the units exhibit with a 95% confidence level over the temperature range 20 to 30°C. Typical performance does not include measurement uncertainty.
- 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.

Conditions Required to Meet Specifications

The following conditions must be met for the analyzer to meet its specifications.

- The analyzer is within its calibration cycle. See the General section of this chapter.
- Under auto couple control, except that Auto Sweep Time Rules = Accy.
- For signal frequencies <10 MHz, DC coupling applied.
- Any analyzer that has been stored at a temperature range inside the allowed storage range but outside the allowed operating range must be stored at an ambient temperature within the allowed operating range for at least two hours before being turned on.
- The analyzer has been turned on at least 30 minutes with Auto Align set to Normal, or if Auto Align is set to Off or Partial, alignments must have been run recently enough to prevent an Alert message. If the Alert condition is changed from “Time and Temperature” to one of the disabled duration choices, the analyzer may fail to meet specifications without informing the user. If Auto Align is set to Light, performance is not warranted, and nominal performance will degrade to become a factor of 1.4 wider for any specification subject to alignment, such as amplitude tolerances.

Certification

Keysight Technologies certifies that this product met its published specifications at the time of shipment from the factory. Keysight Technologies further certifies that its calibration measurements are traceable to the International System of Units (SI) via national metrology institutes (www.keysight.com/find/NMI) that are signatories to the CIPM Mutual Recognition Arrangement.

Frequency and Time

Description	Specifications		Supplemental Information
Frequency Range			
Maximum Frequency			
Option 508	8.4 GHz		
Option 513	13.6 GHz		
Option 526	26.5 GHz		
Option 544	44 GHz		
Option 550	50 GHz		
Preamp *Option P08*	8.4 GHz		
Preamp *Option P13*	13.6 GHz		
Preamp *Option P26*	26.5 GHz		
Preamp *Option P44*	44 GHz		
Preamp *Option P50*	50 GHz		
Minimum Frequency			
Preamp	**AC Coupled**	**DC Coupled**	
Off	10 MHz	2 Hz	
On	10 MHz	9 kHz	
Band	**Harmonic Mixing Mode**	**LO Multiple (N[a])**	**Band Overlaps**[b]
0 (2 Hz to 3.6 GHz)[c]	1–	1	*Options 508, 513, 526*, *544*, *550*
1 (3.5 to 8.4 GHz)	1–	1	*Options 508, 513, 526*, *544*, *550*
2 (8.3 to 13.6 GHz)	1–	2	*Options 513, 526*, *544*, *550*
3 (13.5 to 17.1 GHz)	2–	2	*Options 526*, *544*, *550*
4 (17.0 to 26.5 GHz)	2–	4	*Options 526*, *544*, *550*
5 (26.4 to 34.5 GHz)	2–	4	*Options* 544, *550*
6 (34.4 to 50 GHz)	4–	8	*Options* 544, *550*

a. N is the LO multiplication factor. For negative mixing modes (as indicated by the "–" in the "Harmonic Mixing Mode" column), the desired 1st LO harmonic is higher than the tuned frequency by the 1st IF.

b. In the band overlap regions, for example, 3.5 to 3.6 GHz, the analyzer may use either band for measurements, in this example Band 0 or Band 1. The analyzer gives preference to the band with the better overall specifications (which is the lower numbered band for all frequencies below 26 GHz), but will choose the other band if doing so is necessary to achieve a sweep having minimum band crossings. For example, with CF = 3.58 GHz, with a span of 40 MHz or less, the analyzer uses Band 0, because the stop frequency is 3.6 GHz or less, allowing a span without band crossings in the preferred band. If the span is between 40 and 160 MHz, the analyzer uses Band 1, because the start frequency is above 3.5 GHz, allowing the sweep to be done without a band crossing in Band 1, though the stop frequency is above 3.6 GHz, preventing a Band 0 sweep without band crossing. With a span greater than 160 MHz, a band crossing will be required: the analyzer sweeps up to 3.6 GHz in Band 0; then executes a band crossing and continues the sweep in Band 1.
   Specifications are given separately for each band in the band overlap regions. One of these specifications is for the preferred band, and one for the alternate band. Continuing with the example from the previous paragraph (3.58 GHz), the preferred band is band 0 (indicated as frequencies under 3.6 GHz) and the alternate band is band 1 (3.5 to 8.4 GHz). The specifications for the preferred band are warranted. The specifications for the alternate band are not warranted in the band overlap region, but performance is nominally the same as those warranted specifications in the rest of the band. Again, in this example, consider a signal at 3.58 GHz. If the sweep has been configured so that the signal at 3.58 GHz is measured in Band 1, the analysis behavior is nominally as stated in the Band 1 specification line (3.5 to 8.4 GHz) but is not warranted. If warranted performance is necessary for this signal, the sweep should be reconfigured so that analysis occurs in Band 0. Another way to express this situation in this example Band 0/Band 1 crossing is this: The specifications given in the “Specifications” column which are described as “3.5 to 8.4 GHz” represent nominal performance from 3.5 to 3.6 GHz, and warranted performance from 3.6 to 8.4 GHz.
c. Band 0 is extendable (set “Extend Low Band” to On) to 3.7 GHz instead of 3.6 GHz in instruments with frequency option 508, 513 or 526 and with firmware of version A.16.17 or later.

Description	Specifications	Supplemental Information
Precision Frequency Reference		
Accuracy	±[(time since last adjustment x aging rate) + temperature stability + calibration accuracy[a]][b]	
Temperature Stability		
Full temperature range	$\pm 4.5 \times 10^{-9}$	
Aging Rate		$\pm 2.5 \times 10^{-10}$/day (nominal)
Total Aging		
1 Year	$\pm 3 \times 10^{-8}$	
Settability	$\pm 4 \times 10^{-11}$	
Warm-up and Retrace[c]		Nominal
300 s after turn on		$\pm 1 \times 10^{-7}$ of final frequency
600 s after turn on		$\pm 1 \times 10^{-8}$ of final frequency
Achievable Initial Calibration Accuracy[d]	$\pm 3.1 \times 10^{-8}$	
Standby power		Standby power is supplied to both the CPU and the frequency reference oscillator.
Residual FM (Center Frequency = 1 GHz 10 Hz RBW, 10 Hz VBW)		≤0.25 Hz × N[e] p-p in 20 ms (nominal)

a. Calibration accuracy depends on how accurately the frequency standard was adjusted to 10 MHz. If the adjustment procedure is followed, the calibration accuracy is given by the specification "Achievable Initial Calibration Accuracy."
b. The specification applies after the analyzer has been powered on for four hours.
c. Standby mode applies power to the oscillator. Therefore warm-up and retrace only apply if the power connection is lost and restored. The warm-up reference is one hour after turning the power on. The effect of retracing is included within the "Achievable Initial Calibration Accuracy" term of the Accuracy equation.
d. The achievable calibration accuracy at the beginning of the calibration cycle includes these effects:
1) Temperature difference between the calibration environment and the use environment
2) Orientation relative to the gravitation field changing between the calibration environment and the use environment
3) Retrace effects in both the calibration environment and the use environment due to turning the instrument power off.
4) Settability
e. N is the LO multiplication factor.

Description	Specifications	Supplemental Information
Frequency Readout Accuracy	±(marker freq × freq ref accy + 0.10% × span + 5% × RBW[a] + 2 Hz + 0.5 × horizontal resolution[b])	Single detector only[c]
Example for EMC[d]		±0.0032% (nominal)

a. The warranted performance is only the sum of all errors under autocoupled conditions. Under non-autocoupled conditions, the frequency readout accuracy will nominally meet the specification equation, except for conditions in which the RBW term dominates, as explained in examples below. The nominal RBW contribution to frequency readout accuracy is 2% of RBW for RBWs from 1 Hz to 390 kHz, 4% of RBW from 430 kHz through 3 MHz (the widest autocoupled RBW), and 30% of RBW for the (manually selected) 4, 5, 6 and 8 MHz RBWs.
First example: a 120 MHz span, with autocoupled RBW. The autocoupled ratio of span to RBW is 106:1, so the RBW selected is 1.1 MHz. The 5% × RBW term contributes only 55 kHz to the total frequency readout accuracy, compared to 120 kHz for the 0.10% × span term, for a total of 175 kHz.
Second example: a 20 MHz span, with a 4 MHz RBW. The specification equation does not apply because the Span: RBW ratio is not autocoupled. If the equation did apply, it would allow 20 kHz of error (0.10%) due to the span and 200 kHz error (5%) due to the RBW. For this non-autocoupled RBW, the RBW error is nominally 30%, or 1200 kHz.

b. Horizontal resolution is due to the marker reading out one of the trace points. The points are spaced by span/(Npts – 1), where Npts is the number of sweep points. For example, with the factory preset value of 1001 sweep points, the horizontal resolution is span/1000. However, there is an exception: When both the detector mode is “normal” and the span > 0.25 × (Npts – 1) × RBW, peaks can occur only in even-numbered points, so the effective horizontal resolution becomes doubled, or span/500 for the factory preset case. When the RBW is autocoupled and there are 1001 sweep points, that exception occurs only for spans >750 MHz

c. Specifications apply to traces in most cases, but there are exceptions. Specifications always apply to the peak detector. Specifications apply when only one detector is in use and all active traces are set to Clear Write. Specifications also apply when only one detector is in use in all active traces and the "Restart" key has been pressed since any change from the use of multiple detectors to a single detector. In other cases, such as when multiple simultaneous detectors are in use, additional errors of 0.5, 1.0 or 1.5 sweep points will occur in some detectors, depending on the combination of detectors in use.

d. In most cases, the frequency readout accuracy of the analyzer can be exceptionally good. As an example, Keysight has characterized the accuracy of a span commonly used for Electro-Magnetic Compatibility (EMC) testing using a source frequency locked to the analyzer. Ideally, this sweep would include EMC bands C and D and thus sweep from 30 to 1000 MHz. Ideally, the analysis bandwidth would be 120 kHz at –6 dB, and the spacing of the points would be half of this (60 kHz). With a start frequency of 30 MHz and a stop frequency of 1000.2 MHz and a total of 16168 points, the spacing of points is ideal. The detector used was the Peak detector. The accuracy of frequency readout of all the points tested in this span was with ±0.0032% of the span. A perfect analyzer with this many points would have an accuracy of ±0.0031% of span. Thus, even with this large number of display points, the errors in excess of the bucket quantization limitation were negligible.

Description	Specifications	Supplemental Information
Frequency Counter[a]		See note[b]
Count Accuracy	±(marker freq × freq ref accy. + 0.100 Hz)	
Delta Count Accuracy	±(delta freq. × freq ref accy. + 0.141 Hz)	
Resolution	0.001 Hz	

a. Instrument conditions: RBW = 1 kHz, gate time = auto (100 ms), S/N ≥ 50 dB, frequency = 1 GHz
b. If the signal being measured is locked to the same frequency reference as the analyzer, the specified count accuracy is ±0.100 Hz under the test conditions of footnote a. This error is a noisiness of the result. It will increase with noisy sources, wider RBWs, lower S/N ratios, and source frequencies > 1 GHz.

Description	Specifications	Supplemental Information
Frequency Span		
Range		
Option 508	0 Hz, 10 Hz to 8.4 GHz	
Option 513	0 Hz, 10 Hz to 13.6 GHz	
Option 526	0 Hz, 10 Hz to 26.5 GHz	
Option 544	0 Hz, 10 Hz to 44 GHz	
Option 550	0 Hz, 10 Hz to 50 GHz	
Resolution	2 Hz	
Span Accuracy		
Swept	±(0.1% × span + horizontal resolution[a])	
FFT	±(0.1% × span + horizontal resolution[a])	

a. Horizontal resolution is due to the marker reading out one of the sweep points. The points are spaced by span/(Npts – 1), where Npts is the number of sweep points. For example, with the factory preset value of 1001 sweep points, the horizontal resolution is span/1000. However, there is an exception: When both the detector mode is “normal” and the span > 0.25 × (Npts – 1) × RBW, peaks can occur only in even-numbered points, so the effective horizontal resolution becomes doubled, or span/500 for the factory preset case. When the RBW is auto coupled and there are 1001 sweep points, that exception occurs only for spans >750 MHz.

Description	Specifications	Supplemental Information
Sweep Time and Trigger		
Sweep Time Range		
Span = 0 Hz	1 μs to 6000 s	
Span ≥ 10 Hz	1 ms to 4000 s	
Sweep Time Accuracy		
Span ≥ 10 Hz, swept		±0.01% (nominal)
Span ≥ 10 Hz, FFT		±40% (nominal)
Span = 0 Hz		±0.01% (nominal)
Sweep Trigger	Free Run, Line, Video, External 1, External 2, RF Burst, Periodic Timer	
Delayed Trigger[a]		
Range		
Span ≥ 10 Hz	–150 to 500 ms	
Span = 0 Hz	–10 s to +500 ms[b]	
Resolution	0.1 μs	

a. Delayed trigger is available with line, video, RF burst and external triggers.
b. Prior to A.19.28 software, zero span trigger delay was limited to -150 ms to 500 ms.

Description	Specifications	Supplemental Information
Triggers		Additional information on some of the triggers and gate sources
Video		Independent of Display Scaling and Reference Level
Minimum settable level	–170 dBm	Useful range limited by noise
Maximum usable level		Highest allowed mixer level[a] + 2 dB (nominal)
Detector and Sweep Type relationships		
Sweep Type = Swept		
Detector = Normal, Peak, Sample or Negative Peak		Triggers on the signal before detection, which is similar to the displayed signal
Detector = Average		Triggers on the signal before detection, but with a single-pole filter added to give similar smoothing to that of the average detector
Sweep Type = FFT		Triggers on the signal envelope in a bandwidth wider than the FFT width
RF Burst		
Level Range		–40 to –10 dBm plus attenuation (nominal)[b]
Level Accuracy[c]		
Absolute		±2 dB + Absolute Amplitude Accuracy (nominal)
Relative		±2 dB (nominal)
Bandwidth (–10 dB)		
Most cases[d]		>80 MHz (nominal)
Start Freq <300 MHz, RF Burst Level Type = Absolute		
Sweep Type = Swept		16 MHz (nominal)
Sweep Type = FFT FFT Width > 25 MHz; FFT Width 8 to 25 MHz; FFT Width < 8 MHz		 >80 MHz (nominal) 30 MHz (nominal) 16 MHz (nominal)
Frequency Limitations		If the start or center frequency is too close to zero, LO feedthrough can degrade or prevent triggering. How close is too close depends on the bandwidth listed above.

Description	Specifications	Supplemental Information
External Triggers		See “Trigger Inputs” on page 78
TV Triggers		Triggers on the leading edge of the selected sync pulse of standardized TV signals.
Amplitude Requirements		–65 dBm minimum video carrier power at the input mixer, nominal
Compatible Standards	NTSC-M, NTSC-Japan, NTSC-4.43, PAL-M, PAL-N, PAL-N Combination, PAL-B/-D/-G/-H/-I. PAL-60, SECAM-L	
Field Selection	Entire Frame, Field One, Field Two	
Line Selection	1 to 525, or 1 to 625, standard dependent	

a. The highest allowed mixer level depends on the IF Gain. It is nominally –10 dBm for Preamp Off and IF Gain = Low.
b. Noise will limit trigger level range at high frequencies, such as above 15 GHz.
c. With positive slope trigger. Trigger level with negative slope is nominally 1 to 4 dB lower than positive slope.
d. Include RF Burst Level Type = Relative.

Description	Specifications	Supplemental Information
Gated Sweep		
Gate Methods	Gated LO Gated Video Gated FFT	
Span Range	Any span	
Gate Delay Range	0 to 100.0 s	
Gate Delay Settability	4 digits, ≥100 ns	
Gate Delay Jitter		33.3 ns p-p (nominal)
Gate Length Range (Except Method = FFT)	1 μs to 5.0 s	Gate length for the FFT method is fixed at 1.83/RBW, with nominally 2% tolerance.
Gated FFT and Gated Video Frequency and Amplitude Errors		Nominally no additional error for gated measurements when the Gate Delay is greater than the MIN FAST setting
Gated LO Frequency Errors		
Gate ≥ 10 μs		Nominally no additional error when the Gate Delay is greater than the MIN FAST setting
1.0 μs ≤ Gate < 10 μs		Nominal error given by 100 ns × N × (Span/ST) × √(SpanPosition × ST / GateLength); see footnote[a]
Gated LO Amplitude Errors		Nominally no additional error when the Gate Delay is greater than the MIN FAST setting
Phase Noise Effects		Gated LO method overrides the loop configuration to force single loop in place of dual loop.
Gate Sources	External 1 External 2 Line RF Burst Periodic	Pos or neg edge triggered

a. ST is sweep time; SpanPosition is the location of the on-screen signal, 0 being the left edge of the screen and 1 being the right edge. N is the harmonic mixing number.

Description	Specifications	Supplemental Information
Number of Frequency Sweep Points (buckets)		
Factory preset	1001	
Range	1 to 100,001	Zero and non-zero spans

Description		Specifications	Supplemental Information
Resolution Bandwidth (RBW)			
Range (–3.01 dB bandwidth) Standard		1 Hz to 10 MHz[a] Bandwidths above 3 MHz are 4, 5, 6, 8, and 10 MHz.[a] Bandwidths 1 Hz to 3 MHz are spaced at 10% spacing using the E24 series (24 per decade): 1.0, 1.1, 1.2, 1.3, 1.5, 1.6, 1.8, 2.0, 2.2, 2.4, 2.7, 3.0, 3.3, 3.6, 3.9, 4.3, 4.7, 5.1, 5.6, 6.2, 6.8, 7.5, 8.2, 9.1 in each decade.	
With *Option B2X*, *B5X*, or *H1G* and *Option RBE*[b]		10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 100, 133, 150, 200, and 212 MHz, in Spectrum Analyzer mode and zero span.	
Power bandwidth accuracy[c]			
RBW Range	**CF Range**		
1 Hz to 100 kHz	All	±0.5% (0.022 dB)	
110 kHz to 1.0 MHz	< 3.6 GHz	±1.0% (0.044 dB)	
1.1 to 2.0 MHz	< 3.6 GHz		±0.07 dB (nominal)
2.2 to 3 MHz	< 3.6 GHz		0 to –0.2 dB (nominal)
4 to 10 MHz[a]	< 3.6 GHz		0 to –0.4 dB (nominal)
Noise BW to RBW ratio[d]			1.056 ±2% (nominal)
Accuracy (–3.01 dB bandwidth)[e]			
1 Hz to 1.3 MHz RBW			±2% (nominal)
1.5 MHz to 3 MHz RBW CF ≤ 3.6 GHz CF > 3.6 GHz			 ±7% (nominal) ±8% (nominal)
4 MHz to 10 MHz RBW[a] CF ≤ 3.6 GHz CF > 3.6 GHz			 ±15% (nominal) ±20% (nominal)
Selectivity (–60 dB/–3 dB)			4.1:1 (nominal)

a. The 10 MHz RBW setting is only available on analyzers with instrument software version ≥ A.30.05 and which also have option FS1 installed. Otherwise, the maximum RBW setting is 8 MHz.
b. Option RBE enables wider bandwidth filters in zero span in the Signal Analyzer mode. Available detectors are Peak+ and Average. VBW filtering is disabled. Minimum sweep time is the greater of 200 µS or 200ns/pt. The filter shape is approximately square. Support for Average detector was first added in SW Version A.23.05.

c. The noise marker, band power marker, channel power and ACP all compute their results using the power bandwidth of the RBW used for the measurement. Power bandwidth accuracy is the power uncertainty in the results of these measurements due only to bandwidth-related errors. (The analyzer knows this power bandwidth for each RBW with greater accuracy than the RBW width itself, and can therefore achieve lower errors.) The warranted specifications shown apply to the Gaussian RBW filters used in swept and zero span analysis. There are four different kinds of filters used in the spectrum analyzer: Swept Gaussian, Swept Flattop, FFT Gaussian and FFT Flattop. While the warranted performance only applies to the swept Gaussian filters, because only they are kept under statistical process control, the other filters nominally have the same performance.
d. The ratio of the noise bandwidth (also known as the power bandwidth) to the RBW has the nominal value and tolerance shown. The RBW can also be annotated by its noise bandwidth instead of this 3 dB bandwidth. The accuracy of this annotated value is similar to that shown in the power bandwidth accuracy specification.
e. Resolution Bandwidth Accuracy can be observed at slower sweep times than auto-coupled conditions. Normal sweep rates cause the shape of the RBW filter displayed on the analyzer screen to widen significantly. The true bandwidth, which determines the response to impulsive signals and noise-like signals, is not affected by the sweep rate.

Description	Specification	Supplemental information
Analysis Bandwidth[a]		
With *Option B25* (standard)	25 MHz	
With *Option B40*	40 MHz	
With *Option B2X*	255 MHz	
With *Option B5X*	510 MHz	

a. Analysis bandwidth is the instantaneous bandwidth available about a center frequency over which the input signal can be digitized for further analysis or processing in the time, frequency, or modulation domain.

Description	Specifications	Supplemental Information	
Preselector Bandwidth			
Mean Bandwidth at CF[a]		**Freq *Option* ≤ *526***	**Freq *Option* > *526***
5 GHz		58 MHz	46 MHz
10 GHz		57 MHz	52 MHz
15 GHz		59 MHz	53MHz
20 GHz		64 MHz	55 MHz
25 GHz		74 MHz	56 MHz
35 GHz			62 MHz
44 GHz			70 MHz
Standard Deviation		9%	7%
–3 dB Bandwidth		–7.5% relative to –4 dB bandwidth, nominal	

a. The preselector can have a significant passband ripple. To avoid ambiguous results, the –4 dB bandwidth is characterized.

Description	Specifications	Supplemental Information
Video Bandwidth (VBW)		
Range	Same as Resolution Bandwidth range plus wide-open VBW (labeled 50 MHz)	
Accuracy		±6% (nominal) in swept mode and zero span[a]

a. For FFT processing, the selected VBW is used to determine a number of averages for FFT results. That number is chosen to give roughly equivalent display smoothing to VBW filtering in a swept measurement. For example, if VBW = 0.1 × RBW, four FFTs are averaged to generate one result.

Amplitude Accuracy and Range

Description	Specifications	Supplemental Information
Measurement Range		
Preamp Off	Displayed Average Noise Level to +30 dBm	
Preamp On	Displayed Average Noise Level to +24 dBm	*Options P08, P13, P26, P44, P50*
Input Attenuation Range	0 to 70 dB, in 2 dB steps	

Description	Specifications	Supplemental Information
Maximum Safe Input Level		Applies with or without preamp *(Options P08, P13, P26, P44, P50)*
Average Total Power	+30 dBm (1 W)	
Peak Pulse Power (≤10 μs pulse width, ≤1% duty cycle, input attenuation ≥ 30 dB)	+50 dBm (100 W)	
DC voltage		
DC Coupled	±0.2 Vdc	
AC Coupled	±100 Vdc	

Description	Specifications	Supplemental Information
Display Range		
Log Scale	Ten divisions displayed; 0.1 to 1.0 dB/division in 0.1 dB steps, and 1 to 20 dB/division in 1 dB steps	
Linear Scale	Ten divisions	

Description	Specifications	Supplemental Information
Marker Readout		
Resolution		
Log (decibel) units		
Trace Averaging Off, on-screen	0.01 dB	
Trace Averaging On or remote	0.001 dB	
Linear units resolution		≤1% of signal level (nominal)

Frequency Response

Description	*Option 508*, *513*, or *526* (µW)	*Option 544* or *550* (mmW)	Specifications 20 to 30°C	Specifications Full range	Supplemental Information
Frequency Response (Maximum error relative to reference condition (50 MHz) Mechanical attenuator only[b], Swept operation[c], LNP off[d], Attenuation 10 dB)					Refer to the footnote for Band Overlaps on page 17. Freq *Option 526* only: Modes above 18 GHz[a]
			20 to 30°C	**Full range**	**95th Percentile** (≈2σ)
3 Hz to 10 MHz	x	x	±0.46 dB	±0.54 dB	
10 to 20 MHz	x		±0.35 dB	±0.44 dB	±0.19 dB
10 to 20 MHz		x	±0.46 dB	±0.54 dB	±0.20 dB
20 to 50 MHz[e]	x		±0.35 dB	±0.44 dB	±0.19 dB
20 to 50 MHz		x	±0.35 dB	±0.44 dB	±0.20 dB
50 MHz to 3.6 GHz	x		±0.35 dB	±0.44 dB	±0.14 dB
50 MHz to 3.6 GHz		x	±0.35 dB	±0.47 dB	±0.16 dB
3.6 to 3.7 GHz (Band 0)	x				See note[f]
3.5 to 5.2 GHz[gh]	x		±1.5 dB	±2.5 dB	±0.50 dB
3.5 to 5.2 GHz[gh]		x	±1.7 dB	±3.5 dB	±0.69 dB
5.2 to 8.4 GHz[gh]	x		±1.5 dB	±2.5 dB	±0.42 dB
5.2 to 8.4 GHz[gh]		x	±1.5 dB	±2.5 dB	±0.42 dB
8.3 to 13.6 GHz[gh]	x		±2.0 dB	±2.7 dB	±0.51 dB
8.3 to 13.6 GHz[gh]		x	±2.0 dB	±2.5 dB	±0.39 dB
13.5 to 17.1 GHz[gh]	x		±2.0 dB	±2.7 dB	±0.57 dB
13.5 to 17.1 GHz[gh]		x	±2.0 dB	±2.7 dB	±0.54 dB
17.0 to 22 GHz[gh]	x		±2.0 dB	±2.7 dB	±0.65 dB
17.0 to 22 GHz[gh]		x	±2.0 dB	±2.8 dB	±0.62 dB

Description			Specifications		Supplemental Information
22.0 to 26.5 GHz[g,h]	x		±2.5 dB	±3.7 dB	±0.87 dB
22.0 to 26.5 GHz[g,h]		x	±2.5 dB	±3.5 dB	±0.59 dB
26.4 to 34.5 GHz[g,h]		x	±2.5 dB	±3.6 dB	±0.93 dB
34.4 to 50 GHz[g,h]		x	±3.2 dB	±4.9 dB	±1.28 dB

a. Signal frequencies above 18 GHz are prone to additional response errors due to modes in the Type-N connector used. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes.With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. The effect of these modes with this connector are included within these specifications.
b. See the Electronic Attenuator (*Option EA3*) chapter for Frequency Response using the electronic attenuator.
c. For Sweep Type = FFT, add the RF flatness errors of this table to the IF Frequency Response errors. An additional error source, the error in switching between swept and FFT sweep types, is nominally ±0.01 dB and is included within the "Absolute Amplitude Error" specifications.
d. Refer to LNP Chapter for the frequency response specifications with LNP on.
e. Specifications apply with DC coupling at all frequencies. With AC coupling, specifications apply at frequencies of 50 MHz and higher. Statistical observations at 10 MHz and lower show that most instruments meet the specifications, but a few percent of instruments can be expected to have errors that, while within the specified limits, are closer to those limits than the measurement uncertainty guardband, and thus are not warranted. The AC coupling effect at 20 to 50 MH is negligible, but not warranted.
f. Band 0 is extendable (set "Extend Low Band" to On) to 3.7 GHz instead of 3.6 GHz in instruments with frequency *Option 508*, *513* or *526* and with firmware of version A.16.17 or later. Subject to these conditions, statistical observations show that performance nominally fits within the same range within the 3.6 to 3.7 GHz frequencies as within the next lower specified frequency range, but is not warranted.
g. Specifications for frequencies >3.5 GHz apply for sweep rates ≤100 MHz/ms.
h. Preselector centering applied when preselector is not bypassed. Refer to Option MPB – Microwave Preselector Bypass chapter for performance affected by bypassing the preselector.

Description			Specifications	Supplemental Information		
IF Frequency Response[a]				Freq *Option 526* only: Modes above 18 GHz[b]		
(Demodulation and FFT response relative to the center frequency)						
Center Freq (GHz)	**Span**[c] **(MHz)**	**Preselector**	**Max Error**[d]	**Midwidth Error (95th Percentile)**	**Slope (dB/MHz) (95th Percentile)**	**RMS**[e] **(nominal)**
<3.6	≤10		±0.20 dB	±0.12 dB	±0.10	0.02 dB
≥3.6, ≤26.5	≤10	On				0.23 dB
≥3.6, ≤26.5	≤10	Off[f]	±0.25 dB	±0.12 dB	±0.10	0.02 dB
>26.5, ≤50	≤10	On				0.12 dB
>26.5, ≤50	≤10	Off[f]	±0.30 dB	±0.12 dB	±0.10	0.024 dB

a. The IF frequency response includes effects due to RF circuits such as input filters, that are a function of RF frequency, in addition to the IF passband effects.
b. Signal frequencies above 18 GHz are prone to additional response errors due to modes in the Type-N connector used. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes.With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to –0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
c. This column applies to the instantaneous analysis bandwidth in use. In the Spectrum Analyzer Mode, this would be the FFT width.
d. The maximum error at an offset (f) from the center of the FFT width is given by the expression ± [Midwidth Error + (f × Slope)], but never exceeds ±Max Error. Here the Midwidth Error is the error at the center frequency for a given FFT span. Usually, the span is no larger than the FFT width in which case the center of the FFT width is the center frequency of the analyzer. When using the Spectrum Analyzer mode with an analyzer span is wider than the FFT width, the span is made up of multiple concatenated FFT results, and thus has multiple centers of FFT widths; in this case the f in the equation is the offset from the nearest center. Performance is nominally three times better at most center frequencies.
e. The “rms” nominal performance is the standard deviation of the response relative to the center frequency, integrated across the span. This performance measure was observed at a center frequency in each harmonic mixing band, which is representative of all center frequencies; it is not the worst case frequency.
f. Standard *Option MPB* is enabled.

Description			Specifications	Supplemental Information	
IF Phase Linearity				Deviation from mean phase linearity Freq *Option 526* only: Modes above 18 GHz[a]	
Center Freq (GHz)	**Span (MHz)**	**Preselector**		**Peak-to-peak** (nominal)	**RMS** (nominal)[b]
≥0.02, <3.6	≤10	n/a		0.14°	0.032°
≥3.6	≤10	Off[c]		0.27°	0.057°
≥3.6	≤10	On		0.93°	0.22°

a. Signal frequencies above 18 GHz are prone to additional response errors due to modes in the Type-N connector used. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes.With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to –0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.

b. The listed performance is the standard deviation of the phase deviation relative to the mean phase deviation from a linear phase condition, where the rms is computed across the span shown and over the range of center frequencies shown.

c. Standard *Option MPB* is enabled.

Description	Specifications	Supplemental Information
Absolute Amplitude Accuracy		
At 50 MHz[a]		
20 to 30°C	±0.24 dB	±0.13 dB (95th percentile)
Full temperature range	±0.28 dB	
At all frequencies[a]		
20 to 30°C	±(0.24 dB + frequency response)	
Full temperature range	±(0.28 dB + frequency response)	
95th Percentile Absolute Amplitude Accuracy[b]		
(Wide range of signal levels, RBWs, RLs, etc., 0.01 to 3.6 GHz)		
Atten = 10 dB		±0.16 dB
Atten = 10, 20, 30, or 40 dB		±0.18 dB
Amplitude Reference Accuracy		±0.05 dB (nominal)
Preamp On[c] *(P08, P13, P26, P44, P50*)	±(0.36 dB + frequency response)	

a. Absolute amplitude accuracy is the total of all amplitude measurement errors, and applies over the following subset of settings and conditions: 1 Hz ≤ RBW ≤ 1 MHz; Input signal –10 to –50 dBm (details below); Input attenuation 10 dB; span < 5 MHz (nominal additional error for span ≥ 5 MHz is 0.02 dB); all settings auto-coupled except Swp Time Rules = Accuracy; combinations of low signal level and wide RBW use VBW ≤ 30 kHz to reduce noise. When using FFT sweeps, the signal must be at the center frequency.
This absolute amplitude accuracy specification includes the sum of the following individual specifications under the conditions listed above: Scale Fidelity, Reference Level Accuracy, Display Scale Switching Uncertainty, Resolution Bandwidth Switching Uncertainty, 50 MHz Amplitude Reference Accuracy, and the accuracy with which the instrument aligns its internal gains to the 50 MHz Amplitude Reference.
The only difference between signals within the range above –50 dBm and those signals below that level is the scale fidelity. Our specifications and experience show no difference between signals above and below this level. The only reason our Absolute Amplitude Uncertainty specification does not go below this level is that noise detracts from our ability to verify the performance at all levels with acceptable test times and yields. So the performance is not warranted at lower levels, but we fully expect it to be the same.

b. Absolute Amplitude Accuracy for a wide range of signal and measurement settings, covers the 95th percentile proportion with 95% confidence. Here are the details of what is covered and how the computation is made: The wide range of conditions of RBW, signal level, VBW, reference level and display scale are discussed in footnote a. There are 44 quasi-random combinations used, tested at a 50 MHz signal frequency. We compute the 95th percentile proportion with 95% confidence for this set observed over a statistically significant number of instruments. Also, the frequency response relative to the 50 MHz response is characterized by varying the signal across a large number of quasi-random verification frequencies that are chosen to not correspond with the frequency response adjustment frequencies. We again compute the 95th percentile proportion with 95% confidence for this set observed over a statistically significant number of instruments. We also compute the 95th percentile accuracy of tracing the calibration of the 50 MHz absolute amplitude accuracy to a national standards organization. We also compute the 95th percentile accuracy of tracing the calibration of the relative frequency response to a national standards organization. We take the root-sum-square of these four independent Gaussian parameters. To that rss we add the environmental effects of temperature variations across the 20 to 30°C range. These computations and measurements are made with the mechanical attenuator only in circuit, set to the reference state of 10 dB.
A similar process is used for computing the result when using the electronic attenuator under a wide range of settings: all even settings from 4 through 24 dB inclusive, with the mechanical attenuator set to 10 dB. The 95th percentile result was 0.21 dB.

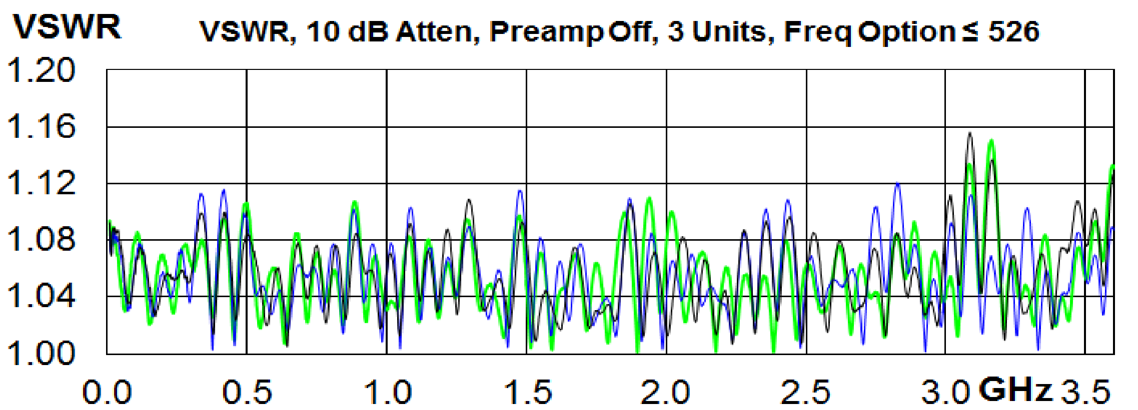
c. Same settings as footnote a, except that the signal level at the preamp input is –40 to –80 dBm. Total power at preamp (dBm) = total power at input (dBm) minus input attenuation (dB). This specification applies for signal frequencies above 100 kHz.

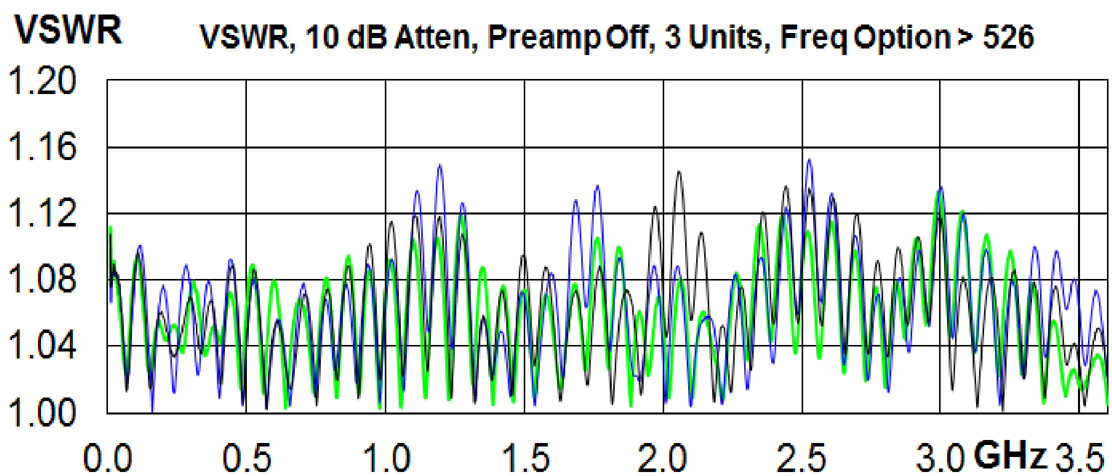
Description	Specifications	Supplemental Information
Input Attenuation Switching Uncertainty		Refer to the footnote for Band Overlaps on page 17
(Relative to 10 dB (reference setting))		
50 MHz (reference frequency), preamp off		
Attenuation 12 to 40 dB	±0.14 dB	±0.04 dB (typical)
Attenuation 2 to 8 dB, or > 40 dB	±0.18 dB	±0.06 dB (typical)
Attenuation 0 dB		±0.05 dB (nominal)
Attenuation >2 dB, preamp off		
3 Hz to 3.6 GHz		±0.3 dB (nominal)
3.5 to 8.4 GHz		±0.5 dB (nominal)
8.3 to 13.6 GHz		±0.7 dB (nominal)
13.5 to 26.5 GHz		±0.7 dB (nominal)
26.5 to 50 GHz		±1.0 dB (nominal)

Description	Specifications	Supplemental Information	
RF Input VSWR			
(at tuned frequency, DC coupled)			
10 dB atten. 50 MHz (ref condition)		1.07:1 (nominal)	
0 dB atten. 0.01 to 3.6 GHz		< 2.2:1 (nominal)	
		95th Percentile[a]	
		RF/μW	mmW
Band 0 (0.01 to 3.6 GHz,10 dB atten)		1.101	1.116
Band 1 (3.5 to 8.4 GHz,10 dB atten)		1.278	1.144
Band 2 (8.3 to 13.6 GHz,10 dB atten)		1.341	1.158
Band 3 (13.5 to 17.1 GHz,10 dB atten)		1.58	1.258
Band 4 (17.0 to 26.5 GHz,10 dB atten)		1.560	1.233
Band 5 (26.4 to 34.5 GHz,10 dB atten)			1.363
Band 6 (34.4 to 50 GHz,10 dB atten)			1.55
Nominal VSWR vs. Freq, 10 dB		See plots following	
Atten. > 10 dB		Similar to atten. = 10 dB	
RF Calibrator (e.g. 50 MHz) is On		Open input	
Alignments running		Open input for some, unless "All but RF" is selected	
Preselector centering		Open input	

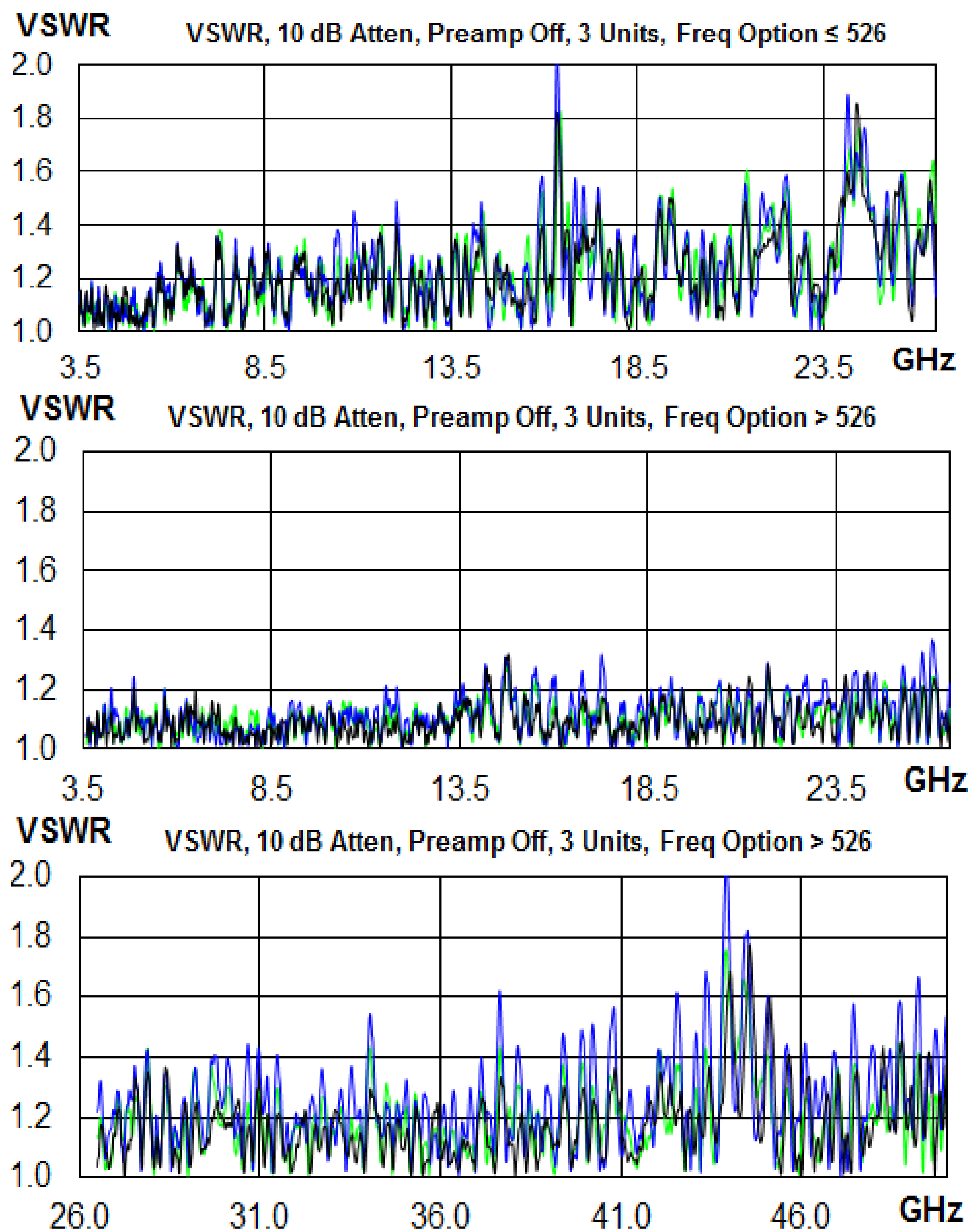
a. X-Series analyzers have a reflection coefficient that is excellently modeled with a Rayleigh probability distribution. Keysight recommends using the methods outlined in Application Note 1449-3 and companion Average Power Sensor Measurement Uncertainty Calculator to compute mismatch uncertainty. Use this 95th percentile VSWR information and the Rayleigh model (Case C or E in the application note) with that process.

Nominal VSWR Band [Plot]





Nominal VSWR, above 3.5 GHz [Plot]



Description	Specifications	Supplemental Information
Resolution Bandwidth Switching Uncertainty		Relative to reference BW of 30 kHz, verified in low band[a]
1.0 Hz to 1.5 MHz RBW	±0.03 dB	
1.6 MHz to 2.7 MHz RBW	±0.05 dB	
3.0 MHz RBW	±0.10 dB	
Manually selected wide RBWs: 4, 5, 6, 8, 10 MHz[b]	±0.30 dB	

a. RBW switching uncertainty is verified at 50 MHz. It is consistent for all measurements made without the preselector, thus in Band 0 and also in higher bands with the Preselector Bypass option. In preselected bands, the slope of the preselector passband can interact with the RBW shape to make an apparent additional RBW switching uncertainty of nominally ±0.05 dB/MHz times the RBW.

b. The 10 MHz RBW setting is only available on analyzers with instrument software version ≥ A.30.05 and which also have option FS1 installed. Otherwise, the maximum RBW setting is 8 MHz.

Description	Specifications	Supplemental Information
Reference Level		
Range		
Log Units	–170 to +30 dBm, in 0.01 dB steps	
Linear Units	707 pV to 7.07 V, with 0.01 dB resolution (0.11%)	
Accuracy	0 dB[a]	

a. Because reference level affects only the display, not the measurement, it causes no additional error in measurement results from trace data or markers.

Description	Specifications	Supplemental Information
Display Scale Switching Uncertainty		
Switching between Linear and Log	0 dB[a]	
Log Scale Switching	0 dB[a]	

a. Because Log/Lin and Log Scale Switching affect only the display, not the measurement, they cause no additional error in measurement results from trace data or markers.

Description	Specifications	Supplemental Information
Display Scale Fidelity[a,b]		
Absolute Log-Linear Fidelity (Relative to the reference condition: –25 dBm input through 10 dB attenuation, thus –35 dBm at the input mixer)		
Input mixer level[c]	**Linearity**	Typical
-18 dBm ≤ ML ≤ -10 dBm	±0.10 dB	±0.04 dB
ML < –18 dBm	±0.07 dB	±0.02 dB
Relative Fidelity[d]		Applies for mixer level[c] range from –10 to –80 dBm, mechanical attenuator only, preamp off, and dither on.
Sum of the following terms:		Nominal
high level term		Up to ±0.015 dB[e]
instability term		0.0019 dBrms[f]
slope term		From equation[g]
prefilter term		Up to ±0.005 dB[h]

a. Supplemental information: The amplitude detection linearity specification applies at all levels below –10 dBm at the input mixer; however, noise will reduce the accuracy of low level measurements. The amplitude error due to noise is determined by the signal-to-noise ratio, S/N. If the S/N is large (20 dB or better), the amplitude error due to noise can be estimated from the equation below, given for the 3-sigma (three standard deviations) level.

$$3\sigma = 3(20dB)\log\langle 1 + 10^{-((S/N + 3dB)/20dB)}\rangle$$

The errors due to S/N ratio can be further reduced by averaging results. For large S/N (20 dB or better), the 3-sigma level can be reduced proportional to the square root of the number of averages taken.

b. The scale fidelity is warranted with ADC dither set to Medium. Dither increases the noise level by nominally only 0.28 dB for the most sensitive case (preamp Off, best DANL frequencies). With dither Off, scale fidelity for low level signals, around –60 dBm or lower, will nominally degrade by 0.2 dB. Dither High will give exceptional linear relative scale fidelity, but increase DANL by 0.63 dB instead of 0.28 dB.

c. Mixer level = Input Level – Input Attenuation

d. The relative fidelity is the error in the measured difference between two signal levels. It is so small in many cases that it cannot be verified without being dominated by measurement uncertainty of the verification. Because of this verification difficulty, this specification gives nominal performance, based on numbers that are as conservatively determined as those used in warranted specifications. We will consider one example of the use of the error equation to compute the nominal performance.
Example: the accuracy of the relative level of a sideband around –60 dBm, with a carrier at –5 dBm, using attenuation = 10 dB, RBW = 3 kHz, evaluated with swept analysis. The high level term is evaluated with P1 = –15 dBm and P2 = –70 dBm at the mixer. This gives a maximum error within ±0.008 dB. The instability term is ±0.0019 dB if the measurement is completed within a minute. The slope term evaluates to ±0.022 dB. The prefilter term applies and evaluates to the limit of ±0.005 dB. The sum of all these terms is ±0.037 dB.

e. Errors at high mixer levels will nominally be well within the range of ±0.015 dB × {exp[(P1 – Pref)/(8.69 dB)] – exp[(P2 – Pref)/(8.69 dB)]} (exp is the natural exponent function, e^x). In this expression, P1 and P2 are the powers of the two signals, in decibel units, whose relative power is being measured. Pref is –10 dBm (–10 dBm is the highest power for which linearity is specified). All these levels are referred to the mixer level.
f. The stability of the analyzer gain can be an error term of importance when no settings have changed. These have been studied carefully in the UXA. One source of instability is the variation in analyzer response with time when fully warmed up in a stable lab environment. This has been observed to be well modeled as a random walk process, where the difference in two measurements spaced by time t is given by a × sqrt(t), where a is 0.0019 dBrms per root minute. The other source of instability is updated alignments from running full or partial alignments in the background or invoking an alignment. Invoked alignments (Align Now, All) have a standard deviation of 0.0018 dB, and performing these will restart the random walk behavior. Partial alignments (Auto Align set to "Partial") have a standard deviation that is, coincidentally, also 0.0018 dBrms, and only occurs once every ten minutes. The standard deviation from full background alignment (Auto Align set to "Normal") is 0.015 dBrms; with these alignments on, there is no additional random walk behavior. (Keysight recommends setting alignments (Auto Align) to Normal in order to make the best measurements over long periods of time or in environments without very high temperature stability. For short term measurements in highly stable environments, setting alignments to Partial can give the best stability. Setting Alignments to Off is not recommended where stability matters.)
g. Slope error will nominally be well within the range of ±0.0004 × (P1 – P2). P1 and P2 are defined in footnote e.
h. A small additional error is possible. In FFT sweeps, this error is possible for spans under 4.01 kHz. For non-FFT measurements, it is possible for RBWs of 3.9 kHz or less. The error is well within the range of ±0.0021 × (P1 - P2) subject to a maximum of ±0.005 dB. (The maximum dominates for all but very small differences.) P1 and P2 are defined in footnote e.

Description	Specifications	Supplemental Information
Available Detectors	Normal, Peak, Sample, Negative Peak, Average	Average detector works on RMS, Voltage and Logarithmic scales

Dynamic Range

Gain Compression

Description		Specifications	Supplemental Information
1 dB Gain Compression Point (Two-tone)[a][b][c]			Maximum power at mixer[d], LNP off
20 to 40 MHz			+2 dBm (nominal)
40 to 3.6 GHz			+5 dBm (nominal)
3.6 to 26.5 GHz			+10 dBm (nominal)
26.5 to 50 GHz			0 dBm (nominal)
Clipping (ADC Over-range)			
Any signal offset		–10 dBm	Low frequency exceptions[e]
Signal offset > 5 times IF prefilter bandwidth and IF Gain set to Low			+12 dBm (nominal)
IF Prefilter Bandwidth			
Zero Span or Swept[f]**, RBW =**	**Sweep Type = FFT, FFT Width =**		**–3 dB Bandwidth (nominal)**
≤3.9 kHz	<4.01 kHz		8.9 kHz
4.3 to 27 kHz	<28.81 kHz		79 kHz
30 to 160 kHz	<167.4 kHz		303 kHz
180 to 390 kHz	<411.9 kHz		966 kHz
430 kHz to 10 MHz[g]	<7.99 MHz		10.9 MHz

a. Large signals, even at frequencies not shown on the screen, can cause the analyzer to incorrectly measure on-screen signals because of two-tone gain compression. This specification tells how large an interfering signal must be in order to cause a 1 dB change in an on-screen signal.
b. Specified at 1 kHz RBW with 100 kHz tone spacing. The compression point will nominally equal the specification for tone spacing greater than 5 times the prefilter bandwidth. At smaller spacings, ADC clipping may occur at a level lower than the 1 dB compression point.

c. Reference level and off-screen performance: The reference level (RL) behavior differs from some earlier analyzers in a way that makes this analyzer more flexible. In other analyzers, the RL controlled how the measurement was performed as well as how it was displayed. Because the logarithmic amplifier in these analyzers had both range and resolution limitations, this behavior was necessary for optimum measurement accuracy. The logarithmic amplifier in this signal analyzer, however, is implemented digitally such that the range and resolution greatly exceed other instrument limitations. Because of this, the analyzer can make measurements largely independent of the setting of the RL without compromising accuracy. Because the RL becomes a display function, not a measurement function, a marker can read out results that are off-screen, either above or below, without any change in accuracy. The only exception to the independence of RL and the way in which the measurement is performed is in the input attenuation setting: When the input attenuation is set to auto, the rules for the determination of the input attenuation include dependence on the reference level. Because the input attenuation setting controls the tradeoff between large signal behaviors (third-order intermodulation, compression, and display scale fidelity) and small signal effects (noise), the measurement results can change with RL changes when the input attenuation is set to auto.
d. Mixer power level (dBm) = input power (dBm) – input attenuation (dB).
e. The ADC clipping level declines at low frequencies (below 50 MHz) when the LO feedthrough (the signal that appears at 0 Hz) is within 5 times the prefilter bandwidth (see table) and must be handled by the ADC. For example, with a 300 kHz RBW and prefilter bandwidth at 966 kHz, the clipping level reduces for signal frequencies below 4.83 MHz. For signal frequencies below 2.5 times the prefilter bandwidth, there will be additional reduction due to the presence of the image signal (the signal that appears at the negative of the input signal frequency) at the ADC.
f. This table applies without *Option FS1* or *FS2*, fast sweep. With *Option FS1* or *FS2*, which is a standard option in the UXA, this table applies for sweep rates that are manually chosen to be the same as or slower than "traditional" sweep rates, instead of the much faster sweep rates, such as autocoupled sweep rates, available with *FS1* or *FS2*. Sweep rate is defined to be span divided by sweep time. If the sweep rate is ≤ 1.1 times RBW-squared, the table applies. Otherwise, compute an "effective RBW" = Span / (SweepTime × RBW). To determine the IF Prefilter Bandwidth, look up this effective RBW in the table instead of the actual RBW. For example, for RBW = 3 kHz, Span = 300 kHz, and Sweep time = 42 ms, we compute that Sweep Rate = 7.1 MHz/s, while RBW-squared is 9 MHz/s. So the Sweep Rate is < 1.1 times RBW-squared and the table applies; row 1 shows the IF Prefilter Bandwidth is nominally 8.9 kHz. If the sweep time is 1 ms, then the effective RBW computes to 100 kHz. This would result in an IF Prefilter Bandwidth from the third row, nominally 303 kHz.
g. The 10 MHz RBW setting is only available on analyzers with instrument software version ≥ A.30.05 and which also have option FS1 installed. Otherwise, the maximum RBW setting is 8 MHz.

Displayed Average Noise Level

Description			Specifications		Supplemental Information
Displayed Average Noise Level (DANL) without Noise Floor Extension (mmW)[a]			Input terminated Sample or Average detector Averaging type = Log 0 dB input attenuation IF Gain = High 1 Hz Resolution Bandwidth		Refer to the footnote for Band Overlaps on page 17.
Option 544 or *550*	LNP off	LNP on	**20 to 30°C**	**Full range**	**Typical**
3 to 10 Hz	x				–95 dBm (nominal)
10 to 100 Hz	x				–114 dBm (nominal)
100 Hz to 1 kHz	x				–128 dBm (nominal)
1 to 9 kHz	x				–136 dBm (nominal)
9 to 100 kHz	x		–141 dBm	–141 dBm	–144 dBm
100 kHz to 1 MHz	x		–150 dBm	–150 dBm	–154 dBm
1 to 10 MHz[b]	x		–154 dBm	–153 dBm	–156 dBm
10 MHz to 1.2 GHz	x		–153 dBm	–152 dBm	–155 dBm
1.2 to 2.1 GHz	x		–151 dBm	–150 dBm	–153 dBm
2.1 to 3 GHz	x		–150 dBm	–149 dBm	–152 dBm
3.0 to 3.6 GHz	x		–149 dBm	–148 dBm	–151 dBm
3.5 to 4.2 GHz	x		–145 dBm	–142 dBm	–148 dBm
3.5 to 4.2 GHz		x	–151 dBm	–149 dBm	–154 dBm
4.2 to 6.6 GHz	x		–144 dBm	–142 dBm	–148 dBm
4.2 to 6.6 GHz		x	–152 dBm	–150 dBm	–154 dBm
6.6 to 8.4 GHz	x		–147 dBm	–145 dBm	–149 dBm
6.6 to 8.4 GHz		x	–153 dBm	–151 dBm	–155 dBm
8.3 to 13.6 GHz	x		–147 dBm	–145 dBm	–149 dBm
8.3 to 13.6 GHz		x	–153 dBm	–151 dBm	–155 dBm
13.5 to 14 GHz	x		–144 dBm	–142 dBm	–148 dBm
13.5 to 14 GHz		x	–150 dBm	–148 dBm	–153 dBm

Description			Specifications		Supplemental Information
14 to 17 GHz	x		–145 dBm	–143 dBm	–148 dBm
14 to 17 GHz		x	–151 dBm	–149 dBm	–153 dBm
17 to 22.5 GHz	x		–141 dBm	–139 dBm	–146 dBm
17 to 22.5 GHz		x	–149 dBm	–147 dBm	–152 dBm
22.5 to 26.5 GHz	x		–139 dBm	–137 dBm	–143 dBm
22.5 to 26.5 GHz		x	–146 dBm	–145 dBm	–150 dBm
26.4 to 30 GHz	x		–138 dBm	–136 dBm	–143 dBm
26.4 to 30 GHz		x	–146 dBm	–144 dBm	–150 dBm
30 to 34 GHz	x		–138 dBm	–135 dBm	–143 dBm
30 to 34 GHz		x	–146 dBm	–144 dBm	–150 dBm
33.9 to 37 GHz	x		–134 dBm	–131 dBm	–140 dBm
33.9 to 37 GHz		x	–142 dBm	–139 dBm	–148 dBm
37 to 40 GHz	x		–132 dBm	–129 dBm	–139 dBm
37 to 46 GHz		x	–141 dBm	–138 dBm	–146 dBm
40 to 49 GHz	x		–130 dBm	–126 dBm	–137 dBm
46 to 50 GHz		x	–139 dBm	–136 dBm	–145 dBm
49 to 50 GHz	x		–128 dBm	–124 dBm	–135 dBm
Additional DANL, IF Gain = Low[b]	x	x			–164.5 dBm (nominal)

a. DANL for zero span and swept is measured in a 1 kHz RBW and normalized to the narrowest available RBW, because the noise figure does not depend on RBW and 1 kHz measurements are faster.
b. Setting the IF Gain to Low is often desirable in order to allow higher power into the mixer without overload, better compression and better third-order intermodulation. When the Swept IF Gain is set to Low, either by auto coupling or manual coupling, there is noise added above that specified in this table for the IF Gain = High case. That excess noise appears as an additional noise at the input mixer. This level has sub-decibel dependence on center frequency. To find the total displayed average noise at the mixer for Swept IF Gain = Low, sum the powers of the DANL for IF Gain = High with this additional DANL. To do that summation, compute DANLtotal = 10 × log (10^(DANLhigh/10) + 10^(AdditionalDANL / 10)). In FFT sweeps, the same behavior occurs, except that FFT IF Gain can be set to autorange, where it varies with the input signal level, in addition to forced High and Low settings.

Description			Specifications		Supplemental Information
Displayed Average Noise Level (DANL) without Noise Floor Extension (RF/µW)[a]			Input terminated Sample or Average detector Averaging type = Log 0 dB input attenuation IF Gain = High 1 Hz Resolution Bandwidth		Refer to the footnote for Band Overlaps on page 17.
Option 508, *513*, or *526*	LNP off	LNP on	**20 to 30°C**	**Full range**	**Typical**
3 to 10 Hz	x				–100 dBm (nominal)
10 to 100 Hz	x				–125 dBm (nominal)
100 Hz to 1 kHz	x				–130 dBm (nominal)
1 to 9 kHz	x				–137 dBm (nominal)
9 to 100 kHz	x		–141 dBm	–141 dBm	–146 dBm
100 kHz to 1 MHz	x		–150 dBm	–150 dBm	–155 dBm
1 to 10 MHz[b]	x		–155 dBm	–152 dBm	–157 dBm
10 MHz to 1.2 GHz	x		–155 dBm	–153 dBm	–156 dBm
1.2 to 2.1 GHz	x		–153 dBm	–152 dBm	–155 dBm
2.1 to 3 GHz	x		–152 dBm	–151 dBm	–153 dBm
3.0 to 3.6 GHz	x		–151 dBm	–149 dBm	–152 dBm
3.5 to 4.2 GHz	x		–149 dBm	–147 dBm	–152 dBm
3.6 to 4.2 GHz		x	–154 dBm	–152 dBm	–155 dBm
3.6 to 3.7 GHz	x				See note[c]
4.2 to 8.4 GHz	x		–150 dBm	–148 dBm	–152 dBm
4.2 to 8.4 GHz		x	–155 dBm	–153 dBm	–156 dBm
8.3 to 13.6 GHz	x		–149 dBm	–147 dBm	–151 dBm
8.3 to 13.6 GHz		x	–155 dBm	–153 dBm	–156 dBm
13.5 to 16.9 GHz	x		–145 dBm	–143 dBm	–147 dBm
13.5 to 16.9 GHz		x	–152 dBm	–150 dBm	–155 dBm
16.9 to 20 GHz	x		–143 dBm	–140 dBm	–146 dBm
16.9 to 20 GHz		x	–151 dBm	–149 dBm	–154 dBm

Description			Specifications		Supplemental Information
20.0 to 26.5 GHz	x		–136 dBm	–133 dBm	–139 dBm
20.0 to 26.5 GHz		x	–148 dBm	–146 dBm	–151 dBm
Additional DANL, IF Gain = Low[d]	x	x			–164.5 dBm (nominal)

a. DANL for zero span and swept is measured in a 1 kHz RBW and normalized to the narrowest available RBW, because the noise figure does not depend on RBW and 1 kHz measurements are faster.
b. DANL below 10 MHz is affected by phase noise around the LO feedthrough signal. Specifications apply with the best setting of the Phase Noise Optimization control, which is to choose the “Best Close-in ϕ Noise" for frequencies below about 150 kHz, and “Best Wide Offset ϕ Noise" for frequencies above about 150 kHz.
c. Band 0 is extendable (set “Extend Low Band” to On) to 3.7 GHz instead of 3.6 GHz in instruments with frequency option 508, 513 or 526 and with firmware of version A.16.17 or later. Subject to these conditions, statistical observations show that performance nominally fits within the same range within the 3.6 to 3.7 GHz frequencies as within the next lower specified frequency range, but is not warranted.
d. Setting the IF Gain to Low is often desirable in order to allow higher power into the mixer without overload, better compression and better third-order intermodulation. When the Swept IF Gain is set to Low, either by auto coupling or manual coupling, there is noise added above that specified in this table for the IF Gain = High case. That excess noise appears as an additional noise at the input mixer. This level has sub-decibel dependence on center frequency. To find the total displayed average noise at the mixer for Swept IF Gain = Low, sum the powers of the DANL for IF Gain = High with this additional DANL. To do that summation, compute DANLtotal = 10 × log (10^(DANLhigh/10) + 10^(AdditionalDANL / 10)). In FFT sweeps, the same behavior occurs, except that FFT IF Gain can be set to autorange, where it varies with the input signal level, in addition to forced High and Low settings.

Description	Specifications	Supplemental Information		
Displayed Average Noise Level with Noise Floor Extension Improvement (mmW)[a]		**95th Percentile (≈2σ)**[b]		
Option 544 or *550*		**Preamp Off**	**Preamp On**[c]	**LNP On**
Band 0, f > 20 MHz[d]		10 dB	9 dB	n/a
Band 1		8 dB	9 dB	9 dB
Band 2		8 dB	8 dB	9 dB
Band 3		9 dB	8 dB	10 dB
Band 4		10 dB	8 dB	11 dB
Band 5		11 dB	8 dB	11 dB
Band 6		11 dB	7 dB	11 dB
Improvement for CW Signals[e]		3.5 dB (nominal)		
Improvement, Pulsed-RF Signals[f]		10.8 dB (nominal)		
Improvement, Noise-Like Signals		9.1 dB (nominal)		

a. This statement on the improvement in DANL is based on the statistical observations of the error in the effective noise floor after NFE is applied. That effective noise floor can be a negative or a positive power at any frequency. These 95th percentile values are based on the absolute value of that effective remainder noise power.
b. Unlike other 95th percentiles, these table values do not include delta environment effects. NFE is aligned in the factory at room temperature. For best performance, in an environment that is different from room temperature, such as an equipment rack with other instruments, we recommend running the "Characterize Noise Floor" operation after the first time the analyzer has been installed in the environment, and given an hour to stabilize.
c. DANL of the preamp is specified with a 50**Ω** source impedance. Like all amplifiers, the noise varies with the source impedance. When NFE compensates for the noise with an ideal source impedance, the variation in the remaining noise level with the actual source impedance is greatly multiplied in a decibel sense.
d. NFE does not apply to the low frequency sensitivity. At frequencies below about 1 MHz, the sensitivity is dominated by phase noise surrounding the LO feedthrough. The NFE is not designed to improve that performance. At frequencies between 1 and 20 MHz the NFE effectiveness increases from nearly none to near its maximum.
e. Improvement in the uncertainty of measurement due to amplitude errors and variance of the results is modestly improved by using NFE. The nominal improvement shown was evaluated for a 2 dB error with 250 traces averaged. For extreme numbers of averages, the result will be as shown in the "Improvement for Noise-like Signals" and DANL sections of this table.
f. Pulsed-RF signals are usually measured with peak detection. Often, they are also measured with many “max hold” traces. When the measurement time in each display point is long compared to the reciprocal of the RBW, or the number of traces max held is large, considerable variance reduction occurs in each measurement point. When the variance reduction is large, NFE can be quite effective; when it is small, NFE has low effectiveness. For example, in Band 0 with 100 pulses per trace element, in order to keep the error within ±3 dB error 95% of the time, the signal can be 10.8 dB lower with NFE than without NFE.

Description	Specifications	Supplemental Information		
Displayed Average Noise Level with Noise Floor Extension Improvement (RF/μW)[a]		**95th Percentile (≈2σ)**[b]		
Option 508, *513*, or *526*		**Preamp Off**	**Preamp On**[c]	**LNP On**
Band 0, f > 20 MHz[d]		9 dB	10 dB	n/a
Band 1		10 dB	9 dB	10 dB
Band 2		10 dB	10 dB	10 dB
Band 3		9 dB	9 dB	10 dB
Band 4		9 dB	8 dB	9 dB
Improvement for CW Signals[e]		3.5 dB (nominal)		
Improvement, Pulsed-RF Signals[f]		10.8 dB (nominal)		
Improvement, Noise-Like Signals		9.1 dB (nominal)		

a. This statement on the improvement in DANL is based on the statistical observations of the error in the effective noise floor after NFE is applied. That effective noise floor can be a negative or a positive power at any frequency. These 95th percentile values are based on the absolute value of that effective remainder noise power.
b. Unlike other 95th percentiles, these table values do not include delta environment effects. NFE is aligned in the factory at room temperature. For best performance, in an environment that is different from room temperature, such as an equipment rack with other instruments, we recommend running the "Characterize Noise Floor" operation after the first time the analyzer has been installed in the environment, and given an hour to stabilize.
c. DANL of the preamp is specified with a 50**Ω** source impedance. Like all amplifiers, the noise varies with the source impedance. When NFE compensates for the noise with an ideal source impedance, the variation in the remaining noise level with the actual source impedance is greatly multiplied in a decibel sense.
d. NFE does not apply to the low frequency sensitivity. At frequencies below about 1 MHz, the sensitivity is dominated by phase noise surrounding the LO feedthrough. The NFE is not designed to improve that performance. At frequencies between 1 and 20 MHz the NFE effectiveness increases from nearly none to near its maximum.
e. Improvement in the uncertainty of measurement due to amplitude errors and variance of the results is modestly improved by using NFE. The nominal improvement shown was evaluated for a 2 dB error with 250 traces averaged. For extreme numbers of averages, the result will be as shown in the "Improvement for Noise-like Signals" and DANL sections of this table.
f. Pulsed-RF signals are usually measured with peak detection. Often, they are also measured with many “max hold” traces. When the measurement time in each display point is long compared to the reciprocal of the RBW, or the number of traces max held is large, considerable variance reduction occurs in each measurement point. When the variance reduction is large, NFE can be quite effective; when it is small, NFE has low effectiveness. For example, in Band 0 with 100 pulses per trace element, in order to keep the error within ±3 dB error 95% of the time, the signal can be 10.8 dB lower with NFE than without NFE.

Description	Specifications	Supplemental Information		
Displayed Average Noise Level with Noise Floor Extension (mmW)[a]		**95th Percentile (≈2σ)** [b]		
Option 544 or *550*		**Preamp Off**	**Preamp On**[cd]	**LNP On**
Band 0, f >20 MHz[e]		–163 dBm	–174 dBm	n/a
Band 1		–157 dBm	–173 dBm	–163 dBm
Band 2		–159 dBm	–174 dBm	–164 dBm
Band 3		–160 dBm	–174 dBm	–164 dBm
Band 4		–155 dBm	–171 dBm	–163 dBm
Band 5		–156 dBm	–169 dBm	–162 dBm
Band 6		–148 dBm	–161 dBm	–156 dBm

a. DANL with NFE is unlike DANL without NFE. It is based on the statistical observations of the error in the effective noise floor after NFE is applied. That effective noise floor can be a negative or a positive power at any frequency. These 95th percentile values are based on the absolute value of that effective remainder noise power.
b. Unlike other 95th percentiles, these table values do not include delta environment effects. NFE is aligned in the factory at room temperature. For best performance, in an environment that is different from room temperature, such as an equipment rack with other instruments, we recommend running the "Characterize Noise Floor" operation after the first time the analyzer has been installed in the environment, and given an hour to stabilize.
c. DANL of the preamp is specified with a 50Ω source impedance. Like all amplifiers, the noise varies with the source impedance. When NFE compensates for the noise with an ideal source impedance, the variation in the remaining noise level with the actual source impedance is greatly multiplied in a decibel sense.
d. NFE performance can give results below theoretical levels of noise in a termination resistor at room temperature, about –174 dBm/Hz. this is intentional and usually desirable. NFE is not designed to report the noise at the input of the analyzer; it reports how much more noise is at the input of the analyzer than was present in its alignment. And its alignment includes the noise of a termination at room temperature. So it can often see the added noise below the theoretical noise. Furthermore, DANL is defined with log averaging in a 1 Hz RBW, which is about 2.3 dB lower than the noise density (power averaged) in a 1 Hz noise bandwidth.
e. NFE does not apply to the low frequency sensitivity. At frequencies below about 1 MHz, the sensitivity is dominated by phase noise surrounding the LO feedthrough. The NFE is not designed to improve that performance. At frequencies between 1 and 20 MHz the NFE effectiveness increases from nearly none to near its maximum.

Description	Specifications	Supplemental Information		
Displayed Average Noise Level with Noise Floor Extension (RF/μW)[a]		**95th Percentile (≈2σ)**[b]		
Option 508, *513*, or *526*		**Preamp Off**	**Preamp On**[cd]	**LNP On**
Band 0, f >20 MHz[e]		–163 dBm	–174 dBm	n/a
Band 1		–162 dBm	–174 dBm	–166 dBm
Band 2		–162 dBm	–174 dBm	–167 dBm
Band 3		–159 dBm	–172 dBm	–165 dBm
Band 4		–148 dBm	–166 dBm	–162 dBm

a. DANL with NFE is unlike DANL without NFE. It is based on the statistical observations of the error in the effective noise floor after NFE is applied. That effective noise floor can be a negative or a positive power at any frequency. These 95th percentile values are based on the absolute value of that effective remainder noise power.

b. Unlike other 95th percentiles, these table values do not include delta environment effects. NFE is aligned in the factory at room temperature. For best performance, in an environment that is different from room temperature, such as an equipment rack with other instruments, we recommend running the "Characterize Noise Floor" operation after the first time the analyzer has been installed in the environment, and given an hour to stabilize.

c. DANL of the preamp is specified with a 50**Ω** source impedance. Like all amplifiers, the noise varies with the source impedance. When NFE compensates for the noise with an ideal source impedance, the variation in the remaining noise level with the actual source impedance is greatly multiplied in a decibel sense.

d. NFE performance can give results below theoretical levels of noise in a termination resistor at room temperature, about –174 dBm/Hz. this is intentional and usually desirable. NFE is not designed to report the noise at the input of the analyzer; it reports how much more noise is at the input of the analyzer than was present in its alignment. And its alignment includes the noise of a termination at room temperature. So it can often see the added noise below the theoretical noise. Furthermore, DANL is defined with log averaging in a 1 Hz RBW, which is about 2.3 dB lower than the noise density (power averaged) in a 1 Hz noise bandwidth.

e. NFE does not apply to the low frequency sensitivity. At frequencies below about 1 MHz, the sensitivity is dominated by phase noise surrounding the LO feedthrough. The NFE is not designed to improve that performance. At frequencies between 1 and 20 MHz the NFE effectiveness increases from nearly none to near its maximum.

Spurious Responses

Description		Specifications			Supplemental Information	
Spurious Responses (see Band Overlaps on page 17)					Preamp Off[a]	
Residual Responses[b]						
200 kHz to 8.4 GHz (swept)		–100 dBm				
Zero span or FFT or other frequencies					–100 dBm (nominal)	
Image Responses						
Tuned Freq (f)	**Excitation Freq**	**Mixer Level**[c]	**Response**		**Response (typical)**	
			RF/µW	mmW	RF/µW	mmW
10 MHz to 26.5 GHz	f+45 MHz	–10 dBm	–80 dBc	–80 dBc	–105 dBc	–104 dBc
26.5 GHz to 50 GHz	f+45 MHz	–30 dBm				–90 dBc (nominal)
10 MHz to 3.6 GHz	f+10245 MHz	–10 dBm	–80 dBc	–80 dBc	–106 dBc	–106 dBc
10 MHz to 3.6 GHz	f+645 MHz	–10 dBm	–80 dBc	–80 dBc	–101 dBc	–101 dBc
3.5 to 13.6 GHz	f+645 MHz	–10 dBm	–78 dBc[d]	–80 dBc	–86 dBc	–106 dBc
13.5 to 17.1 GHz	f+645 MHz	–10 dBm	–74 dBc	–80 dBc	–84 dBc	–106 dBc
17.0 to 22 GHz	f+645 MHz	–10 dBm	–70 dBc	–80 dBc	–78 dBc	–101 dBc
22 to 26.5 GHz	f+645 MHz	–10 dBm	–66 dBc	–70 dBc	–75 dBc	–102 dBc
26.5 to 34.5 GHz	f+645 MHz	–30 dBm		–70 dBc		–98 dBc
34.4 to 42 GHz	f+645 MHz	–30 dBm		–60 dBc		–84 dBc
42 to 50 GHz	f+645 MHz	–30 dBm				–75 dBc (nominal)
Other Spurious Responses		**Mixer Level**[c]	**Response**			
Carrier Frequency ≤26.5 GHz						
First RF Order[e] (f ≥ 10 MHz from carrier)		–10 dBm	–80 dBc + 20 × log(N^f)		Includes IF feedthrough, LO harmonic mixing responses	
Higher RF Order[g] (f ≥ 10 MHz from carrier)		–40 dBm	–80 dBc + 20 × log(N^f)		Includes higher order mixer responses	

Description	Specifications	Supplemental Information
Carrier Frequency >26.5 GHz		
First RF Order[e] (f ≥ 10 MHz from carrier)	–30 dBm	–90 dBc (nominal)
Higher RF Order[g] (f ≥ 10 MHz from carrier)	–30 dBm	–90 dBc (nominal)
LO-Related Spurious Responses (Offset from carrier 200 Hz to 10 MHz)	–10 dBm –68 dBc[hd] + 20 × log(N[f])	–72 dBc + 20 × log(N[f]) (typical)
Line-Related Spurious Responses		–73 dBc[h] + 20 x log(N[f]) (nominal)

a. The spurious response specifications only apply with the preamp turned off. When the preamp is turned on, performance is nominally the same as long as the mixer level is interpreted to be: Mixer Level = Input Level – Input Attenuation + Preamp Gain.
b. Input terminated, 0 dB input attenuation.
c. Mixer Level = Input Level – Input Attenuation.
d. The following additional spurious responses specifications are supported from 8 to 12 GHz at 20 to 30º C. Image responses are warranted to be better than –81 dBc, with 95th percentile performance of –87 dBc. LO-related spurious responses are warranted to be better than –83 dBc at 1 to 10 MHz offsets from the carrier, with phase noise optimization set to Best Wide-Offset.
e. With first RF order spurious products, the indicated frequency will change at the same rate as the input, with higher order, the indicated frequency will change at a rate faster than the input.
f. N is the LO multiplication factor.
g. RBW=100 Hz. With higher RF order spurious responses, the observed frequency will change at a rate faster than the input frequency.
h. Nominally –40 dBc under large magnetic (0.38 Gauss rms) or vibrational (0.21 g rms) environmental stimuli.

Second Harmonic Distortion

Description			Specifications			Supplemental Information	
Second Harmonic Distortion (mmW)							
Option 544 or *550*			**Mixer Level**[a]	**Distortion**	**SHI**[bc]	**Distortion (nominal)**	**SHI (nominal)**
Source Frequency	LNP off	LNP on					
10 MHz to 1.8 GHz[d]	x		–15 dBm	–60 dBc	+45 dBm		
1.75 to 2.5 GHz		x	–15 dBm	–95 dBc	+80 dBm		
1.75 to 3 GHz	x		–15 dBm	–72 dBc	+57 dBm		
3 to 6.5 GHz	x		–15 dBm	–77 dBc	+62 dBm		
2.5 to 5 GHz		x	–15 dBm	–99 dBc	+84 dBm		
6.5 to 10 GHz	x		–15 dBm	–70 dBc	+55 dBm		
10 to 13.25 GHz	x		–15 dBm	–62 dBc	+47 dBm		
5 to 13.5 GHz		x	–15 dBm	–105 dBc	+90 dBm		
13.25 to 25 GHz	x		–15 dBm			–65 dBc	+50 dBm
13.25 to 25 GHz		x	–15 dBm			–105 dBc	+90 dBm

a. Mixer level = Input Level – Input Attenuation
b. SHI = second harmonic intercept. The SHI is given by the mixer power in dBm minus the second harmonic distortion level relative to the mixer tone in dBc.
c. Performance >3.6 GHz improves greatly with standard *Option LNP* enabled.
d. These frequencies are half of the band edge frequencies. See Band Overlaps on page 17.

Description			Specifications			Supplemental Information
Second Harmonic Distortion (RF/μW)						
Option 508, *513*, or *526*			**Mixer Level**[a]	**Distortion**	**SHI**[bc]	
Source Frequency	LNP off	LNP on				
10 MHz to 1.8 GHz[d]	x		−15 dBm	−60 dBc	+45 dBm	
1.75[d] to 3 GHz	x		−15 dBm	−77 dBc	+62 dBm	
1.75 to 2.5 GHz		x	−15 dBm	−95 dBc	+80 dBm	
3 to 6.5 GHz	x		−15 dBm	−77 dBc	+62 dBm	
2.5 to 4 GHz		x	−15 dBm	−101 dBc	+86 dBm	
6.5 to 10 GHz	x		−15 dBm	−70 dBc	+55 dBm	
10 to 13.25 GHz	x		−15 dBm	−62 dBc	+47 dBm	
4 to 13.25 GHz		x	−15 dBm	−105 dBc	+90 dBm	

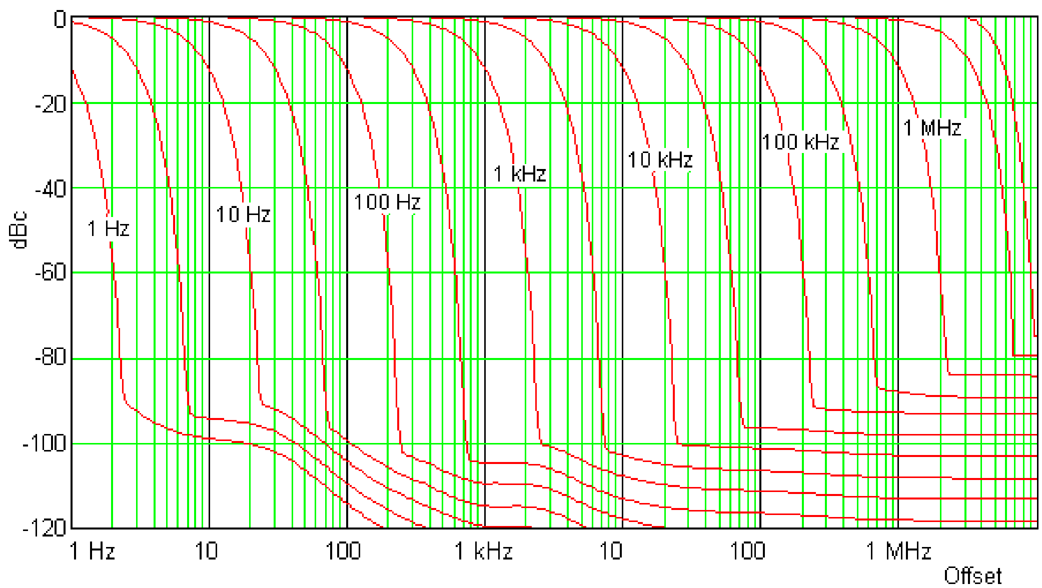
a. Mixer level = Input Level – Input Attenuation
b. SHI = second harmonic intercept. The SHI is given by the mixer power in dBm minus the second harmonic distortion level relative to the mixer tone in dBc.
c. Performance >3.6 GHz improves greatly with standard *Option LNP* enabled.
d. These frequencies are half of the band edge frequencies. See Band Overlaps on page 17.

Third Order Intermodulation

Description	Specifications		Supplemental Information	
Third Order Intermodulation (Tone separation > 5 times IF Prefilter Bandwidth[a] Sweep rate reduced[b] Verification conditions[c], LNP off[d])			Refer to the footnote for Band Overlaps on page 17. Refer to footnote[e] for the "Extrapolated Distortion".	
20 to 30°C	**Intercept**[f]		**Intercept** (typical)	
10 to 300 MHz	+13.5 dBm		+16 dBm	
300 to 600 MHz	+18 dBm		+21 dBm	
600 MHz to 1.5 GHz	+20 dBm		+22 dBm	
1.5 to 3.6 GHz	+21 dBm		+23 dBm	
	RF/µW	mmW	RF/µW	mmW
3.5 to 8.4 GHz	+19 dBm	+16 dBm	+23 dBm	+23 dBm
3.6 to 3.7 GHz			See note[g]	
8.3 to 13.6 GHz	+19 dBm	+16 dBm	+23 dBm	+23 dBm
13.5 to 17.1 GHz	+18 dBm	+13 dBm	+23 dBm	+17 dBm
17.0 to 26.5 GHz	+19 dBm	+13 dBm	+24 dBm	+20 dBm
26.4 to 34.5 GHz		+13 dBm		+18 dBm
34.4 to 50 GHz		+7 dBm		+12 dBm
Full temperature range				
10 to 300 MHz	+12.5 dBm			
300 to 600 MHz	+17 dBm			
600 MHz to 1.5 GHz	+18 dBm			
1.5 to 3.6 GHz	+19 dBm			
3.5 to 13.6 GHz	+17 dBm	+13 dBm		
13.5 to 26.5 GHz	+17 dBm	+10 dBm		
26.4 to 34.5 GHz		+11 dBm		
34.4 to 50 GHz		+3 dBm		

a. See the IF Prefilter Bandwidth table in the Gain Compression specifications on page 42. When the tone separation condition is met, the effect on TOI of the setting of IF Gain is negligible. TOI is verified with IF Gain set to its best case condition, which is IF Gain = Low.
b. Autocoupled sweep rates using *Option FS1* or *FS2* are often too fast for excellent TOI performance. A sweep rate of 1.0 × RBW^2 is often suitable for best TOI performance, because of how it affects the IF Prefilter setting. Footnote [a] links to the details.
c. TOI is verified with two tones, each at –16 dBm at the mixer, spaced by 100 kHz.
d. When LNP is on, the low noise path is enabled, which causes third-order intercept (TOI) to decrease to the same extent as that to which the DANL decreases. Therefore, LNP on does not substantially change the TOI to-noise dynamic range.
e. Traditionally, the distortion components from two tones, each at –30 dBm, were given as specifications. When spectrum analyzers were not as good as they are now, these distortion products were easily measured. As spectrum analyzers improved, the measurement began to be made at higher levels and extrapolated to the industry-standard –30 dBm test level. This extrapolation was justified by excellent conformance with the third-order model, wherein distortion in dBc was given by twice the difference between the test tone level and the intercept, both given in dBm units. In UXA, we no longer make that extrapolation in this Specifications Guide.
One reason we don't extrapolate is that the model does not work as well as it had with higher levels of distortion in older and less capable analyzers, so that the computation is misleading; distortions at low test levels will be modestly higher than predicted from the formula. The second reason is that the distortion components are so small as to be unmeasurable, and thus highly irrelevant, in many cases.
Please note the slope of the third-order intermodulation lines in the graphs that follow. The slope differs somewhat from that of the ideal third-order model, which would have a slope of 2.
f. Intercept = TOI = third order intercept. The TOI is given by the mixer tone level (in dBm) minus (distortion/2) where distortion is the relative level of the distortion tones in dBc.
g. Band 0 is extendable (set "Extend Low Band" to On) to 3.7 GHz instead of 3.6 GHz in instruments with frequency option 508, 513 or 526 and with firmware of version A.16.17 or later. Subject to these conditions, statistical observations show that performance nominally fits within the same range within the 3.6 to 3.7 GHz frequencies as within the next lower specified frequency range, but is not warranted.

Nominal Dynamic Range vs. Offset Frequency vs. RBW [Plot]



Conditions:
CF = 1 GHz
Mixer Level = –10 dBm
Only 2 per decade of the 24/decade RBWs are shown
RBWs 100 kHz and below are shown with phase noise optimized close-in
RBWs 300 kHz and above are shown with phase noise optimized wide offset
Average Type = Log

Phase Noise

Description	Specifications		Supplemental Information
Phase Noise			Noise Sidebands[a]
(Center Frequency = 1 GHz[b] Best-case Optimization[c] Internal Reference[d])			
Offset Frequency	**20 to 30°C**	**Full range**	
10 Hz			
Wide Ref Loop BW	See note[e]		–93 dBc/Hz (typical)[e]
Narrow Ref Loop BW			–88 dBc/Hz (nominal)
100 Hz	–107 dBc/Hz	–107 dBc/Hz	–112 dBc/Hz (typical)
1 kHz	–124 dBc/Hz	–123 dBc/Hz	–127 dBc/Hz (typical)
10 kHz	–134 dBc/Hz	–132 dBc/Hz	–135 dBc/Hz (typical)
100 kHz	–139 dBc/Hz	–138 dBc/Hz	–141 dBc/Hz (typical)
1 MHz[f]	–145 dBc/Hz	–144 dBc/Hz	–146 dBc/Hz (typical)
10 MHz	–155 dBc/Hz	–154 dBc/Hz	–157 dBc/Hz (typical)

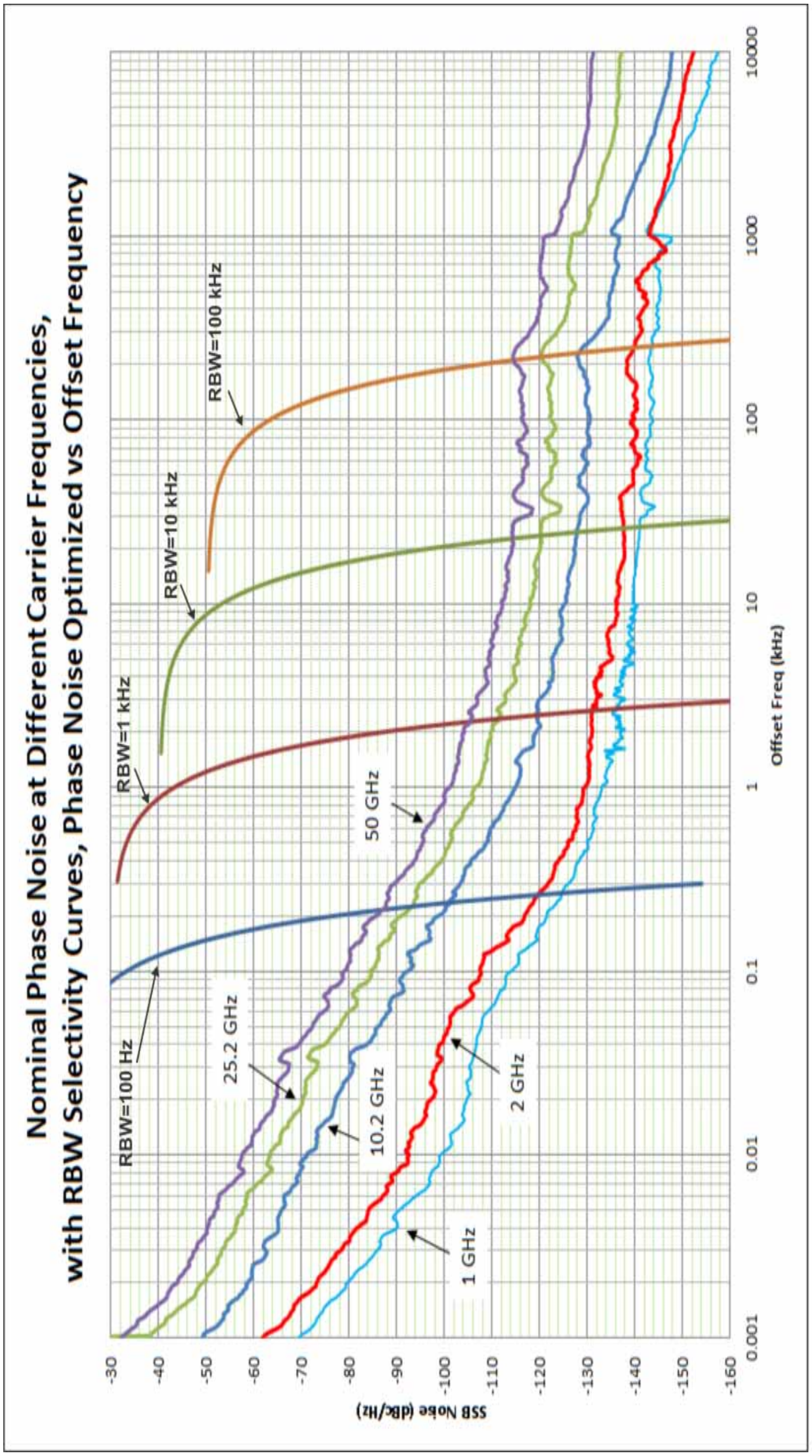
a. Noise sidebands around a signal are dominantly phase noise sidebands. With the extremely low phase noise of the UXA, AM sidebands are non-negligible contributors. These specifications apply to the sum of the AM and PM sidebands.

b. The nominal performance of the phase noise at center frequencies different than the one at which the specifications apply (1 GHz) depends on the center frequency, band and the offset. For low offset frequencies, offsets well under 100 Hz, the phase noise changes by $20 \times \log[(f+0.3225)/1.3225]$. For mid-offset frequencies such as 50 kHz, phase noise changes as $20 \times \log[(f+5.1225)/6.1225]$. In both expressions, f is the larger of 0.5 and the carrier frequency in GHz units. For wide offset frequencies, offsets above about 500 kHz, phase noise increases as $20 \times \log(N)$. N is the LO Multiple as shown on page 9.

c. Noise sidebands for lower offset frequencies, for example, 10 kHz, apply with phase noise optimization (PNO) set to Balance Noise and Spurs. In some frequency settings of the analyzer, a spurious response 60 to 180 MHz offset from the carrier may be present unless the phase locked loop behavior is changed in a way that increases the phase noise. This tradeoff is controlled such that the spurs are better than –70 dBc, at the expense of up to 7 dB increase in phase noise within ±1 octave of 1 MHz offset for those settings where this spurious is likely to be visible. To eliminate this phase noise degradation in exchange for the aforementioned spurs, Best Close-in Noise should be used. When the setting is changed to Best Spurs, the maximum spurious response is held to –90 dBc, but the phase noise at all center frequencies is degraded by up to approximately 12 dB from the best possible setting, mostly within ±1 octave of an offset of 400 kHz from the carrier. Noise sidebands for higher offset frequencies, for example, 1 MHz, apply with the phase noise optimization set to Best Wide-Offset Noise.

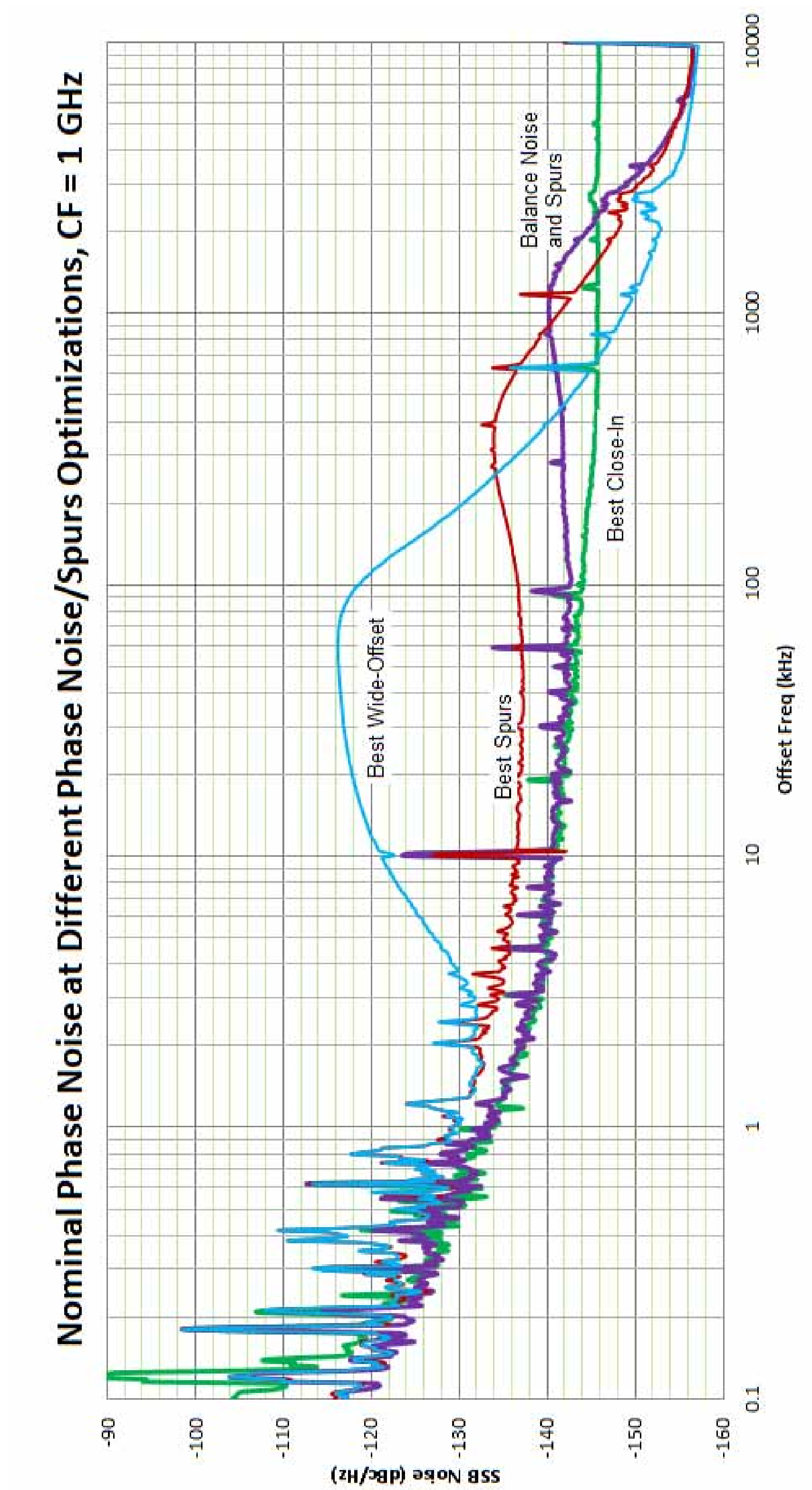
d. Specifications are given with the internal frequency reference. The phase noise at offsets below 100 Hz is impacted or dominated by noise from the reference. Thus, performance with external references will not follow the curves and specifications. When using an external reference with superior phase noise, we recommend setting the external reference phase-locked-loop bandwidth to wide (60 Hz), to take advantage of that superior performance. When using an external reference with inferior phase noise performance, we recommend setting that bandwidth to narrow (15 Hz). In these relationships, inferior and superior phase noise are with respect to –134 dBc/Hz at 30 Hz offset from a 10 MHz reference. Because most reference sources have phase noise behavior that falls off at a rate of 30 dB/decade, this is usually equivalent to –120 dBc/Hz at 10 Hz offset.
e. Keysight measures 100% of the signal analyzers for phase noise at 10 Hz offset from a 1 GHz carrier in the factory production process. This measurement requires a signal of exceptionally low phase noise that is characterized with specialized processes. It is impractical for field and customer use. Because field verification is impractical, Keysight only gives a typical result. More than 80% of prototype instruments met this "typical" specification; the factory test line limit is set commensurate with an on-going 80% yield to this typical. Like all typical specifications, there is no guardbanding for measurement uncertainty. The factory test line limit is consistent with a warranted specification of –89 dBc/Hz.
f. Analyzer-contributed phase noise at the low levels of this offset requires advanced verification techniques because broadband noise would otherwise cause excessive measurement error. Keysight uses a high level low phase noise CW test signal and sets the input attenuator so that the mixer level will be well above the normal top-of-screen level (-10 dBm) but still well below the 1 dB compression level. This improves dynamic range (carrier to broadband noise ratio) at the expense of amplitude uncertainty due to compression of the phase noise sidebands of the analyzer. (If the mixer level were increased to the "1 dB Gain Compression Point," the compression of a single sideband is specified to be 1 dB or lower. At lower levels, the compression falls off rapidly. The compression of phase noise sidebands is substantially less than the compression of a single-sideband test signal, further reducing the uncertainty of this technique.) Keysight also measures the broadband noise of the analyzer without the CW signal and subtracts its power from the measured phase noise power. The same techniques of overdrive and noise subtraction can be used in measuring a DUT, of course.

Nominal Phase Noise at Different Carrier Frequencies, Phase Noise Optimized vs Offset Frequency [Plot]



* Unlike other curves, which are measured results from the measurement of excellent sources, the CF = 50 GHz curve is the predicted, not observed, phase noise, computed from the 25.2 GHz observation. See the footnotes in the Frequency Stability section for the details of phase noise performance versus center frequency.

Nominal Phase Noise at Different Phase Noise/Spurs Optimization [Plot]



Power Suite Measurements

The specifications for this section apply only to instruments with Frequency *Option 508*, *513*, or *526*.

Description	Specifications	Supplemental Information
Channel Power		
Amplitude Accuracy		Absolute Amplitude Accuracy[a] + Power Bandwidth Accuracy[bc]
Case: Radio Std = 3GPP W-CDMA, or IS-95		
Absolute Power Accuracy (20 to 30°C, Attenuation = 10 dB)	±0.61 dB	±0.19 dB (95th percentile)

a. See “Absolute Amplitude Accuracy” on page 34.
b. See “Frequency and Time” on page 17.
c. Expressed in dB.

Description	Specifications	Supplemental Information
Occupied Bandwidth		
Frequency Accuracy		±(Span/1000) (nominal)

Description			Specifications	Supplemental Information	
Adjacent Channel Power (ACP)					
Case: Radio Std = None					
Accuracy of ACP Ratio (dBc)				Display Scale Fidelity[a]	
Accuracy of ACP Absolute Power (dBm or dBm/Hz)				Absolute Amplitude Accuracy[b] + Power Bandwidth Accuracy[cd]	
Accuracy of Carrier Power (dBm), or Carrier Power PSD (dBm/Hz)				Absolute Amplitude Accuracy[b] + Power Bandwidth Accuracy[cd]	
Passband Width[e]			−3 dB		
Case: Radio Std = 3GPP W-CDMA				(ACPR; ACLR)[f]	
Minimum power at RF Input				−36 dBm (nominal)	
ACPR Accuracy[g]				RRC weighted, 3.84 MHz noise bandwidth, method ≠ RBW	
Radio	**Offset Freq**				
MS (UE)	5 MHz		±0.08 dB	At ACPR range of −30 to −36 dBc with optimum mixer level[h]	
MS (UE)	10 MHz		±0.09 dB	At ACPR range of −40 to −46 dBc with optimum mixer level[i]	
BTS	5 MHz		±0.22 dB	At ACPR range of −42 to −48 dBc with optimum mixer level[j]	
BTS	10 MHz		±0.18 dB	At ACPR range of −47 to −53 dBc with optimum mixer level[i]	
BTS	5 MHz		±0.10 dB	At −48 dBc non-coherent ACPR[k]	
Dynamic Range				RRC weighted, 3.84 MHz noise bandwidth	
Noise Correction[l]	**Offset Freq**	**Method**		**ACLR (typical)**[m]	**Optimum ML**[n] **(Nominal)**
Off	5 MHz	Filtered IBW		−81 dB	−8 dBm
Off	5 MHz	Fast		−81 dB	−8 dBm
Off	10 MHz	Filtered IBW		−87 dB	−4 dBm
On	5 MHz	Filtered IBW		−82.5 dB	−8 dBm
On	10 MHz	Filtered IBW		−89 dB	−4 dBm

Description	Specifications	Supplemental Information
RRC Weighting Accuracy[o]		
White noise in Adjacent Channel TOI-induced spectrum rms CW error		0.00 dB nominal 0.001 dB nominal 0.012 dB nominal

a. The effect of scale fidelity on the ratio of two powers is called the relative scale fidelity. The scale fidelity specified in the Amplitude section is an absolute scale fidelity with –35 dBm at the input mixer as the reference point. The relative scale fidelity is nominally only 0.01 dB larger than the absolute scale fidelity.
b. See Amplitude Accuracy and Range section.
c. See Frequency and Time section.
d. Expressed in decibels.
e. An ACP measurement measures the power in adjacent channels. The shape of the response versus frequency of those adjacent channels is occasionally critical. One parameter of the shape is its 3 dB bandwidth. When the bandwidth (called the Ref BW) of the adjacent channel is set, it is the 3 dB bandwidth that is set. The passband response is given by the convolution of two functions: a rectangle of width equal to Ref BW and the power response versus frequency of the RBW filter used. Measurements and specifications of analog radio ACPs are often based on defined bandwidths of measuring receivers, and these are defined by their –6 dB widths, not their –3 dB widths. To achieve a passband whose –6 dB width is x, set the Ref BW to be x – 0.572 × RBW.
f. Most versions of adjacent channel power measurements use negative numbers, in units of dBc, to refer to the power in an adjacent channel relative to the power in a main channel, in accordance with ITU standards. The standards for W-CDMA analysis include ACLR, a positive number represented in dB units. In order to be consistent with other kinds of ACP measurements, this measurement and its specifications will use negative dBc results, and refer to them as ACPR, instead of positive dB results referred to as ACLR. The ACLR can be determined from the ACPR reported by merely reversing the sign.
g. The accuracy of the Adjacent Channel Power Ratio will depend on the mixer drive level and whether the distortion products from the analyzer are coherent with those in the UUT. These specifications apply even in the worst case condition of coherent analyzer and UUT distortion products. For ACPR levels other than those in this specifications table, the optimum mixer drive level for accuracy is approximately –37 dBm – (ACPR/3), where the ACPR is given in (negative) decibels.
h. To meet this specified accuracy when measuring mobile station (MS) or user equipment (UE) within 3 dB of the required –33 dBc ACPR, the mixer level (ML) must be optimized for accuracy. This optimum mixer level is –22 dBm, so the input attenuation must be set as close as possible to the average input power – (–22 dBm). For example, if the average input power is –6 dBm, set the attenuation to 16 dB. This specification applies for the normal 3.5 dB peak-to-average ratio of a single code. Note that, if the mixer level is set to optimize dynamic range instead of accuracy, accuracy errors are nominally doubled.
i. ACPR accuracy at 10 MHz offset is warranted when the input attenuator is set to give an average mixer level of –14 dBm.
j. In order to meet this specified accuracy, the mixer level must be optimized for accuracy when measuring node B Base Transmission Station (BTS) within 3 dB of the required –45 dBc ACPR. This optimum mixer level is –18 dBm, so the input attenuation must be set as close as possible to the average input power – (–18 dBm). For example, if the average input power is –6 dBm, set the attenuation to 12 dB. This specification applies for the normal 10 dB peak-to-average ratio (at 0.01% probability) for Test Model 1. Note that, if the mixer level is set to optimize dynamic range instead of accuracy, accuracy errors are nominally doubled.
k. Accuracy can be excellent even at low ACPR levels assuming that the user sets the mixer level to optimize the dynamic range, and assuming that the analyzer and UUT distortions are incoherent. When the errors from the UUT and the analyzer are incoherent, optimizing dynamic range is equivalent to minimizing the contribution of analyzer noise and distortion to accuracy, though the higher mixer level increases the display scale fidelity errors. This incoherent addition case is commonly used in the industry and can be useful for comparison of analysis equipment, but this incoherent addition model is rarely justified. This derived accuracy specification is based on a mixer level of –14 dBm.

l. The dynamic range shown with Noise Correction = Off applies with Noise Floor Extension On. (Noise Correction is the process within the measurement of making a calibration of the noise floor at the exact analyzer settings used for the measurement. Noise Floor Extension is the factory calibration of the noise floor.)
m. Keysight measures 100% of the signal analyzers for dynamic range in the factory production process. This measurement requires a near-ideal signal, which is impractical for field and customer use. Because field verification is impractical, Keysight only gives a typical result. More than 80% of prototype instruments met this “typical” specification; the factory test line limit is set commensurate with an on-going 80% yield to this typical.
The ACPR dynamic range is verified only at 2 GHz, where Keysight has the near-perfect signal available. The dynamic range is specified for the optimum mixer drive level, which is different in different instruments and different conditions. The test signal is a 1 DPCH signal.
The ACPR dynamic range is the observed range. This typical specification includes no measurement uncertainty.
n. ML is Mixer Level, which is defined to be the input signal level minus attenuation.
o. 3GPP requires the use of a root-raised-cosine filter in evaluating the ACLR of a device. The accuracy of the passband shape of the filter is not specified in standards, nor is any method of evaluating that accuracy. This footnote discusses the performance of the filter in this instrument. The effect of the RRC filter and the effect of the RBW used in the measurement interact. The analyzer compensates the shape of the RRC filter to accommodate the RBW filter. The effectiveness of this compensation is summarized in three ways:
– White noise in Adj Ch: The compensated RRC filter nominally has no errors if the adjacent channel has a spectrum that is flat across its width.
– TOI–induced spectrum: If the spectrum is due to third–order intermodulation, it has a distinctive shape. The computed errors of the compensated filter are –0.001 dB for the 100 kHz RBW used for UE testing with the IBW method. It is 0.000 dB for the 27 kHz RBW filter used for BTS testing with the Filtered IBW method. The worst error for RBWs between 27 and 390 kHz is 0.05 dB for a 330 kHz RBW filter.
– rms CW error: This error is a measure of the error in measuring a CW–like spurious component. It is evaluated by computing the root of the mean of the square of the power error across all frequencies within the adjacent channel. The computed rms error of the compensated filter is 0.012 dB for the 100 kHz RBW used for UE testing with the IBW method. It is 0.000 dB for the 27 kHz RBW filter used for BTS testing. The worst error for RBWs between 27 kHz and 470 kHz is 0.057 dB for a 430 kHz RBW filter.

Description			Specifications	Supplemental Information	
Multi-Carrier Adjacent Channel Power					
Case: Radio Std = 3GPP W-CDMA				RRC weighted, 3.84 MHz noise bandwidth, Noise Correction (NC) on	
ACPR Accuracy (4 carriers)					
Radio	**Offset**	**Coher**[a]		**UUT ACPR Range**	**MLOpt**[b]
BTS	5 MHz	no	±0.09 dB	–42 to –48 dB	–15 dBm

a. Coher = no means that the specified accuracy only applies when the distortions of the device under test are not coherent with the third-order distortions of the analyzer. Incoherence is often the case with advanced multi-carrier amplifiers built with compensations and predistortions that mostly eliminate coherent third-order effects in the amplifier.
b. Optimum mixer level (MLOpt). The mixer level is given by the average power of the sum of the four carriers minus the input attenuation.

Description	Specifications	Supplemental Information
Power Statistics CCDF		
Histogram Resolution[a]	0.01 dB	

a. The Complementary Cumulative Distribution Function (CCDF) is a reformatting of a histogram of the power envelope. The width of the amplitude bins used by the histogram is the histogram resolution. The resolution of the CCDF will be the same as the width of those bins.

Description	Specifications	Supplemental Information
Burst Power		
Methods	Power above threshold Power within burst width	
Results	Output power, average Output power, single burst Maximum power Minimum power within burst Burst width	

Description	Specifications	Supplemental Information
TOI (Third Order Intermodulation)		Measures TOI of a signal with two dominant tones
Results	Relative IM tone powers (dBc)	
	Absolute tone powers (dBm)	
	Intercept (dBm)	

Description	Specifications	Supplemental Information
Harmonic Distortion		
Maximum harmonic number	10th	
Results	Fundamental Power (dBm)	
	Relative harmonics power (dBc)	
	Total harmonic distortion (%, dBc)	

Description	Specifications	Supplemental Information
Spurious Emissions		Table-driven spurious signals; search across regions
Case: Radio Std = 3GPP W-CDMA		
Dynamic Range[a], relative (RBW=1 MHz) (1 to 3.0 GHz)	88.4 dB	90.7 dB (typical)
Sensitivity[b], absolute (RBW=1 MHz) (1 to 3.0 GHz)	–88.5 dBm	–90.5 dBm (typical)
Accuracy		Attenuation = 10 dB
20 Hz to 3.6 GHz		±0.19 dB (95th percentile)
3.5 to 8.4 GHz		±1.13 dB (95th percentile)
8.3 to 13.6 GHz		±1.50 dB (95th percentile)

a. The dynamic range is specified at 12.5 MHz offset from center frequency with mixer level of 1 dB compression point, which will degrade accuracy 1 dB.
b. The sensitivity is specified at far offset from carrier, where phase noise does not contribute. You can derive the dynamic range at far offset from 1 dB compression mixer level and sensitivity.

Description	Specifications	Supplemental Information
Spectrum Emission Mask		Table-driven spurious signals; measurement near carriers
Case: Radio Std = cdma2000		
Dynamic Range, relative (750 kHz offset[ab])	84.8 dB	88.1 dB (typical)
Sensitivity, absolute (750 kHz offset[c])	–103.7 dBm	–105.7 dBm (typical)
Accuracy (750 kHz offset)		
Relative[d]	±0.06 dB	
Absolute[e] (20 to 30°C)	±0.62 dB	±0.20 dB (95th percentile ≈ 2σ)
Case: Radio Std = 3GPP W–CDMA		
Dynamic Range, relative (2.515 MHz offset[ad])	86.7 dB	91.2 dB (typical)
Sensitivity, absolute (2.515 MHz offset[c])	–103.7 dBm	–105.7 dBm (typical)
Accuracy (2.515 MHz offset)		
Relative[d]	±0.08 dB	
Absolute[e] (20 to 30°C)	±0.62 dB	±0.20 dB (95th percentile ≈ 2σ)

a. The dynamic range specification is the ratio of the channel power to the power in the offset specified. The dynamic range depends on the measurement settings, such as peak power or integrated power. Dynamic range specifications are based on default measurement settings, with detector set to average, and depend on the mixer level. Default measurement settings include 30 kHz RBW.
b. This dynamic range specification applies for the optimum mixer level, which is about –18 dBm. Mixer level is defined to be the average input power minus the input attenuation.
c. The sensitivity is specified with 0 dB input attenuation. It represents the noise limitations of the analyzer. It is tested without an input signal. The sensitivity at this offset is specified in the default 30 kHz RBW, at a center frequency of 2 GHz.
d. The relative accuracy is a measure of the ratio of the power at the offset to the main channel power. It applies for spectrum emission levels in the offsets that are well above the dynamic range limitation.
e. The absolute accuracy of SEM measurement is the same as the absolute accuracy of the spectrum analyzer. See “Absolute Amplitude Accuracy” on page 34 for more information. The numbers shown are for 0 to 3.6 GHz, with attenuation set to 10 dB.

Options

The following options and applications affect instrument specifications.

Standard Option CR3:	Connector Rear, second IF Out
Standard Option EXM:	External mixing
Standard Option LNP:	Low Noise Path
Standard Option MPB:	Preselector bypass
Standard Option NFE:	Noise floor extension, instrument alignment
Option 508:	Frequency range, 2 Hz to 8.4 GHz
Option 513:	Frequency range, 2 Hz to 13.6 GHz
Option 526:	Frequency range, 2 Hz to 26.5 GHz
Option 544:	Frequency range, 2 Hz to 44 GHz
Option 550:	Frequency range, 2 Hz to 50 GHz
Option ALV:	Auxiliary Log Video output
Option B25:	Analysis bandwidth, 25 MHz
Option B40:	Analysis bandwidth, 40 MHz
Option B2X:	Analysis bandwidth, 255 MHz
Option B5X:	Analysis bandwidth, 510 MHz
Option C35:	APC 3.5 mm connector (for Freq *Option 526* only)
Option CRP:	Connector Rear, arbitrary IF Out
Option EA3:	Electronic attenuator, 3.6 GHz
Option EMC:	Precompliance EMC Features
Option P08:	Preamplifier, 8.4 GHz
Option P13:	Preamplifier, 13.6 GHz
Option P26:	Preamplifier, 26.5 GHz
Option P44:	Preamplifier, 44 GHz
Option P50:	Preamplifier, 50 GHz
Option RT1:	Real-time analysis up to the maximum analysis bandwidth, basic detection
Option RT2:	Real-time analysis up to the maximum analysis bandwidth, optimum detection
Option RTS:	Real-time I/Q data streaming
Option FBP	Full Bypass Path
Option FT1:	Frequency mask trigger, basic detection

Option FT2:	Frequency mask trigger, optimum detection
Option H1G	1 GHz analysis bandwidth
Option YAV:	Y-Axis Video output
N9063EM0E:	Analog Demod measurement application
N9067EM0E:	Pulse measurement application
N9068EM0E:	Phase Noise measurement application
N9069EM0E:	Noise Figure measurement application
N9071EM0E:	GSM/EDGE/EDGE Evolution measurement application
N9073EM0E/EM1E:	WCDMA/HSPA/HSPA+ measurement application
N9077EM0E/EM1E:	WLAN measurement application
N9080EM0E:	LTE/LTE-Advanced FDD measurement application
N9081EM0E:	Bluetooth measurement application
N9082EM0E:	LTE/LTE-Advanced TDD measurement application
N9083EM0E:	Multi-Standard Radio measurement application
N9084EM0E:	Short Range Communications measurement application
N9085EM0E:	5G NR measurement application

General

Description	Specifications	Supplemental Information
Calibration Cycle	1 year	

Description	Specifications	Supplemental Information
Environmental		
Indoor use		
Temperature Range		
Operating		
Altitude ≤ 2,300 m	0 to 55°C	
Altitude = 4,600 m	0 to 47°C	
Derating[a]		
Storage	–40 to +70°C	
Altitude	4,600 m (approx 15,000 feet)	
Humidity		
Relative humidity		Type tested at 95% RH up to 40°C decreasing linearly to 45% RH at 55°C (non-condensing).[b]

a. The maximum operating temperature derates linearly from altitude of 4,600 m to 2,300 m.
b. From 40°C to 55°C, the maximum % Relative Humidity follows the line of constant dew point.

Description	Specifications	Supplemental Information
Environmental and Military Specifications		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.

Description	Specification	Supplemental Information
Acoustic Noise		Values given are per ISO 7779 standard in the "Operator Sitting" position
Ambient Temperature		
< 35°C		Nominally under 55 dBA Sound Pressure. 55 dBA is generally considered suitable for use in quiet office environments.
≥ 35°C		Nominally under 65 dBA Sound Pressure. 65 dBA is generally considered suitable for use in noisy office environments. (The fan speed, and thus the noise level, increases with increasing ambient temperature.)

Description	Specification	Supplemental Information
Power Requirements		
Low Range		
Voltage	100 /120 V	± 10% operating range
Frequency	50/60/400 Hz	
High Range		
Voltage	220/240 V	± 10% operating range
Frequency	50/60 Hz	
Power Consumption, On	850 W (Maximum)	470 W (typical)
Power Consumption, Standby	25 W	Standby power is supplied to both the CPU and the frequency reference oscillator.

CAUTION The UXA has autoranging line voltage input. Before switching on the instrument, be sure the supply voltage is within the specified range and voltage fluctuations do not exceed 10 percent of the nominal supply voltage.

Description	Supplemental Information
Measurement Speed[a]	Nominal
Local measurement and display update rate[bc]	10 ms
Remote measurement and LAN transfer rate[bc]	10.7 ms
Marker Peak Search	4.4 ms
Center Frequency Tune and Transfer (Band 0)	20 ms
Center Frequency Tune and Transfer (Bands 1-4)	48 ms
Measurement/Mode Switching	100 ms

a. Sweep Points = 101.
b. Factory preset, fixed center frequency, RBW = 1 MHz, 10 MHz < span ≤ 600 MHz, stop frequency ≤ 3.6 GHz, Auto Align Off.
c. Phase Noise Optimization set to Fast Tuning, Display Off, 32 bit REAL, markers Off, single sweep, measured with HP Z420(memory 120 Gb, Windows 7. Intel Xcon CPU E5-1620 3.6 GHz), Keysight I/O Libraries Suite Version 16.317914, one meter GPIB cable, Keysight GPIB Card.

Description	Specifications	Supplemental Information
Display		
Resolution	1280 × 800	Capacitive multi-touch screen
Size		357 mm (14.1 in) diagonal (nominal)

Description	Specifications	Supplemental Information
Data Storage		
Removable solid state drive (SSD)		≥80 GB total volume; ≥9 GB for user data, available on separate partition.
Secured digital (SD) memory device		For calibration data backup.

Description	Specifications	Supplemental Information
Weight		Weight without options
Net		30.9 kg (68 lbs) (nominal)
Shipping		39.5 kg (87 lbs) (nominal)
Cabinet Dimensions		Cabinet dimensions exclude front and rear protrusions.
Height	280 mm (11 in)	
Width	459 mm (18 in)	
Length	500 mm (19.8 in)	

Inputs/Outputs

Front Panel

Description	Specifications	Supplemental Information
RF Input		
Connector		
Standard	Type-N female	Frequency *Option 508*, *513*, *526*
	2.4 mm male	Frequency *Option 544*, *550*
Option C35	3.5 mm male	Frequency *Option 526* only
Impedance		50Ω (nominal)

Description	Specifications	Supplemental Information
Probe Power		
Voltage/Current		+15 Vdc, ±7% at 0 to 150 mA (nominal)
		–12.6 Vdc, ±10% at 0 to 150 mA (nominal)
		GND

Description	Specifications	Supplemental Information
USB Ports		
Host (3 ports)		Compliant with USB 2.0
Connector	USB Type “A” female	
Output Current		
Port marked with Lightning Bolt, if any		1.2 A (nominal)
Port not marked with Lightning Bolt	0.5 A	

Description	Specifications	Supplemental Information
External Mixing		
Connector	SMA female	Standard. Refer to Chapter 4, “Standard Option EXM - External Mixing”, on page 93 for more details.

Description	Specifications	Supplemental Information
Headphone Jack		
Connector	miniature stereo audio jack	3.5 mm (also known as "1/8 inch")
Output Power		90 mW per channel into 16Ω (nominal)

Rear Panel

Description	Specifications	Supplemental Information
10 MHz Out		
Connector	BNC female	
Impedance		50Ω (nominal)
Output Amplitude		≥0 dBm (nominal)
Output Configuration	AC coupled, sinusoidal	
Frequency	10 MHz × (1 + frequency reference accuracy)	

Description	Specifications	Supplemental Information
Ext Ref In		
Connector	BNC female	Note: Analyzer noise sidebands and spurious response performance may be affected by the quality of the external reference used. See footnote [e] in the Phase Noise specifications within the Dynamic Range section on page 59.
Impedance		50Ω (nominal)
Input Amplitude Range sine wave square wave		 –5 to +10 dBm (nominal) 0.2 to 1.5 V peak-to-peak (nominal)
Input Frequency		1 to 50 MHz (nominal) (selectable to 1 Hz resolution)
Lock range	$\pm 2 \times 10^{-6}$ of ideal external reference input frequency	

Description	Specifications	Supplemental Information
Sync		Reserved for future use
Connector	BNC female	

Description	Specifications	Supplemental Information
Trigger Inputs		Either trigger source may be selected
(Trigger 1 In, Trigger 2 In)		
Connector	BNC female	
Impedance		10 kΩ (nominal)
Trigger Level Range	–5 to +5 V	1.5 V (TTL) factory preset

Description	Specifications	Supplemental Information
Trigger Outputs (Trigger 1 Out, Trigger 2 Out)		
Connector	BNC female	
Impedance		50Ω (nominal)
Level		0 to 5 V (CMOS)

Description	Specifications	Supplemental Information
Monitor Output 1 (Option PC6, PC6S, PC8 CPUs)		
VGA compatible		
Connector	15-pin mini D-SUB	
Format		XGA (60 Hz vertical sync rates, non-interlaced) Analog RGB
Monitor Output 2 (Option PC6, PC6S, PC8 CPUs)		
Connector	Mini DisplayPort	
Resolution	1280 x 800	
Monitor Output (Option PCA CPU)		
Connector	DisplayPort	
Resolution	1280 x 800	

Description	Specifications	Supplemental Information
Analog Out		
Connector	BNC female	
Impedance		50Ω (nominal)

Description	Specifications	Supplemental Information
Digital Bus		This port allows the UXA to connect to the X-Com data recorder for data streaming (up to 255 MHz BW with *Option RTS*), and to the Keysight N5105 and N5106 products only. It is not available for general purpose use.
Connector	MDR-80	

Description	Specifications	Supplemental Information
USB Ports (Option PC6, PC6S, PC8 CPUs)		
Host, Super Speed		2 ports
Compatibility	USB 3.0	
Connector	USB Type “A” (female)	
Output Current	0.9 A	
Host, stacked with LAN		1 port
Compatibility	USB 2.0	
Connector	USB Type “A” (female)	
Output Current	0.5 A	
Device		1 port
Compatibility	USB 3.0	
Connector	USB Type “B” (female)	
USB Ports (Option PCA CPU)		
Host, Super Speed		4 ports
Compatibility	USB 3.0	
Connector	USB Type-A (female)	
Output Current	0.9 A	
Device		1 port
Compatibility	USB 3.0	
Connector	USB Type-B (female)	
Thunderbolt (Option PCA CPU)		
Connector	USB Type-C (female)	2 ports
Output power	5V, 1.0 A max	

Description	Specifications	Supplemental Information
GPIB Interface		
Connector	IEEE-488 bus connector	
GPIB Codes		SH1, AH1, T6, SR1, RL1, PP0, DC1, C1, C2, C3 and C28, DT1, L4, C0
Mode		Controller or device

Description	Specifications	Supplemental Information
LAN TCP/IP Interface (Option PC6, PC6S, PC8 CPUs)	RJ45 Ethertwist	1000BaseT
LAN TCP/IP Interface (Option PCA CPU)		
Standard	1G Base-T	
Connector	RJ45 Ethertwist	
Standard	10G Base-T	
Connector	RJ45 Ethertwist	

Regulatory Information

This product is designed for use in Installation Category II and Pollution Degree 2 per IEC 61010 3rd ed, and 664 respectively.

This product has been designed and tested in accordance with accepted industry standards, and has been supplied in a safe condition. The instruction documentation contains information and warnings which must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

This product is intended for indoor use.

The table below lists the definitions of markings that may be on or with the product.

CE	The CE mark is a registered trademark of the European Community (if accompanied by a year, it is the year when the design was proven). This product complies with all relevant directives.
UK CA	The UK conformity mark is a UK government owned mark. Products showing this mark comply with all applicable UK regulations.
ccr.keysight@keysight.com	The Keysight email address is required by EU directives applicable to our product.
	The RCM mark is a registered trademark of the Australian Communications and Media Authority.
KC	South Korean Certification (KC) mark. It includes the marking’s identifier code.
CAN ICES/NMB-001(A)	Canada EMC label. Interference-Causing Equipment Standard for industrial, scientific and medical (ISM) equipment. Matériel industriel, scientifique et médical (ISM)
ISM 1-A	This is a symbol of an Industrial Scientific and Medical Group 1 Class A product. (CISPR 11, Clause 5)
CAN ICES/NMB-001(A) ISM GRP 1-A	ICES/ISM Label. This is a space saver label that combines two markings – CAN ICES and ISM
CE CAN ICES/NMB-001(A) ISM GRP 1-A	CE/ICES/ISM Label. This is a space saver label that combines three markings – CE, CAN ICES, and ISM.
CSA ® C US	The CSA mark is a registered trademark of the CSA International.
	The crossed-out wheeled bin symbol indicates that separate collection for waste electric and electronic equipment (WEEE) is required, as obligated by the EU DIRECTIVE and other National legislation. Please refer to www.keysight.com/go/takeback to understand your trade-in options with Keysight, in addition to product takeback instructions.

	China Restricted Substance Product Label. The EPUP (environmental protection use period) number in the center indicates the time period during which no hazardous or toxic substances or elements are expected to leak or deteriorate during normal use and generally reflects the expected useful life of the product.
	Universal recycling symbol. This symbol indicates compliance with the China standard GB 18455-2001 as required by the China RoHS regulations for paper/fiberboard packaging.

NOTE The input terminals for this product are classified as Measurement Category None.

EMC: Complies with the essential requirements of the European EMC Directive and the UK Electromagnetic Compatibility Regulations 2016 as well as current editions of the following standards (dates and editions are cited in the Declaration of Conformity):

- IEC/EN 61326-1
- CISPR 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.

NOTE This is a sensitive measurement apparatus by design and may have some performance loss (up to 25 dBm above the Spurious Responses, Residual specification of -100 dBm) when exposed to ambient continuous electromagnetic phenomenon in the range of 80 MHz -2.7 GHz when tested per IEC 61000-4-3.

South Korean Class A EMC declaration:

This equipment has been conformity assessed for use in business environments. In a residential environment this equipment may cause radio interference.
This EMC statement applies to the equipment only for use in business environment.

사 용 자 안 내 문
이 기기는 업무용 환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가정용 환경에서 사용하는 경우 전파간섭의 우려가 있습니다.

※ 사용자 안내문은 "업무용 방송통신기자재"에만 적용한다.

SAFETY: Complies with the essential requirements of the European Low Voltage Directive as well as current editions of the following standards (dates and editions are cited in the Declaration of Conformity):

- IEC/EN 61010-1
- Canada: CSA C22.2 No. 61010-1
- USA: UL std no. 61010-1

Acoustic statement: (European Machinery Directive)

Acoustic noise emission

LpA <70 dB

Operator position

Normal operation mode per ISO 7779

To find a current **Declaration of Conformity** for a specific Keysight product, go to: http://www.keysight.com/go/conformity

2 I/Q Analyzer, Standard

This chapter contains specifications for the I/Q Analyzer measurement application (Basic Mode).

Specifications Affected by I/Q Analyzer

Specification Name	Information
Number of Frequency Display Trace Points (buckets)	Does not apply.
Resolution Bandwidth	See "Frequency" on page 85 in this chapter.
Video Bandwidth	Not available.
Clipping-to-Noise Dynamic Range	See "Clipping-to-Noise Dynamic Range" on page 86 in this chapter.
Resolution Bandwidth Switching Uncertainty	Not specified because it is negligible.
Available Detectors	Does not apply.
Spurious Responses	The "Spurious Responses" on page 52 of core specifications still apply. Additional bandwidth-option-dependent spurious responses are given in the Analysis Bandwidth chapter for any optional bandwidths in use.
IF Amplitude Flatness	See "IF Frequency Response" on page 32 of the core specifications for the 10 MHz bandwidth. Specifications for wider bandwidths are given in the Analysis Bandwidth chapter for any optional bandwidths in use.
IF Phase Linearity	See "IF Phase Linearity" on page 33 of the core specifications for the 10 MHz bandwidth. Specifications for wider bandwidths are given in the Analysis Bandwidth chapter for any optional bandwidths in use.
Data Acquisition	See "Data Acquisition" on page 87 in this chapter for the 10 MHz bandwidth. Specifications for wider bandwidths are given in the Analysis Bandwidth chapter for any optional bandwidths in use.

Frequency

Description	Specifications	Supplemental Information
Frequency Span		
Option *B25* (Standard)	10 Hz to 25 MHz	
Option B40	10 Hz to 40 MHz	
Option B2X	10 Hz to 255 MHz	
Option B5X	10 Hz to 510 MHz	
Option H1G[a]	40 MHz to 1 GHz	
Resolution Bandwidth (Spectrum Measurement) Range		
Overall Span = 1 MHz Span = 10 kHz Span = 100 Hz	100 mHz to 3 MHz 50 Hz to 1 MHz 1 Hz to 10 kHz 100 mHz to 100 Hz	
Window Shapes	Flat Top, Uniform, Hanning, Hamming, Gaussian, Blackman, Blackman-Harris, Kaiser Bessel (K-B 70 dB, K-B 90 dB & K-B 110 dB)	
Analysis Bandwidth (Span) (Waveform Measurement)		
Option B25 (Standard)	10 Hz to 25 MHz	
Option B40	10 Hz to 40 MHz	
Option B2X	10 Hz to 255 MHz	
Option B5X	10 Hz to 510 MHz	
Option H1G[a]	40 MHz to 1 GHz	

a. In the 1 GHz bandwidth path, the span and bandwidth will be 40 MHz minimum. Below 40 MHz, a narrower IF path is used.

Clipping-to-Noise Dynamic Range

Description	Specifications	Supplemental Information
Clipping-to-Noise Dynamic Range[a]		Excluding residuals and spurious responses
Clipping Level at Mixer		Center frequency ≥ 20 MHz
IF Gain = Low	–10 dBm	–8 dBm (nominal)
IF Gain = High	–20 dBm	–17.5 dBm (nominal)
Noise Density at Mixer at center frequency[b]	(DANL[c] + IFGainEffect[d]) + 2.25 dB[e]	Example[f]

a. This specification is defined to be the ratio of the clipping level (also known as "ADC Over Range") to the noise density. In decibel units, it can be defined as clipping_level [dBm] – noise_density [dBm/Hz]; the result has units of dBFS/Hz (fs is "full scale").
b. The noise density depends on the input frequency. It is lowest for a broad range of input frequencies near the center frequency, and these specifications apply there. The noise density can increase toward the edges of the span. The effect is nominally well under 1 dB.
c. The primary determining element in the noise density is the "Displayed Average Noise Level" on page 44.
d. DANL is specified with the IF Gain set to High, which is the best case for DANL but not for Clipping-to-noise dynamic range. The core specifications "Displayed Average Noise Level" on page 44, gives a line entry on the excess noise added by using IF Gain = Low, and a footnote explaining how to combine the IF Gain noise with the DANL.
e. DANL is specified for log averaging, not power averaging, and thus is 2.51 dB lower than the true noise density. It is also specified in the narrowest RBW, 1 Hz, which has a noise bandwidth slightly wider than 1 Hz. These two effects together add up to 2.25 B.
f. As an example computation, consider this: For the case where DANL = –151 dBm in 1 Hz, IF Gain is set to low, and the "Additional DANL" is –160 dBm, the total noise density computes to –148.2 dBm/Hz and the Clipping-to-noise ratio for a –10 dBm clipping level is –138.2 dBFS/Hz.

Data Acquisition

Description	Specifications		Supplemental Information	
Time Record Length				
IQ Analyzer	32,000,001 IQ sample pairs[a]		Waveform measurement[b]	
Advanced Tools	**Data Packing**		89600 VSA software or Fast Capture[c]	
	32-bit	**64-bit**		
Length (IQ sample pairs)				
IFBW ≤255.176 MHz	536 MSa (2^{29} Sa)	268 MSa (2^{28} Sa)	2 GB total memory	
IFBW >255.176 MHz	1073 MSa (2^{29} Sa)	2536 MSa (2^{28} Sa)	2 GB total memory	
Maximum IQ Capture Time	**Data Packing**		**Data Packing**	
(89600VSA and Fast Capture)	**32-bit**	**64-bit**	**32-bit**	**64-bit**
10 MHz IFBW	42.94 s	21.47 s	(2^{29})/10 MHz ×1.25)	(2^{28})/10 MHz ×1.25)
25 MHz IFBW	17.17 s	8.58 s	(2^{29})/25 MHz ×1.25)	(2^{28})/25 MHz ×1.25)
40 MHz IFBW	10.73 s	5.36 s	(2^{29})/40 MHz ×1.25)	(2^{28})/40 MHz ×1.25)
240 MHz IFBW	1.78 s	0.89 s	(2^{29})/240 MHz ×1.25)	(2^{28})/240 MHz ×1.25)
255 MHz IFBW	1.78 s	0.89 s	(2^{29})/300 MSA/s)	(2^{28})/300 MSa/s)
256 MHz IFBW	3.35 s	1.67 s	(2^{30})/256 MHz ×1.25)	(2^{29})/256 MHz ×1.25)
480 MHz IFBW	1.78 s	0.89 s	(2^{30})/480 MHz ×1.25)	(2^{29})/480 MHz ×1.25)
510 MHz IFBW	1.78 s	0.89 s	(2^{30})/600 MSa/s)	(2^{29})/600 MSa/s)
Maximum IQ Capture Time	**Data Packing**			
(89600 VSA and Fast Capture)	**32-bit**	**64-bit**	Calculated by: Length of IQ sample pairs/Sample Rate (IQ Pairs)[d]	
10 MHz IFBW	42.94 s	21.47 s		
Sample Rate (IQ Pairs)	1.25 × IFBW			
ADC Resolution	16 bits			

a. Requires instrument software version >=A.31.00. Otherwise, IQ Sample Pairs is limited to 8,000,001.
b. This can also be accessed with the remote programming command of "read:wav0?".
c. This can only be accessed with the remote programming command of "init:fcap" in the IQ Analyzer (Basic) waveform measurement.
d. For example, using 32-bit data packing at 10 MHz IF bandwidth (IFBW) the Maximum Capture Time is calculated using the formula: "Max Capture Time = (2^{29})/(10 MHz × 1.25)".

3 Standard Option CR3 - Connector Rear, 2nd IF Output

This chapter contains specifications for *Option CR3*, Connector Rear, 2nd IF Output.

Specifications Affected by Connector Rear, 2nd IF Output

No other analyzer specifications are affected by the presence or use of this option. New specifications are given in the following pages.

Other Connector Rear, 2nd IF Output Specifications

Aux IF Out Port

Description	Specifications	Supplemental Information
Connector	SMA female	Shared with other options
Impedance		50Ω (nominal)

Second IF Out

Description	Specifications	Supplemental Information
Second IF Out		
Output Center Frequency		
SA Mode		322.5 MHz
I/Q Analyzer Mode		
IF Path ≤ 25 MHz		322.5 MHz
IF Path 40 MHz		250 MHz
IF Path 255 MHz		750 MHz
IF Path 510 MHz		877.1484375 MHz
IF Path 1 GHz		750 MHz
Conversion Gain at 2nd IF output center frequency		1 dB (nominal)[a]
Bandwidth (–6 dB)		
Low band		
IF Path ≤ 40 MHz		Up to 140 MHz (nominal)[b]
IF Path 255 MHz		255 MHz (nominal)
IF Path 510 MHz		510 MHz (nominal)
High band		
With preselector		Depends on RF center frequency[c]
Range		
Preselector bypassed		100 - 800 MHz ±3 dB (nominal)
External Mixing		100 - 1200 MHz ±6 dB (nominal)
Residual Output Signals		–94 dBm or lower (nominal)

a. "Conversion Gain" is defined from RF input to IF out with 0 dB mechanical attenuation and the electronic attenuator off. The nominal performance applies in zero span.
b. The passband width at –3 dB nominally extends from IF frequencies of 230 to 370 MHz. When the IF in use is centered at a frequency different from 300 MHz, the passband will be asymmetric.
c. The YIG-tuned preselector bandwidth nominally varies from 55 MHz for a center frequencies of 3.6 GHz through 57 MHz at 15 GHz to 75 MHz at 26.5 GHz. The preselector effect will dominate the passband width. See “Preselector Bandwidth” on page 28.

4 Standard Option EXM - External Mixing

This chapter contains specifications for the *Option EXM* External Mixing.

Specifications Affected by External mixing

Specification Name	Information
RF-Related Specifications, such as TOI, DANL, SHI, Amplitude Accuracy, and so forth.	Specifications do not apply; some related specifications are contained in IF Input in this chapter
IF-Related Specifications, such as RBW range, RBW accuracy, RBW switching uncertainty, and so forth.	Specifications unchanged, except IF Frequency Response — see specifications in this chapter.
New specifications: IF Input Mixer Bias LO Output	See specifications in this chapter.

Other External Mixing Specifications

Description	Specifications	Supplemental Information
Connection Port EXT MIXER		
Connector	SMA, female	
Impedance		50Ω (nominal) at IF and LO frequencies
Functions	Triplexed for Mixer Bias, IF Input and LO output	

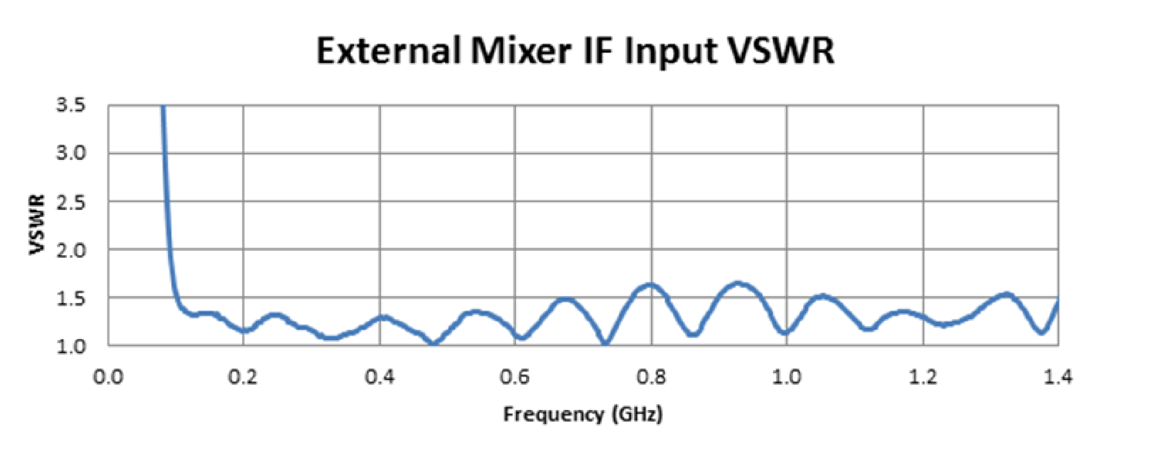
Description	Specifications	Supplemental Information
Mixer Bias[a]		
Bias Current		Short circuit current[b]
Range	±10 mA	
Resolution	10 μA	
Output impedance		477Ω (nominal)
Voltage clamp		±3.7 V (nominal)

a. The mixer bias circuit has a Norton equivalent, characterized by its short circuit current and its impedance. It is also clamped to a voltage range less than the Thevenin voltage capability.
b. The actual port current is often less than the short circuit current, due to the diode voltage drop of many mixers.

Description		Specifications		Supplemental Information
IF Input				
Maximum Safe Level		+7 dBm		
Center Frequency				
IF BW ≤25 MHz		322.5 MHz		
40 MHz IF path		250 MHz		
255 MHz IF path		750 MHz		
510 MHz IF path		877.1484375 MHz		
1000 MHz IF path		750 MHz		
Bandwidth				Supports all optional IFs
ADC Clipping Level				
25, 255, or 510 MHz IF paths				–15 dBm (nominal)
40 MHz IF path				–20 dBm (nominal)
1000 MHz IF path				–15dBm (nominal)
1 dB Gain Compression				–2 dBm (nominal)
Gain Accuracy[a]		**20 to 30°C**	**Full Range**	
IF BW ≤25 MHz		±1.2 dB	±2.5 dB	Swept and narrowband
Wider IF BW				±1.2 dB (nominal)
IF Frequency Response				RMS (nominal)
CF	**Width**			
322.5 MHz (10 MHz IF path)	±5 MHz			0.05 dB
322.5 MHz (25 MHz IF path)	±12.5 MHz			0.07 dB
250 MHz (40 MHz IF path)	±20 MHz			0.10 dB
750 MHz (255 MHz IF path)	±127.5 MHz			0.12 dB
877.1484375 MHz (510 MHz IF path)	±255 MHz			0.15 dB
750 MHz (1 GHz IF path)	±500 MHz			0.18 dB
Noise Figure (322.5 MHz, swept operation high IF gain)				9 dB (nominal)
VSWR				See plot below.

a. The amplitude accuracy of a measurement includes this term and the accuracy with which the settings of corrections model the loss of the external mixer.

External Mixer IF Input VSWR [Plot]



Description	Specifications		Supplemental Information
LO Output			
Frequency Range	3.75 to 14.1 GHz		
Output Power[a]	**20 to 30°C**	**Full Range**	
3.75 to 8.72 GHz[b]	+15.0 to 18.0 dBm	+13.5 to 19 dBm	
7.8 to 14.1 GHz[c]	+14.0 to 18.5 dBm	Not specified	
Second Harmonic			–20 dB (nominal)[b]
Fundamental Feedthrough and Undesired Harmonics[c]			–30 dB (nominal)
VSWR			1.8:1 (nominal)[d]

a. The LO output port power is compatible with Keysight M1970 and 11970 Series mixers except for the 11970K. The power is specified at the connector. Cable loss will affect the power available at the mixer. With non-Keysight/Agilent mixer units, supplied loss calibration data may be valid only at a specified LO power that may differ from the power available at the mixer. In such cases, additional uncertainties apply.
b. LO Doubler = Off settings.
c. LO Doubler = On setting. Fundamental frequency = 3.9 to 7.05 GHz.
d. The reflection coefficient has a Rayleigh probability distribution from 3.75 GHz to 14.1 GHz with a median VSWR of 1.22:1.

5 Standard Option LNP - Low Noise Path Specifications

This chapter contains specifications for the *Option LNP*, Low Noise Path.

Specifications Affected by Low Noise Path

The low noise path is in use when all the following are true:

- The setting of the Microwave Path is "Low Noise Path Enabled"
- The start frequency is at least 3.5 GHz and the stop frequency is above 3.6 GHz
- The preamp is either not licensed, or set to Off, or set to “Low Band”

Specification Name	Information
Displayed Average Noise Level (DANL)	See DANL specifications on page 44 of the core specifications.
Compression	Little change in dynamic range[a]
VSWR	The magnitude will be very similar between LNP and non-LNP operation, but the details, such as the frequencies of the peaks and valleys, will shift.
Frequency Response	See specifications in this chapter. The specifications are very similar to the normal path. But the details of the response can be quite different, with the frequencies of the peaks and valleys shifting between LNP and non-LNP operation. That means that any relative measurements between, for example, a large signal measured without LNP, and a small signal measured with LNP, could be subject to relative frequency response errors as large as the sum of the individual errors.
Second Harmonic Distortion	See “Second Harmonic Distortion” on page 54 of the core specifications.
Third-Order Intermodulation	Little change in dynamic range[a]
Other Input Related Spurious	See “Spurious Responses” on page 52 of the core specifications. This performance with LNP is not warranted, but is nominally the same as non-LNP performance.

a. The low noise path, when in use, does not substantially change the compression-to-noise dynamic range or the TOI-to-noise dynamic range because it mostly just reduces losses in the signal path in front of all significant noise, TOI and compression-affecting circuits. In other words, the compression threshold and the third-order intercept both decrease, and to the same extent as that to which the DANL decreases.

Other Low Noise Path Specifications

Description	RF/µW (*Option 508*, *513*, or *526*)	mmW (*Option 544* or *550*)	Specifications: 20 to 30°C	Specifications: Full range	Supplemental Information: 95th Percentile (≈2σ)
Frequency Response (Maximum error relative to reference condition (50 MHz) Swept operation[a], Attenuation 10 dB)					Refer to the footnote for Band Overlaps on page 17. Freq *Option 526* only: Modes above 18 GHz[b]
3.5 to 8.4 GHz	x		±1.5 dB	±2.5 dB	±0.71 dB
3.5 to 5.2 GHz		x	±1.9 dB	±3.7 dB	±0.74 dB
5.2 to 8.4 GHz		x	±1.5 dB	±2.5 dB	±0.58 dB
8.3 to 13.6 GHz	x	x	±2.0 dB	±2.7 dB	±0.62 dB
13.5 to 17.1 GHz	x	x	±2.0 dB	±2.7 dB	±0.64 dB
17.0 to 22.0 GHz	x	x	±2.0 dB	±2.7 dB	±0.75 dB
22.0 to 26.5 GHz	x	x	±2.5 dB	±3.7 dB	±0.89 dB
26.4 to 34.5 GHz		x	±2.3 dB	±3.5 dB	±0.94 dB
34.4 to 50 GHz		x	±3.2 dB	±5.0 dB	±1.28 dB

a. For Sweep Type = FFT, add the RF flatness errors of this table to the IF Frequency Response errors. An additional error source, the error in switching between swept and FFT sweep types, is nominally ±0.01 dB and is included within the "Absolute Amplitude Error" specifications.

b. Signal frequencies above 18 GHz are prone to response errors due to modes in the Type-N connector. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes.With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. The effect of these modes with this connector are included within these specifications.

6 Standard Option MPB - Microwave Preselector Bypass

This chapter contains specifications for the *Option MPB*, Microwave Preselector Bypass.

NOTE The preselector eliminates image frequencies and unwanted signals outside the preselector passband. Using option MPB to bypass the preselector will improve measurement repeatability and amplitude accuracy, since the preselector can drift over time. With the preselector bypassed, the measurement speed will be improved and attenuator cycles reduced, because Preselector Centering is no longer required before making a measurement. The reduction in attenuator cycles will extend the life of the mechanical attenuators in the instrument.

Specifications Affected by Microwave Preselector Bypass

Specification Name	Information
Displayed Average Noise Level with Preamp OFF	For analyzers with frequency Option 526 (26.5 GHz) or lower: MPB path Displayed Average Noise Levels are nominally 2 dB worse compared to Preamp OFF levels. For analyzers with frequency option higher than 526 (26.5 GHz): MPB path Displayed Average Noise Levels are nominally 3 dB better compared to Preamp OFF levels.
Displayed Average Noise Level with Preamp ON	For all analyzers frequency options: Preamp/MPB path Displayed Average Noise Levels are nominally 3 dB worse compared with Preamp ON levels.
IF Frequency Response and IF Phase Linearity	See “IF Frequency Response” on page 32 and “IF Phase Linearity” on page 33 for the standard 10 MHz analysis bandwidth; also, see the associated "Analysis Bandwidth" chapter for any optional bandwidths.
Frequency Response	See specifications in this chapter.
VSWR	The magnitude of the mismatch over the range of frequencies will be very similar between MPB and non-MPB operation, but the details, such as the frequencies of the peaks and valleys, will shift.
Additional Spurious Responses	In addition to the “Spurious Responses” on page 52 of the core specifications, “Additional Spurious Responses” on page 106 of this chapter also apply.

Other Microwave Preselector Bypass Specifications

Description	RF/μW	mmW	Specifications 20 to 30°C	Specifications Full range	Supplemental Information
Frequency Response (Maximum error relative to reference condition (50 MHz), Swept operation[a], Attenuation 10 dB)					Refer to the footnote for Band Overlaps on page 17. Freq *Option 526* only: Modes above 18 GHz[b]
	RF/μW	mmW	**20 to 30°C**	**Full range**	**Nominal**
3.5 to 8.4 GHz	x	x	±0.9 dB	±1.5 dB	±0.35 dB
8.3 to 13.6 GHz	x	x	±1.0 dB	±2.0 dB	±0.40 dB
13.5 to 17.1 GHz	x	x	±1.3 dB	±2.0 dB	±0.49 dB
17.0 to 22.0 GHz	x	x	±1.3 dB	±2.0 dB	±0.53 dB
22.0 to 26.5 GHz	x		±2.0 dB	±2.8 dB	±0.62 dB
22.0 to 26.5 GHz		x	±1.5 dB	±2.4 dB	±0.55 dB
26.4 to 34.5 GHz		x	±1.7 dB	±2.6dB	±0.79 dB
34.4 to 50 GHz		x	±3.1 dB	±4.8 dB	±1.17 dB

a. For Sweep Type = FFT, add the RF flatness errors of this table to the IF Frequency Response errors. An additional error source, the error in switching between swept and FFT sweep types, is nominally ±0.01 dB and is included within the “Absolute Amplitude Error” specifications.

b. Signal frequencies above 18 GHz are prone to response errors due to modes in the Type-N connector. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes.With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. The effect of these modes with this connector are included within these specifications.

Description		Specifications	Supplemental Information
Additional Spurious Responses[a]			
Tuned Frequency (f)	**Excitation**		
Image Response			
3.5 to 50 GHz	f + fIF[b]		0 dBc (nominal), High Band Image Suppression is lost with Option MPB.
LO Harmonic and Subharmonic Responses			
3.5 to 8.4 GHz	N(f + fIF) ±fIF[b]		−10 dBc (nominal), N = 2, 3
8.3 to 26.5 GHz	[N(f + fIF)/2] ±fIF[b]		−10 dBc (nominal), N = 1, 3, 4
26.4 to 34.5 GHz	[N(f + fIF)/2] ±fIF[b]		−10 dBc (nominal), N = 1, 2, 3, 5, 6, 7
34.4 to 50 GHz	[N(f + fIF)/2] ±fIF[b]		−10 dBc (nominal), N = 1, 2, 3, 5, 6, 7, 9, 10
Second Harmonic Response			
3.5 to 13.6 GHz	f/2		−72 dBc (nominal) for −40 dBm mixer level
13.5 to 34.5 GHz	f/2		−68 dBc (nominal) for −40 dBm mixer level
34.4 to 50 GHz	f/2		−68 dBc (nominal) for −40 dBm mixer level
IF Feedthrough Response			
3.5 to 13.6 GHz	fIF[b]		−100 dBc (nominal)
13.5 to 50 GHz	fIF[b]		−90 dBc (nominal)

a. Dominate spurious responses are described here. Generally, other *Option MPB*-specific spurious responses will be substantially lower than those listed here, but may exceed core specifications.
b. fIF = 322.5 MHz for bandwidth <25 MHz. Refer to *Option CR3* chapter for fIF at each IF Path.

7 Standard Option B25 - 25 MHz Analysis Bandwidth

This chapter contains specifications for the *Option B25* 25 MHz Analysis Bandwidth, and are unique to this IF Path.

Specifications Affected by Analysis Bandwidth

The specifications in this chapter apply when the 25 MHz path is in use. In IQ Analyzer, this will occur when the IF Path is set to 25 MHz, whether by Auto selection (depending on Span) or manually.

Specification Name	Information
IF Frequency Response	See specifications in this chapter.
IF Phase Linearity	See specifications in this chapter.
Spurious and Residual Responses	The "Spurious Responses" on page 52 still apply. Further, bandwidth-option-dependent spurious responses are contained within this chapter.
Displayed Average Noise Level, Third-Order Intermodulation and Phase Noise	The performance of the analyzer will degrade by an unspecified extent when using this bandwidth option. This extent is not substantial enough to justify statistical process control.

Other Analysis Bandwidth Specifications

Description				Specifi-cations	Supplemental Information
IF Spurious Response[a]					Preamp Off[b]
IF Second Harmonic					
Apparent Freq	**Excitation Freq**	**Mixer Level**[c]	**IF Gain**		
Any on-screen f	(f + fc + 22.5 MHz)/2	–15 dBm	Low		–54 dBc (nominal)
		–25 dBm	High		–54 dBc (nominal)
IF Conversion Image					
Apparent Freq	**Excitation Freq**	Mixer Level[c]	**IF Gain**		
Any on-screen f	2 × fc – f + 45 MHz	–10 dBm	Low		–70 dBc (nominal)
		–20 dBm	High		–70 dBc (nominal)

a. The level of these spurs is not warranted. The relationship between the spurious response and its excitation is described in order to make it easier for the user to distinguish whether a questionable response is due to these mechanisms. f is the apparent frequency of the spurious signal, fc is the measurement center frequency.
b. The spurious response specifications only apply with the preamp turned off. When the preamp is turned on, performance is nominally the same as long as the mixer level is interpreted to be Mixer Level = Input Level – Input Attenuation – Preamp Gain.
c. Mixer Level = Input Level - Input Attenuation.

Description			Specifications	Supplemental Information		
IF Frequency Response[a] (Demodulation and FFT response relative to the center frequency)				Freq *Option 526* only: Modes above 18 GHz[b]		
Center Freq (GHz)	**Span**[c] **(MHz)**	**Preselector**	**Max Error**[d]	**Midwidth Error (95th Percentile)**	**Slope (dB/MHz) (95th Percentile)**	**RMS**[e] **(nominal)**
≥0.02, ≤3.6	10 to ≤25	n/a	±0.30 dB	±0.12 dB	±0.10	0.02 dB
3.6 to 26.5	10 to ≤25[f]	On				0.50 dB
3.6 to 26.5	10 to ≤25	Off[g]	±0.40 dB	±0.12 dB	±0.10	0.03 dB
>26.5	10 to ≤25[f]	On				0.31 dB
>26.5	10 to ≤25	Off[g]	±0.40 dB			0.02 dB

a. The IF frequency response includes effects due to RF circuits such as input filters, that are a function of RF frequency, in addition to the IF passband effects.
b. Signal frequencies above 18 GHz are prone to additional response errors due to modes in the Type-N connector used. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes.With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to –0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
c. This column applies to the instantaneous analysis bandwidth in use. In the Spectrum analyzer Mode, this would be the FFT width. For Span < 10 MHz. see “Frequency Response” on page 30.
d. The maximum error at an offset (f) from the center of the FFT width is given by the expression ± [Midwidth Error + (f × Slope)], but never exceeds ±Max Error. Here the Midwidth Error is the error at the center frequency for the given FFT span. Usually, the span is no larger than the FFT width in which case the center of the FFT width is the center frequency of the analyzer. In the Spectrum Analyzer mode, when the analyzer span is wider than the FFT width, the span is made up of multiple concatenated FFT results, and thus has multiple centers of FFT widths so the f in the equation is the offset from the nearest center. These specifications include the effect of RF frequency response as well as IF frequency response at the worst case center frequency. Performance is nominally three times better at most center frequencies.
e. The “RMS” nominal performance is the standard deviation of the response relative to the center frequency, integrated across the span. This performance measure was observed at a center frequency in each harmonic mixing band, which is representative of all center frequencies; it is not the worst case frequency.
f. For information on the preselector which affects the passband for frequencies above 3.6 GHz when *Option MPB* is not enabled, see “Preselector Bandwidth” on page 28.
g. Standard *Option MPB* is enabled.

Description			Specifications	Supplemental Information	
IF Phase Linearity				Deviation from mean phase linearity For Freq *Option 526* only: Modes above 18 GHz[a]	
Center Freq (GHz)	**Span (MHz)**	**Preselector**		**Peak-to-peak** (nominal)	**RMS** (nominal)[b]
≥0.02, ≤3.6	≤25	n/a		0.41°	0.11°
>3.6	≤25	Off[c]		1.0°	0.27°

a. Signal frequencies above 18 GHz are prone to additional response errors due to modes in the Type-N connector used. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes.With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to –0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
b. The listed performance is the standard deviation of the phase deviation relative to the mean phase deviation from a linear phase condition, where the RMS is computed across the span shown.
c. Standard *Option MPB* is enabled.

Description	Specification	Supplemental Information
Full Scale (ADC Clipping)[a]		
Default settings, signal at CF		
(IF Gain = Low)		
Band 0		–8 dBm mixer level[b] (nominal)
Band 1 through 4		–7 dBm mixer level[b] (nominal)
High Gain setting, signal at CF		
(IF Gain = High)		
Band 0		–18 dBm mixer level[b] (nominal), subject to gain limitations[c]
Band 1 through 6		–17 dBm mixer level[b] (nominal), subject to gain limitations[c]
Effect of signal frequency ≠ CF		up to ±3 dB (nominal)

a. This table is meant to help predict the full-scale level, defined as the signal level for which ADC overload (clipping) occurs. The prediction is imperfect, but can serve as a starting point for finding that level experimentally. A SCPI command is also available for that purpose.
b. Mixer level is signal level minus input attenuation.
c. The available gain to reach the predicted mixer level will vary with center frequency. Combinations of high gains and high frequencies will not achieve the gain required, increasing the full scale level.

Data Acquisition

Description	Specifications		Supplemental Information
Time Record Length			
Analysis Tool			
IQ Analyzer	32,000,001 IQ sample pairs[a]		Waveform measurement[b]
Advanced Tools	**Data Packing**		89600 VSA software or Fast Capture[c]
	32-bit	**64-bit**	
Length (IQ sample pairs)	536 MSa (2^{29} Sa)	268 MSa (2^{28} Sa)	2 GB total memory
Maximum IQ Capture Time	**Data Packing**		
(89600 VSA and Fast Capture[c])	**32-bit**	**64-bit**	Calculated by: Length of IQ sample pairs/Sample Rate (IQ Pairs)[d]
10 MHz IFBW	42.94 s	21.47 s	
25 MHz IFBW	17.17 s	8.58 s	
Sample Rate (IQ Pairs)	1.25 × IFBW		
ADC Resolution	16 bits		

a. Requires instrument software version >=A.31.00. Otherwise, IQ Sample Pairs is limited to 8,000,001.
b. This can also be accessed with the remote programming command of "read:wav0?".
c. This can only be accessed with the remote programming command of "init:fcap" in the IQ Analyzer (Basic) waveform measurement.
d. For example, using 32-bit data packing at 10 MHz IF bandwidth (IFBW) the Maximum Capture Time is calculated using the formula: "Max Capture Time = (2^{29})/(10 MHz × 1.25)".

8 Option B40 - 40 MHz Analysis Bandwidth

This chapter contains specifications for the *Option B40* 40 MHz Analysis Bandwidth, and are unique to this IF Path.

Specifications Affected by Analysis Bandwidth

The specifications in this chapter apply when the 40 MHz path is in use. In IQ Analyzer, this will occur when the IF Path is set to 40 MHz, whether by Auto selection (depending on Span) or manually.

Specification Name	Information
IF Frequency Response	See specifications in this chapter.
IF Phase Linearity	See specifications in this chapter.
Spurious Responses	There are three effects of the use of Option B40 on spurious responses. Most of the warranted elements of the "Spurious Responses" on page 52 still apply without changes, but the revised-version of the table on page 52, modified to reflect the effect of Option B40, is shown in its place in this chapter. The image responses part of that table have the same warranted limits, but apply at different frequencies as shown in the table. The "higher order RF spurs" line is slightly degraded. Also, spurious-free dynamic range specifications are given in this chapter, as well as IF Residuals.
Noise Density	See specifications in this chapter. Noise Density specification replaces DANL specification when in wideband analysis.
Third-Order Intermodulation	This bandwidth option can create additional TOI products to those that are created by other instrument circuitry. These products do not behave with typical analog third-order behavior, and thus cannot be specified in the same manner. Nominal performance statements are given in this chapter, but they cannot be expected to decrease as the cube of the voltage level of the signals.
Phase Noise	The performance of the analyzer will degrade by an unspecified extent when using wideband analysis. This extent is not substantial enough to justify statistical process control.
Absolute Amplitude Accuracy	Nominally 0.5 dB degradation from base instrument absolute amplitude accuracy. (Refer to Absolute Amplitude Accuracy on page 34.)
Frequency Range Over Which Specifications Apply	Specifications on this bandwidth only apply with center frequencies of 30 MHz and higher.

Other Analysis Bandwidth Specifications

Description	Specifications	Supplemental Information
SFDR (Spurious-Free Dynamic Range)		Test conditions[a]
Signal Frequency within ±12 MHz of center		–80 dBc (nominal)
Signal Frequency anywhere within analysis BW		
Spurious response within ±18 MHz of center		–79 dBc (nominal)
Response anywhere within analysis BW		–77 dBc (nominal)

a. Signal level is –6 dB relative to full scale at the center frequency. Verified in the full IF width.

Description		Specifications		Supplemental Information	
Spurious Responses[a] (see Band Overlaps on page 17)				Preamp Off[b]	
Residual Responses[c]				–100 dBm (nominal)	
Image Responses					
Tuned Freq (f)	**Excitation Freq**	**Mixer Level**[d]	**Response**	**Response** (nominal)	
				µW	mmW
10 MHz to 3.6 GHz	f+10100 MHz	–10 dBm	–80 dBc	–120 dBc	–120 dBc
10 MHz to 3.6 GHz	f+500 MHz	–10 dBm	–80 dBc	–101 dBc	–101 dBc
3.6 to 13.6 GHz	f+500 MHz	–10 dBm	–78 dBc	–86 dBc	–102 dBc
13.6 to 17.1 GHz	f+500 MHz	–10 dBm	–74 dBc	–85 dBc	–102 dBc
17.1 to 22 GHz	f+500 MHz	–10 dBm	–70 dBc	–81 dBc	–100 dBc
22 to 26.5 GHz	f+500 MHz	–10 dBm	–66 dBc	–78 dBc	–99 dBc
26.5 to 34.5 GHz	f+500 MHz	–30 dBm	–60 dBc		–95 dBc
34.5 to 42 GHz	f+500 MHz	–30 dBm	–57 dBc		–83 dBc
42 to 50 GHz	f+500 MHz	–30 dBm			–75 dBc
Other Spurious Responses					
Carrier Frequency ≤26.5 GHz					
First RF Order[e] (f ≥ 10 MHz from carrier)		-10 dBm	–80 dBc + 20 × log(N^f)	–97 dBc	–98 dBc
Higher RF Order[g] (f ≥ 10 MHz from carrier)		–40 dBm	–78 dBc + 20 × log(N^f)	–101 dBc	–97 dBc
Carrier Frequency >26.5 GHz					
First RF Order[e] (f ≥ 10 MHz from carrier)		-30 dBm			–95 dBc
Higher RF Order[g] (f ≥ 10 MHz from carrier)		–40 dBm			–95 dBc
LO-Related Spurious Response Offset from carrier 200 Hz to 10 MHz		–10 dBm	–68 dBc+ 20 × log(N^f)		
Line-Related Spurious Responses				–73 dBc[h] + 20 × log(N^f) (nominal)	

a. Preselector enabled for frequencies >3.6 GHz.

b. The spurious response specifications only apply with the preamp turned off. When the preamp is turned on, performance is nominally the same as long as the mixer level is interpreted to be: Mixer Level = Input Level – Input Attenuation – Preamp Gain
c. Input terminated, 0 dB input attenuation.
d. Mixer Level = Input Level – Input Attenuation. Verify with mixer levels no higher than −12 dBm if necessary to avoid ADC overload.
e. With first RF order spurious products, the indicated frequency will change at the same rate as the input, with higher order, the indicated frequency will change at a rate faster than the input.
f. N is the LO multiplication factor.
g. RBW=100 Hz. With higher RF order spurious responses, the observed frequency will change at a rate faster than the input frequency.
h. Nominally –40 dBc under large magnetic (0.38 Gauss rms) or vibrational (0.21 g rms) environmental stimuli.

Description	Specification	Supplemental Information
IF Residual Responses		Relative to full scale; see the Full Scale table for details
Band 0		–112 dBFS (nominal)
Band 1, Preselector Bypassed (MPB on)		–110 dBFS (nominal)

Description			Specifications	Supplemental Information	
IF Frequency Response[a]				Relative to center frequency Freq *Option 526* only: Modes above 18 GHz[b]	
Center Freq (GHz)	**Span (MHz)**	**Preselector**		**Typical**	**RMS** (nominal)[c]
≥0.03, <3.6	≤40	n/a	±0.37 dB	±0.22 dB	0.07 dB
≥3.6, ≤8.4	≤40	Off[d]	±0.5 dB	±0.13 dB	0.05 dB
>8.4, ≤26.5	≤40	Off[d]	±0.7 dB	±0.14 dB	0.05 dB
>26.5, ≤34.4	≤40	Off[d]	±0.8 dB	±0.25 dB	0.07 dB
>34.4	≤40	Off[d]	±1 dB	±0.35 dB	0.07 dB
≥3.6, ≤26.5	≤40	On		See footnote[e]	

a. The IF frequency response includes effects due to RF circuits such as input filters, that are a function of RF frequency, in addition to the IF passband effects.
b. Signal frequencies above 18 GHz are prone to response errors due to modes in the Type-N connector. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes.With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to –0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
c. The listed performance is the rms of the amplitude deviation from the mean amplitude response of a span/CF combination. 50% of the combinations of prototype instruments, center frequencies and spans had performance better than the listed values.
d. Standard Option MPB is enabled.
e. The passband shape will be greatly affected by the preselector. See “Preselector Bandwidth” on page 28.

Description			Specifications	Supplemental Information	
IF Phase Linearity				Deviation from mean phase linearity Freq *Option 526* only: Modes above 18 GHz[a]	
Center Freq (GHz)	**Span (MHz)**	**Preselector**		**Peak-to-peak (nominal)**	**RMS** (nominal)[b]
≥0.02, <3.6	≤40	n/a		0.36°	0.083°
≥3.6	≤40	Off[c]		1.0°	0.24°

a. Signal frequencies above 18 GHz are prone to additional response errors due to modes in the Type-N connector used. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes.With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to –0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
b. The listed performance is the standard deviation of the phase deviation relative to the mean phase deviation from a linear phase condition, where the RMS is computed across the span shown.
c. Standard *Option MPB* is enabled.

Description	Specification	Supplemental Information	
Full Scale (ADC Clipping)[a]			
Default settings, signal at CF			
(IF Gain = Low; IF Gain Offset = 0 dB)			
		Mixer level[b] (nominal)	
		μW	mmW
Band 0		–8 dBm	–8 dBm
Band 1 through 4		–6 dBm	–7 dBm
Band 5 through 6			–7 dBm
High Gain setting, signal at CF		Mixer level[b] (nominal), subject to gain limitations[c]	
(IF Gain = High; IF Gain Offset = 0 dB)		μW	mmW
Band 0		–16 dBm	–12 dBm
Band 1 through 2		–9 dBm	–16 dBm
Band 3 through 4		–6 dBm	–16 dBm
Band 5 through 6			–15 dBm
IF Gain Offset ≠ 0 dB, signal at CF		See formula[d], subject to gain limitations[c]	
Effect of signal frequency ≠ CF		up to ±4 dB (nominal)	

a. This table is meant to help predict the full-scale level, defined as the signal level for which ADC overload (clipping) occurs. The prediction is imperfect, but can serve as a starting point for finding that level experimentally. A SCPI command is also available for that purpose.
b. Mixer level is signal level minus input attenuation.
c. The available gain to reach the predicted mixer level will vary with center frequency. Combinations of high gains and high frequencies will not achieve the gain required, increasing the full scale level.
d. The mixer level for ADC clipping is nominally given by that for the default settings, minus IF Gain Offset, minus 10 dB if IF Gain is set to High.

Description	Specifications	Supplemental Information
Third Order Intermodulation Distortion[a]		Two tones of equal level 1 MHz tone separation Each tone –13 dB relative to full scale (ADC clipping) IF Gain = High IF Gain Offset = 0 dB Preselector Bypassed[b] (Option MPB) in Bands 1 through 6
Band 0		–85 dBc (nominal)
Band 1 - 5		–84 dBc (nominal)
Band 6		–79 dBc (nominal)

a. Intercept = TOI = third order intercept. The TOI equivalent can be determined from the mixer tone level (in dBm) minus (distortion/2) where distortion is the relative level of the distortion tones in dBc. The mixer tone level can be calculated using the information in the Full Scale table in this chapter.
b. When using the preselector, performance is similar

Description		Specifications		Supplemental Information
Noise Density with Preselector Bypass (MPB on)				0 dB attenuation; Preselector bypassed above Band 0; center of IF bandwidth[a]
Band	**Freq (GHz)**[b]	**IF Gain**[c] **= Low**	**IF Gain = High**	
0	1.80	–144 dBm/Hz	–144 dBm/Hz	
1	5.95	–140 dBm/Hz	–140 dBm/Hz	
2	10.95	–141 dBm/Hz	–141 dBm/Hz	
3	15.3	–135 dBm/Hz	–135 dBm/Hz	
4	21.75	–133 dBm/Hz	–133 dBm/Hz	
5	30.45	–130 dBm/Hz	–130 dBm/Hz	
6	42.2	–130 dBm/Hz	–130 dBm/Hz	

a. The noise level in the IF will change for frequencies away from the center of the IF. Usually, the IF part of the total noise will get worse by nominally 3 dB as the edge of the IF bandwidth is approached. The IF part of the total noise dominates in Band 0 and becomes much less significant in higher bands.
b. Specifications apply at the center of each band. IF Noise dominates the system noise, therefore the noise density will not change substantially with center frequency.
c. IF Gain Offset = 0 dB. IF Gain = High is about 10 dB extra IF gain. High IF gain gives better noise levels to such a small extent that the warranted specifications do not change. High gain gives a full-scale level (ADC clipping) that is reduced by about 10 dB. For the best clipping-to-noise dynamic range, use IF Gain = Low and negative IF Gain Offset settings.

Description	Specification	Supplemental Information
Signal to Noise Ratio		Ratio of clipping level[a] to noise level
Example: 1.8 GHz		136 dBc/Hz, IF Gain = Low, IF Gain Offset = 0 dB

a. For the clipping level, see the table above, "Full Scale." Note that the clipping level is not a warranted specification, and has particularly high uncertainty at high microwave frequencies.

Data Acquisition

Description	Specifications		Supplemental Information
Time Record Length			
IQ Analyzer	32,000,001 IQ sample pairs[a]		Waveform measurement[b]
Advanced Tools	**Data Packing**		89600 VSA software or Fast Capture[c]
	32-bit	**64-bit**	
Length (IQ sample pairs)	536 MSa (2^{29} Sa)	268 MSa (2^{28} Sa)	2 GB total memory
Maximum IQ Capture Time	**Data Packing**		
(89600 VSA and Fast Capture)	**32-bit**	**64-bit**	Calculated by: Length of IQ sample pairs/Sample Rate (IQ Pairs)[d]
10 MHz IFBW	42.94 s	21.47 s	
25 MHz IFBW	17.17 s	8.58 s	
40 MHz IFBW	10.73 s	5.36 s	
Sample Rate (IQ Pairs)	1.25 × IFBW		
ADC Resolution	12 bits		

a. Requires instrument software version >=A.31.00. Otherwise, IQ Sample Pairs is limited to 8,000,001.
b. This can also be accessed with the remote programming command of "read:wav0?".
c. This can only be accessed with the remote programming command of "init:fcap" in the IQ Analyzer (Basic) waveform measurement.
d. For example, using 32-bit data packing at 10 MHz IF bandwidth (IFBW) the Maximum Capture Time is calculated using the formula: "Max Capture Time = $(2^{29})/(10\ \text{MHz} \times 1.25)$".

9 Option B2X - 255 MHz Analysis Bandwidth

This chapter contains specifications for the *Option B2X* 255 MHz Analysis Bandwidth, and are unique to this IF Path.

Specifications Affected by Analysis Bandwidth

The specifications in this chapter apply when the 255 MHz path is in use. In IQ Analyzer, this will occur when the IF Path is set to 255 MHz, whether by Auto selection (depending on Span) or manually.

Specification Name	Information
IF Frequency Response	See specifications in this chapter.
IF Phase Linearity	See specifications in this chapter.
Spurious Responses	There are three effects of the use of Option B2X on spurious responses. Most of the warranted elements of the "Spurious Responses" on page 52 still apply without changes, modified to reflect the effect of Option B2X, is shown in its place in this chapter. The image responses part of that table have the same warranted limits, but apply at different frequencies as shown in the table. The "higher order RF spurs" line is slightly degraded. Also, spurious-free dynamic range specifications are given in this chapter, as well as IF Residuals.
Noise Density	See specifications in this chapter. Noise Density specification replaces DANL specification when in wideband analysis.
Third-Order Intermodulation	This bandwidth option can create additional TOI products to those that are created by other instrument circuitry. These products do not behave with typical analog third-order behavior, and thus cannot be specified in the same manner. Nominal performance statements are given in this chapter, but they cannot be expected to decrease as the cube of the voltage level of the signals.
Phase Noise	The performance of the analyzer will degrade by an unspecified extent when using wideband analysis. This extent is not substantial enough to justify statistical process control.
Absolute Amplitude Accuracy	Nominally 0.5 dB (for Band 0 through Band 3) or 0.8 dB (for Band 4) degradation from base instrument absolute amplitude accuracy. (Refer to "Absolute Amplitude Accuracy" on page 34.)
Frequency Range Over Which Specifications Apply	Specifications on this bandwidth only apply with center frequencies of 400 MHz and higher.

Other Analysis Bandwidth Specifications

Description	Specifications	Supplemental Information
SFDR (Spurious-Free Dynamic Range)		Test conditions[a]
Anywhere within the analysis BW		–78 dBc (nominal)

a. Signal level is –6 dB relative to full scale at the center frequency. Verified in the full IF bandwidth.

Description		Specifications		Supplemental Information	
Spurious Responses[a]				Preamp Off[b]; Verification conditions[c]	
Residual Responses[d]				–95 dBm (nominal)	
Image Responses					
Tuned Freq (f)	**Excitation Freq**	**Mixer Level**[e]	**Response**	**Response** (nominal)	
				RF/µW	mmW
10 MHz to 3.6 GHz	f+11100 MHz	–10 dBm	–80 dBc	–131 dBc	–131 dBc
10 MHz to 3.6 GHz	f+1500 MHz	–10 dBm	–73 dBc	–95 dBc	–95 dBc
3.6 to 13.6 GHz	f+1500 MHz	–10 dBm	–78 dBc	–91 dBc	–108 dBc
13.6 to 17.1 GHz	f+1500 MHz	–10 dBm	–74 dBc	–90 dBc	–109 dBc
17.1 to 22 GHz	f+1500 MHz	–10 dBm	–70 dBc	–87 dBc	–109 dBc
22 to 26.5 GHz	f+1500 MHz	–10 dBm	–66 dBc	–86 dBc	–102 dBc
26.5 to 34.5 GHz	f+1500 MHz	–30 dBm	–60 dBc		–102 dBc
34.5 to 42 GHz	f+1500 MHz	–30 dBm	–57 dBc		–91 dBc
42 to 50 GHz	f+1500 MHz	–30 dBm			–94 dBc
Other Spurious Responses					
Carrier Frequency ≤26.5 GHz					
First RF Order[f] (f ≥ 10 MHz from carrier)		–10 dBm	–80 dBc + $20 \times \log(N^g)$	–111 dBc	–116 dBc
Higher RF Order[h] (f ≥ 10 MHz from carrier)		–40 dBm	–78 dBc + $20 \times \log(N^g)$	–98 dBc	–98 dBc
Carrier Frequency >26.5 GHz					
First RF Order[f] (f ≥ 10 MHz from carrier)		–30 dBm			–97 dBc
Higher RF Order[h] (f ≥ 10 MHz from carrier)		–30 dBm			–97 dBc
LO-Related Spurious Response (Offset from carrier 200 Hz to 10 MHz)		–10 dBm	–68 dBc[i] + $20 \times \log(N^g)$		
Line-Related Spurious Responses				–73 dBc[i] + $20 \times \log(N^g)$ (nominal)	

a. Preselector enabled for frequencies >3.6 GHz.

b. The spurious response specifications only apply with the preamp turned off. When the preamp is turned on, performance is nominally the same as long as the mixer level is interpreted to be: Mixer Level = Input Level – Input Attenuation – Preamp Gain
c. Verified in the full IF width.
d. Input terminated, 0 dB input attenuation.
e. Mixer Level = Input Level – Input Attenuation. Verify with mixer levels no higher than –12 dBm if necessary to avoid ADC overload.
f. With first RF order spurious products, the indicated frequency will change at the same rate as the input, with higher order, the indicated frequency will change at a rate faster than the input.
g. N is the LO multiplication factor.
h. RBW=100 Hz. With higher RF order spurious responses, the observed frequency will change at a rate faster than the input frequency.
i. Nominally –40 dBc under large magnetic (0.38 Gauss rms) or vibrational (0.21 g rms) environmental stimuli.

Description	Specifications	Supplemental Information
IF Residual Responses		Relative to full scale; see the Full Scale table for details.
Band 0		–110 dBFS (nominal)
Band 1, Preselector Bypassed (MPB on)		–108 dBFS (nominal)

Description			Specifications	Supplemental Information	
IF Frequency Response[a]				Modes above 18 GHz[b] Test conditions[c]	
Center Freq (GHz)	**Span (MHz)**	**Preselector**		**Typical**	**RMS** (nominal)[d]
≥0.4, <3.6	≤255	n/a	±0.75 dB	±0.3 dB	0.1 dB
>3.6, ≤8.4	≤255	Off[e]	±0.85 dB	±0.34 dB	0.1 dB
>8.4, ≤26.5	≤255	Off[e]		±0.6 dB (nominal)	0.2 dB
>26.5	≤255	Off[e]		±0.8 dB (nominal)	0.2 dB
>3.6, ≤50	≤255	On		See footnote[f]	

a. The IF frequency response includes effects due to RF circuits such as input filters, that are a function of RF frequency, in addition to the IF pass-band effects.
b. Signal frequencies above 18 GHz are prone to response errors due to modes in the Type-N connector. With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to –0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
c. Verified in the full IF bandwidth.
d. The listed performance is the rms of the amplitude deviation from the mean amplitude response of a span/CF combination. 50% of the combinations of prototype instruments, center frequencies and spans had performance better than the listed values.
e. Standard *Option MPB* is enabled.
f. The passband shape will be greatly affected by the preselector. See Preselector Bandwidth on page 28.

Description			Specifications	Supplemental Information	
IF Phase Linearity				Deviation from mean phase linearity Freq *Option 526* only: Modes above 18 GHz[a]	
Center Freq (GHz)	**Span (MHz)**	**Preselector**		**Peak-to-peak** (nominal)	**RMS** (nominal)[b]
≥0.03, <3.6	≤255	n/a		3°	0.6°
≥3.6, ≤26.5	≤255	Off[c]		2°	0.5°
≥26.5	≤255	Off[c]		4°	0.8°

a. Signal frequencies above 18 GHz are prone to additional response errors due to modes in the Type-N connector used. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes.With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to –0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
b. The listed performance is the rms of the phase deviation relative to the mean phase deviation from a linear phase condition, where the rms is computed across the span shown.
c. Standard *Option MPB* is enabled.

Description	Specification	Supplemental Information	
Full Scale (ADC Clipping)[a]			
Default settings, signal at CF			
(IF Gain = Low; IF Gain Offset = 0 dB)		**Mixer level[b] (nominal)**	
		RF/μW	**mmW**
Band 0		2 dBm	3 dBm
Band 1 through 2		4 dBm	3 dBm
Band 3 through 4		4 dBm	1 dBm
Band 5 through 6			1 dBm
High Gain setting, signal at CF		**Mixer level[b] (nominal), subject to gain limitations[c]**	
(IF Gain = High; IF Gain Offset = 0 dB)		**RF/μW**	**mmW**
Band 0		–4 dBm	–1 dBm
Band 1 through 2		2 dBm	–4 dBm
Band 3 through 4		4 dBm	–6 dBm
Band 5 through 6			–5 dBm
IF Gain Offset ≠ 0 dB, signal at CF		See formula[d], subject to gain limitations[c]	
Effect of signal frequency ≠ CF		up to ±4 dB (nominal)	

a. This table is meant to help predict the full-scale level, defined as the signal level for which ADC overload (clipping) occurs. The prediction is imperfect, but can serve as a starting point for finding that level experimentally. A SCPI command is also available for that purpose.
b. Mixer level is signal level minus input attenuation.
c. The available gain to reach the predicted mixer level will vary with center frequency. Combinations of high gains and high frequencies will not achieve the gain required, increasing the full scale level.
d. The mixer level for ADC clipping is nominally given by that for the default settings, minus IF Gain Offset, minus 10 dB if IF Gain is set to High.

Description	Specification	Supplemental Information	
Full Scale (ADC Clipping) - Full Bypass Path[a]			
Default settings, signal at CF			
(IF Gain = Low; IF Gain Offset = 0 dB)		**Mixer level**[b] **(nominal)**	
		RF/μW	**mmW**
Band 0		N/A	N/A
Band 1 through 2		3 dBm	3 dBm
Band 3 through 4		2 dBm	2 dBm
Band 5 through 6		N/A	2 dBm
High Gain setting, signal at CF		**Mixer level**[b] **(nominal), subject to gain limitations**[c]	
(IF Gain = High; IF Gain Offset = 0 dB)		**RF/μW**	**mmW**
Band 0		N/A	N/A
Band 1 through 2		–6 dBm	–7 dBm
Band 3 through 4		–6 dBm	–8 dBm
Band 5 through 6		N/A	–8 dBm
IF Gain Offset ≠ 0 dB, signal at CF		See formula[d], subject to gain limitations[c]	
Effect of signal frequency ≠ CF		up to ±4 dB (nominal)	

a. This table is meant to help predict the full-scale level, defined as the signal level for which ADC overload (clipping) occurs. The prediction is imperfect, but can serve as a starting point for finding that level experimentally. A SCPI command is also available for that purpose.
b. Mixer level is signal level minus input attenuation.
c. The available gain to reach the predicted mixer level will vary with center frequency. Combinations of high gains and high frequencies will not achieve the gain required, increasing the full scale level.
d. The mixer level for ADC clipping is nominally given by that for the default settings, minus IF Gain Offset, minus 10 dB if IF Gain is set to High.

Description	Specifications	Supplemental Information
Third Order Intermodulation Distortion[a,b]		Two tones of equal level 1 MHz tone separation Each tone –23 dB relative to full scale (ADC clipping) IF Gain = High IF Gain Offset = 0 dB Preselector Bypassed (MPB on) in Bands 1 through 6
Band 0		–85 dBc (nominal)
Band 1 through 4		–85 dBc (nominal)
Band 5 through 6		–80 dBc (nominal)

a. Most applications of this wideband IF will have their dynamic range limited by the noise of the IF. In cases where TOI is relevant, wide-band IFs usually have distortion products that, unlike mixers and traditional signal analyzer signal paths, behave chaotically with drive level, so that reducing the mixer level does not reduce the distortion products. In this IF, distortion performance variation with drive level behaves surprisingly much like traditional signal paths. The distortion contributions for wideband signals such as OFDM signals is best estimated from the TOI products at total CW signal power levels near the average total OFDM power level. This power level must be well below the clipping level to prevent clipping distortion in the IF. So a test level of two tones each at –23 dB is useful for estimating the contribution of TOI to a typical measurement of a wide-band OFDM signal, which will usually be quite far below the IF noise contribution.

b. Intercept = TOI = third order intercept. The TOI equivalent can be determined from the mixer tone level (in dBm) minus (distortion/2) where distortion is the relative level of the distortion tones in dBc. The mixer tone level can be calculated using the information in the Full Scale table in this chapter.

Description		Specifications		Supplemental Information
Noise Density - Preselector Bypass				0 dB attenuation; Preselector bypassed (MPB on) above Band 0; center of IF bandwidth[a]
Band	**Freq (GHz)**[b]	**IF Gain**[c] **= Low**	**IF Gain = High**	
0	1.80 (RF/μW)	–145 dBm/Hz	–147 dBm/Hz	
0	1.80 (mmW)	–144 dBm/Hz	–145 dBm/Hz	
1	6.00	–141 dBm/Hz	–142 dBm/Hz	
2	10.80	–140 dBm/Hz	–141 dBm/Hz	
3	15.15	–137 dBm/Hz	–137 dBm/Hz	
4	21.80	–135 dBm/Hz	–135 dBm/Hz	
5	30.50	–130 dBm/Hz	–130 dBm/Hz	
6	42.25	–130 dBm/Hz	–130 dBm/Hz	

a. The noise level in the IF will change for frequencies away from the center of the IF. The IF part of the total noise is nominally 2.5 dB worse at the worst frequency in the IF bandwidth. The IF part of the total noise dominates in Band 0 and becomes much less significant in higher bands.
b. Specifications apply at the center of each band. IF noise dominates the system noise, therefore the noise density will not change substantially with center frequency.
c. IF Gain Offset = 0 dB. IF Gain = High is about 10 dB extra IF gain, giving better noise levels but a full-scale level (ADC clipping) that is reduced by about 10 dB. For the best clipping-to-noise dynamic range, use IF Gain = Low and negative IF Gain Offset settings.

Description				Supplemental Information	
Noise Density - Full Bypass Path				0 dB attenuation; Preselector bypassed (MPB on) above Band 0; center of IF bandwidth[a]	
		Option 503, 513, 526	***Option 544, 550***	**Nominal**	
Band	**Freq (GHz)**[b]			**IF Gain**[c] **= Low**	**IF Gain= High**
1	6.00	X		–146 dBm/Hz	–152 dBm/Hz
1	6.00		X	–148 dBm/Hz	–156 dBm/Hz
2	10.80	X		–146 dBm/Hz	–152 dBm/Hz
2	10.80		X	–147 dBm/Hz	–155 dBm/Hz
3	15.15	X		–147 dBm/Hz	–150 dBm/Hz
3	15.15		X	–148 dBm/Hz	–155 dBm/Hz
4	21.80	X		–147 dBm/Hz	–150 dBm/Hz
4	21.80		X	–148 dBm/Hz	–154 dBm/Hz
5	30.50		X	–148 dBm/Hz	–154 dBm/Hz
6	42.25		X	–148 dBm/Hz	–152 dBm/Hz

a. The noise level in the IF will change for frequencies away from the center of the IF. The IF part of the total noise is nominally 2.5 dB worse at the worst frequency in the IF bandwidth. The IF part of the total noise dominates in Band 0 and becomes much less significant in higher bands.
b. Specifications apply at the center of each band. IF noise dominates the system noise, therefore the noise density will not change substantially with center frequency.
c. IF Gain Offset = 0 dB. IF Gain = High is about 10 dB extra IF gain, giving better noise levels but a full-scale level (ADC clipping) that is reduced by about 10 dB. For the best clipping-to-noise dynamic range, use IF Gain = Low and negative IF Gain Offset settings.

Description	Specification	Supplemental Information
Signal to Noise Ratio		Ratio of clipping level[a] to noise level[b]
Example: 1.8 GHz		148 dB nominal, log averaged, 1 Hz RBW, IF Gain = Low, IF Gain Offset = 0 dB

a. For the clipping level, see the table above, "Full Scale." Note that the clipping level is not a warranted specification, and has particularly high uncertainty at high microwave frequencies.
b. The noise level is specified in the table above, "Displayed Average Noise Level." Please consider these details and additional information: DANL is, by Keysight and industry practice, specified with log averaging, which reduces the measured noise level by 2.51 dB. It is specified for a 1 Hz resolution bandwidth, which will nominally have a noise bandwidth of 1.056 Hz. Therefore, the noise density in dBm/Hz units is 2.27 dB above the DANL in dBm (1 Hz RBW) units. Please note that the signal-to-noise ratio can be further improved by using negative settings of IF Gain Offset.

Data Acquisition

Description	Specifications		Supplemental Information
Time Record Length			
IQ Analyzer	32,000,001 IQ sample pairs[a]		Waveform measurement[b]
Advanced Tools	**Data Packing**		89600 VSA software or Fast Capture[c]
	32-bit	**64-bit**	
Length (IQ sample pairs)	1073 MSa (2^{30} Sa)	536 MSa (2^{29} Sa)	4 GB total memory (*Option DP4*)
Maximum IQ Capture Time	**Data Packing**		
(89600 VSA and Fast Capture)	**32-bit**	**64-bit**	Calculated by: Length of IQ sample pairs/Sample Rate (IQ Pairs)[d]
10 MHz IFBW	85.89 s[e]	42.94 s[e]	
25 MHz IFBW	34.34 s[e]	17.17 s[e]	
40 MHz IFBW	21.47 s[e]	10.73 s[e]	
240 MHz IFBW	3.57 s	1.78 s	
255 MHz IFBW	3.57 s	1.78 s	
Sample Rate (IQ Pairs)	Minimum of (1.25 × IFBW, 300 MSa/s)		
ADC Resolution	14 bits		

a. Requires instrument software version >=A.31.00. Otherwise, IQ Sample Pairs is limited to 8,000,001.
b. This can also be accessed with the remote programming command of "read:wav0?".
c. This can only be accessed with the remote programming command of "init:fcap" in the IQ Analyzer (Basic) waveform measurement.
d. For example, using 32-bit data packing at 10 MHz IF bandwidth (IFBW) the Maximum Capture Time is calculated using the formula: "Max Capture Time = $(2^{30})/(10\ \text{MHz} \times 1.25)$".
e. For instruments with Option DP4, to achieve the maximum capture depth for IFBWs <= 40 MHz, the IF Path must be manually set to a path > 40 MHz.

10 Option B5X - 510 MHz Analysis Bandwidth

This chapter contains specifications for the *Option B5X* 510 MHz Analysis Bandwidth, and are unique to this IF Path.

Specifications Affected by Analysis Bandwidth

The specifications in this chapter apply when the 510 MHz path is in use. In IQ Analyzer, this will occur when the IF Path is set to 510 MHz, whether by Auto selection (depending on Span) or manually.

Specification Name	Information
IF Frequency Response	See specifications in this chapter.
IF Phase Linearity	See specifications in this chapter.
Spurious Responses	There are three effects of the use of Option B5X on spurious responses. Most of the warranted elements of the “Spurious Responses” on page 52 still apply without changes, but the revised version of the table on page 45, modified to reflect the effect of Option B5X, is shown in its place in this chapter. The image responses part of that table have the same warranted limits, but apply at different frequencies as shown in the table. The "higher order RF spurs" line is slightly degraded. Also, spurious-free dynamic range specifications are given in this chapter, as well as IF Residuals.
Noise Density	See specifications in this chapter. Noise Density specification replaces DANL specification when in wideband analysis.
Third-Order Intermodulation	This bandwidth option can create additional TOI products to those that are created by other instrument circuitry. These products do not behave with typical analog third-order behavior, and thus cannot be specified in the same manner. Nominal performance statements are given in this chapter, but they cannot be expected to decrease as the cube of the voltage level of the signals.
Phase Noise	The performance of the analyzer will degrade by an unspecified extent when using wideband analysis. This extent is not substantial enough to justify statistical process control.
Absolute Amplitude Accuracy	Nominally 0.5 dB (for Band 0 through Band 3) or 0.8 dB (for Band 4) degradation from base instrument absolute amplitude accuracy. (Refer to Absolute Amplitude Accuracy on page 34.)
Frequency Range Over Which Specifications Apply	Specifications on this bandwidth only apply with center frequencies of 600 MHz and higher.

Other Analysis Bandwidth Specifications

Description	Specifications	Supplemental Information
SFDR (Spurious-Free Dynamic Range)		Test conditions[a]
Anywhere within the analysis bandwidth		–78 dBc (nominal)

a. Signal level is –6 dB relative to full scale at the center frequency. Verified in the full IF width.

Description		Specifications		Supplemental Information	
Spurious Responses[a]				Preamp Off[b], Verification conditions[c]	
Residual Responses[d]				–100 dBm (nominal)	
Image Responses					
Tuned Freq (f)	**Excitation Freq**	**Mixer Level**[e]	**Response**	**Response** (nominal)	
				RF/µW	mmW
10 MHz to 3.6 GHz	f+11354 MHz	–10 dBm	–80 dBc	–105 dBc	–105 dBc
10 MHz to 3.6 GHz	f+1754 MHz	–10 dBm	–80 dBc	–105 dBc	–105 dBc
3.6 to 13.6 GHz	f+1754 MHz	–10 dBm	–78 dBc	–91 dBc	–104 dBc
13.6 to 17.1 GHz	f+1754 MHz	–10 dBm	–74 dBc	–88 dBc	–105 dBc
17.1 to 22 GHz	f+1754 MHz	–10 dBm	–70 dBc	–87 dBc	–104 dBc
22 to 26.5 GHz	f+1754 MHz	–10 dBm	–66 dBc	–85 dBc	–103 dBc
26.5 to 34.5 GHz	f+1754 MHz	–30 dBm	–60 dBc		–83 dBc
34.5 to 42 GHz	f+1754 MHz	–30 dBm	–57 dBc		–79 dBc
42 to 50 GHz	f+1754 MHz	–30 dBm			–79 dBc
Other Spurious Responses Carrier Frequency ≤ 26.5 GHz					
First RF Order[f] (f ≥ 10 MHz from carrier)		–10 dBm	–80 dBc + 20 × log(N[g])	–96 dBc	–99 dBc
Higher RF Order[h] (f ≥ 10 MHz from carrier)		–40 dBm		See footnote[i]	
Carrier Frequency > 26.5 GHz					
First RF Order[f] (f ≥ 10 MHz from carrier)		–30 dBm			–71 dBc
Higher RF Order[h] (f ≥ 10 MHz from carrier)		–30 dBm		See footnote[i]	
LO-Related Spurious Response Offset from carrier 200 Hz to 10 MHz		–10 dBm	–68 dBc[j] + 20 × log(N[g])		
Line-Related Spurious Responses				–73 dBc[j] + 20 × log(N[g])	

a. Preselector enabled for frequencies >3.6 GHz.

b. The spurious response specifications only apply with the preamp turned off. When the preamp is turned on, performance is nominally the same as long as the mixer level is interpreted to be: Mixer Level = Input Level – Input Attenuation – Preamp Gain
c. Verified in the full IF width.
d. Input terminated, 0 dB input attenuation.
e. Mixer Level = Input Level – Input Attenuation. Verify with mixer levels no higher than –12 dBm if necessary to avoid ADC overload.
f. With first RF order spurious products, the indicated frequency will change at the same rate as the input, with higher order, the indicated frequency will change at a rate faster than the input.
g. N is the LO multiplication factor.
h. RBW=100 Hz. With higher RF order spurious responses, the observed frequency will change at a rate faster than the input frequency.
i. At the designated test conditions this spur is nominally below the noise floor and cannot be measured.
j. Nominally –40 dBc under large magnetic (0.38 Gauss rms) or vibrational (0.21 g rms) environmental stimuli.

Description	Specifications	Supplemental Information
IF Residual Responses		Relative to full scale; see the Full Scale table for details.
Band 0		–104 dBFS (nominal)
Band 1, Preselector Bypassed (MPB on)		–103 dBFS (nominal)

Description			Specifications	Supplemental Information	
IF Frequency Response[a]				Modes above 18 GHz[b] Test conditions[c]	
Center Freq (GHz)	**Span (MHz)**	**Preselector**		**Typical**	**RMS** (nominal)[d]
≥0.6 <3.6	≤500	n/a	±1.0 dB	±0.41 dB	0.06 dB
≥0.6 <3.6	≤510	n/a		See note[e]	0.06 dB
≥3.6, ≤8.4	≤500	Off[f]	±1.25 dB	±0.42 dB	0.3 dB
≥3.6, ≤8.4	≤510	Off[f]		±0.3 dB (nominal)[e]	
≥8.4, ≤26.5	≤510	Off[f]		±0.8 dB (nominal)	
≥26.5	≤510	Off[f]		±1.0 dB (nominal)	
≥3.6, ≤26.5	≤510	On		See note[g]	

a. The IF frequency response includes effects due to RF circuits such as input filters, that are a function of RF frequency, in addition to the IF pass-band effects.
b. Signal frequencies above 18 GHz are prone to response errors due to modes in the Type-N connector. With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to –0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
c. Verified in the full IF bandwidth.
d. The listed performance is the rms of the amplitude deviation from the mean amplitude response of a span/CF combination. 50% of the combinations of prototype instruments, center frequencies and spans had performance better than the listed values.
e. IF flatness nominally degrades by 15% in the 510 MHz span setting relative to the 500 MHz span.
f. Standard *Option MPB* is enabled.
g. The passband shape will be greatly affected by the preselector. See "Preselector Bandwidth" on page 28.

Description			Specifications	Supplemental Information	
IF Phase Linearity				Deviation from mean phase linearity Freq *Option 526* only: Modes above 18 GHz[a]	
Center Freq (GHz)	**Span (MHz)**	**Preselector**		**Peak-to-peak** (nominal)	**RMS** (nominal)[b]
≥0.04, <3.6	≤510	n/a		5°	1.0°
≥0.04, <26.5	≤510	Off[c]		6°	1.4°
≥26.5	≤510	Off		7°	1.6°

a. Signal frequencies above 18 GHz are prone to additional response errors due to modes in the Type-N connector used. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes.With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to –0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
b. The listed performance is the rms of the phase deviation relative to the mean phase deviation from a linear phase condition, where the rms is computed across the span shown.
c. Standard *Option MPB* is enabled.

Description	Specification	Supplemental Information	
Full Scale (ADC Clipping)[a]			
Default settings, signal at CF			
(IF Gain = Low; IF Gain Offset = 0 dB)		**Mixer level**[b] **(nominal)**	
		RF/μW	**mmW**
Band 0		+2 dBm	+2.5 dBm
Band 1 through 2		+2 dBm	+3.5 dBm
Band 3 through 4		+2 dBm	+1 dBm
Band 5 through 6			+1 dBm
High Gain setting, signal at CF		**Mixer level**[b] **(nominal), subject to gain limitations**[c]	
(IF Gain = High; IF Gain Offset = 0 dB)		**RF/μW**	**mmW**
Band 0		–3 dBm	–1 dBm
Band 1 through 2		0 dBm	–7 dBm
Band 3 through 4		+2 dBm	–9 dBm
Band 5 through 6			–9 dBm
IF Gain Offset ≠ 0 dB, signal at CF		See formula[d], subject to gain limitations[c]	
Effect of signal frequency ≠ CF		up to ±4 dB (nominal)	

a. This table is meant to help predict the full-scale level, defined as the signal level for which ADC overload (clipping) occurs. The prediction is imperfect, but can serve as a starting point for finding that level experimentally. A SCPI command is also available for that purpose.
b. Mixer level is signal level minus input attenuation.
c. The available gain to reach the predicted mixer level will vary with center frequency. Combinations of high gains and high frequencies will not achieve the gain required, increasing the full scale level.
d. The mixer level for ADC clipping is nominally given by that for the default settings, minus IF Gain Offset, minus 10 dB if IF Gain is set to High.

Description	Specification	Supplemental Information	
Full Scale (ADC Clipping) - Full Bypass Path[a]			
Default settings, signal at CF			
(IF Gain = Low; IF Gain Offset = 0 dB)		**Mixer level**[b] **(nominal)**	
		RF/μW	**mmW**
Band 0		N/A	N/A
Band 1 through 2		3 dBm	3 dBm
Band 3 through 4		2 dBm	1 dBm
Band 5 through 6		N/A	2 dBm
High Gain setting, signal at CF		**Mixer level**[b] **(nominal), subject to gain limitations**[c]	
(IF Gain = High; IF Gain Offset = 0 dB)		**RF/μW**	**mmW**
Band 0		N/A	N/A
Band 1 through 2		–6 dBm	–7 dBm
Band 3 through 4		–7 dBm	–9 dBm
Band 5 through 6		N/A	–10 dBm
IF Gain Offset ≠ 0 dB, signal at CF		See formula[d], subject to gain limitations[c]	
Effect of signal frequency ≠ CF		up to ±4 dB (nominal)	

a. This table is meant to help predict the full-scale level, defined as the signal level for which ADC overload (clipping) occurs. The prediction is imperfect, but can serve as a starting point for finding that level experimentally. A SCPI command is also available for that purpose.
b. Mixer level is signal level minus input attenuation.
c. The available gain to reach the predicted mixer level will vary with center frequency. Combinations of high gains and high frequencies will not achieve the gain required, increasing the full scale level.
d. The mixer level for ADC clipping is nominally given by that for the default settings, minus IF Gain Offset, minus 10 dB if IF Gain is set to High.

Description	Specifications	Supplemental Information
Third Order Intermodulation Distortion[a][b]		Two tones of equal level 1 MHz tone separation Each tone –23 dB relative to full scale (ADC clipping) IF Gain = High IF Gain Offset = 0 dB Preselector Bypassed (MPB on) in Bands 1 through 6
Band 0		–85 dBc (nominal)
Band 1 through 4		–82 dBc (nominal)
Band 5 through 6		–79 dBc (nominal)

a. Most applications of this wideband IF will have their dynamic range limited by the noise of the IF. In cases where TOI is relevant, wide-band IFs usually have distortion products that, unlike mixers and traditional signal analyzer signal paths, behave chaotically with drive level, so that reducing the mixer level does not reduce the distortion products. In this IF, distortion performance variation with drive level behaves surprisingly much like traditional signal paths. The distortion contributions for wideband signals such as OFDM signals is best estimated from the TOI products at total CW signal power levels near the average total OFDM power level. This power level must be well below the clipping level to prevent clipping distortion in the IF. So a test level of two tones each at –23 dB is useful for estimating the contribution of TOI to a typical measurement of a wide-band OFDM signal, which will usually be quite far below the IF noise contribution.

b. Intercept = TOI = third order intercept. The TOI equivalent can be determined from the mixer tone level (in dBm) minus (distortion/2) where distortion is the relative level of the distortion tones in dBc. The mixer tone level can be calculated using the information in the Full Scale table in this chapter.

Description		Specifications		Supplemental Information
Noise Density - Preselector Bypass				0 dB attenuation; Preselector bypassed (MPB on) above Band 0; center of IF bandwidth[a]
Band	**Freq (GHz)**[b]	**IF Gain**[c] **= Low**	**IF Gain = High**	
0	1.80	–144 dBm/Hz	–146 dBm/Hz (RF/μW) –144 dBm/Hz (mmW)	
1	6.0	–140 dBm/Hz	–142 dBm/Hz	
2	10.80	–140 dBm/Hz	–141 dBm/Hz	
3	15.15	–137 dBm/Hz	–137 dBm/Hz	
4	21.80	–135 dBm/Hz	–135 dBm/Hz	
5	30.5	–130 dBm/Hz	–130 dBm/Hz	
6	42.25	–130 dBm/Hz	–130 dBm/Hz	

a. The noise level in the IF will change for frequencies away from the center of the IF. The IF part of the total noise varies significantly and nonmonotonically with IF frequency. At the worst IF frequency, which is at one edge of the bandwidth, it is nominally 5 dB higher. The IF part of the total noise dominates in Band 0 and becomes much less significant in higher bands.
b. Specifications apply at the center of each band. IF noise dominates the system noise, therefore the noise density will not change substantially with center frequency.
c. IF Gain Offset = 0 dB. IF Gain = High is about 10 dB extra IF gain, giving better noise levels but a full-scale level (ADC clipping) that is reduced by about 10 dB. For the best clipping-to-noise dynamic range, use IF Gain = Low and negative IF Gain Offset settings.

Description				Supplemental Information	
Noise Density - Full Bypass Path				0 dB attenuation; Preselector bypassed (MPB on) above Band 0; center of IF bandwidth[a]	
		Option 503, 513, 526	***Option 544, 550***	**Nominal**	
Band	**Freq (GHz)**[b]			**IF Gain**[c] **= Low**	**IF Gain= High**
1	6.00	X		–146 dBm/Hz	–152 dBm/Hz
1	6.00		X	–147 dBm/Hz	–156 dBm/Hz
2	10.80	X		–146 dBm/Hz	–152 dBm/Hz
2	10.80		X	–147 dBm/Hz	–155 dBm/Hz
3	15.15	X		–147 dBm/Hz	–151 dBm/Hz
3	15.15		X	–149 dBm/Hz	–156 dBm/Hz
4	21.80	X		–147 dBm/Hz	–150 dBm/Hz
4	21.80		X	–149 dBm/Hz	–154 dBm/Hz
5	30.50		X	–149 dBm/Hz	–154 dBm/Hz
6	42.25		X	–147 dBm/Hz	–152 dBm/Hz

a. The noise level in the IF will change for frequencies away from the center of the IF. The IF part of the total noise is nominally 2.5 dB worse at the worst frequency in the IF bandwidth. The IF part of the total noise dominates in Band 0 and becomes much less significant in higher bands.
b. Specifications apply at the center of each band. IF noise dominates the system noise, therefore the noise density will not change substantially with center frequency.
c. IF Gain Offset = 0 dB. IF Gain = High is about 10 dB extra IF gain, giving better noise levels but a full-scale level (ADC clipping) that is reduced by about 10 dB. For the best clipping-to-noise dynamic range, use IF Gain = Low and negative IF Gain Offset settings.

Description	Specification	Supplemental Information
Signal to Noise Ratio		Ratio of clipping level[a] to noise level[b]
Example: 1.8 GHz		148 dB nominal, log averaged, 1 Hz RBW, IF Gain = Low, IF Gain Offset = 0 dB

a. For the clipping level, see the table above, "Full Scale." Note that the clipping level is not a warranted specification, and has particularly high uncertainty at high microwave frequencies.
b. The noise level is specified in the table above, "Displayed Average Noise Level." Please consider these details and additional information: DANL is, by Keysight and industry practice, specified with log averaging, which reduces the measured noise level by 2.51 dB. It is specified for a 1 Hz resolution bandwidth, which will nominally have a noise bandwidth of 1.056 Hz. Therefore, the noise density in dBm/Hz units is 2.27 dB above the DANL in dBm (1 Hz RBW). Please note that the signal-to-noise ratio can be further improved by using negative settings of IF Gain Offset.

Data Acquisition

Description	Specifications		Supplemental Information
Time Record Length			
IQ Analyzer	32,000,001 IQ sample pairs[a]		Waveform measurement[b]
Advanced Tools			89600 VSA software or Fast Capture[c]
	Data Packing		
Length (IQ sample pairs)	**32-bit**	**64-bit**	
IFBW ≤255.176 MHz	1073 MSa (2^{30} Sa)	536 MSa (2^{29} Sa)	4 GB total memory (*Option DP4*)
IFBW >255.176 MHz	2147 MSa (2^{31} Sa)	1073 MSa (2^{30} Sa)	8 GB total memory (*Option DP4*)
Maximum IQ Capture Time	**Data Packing**		
(89600 VSA and Fast Capture[c])	**32-bit**	**64-bit**	Calculated by: Length of IQ sample pairs/Sample Rate (IQ Pairs)[d]
10 MHz IFBW	85.89 s[e]	42.94 s[e]	
25 MHz IFBW	34.35 s[e]	17.17 s[e]	
40 MHz IFBW	21.47 s[e]	10.73 s[e]	
240 MHz IFBW	3.57 s	1.78 s	
255 MHz IFBW	3.57 s	1.78 s	
256 MHz IFBW	6.71 s	3.35 s	
480 MHz IFBW	3.57 s	1.79 s	
510 MHz IFBW	3.57 s	1.79 s	
Sample Rate (IQ Pairs)			
IFBW ≤255.176 MHz	Minimum of (1.25 × IFBW, 300 MSa/s)		
IFBW >255.176 MHz	Minimum of (1.25 × IFBW, 600 MSa/s)		
ADC Resolution	14 bits		

a. Requires instrument software version >=A.31.00. Otherwise, IQ Sample Pairs is limited to 8,000,001.
b. This can also be accessed with the remote programming command of "read:wav0?".
c. This can only be accessed with the remote programming command of "init:fcap" in the IQ Analyzer (Basic) waveform measurement.
d. For example, using 32-bit data packing at 10 MHz IF bandwidth (IFBW) the Maximum Capture Time is calculated using the formula: "Max Capture Time = $(2^{30})/(10\text{ MHz} \times 1.25)$".
e. For instruments with Option DP4, to achieve the maximum capture depth for IFBWs <= 40 MHz, the IF Path must be manually set to a path > 40 MHz.

11 Option H1G - 1 GHz Analysis Bandwidth

This chapter contains specifications for the *Option H1G* 1 GHz Analysis Bandwidth, and are unique to this IF Path.

Specifications Affected When the H1G Path Is Not Enabled

Standard instrument specifications apply for all instruments with *Option H1G* from 0 to 40°C. Exceptions to the standard instrument specifications are listed below:

Spurious Responses	
LO-Related Spurious Responses (Offset from carrier 300 Hz to 10 MHz)[a] (Mixer Level -10 dBm)	–72 dBc[b] + 20 x log(N[c]) (nominal)
Close-in Sidebands (LO-Related, Offset <300 Hz) (Mixer Level -10 dBm)	–60 dBc + 20 x log(N) (nominal)

a. A noteworthy group of harmonically related sidebands is often present with a level of nominally –80 dBc at 300 Hz and envelope falling off (30 dB/decade) with increasing offsets.
b. Nominally –40 dBc under large magnetic (0.38 Gauss rms) or vibrational (0.21 g rms) environmental stimuli.
c. N is the LO multiplication factor. Refer to page 17 for the N value versus frequency ranges.

Phase Noise	Specifications	Supplemental Information
Noise Sidebands (20 to 30°C, CF = 1 GHz) Only the 1 kHz offset values are affected		
Offset Frequency		
1 kHz[a]	–123 dBc/Hz	–127 dBc/Hz (typical)

a. Phase noise measurements at this offset are affected by spur performance.

Specifications Affected by Analysis Bandwidth

The specifications in this chapter apply when the 1 GHz path is in use. In IQ Analyzer, this will occur when the IF Path is set to 1 GHz, whether by Auto selection (depending on Span) or manually.

Specification Name	Information
Supported applications	IQ Analyzer, 89600 VSA Software, N9067EM0E Pulse Software. Any application not specifically listed can be used with up to a 255 MHz IF path, but are not supported in the 1 GHz bandwidth path.
IF Frequency Response	See specifications in this chapter.
IF Phase Linearity	See specifications in this chapter.
Spurious Responses	The performance of the analyzer may degrade by an unspecified extent when using wideband analysis. However, spurious-free dynamic range specifications are given in this chapter, as well as IF Residuals.
Noise Density	See specifications in this chapter. Noise Density specification replaces DANL specification when in wideband analysis.
Third-Order Intermodulation	This bandwidth option can create additional TOI products to those that are created by other instrument circuitry. These products do not behave with typical analog third-order behavior, and thus cannot be specified in the same manner. The performance of the analyzer may degrade by an unspecified extent when using H1G wideband analysis.
Phase Noise	The performance of the analyzer will degrade by an unspecified extent when using wideband analysis. This extent is not substantial enough to justify statistical process control.
Absolute Amplitude Accuracy	Nominally 0.7 dB degradation from base instrument absolute amplitude accuracy. (Refer to Absolute Amplitude Accuracy on page 34.)
Frequency Span/Analysis Bandwidth	In the 1 GHz Bandwidth Path, the minimum span and bandwidth is 40 MHz. Below 40 MHz, a narrower IF path is used.
Acoustic Noise Emission	Option H1G adds internal cooling fans that increase the acoustic emissions of the instrument. At ambient temperatures < 24°C, the acoustic noise per ISO 7779 in the "operator position" is nominally 55 dBA.
Real-Time Analysis Bandwidth RT1 and RT2	Limited to analysis bandwidth ≤ 255 MHz.
Frequency Range Over Which Specifications Apply	Specifications on this bandwidth only apply with center frequencies of 700 MHz and higher.
Temperature Range Over Which Specifications Apply	0 to 40°C.

Other Analysis Bandwidth Specifications

For instruments S/N prefix < US/MY/SG57212008:

Description	Specifications	Supplemental Information
SFDR (Spurious-Free Dynamic Range)		
Anywhere within the analysis bandwidth		
< 3.1 GHz CF		–62 dBc[a] (nominal)
≥ 3.1 GHz CF		–56 dBc[b] (nominal)

a. Signal level is –10 dB relative to full scale at the center frequency. Verified in the full IF width.
b. Signal level is –18 dB relative to full scale at the center frequency. Verified in the full IF width.

For instruments S/N prefix ≥ US/MY/SG57212008 or earlier instruments with AIF 1 GHz assembly N9041-60092 or later installed (see footnote[1]on page 151):

Description	Specifications	Supplemental Information
SFDR (Spurious-Free Dynamic Range)		
Anywhere within the analysis bandwidth		
< 4.0 GHz CF		–60 dBc[a] (nominal)
≥ 4.0 GHz CF		–61 dBc[b] (nominal)

a. Signal level is –10 dB relative to full scale at the center frequency. Verified in the full IF width.
b. Signal level is –18 dB relative to full scale at the center frequency. Verified in the full IF width.

1. Press System, Show Hardware to verify AIF 1 GHz assembly part number.

Description	Specifications	Supplemental Information
IF Residual Responses[a]		IF Gain = High, Relative to full scale; see the Full Scale table in this chapter for details.
Band 0		−67 dBFS (nominal)
Band 1, Preselector Bypassed (MPB on)		−69 dBFS (nominal)

a. The residual performance is dominated by a single residual 50 MHz to the left of the center of the screen. It is an artifact of the ADC architecture. If residual performance is critical and span requirements are flexible, then reducing the span to 255 MHz and making use of the 255 MHz IF path (Option B2X) will eliminate this residual.

Description			Specifications	Supplemental Information
IF Frequency Response[a]				Relative to center frequency.
Center Freq (GHz)	**Span (MHz)**	**Preselector**		**Max Error**
≥0.7 <3.6	≤1000	n/a		±0.7 dB (nominal)
≥3.6, ≤8.4	≤1000	Off[b]		±0.7 dB (nominal)
≥8.4, ≤26.5	≤1000	Off[b]		±1.0 dB (nominal)
≥26.5	≤1000	Off[b]		±1.5 dB (nominal)

a. The IF frequency response includes effects due to RF circuits such as input filters, that are a function of RF frequency, in addition to the IF pass-band effects.
b. Standard *Option MPB* is enabled.

Description			Specifications	Supplemental Information	
IF Phase Linearity				Deviation from mean phase linearity	
Center Freq (GHz)	**Span (MHz)**	**Preselector**		**Peak-to-peak** (nominal)	**RMS** (nominal)[a]
≥0.7, <3.6	≤1000	n/a		7°	1.5°
≥3.6, <50	≤1000	Off[b]		6°	1.3°

a. The listed performance is the rms of the phase deviation relative to the mean phase deviation from a linear phase condition, where the RMS is computed across the span shown.
b. Standard *Option MPB* is enabled.

For instruments S/N prefix < US/MY/SG57212008:

Description	Specification	Supplemental Information	
Full Scale (ADC Clipping)[a]			
Default settings, signal at CF (IF Gain = High; IF Gain Offset = 0 dB)		Mixer level[b] (nominal), subject to gain limitations[c]	
		Preselector Bypassed /MPB ON (nominal)	Full Bypass ON
Band 0		−7 dBm	−7 dBm
Band 1 through 2		−14 dBm	−21 dBm
Band 3 through 4		−15 dBm	−21 dBm
Band 5 through 6		−12 dBm	−21 dBm
IF Gain Offset ≠ 0 dB, signal at CF		See formula[d], subject to gain limitations[c]	
Effect of signal frequency ≠ CF		up to ±4 dB (nominal)	

a. This table is meant to help predict the full-scale level, defined as the signal level for which ADC overload (clipping) occurs. The prediction is imperfect, but can serve as a starting point for finding that level experimentally. A SCPI command is also available for that purpose.
b. Mixer level is signal level minus input attenuation.
c. The available gain to reach the predicted mixer level will vary with center frequency. Combinations of high gains and high frequencies will not achieve the gain required, increasing the full scale level.
d. The mixer level for ADC clipping is nominally given by that for the default settings, minus IF Gain Offset.

For instruments S/N prefix ≥ US/MY/SG57212008 or earlier instruments with AIF 1 GHz assembly N9041-60092 or later installed (see footnote[1] on page 154):

Description	Specification	Supplemental Information	
Full Scale (ADC Clipping)[a]			
Default settings, signal at CF (IF Gain = High; IF Gain Offset = 0 dB)		Mixer level[b] (nominal), subject to gain limitations[c]	
		Preselector Bypassed /MPB ON (nominal)	Full Bypass ON
Band 0		−9 dBm	−9 dBm
Band 1 through 2		−21 dBm	−29 dBm
Band 3 through 4		−22 dBm	−28 dBm
Band 5 through 6		−18 dBm	−26 dBm
IF Gain Offset ≠ 0 dB, signal at CF		See formula[d], subject to gain limitations[c]	
Effect of signal frequency ≠ CF		up to ±4 dB (nominal)	

a. This table is meant to help predict the full-scale level, defined as the signal level for which ADC overload (clipping) occurs. The prediction is imperfect, but can serve as a starting point for finding that level experimentally. A SCPI command is also available for that purpose.
b. Mixer level is signal level minus input attenuation.
c. The available gain to reach the predicted mixer level will vary with center frequency. Combinations of high gains and high frequencies will not achieve the gain required, increasing the full scale level.
d. The mixer level for ADC clipping is nominally given by that for the default settings, minus IF Gain Offset.

1. Press System, Show Hardware to verify AIF 1 GHz assembly part number.

Description		Specifications	Supplemental Information	
Noise Density			0 dB attenuation; IF Gain = High, center of IF bandwidth[a]	
Band	**Freq (GHz)**[b]		Preselector Bypassed /MPB ON (nominal)	Full Bypass ON (nominal)
0	1.8		–152 dBm/Hz	–152 dBm/Hz
1	6.0		–153 dBm/Hz	–161 dBm/Hz
2	10.8		–151 dBm/Hz	–161 dBm/Hz
3	15.15		–151 dBm/Hz	–159 dBm/Hz
4	21.80		–149 dBm/Hz	–157 dBm/Hz
5	30.5		–147 dBm/Hz	–157 dBm/Hz
6	42.25		–142 dBm/Hz	–154 dBm/Hz

a. The noise level in the IF will change for frequencies away from the center of the IF. The IF part of the total noise varies significantly and nonmonotonically with IF frequency. At the worst IF frequency, which is at one edge of the bandwidth, it is nominally 5 dB higher. The IF part of the total noise dominates in Band 0 and becomes much less significant in higher bands.

b. Specifications apply at the center of each band. IF noise dominates the system noise, therefore the noise density will not change substantially with center frequency.

Data Acquisition

Description	Specifications	Supplemental Information
Time Record Length		
IQ Analyzer	32,000,001 IQ sample pairs[a]	Waveform measurement
Advanced Tools Length (IQ sample pairs)	Data Packing 32-bit[b]	89600 VSA software or Fast Capture
1 GHz < IFBW ≤500 MHz	838,859,979 to 419,429,990	
500 MHz < IFBW ≤250 MHz	838,859,979 to 419,429,990	
250 MHz < IFBW ≤125MHz	838,859,979 to 419,429,990	
125 MHz < IFBW ≤62.5 MHz	838,859,979 to 419,429,990	
62.5 MHz < IFBW ≤40 MHz	838,859,979 to 419,429,990	
ADC Resolution	12 bits	

a. Requires instrument software version >=A.31.00. Otherwise, IQ Sample Pairs is limited to 8,000,001.

b. When using cardinal bandwidths of 1 GHz/2^n, the maximum capture depth of 838,859,979 sample pairs is available. For smaller bandwidths, the capture depth is reduced by the ratio of the bandwidth chosen to the next higher cardinal bandwidth. For example, at a bandwidth of 800 MHz, the capture depth would approximately be (800/1000) × 838,859,979 samples.

Rear Panel Outputs

Description	Specifications	Supplemental Information
TRIGGER 3 IN		TRIGGER 3 IN is connected to the 1 GHz wideband digital hardware in the system.
Connector	BNC female	
Impedance		50Ω (nominal)
Trigger Level Range		±5 V range (minimum amplitude 0.5 V_{pp})
Trigger Channel Passband		DC to 2 GHz (nominal)

For instruments S/N prefix <US/MY/SG57212008:

Description	Specifications	Supplemental Information
IF2 OUT		See footnote[a]
Connector	SMA	
Impedance		50Ω (nominal)
Frequency		750MHz (nominal)
IF2 IN		
Connector	SMA	
Impedance		50Ω (nominal)

a. The IF2 OUT connector is attached to the output of the 1 GHz wideband analog IF assembly and the IF2 IN connector is the input to the 1 GHz wideband digital section. A semi-rigid cable jumpers these two connections to complete the signal path for the 1 GHz feature. The IF2 OUT connector can provide a corrected analog wideband signal to an external device centered at 750 MHz with a 1 GHz bandwidth.

NOTE

The semi-rigid jumper cable connecting IF2 OUT and IF2 IN must be in place for the analyzer to complete the Auto-Alignment routines. If the jumper cable is disconnected (e.g., using an external digitizer), these alignment routines should be turned off (System, Alignments, Auto Align, OFF). However, it is very important to allow the Auto Align to run periodically. If the jumper cable is not in place and the alignments run, expected alignment failure messages.

For instruments S/N prefix ≥ US/MY/SG57212008 or earlier instruments with AIF 1 GHz assembly N9041-60092 or later installed[1]:

Description	Specifications	Supplemental Information
IF2 OUT		See footnote[a]
Connector	SMA	
Impedance		50Ω (nominal)
Frequency		750 MHz (nominal)

a. The IF2 OUT connector is enabled through a switch, and is the output of the 1 GHz wideband analog IF assembly The IF2 OUT connector can provide a corrected analog wideband signal to an external device centered at 750 MHz with a 1 GHz bandwidth. When the IF2 OUT is enabled, the signal is routed to the rear panel, and the instrument display is not valid.

1. Press System, Show Hardware to verify AIF 1 GHz assembly part number.

12 Option FBP - Full Bypass Path

This chapter contains specifications for *Option FBP*, Full Bypass Path.

Full Bypass Path provides another signal path configuration in addition to the Standard path, Microwave Preselector Bypass, and Low Noise Path Enable.

Full Bypass Path allows better sensitivity through the signal path used above 3.6 GHz start frequency. When Full Bypass Path is enabled, BOTH the Preselector and the Low Band Switch are bypassed. With both these assemblies bypassed, there is less loss in the signal path improving instrument sensitivity.

Specifications Affected by Full Bypass Path

Specification Name	Information
Displayed Average Noise Level	See specifications in this chapter.
IF Frequency Response and IF Phase Linearity	Not warranted, but nominally the same as “IF Frequency Response” on page 32 and “IF Phase Linearity” on page 33. Also see the associated "Analysis Bandwidth" chapter for any optional bandwidths. **Note:** Since *Option FBP* turns off the preselector, under the **Preselector** heading, use the values associated with the OFF notation.
Frequency Response	See specifications in this chapter.
VSWR	The magnitude of the mismatch over the range of frequencies will be very similar between FBP and non-FBP operation, but the details, such as the frequencies of the peaks and valleys, will shift.
Additional Spurious Responses	In addition to the “Spurious Responses” on page 52 of the core specifications, “Additional Spurious Responses” on page 168 of this chapter also apply.
Maximum Safe Input Levels	See specifications in this chapter.

Other Specifications Affected by Full Bypass Path

Description	Specifications	Supplemental Information
Maximum Safe Input Levels		Limiter and Preselector are not in the signal path.
Average Total Power		
Option 508, 513, 526	+26 dBm (398.1 mW)	
Option 544, 550	+20 dBm (100 mW)	
DC Voltage	±0.2 Vdc	

Description	Specifications		Supplemental Information
Frequency Response (Maximum error relative to reference condition (50 MHz) Swept operation[a], Attenuation 10 dB, Option H1G)			Refer to the footnote for Band on page 17.
	20 to 30°C	**Full range[b]**	**95th Percentile (≈2σ)**
3.5 to 8.4 GHz	±0.90	±1.19	±0.30
8.3 to 13.6 GHz	±1.01	±1.31	±0.39
13.5 to 17.1 GHz	±1.26	±1.68	±0.44
17.0 to 22.0 GHz	±1.29	±2.05	±0.55
22.0 to 26.5 GHz	±1.49	±2.11	±0.72
26.4 to 34.5 GHz	±1.63	±2.33	±0.60
34.4 to 50.0 GHz	±3.00	±3.68	±0.96

a. For Sweep Type = FFT, add the RF flatness errors of this table to the IF Frequency Response errors. An additional error source, the error in switching between swept and FFT sweep types, is nominally ±0.01 dB and is included within the “Absolute Amplitude Error” specifications.
b. 0°C to 40°C for instruments with Option H1G.

Description	Option 544 or 550 (mmW)	Option 508, 513, or 526 (µW)	Specifications: 20 to 30°C	Specifications: Full range[b]	Supplemental Information: 95th Percentile (≈2σ)
Frequency Response (Maximum error relative to reference condition (50 MHz) Swept operation[a], Attenuation 10 dB, without Option H1G)					Refer to the footnote for Band Overlaps on page 17.
3.5 to 8.4 GHz	x	x	±0.90 dB	±1.45 dB	±0.62 dB
8.3 to 13.6 GHz	x	x	±1.01 dB	±1.57 dB	±0.81 dB
13.5 to 17.1 GHz	x	x	±1.26 dB	±1.91 dB	±0.89 dB
17.0 to 22.0 GHz	x		±1.29 dB	±2.01 dB	±0.92 dB
17.0 to 22.0 GHz		x	±1.29 dB	±2.30 dB	±0.92 dB
22.0 to 26.5 GHz	x	x	±1.49 dB	±2.37 dB	±1.05 dB
26.4 to 34.5 GHz		x	±1.63 dB	±2.60 dB	±1.16 dB
34.4 to 50.0 GHz		x	±3.00 dB	±3.95 dB	±1.54 dB

a. For Sweep Type = FFT, add the RF flatness errors of this table to the IF Frequency Response errors. An additional error source, the error in switching between swept and FFT sweep types, is nominally ±0.01 dB and is included within the “Absolute Amplitude Error” specifications.
b. At temperatures 0°C to 40°C, the specification for instruments without option H1G is nominally the same as the instruments with H1G.

Description	Option 508, 513, or 526 (RF/mW)	Option 544 or 550 (mmW), with or without option H1G	Specifications 20 to 30°C	Specifications Full range[a]	Supplemental Information Nominal
Displayed Average Noise Level (DANL)					
3.5 to 13.6 GHz	x		–152 dBm	–151 dBm	–156 dBm
3.5 to 13.6 GHz		x	–154 dBm	–153 dBm	–159 dBm
13.5 to 17.1 GHz	x		–150 dBm	–149 dBm	–153 dBm
13.5 to 17.1 GHz		x	–153 dBm	–152 dBm	–157 dBm
17.0 to 22.5 GHz	x		–149 dBm	–148 dBm	–152 dBm
17.0 to 22.5 GHz		x	–152 dBm	–151 dBm	–156 dBm
22.5 to 26.5 GHz	x		–147 dBm	–145 dBm	–150 dBm
22.5 to 26.5 GHz		x	–151 dBm	–150 dBm	–155 dBm
26.4 to 34 GHz		x	–151 dBm	–150 dBm	–156 dBm
33.9 to 46 GHz		x	–149 dBm	–148 dBm	–154 dBm
46 to 50 GHz		x	–148 dBm	–147 dBm	–152 dBm

a. 0°C to 40°C for instruments with option H1G. 0°C to 55°C for instruments without option H1G.

Description		Specifications	Supplemental Information
Additional Spurious Responses[a]			
Tuned Frequency (f)	**Excitation**		
Image Response			
3.5 to 50 GHz	f + fIF[b]		0 dBc (nominal), High Band Image Suppression is lost with Option FBP.
LO Harmonic and Subharmonic Responses			
3.5 to 8.4 GHz	N(f + fIF) ±fIF[b]		–10 dBc (nominal), N = 2, 3
8.3 to 26.5 GHz	[N(f + fIF)/2] ±fIF[b]		–10 dBc (nominal), N = 1, 3, 4
26.4 to 34.5 GHz	[N(f + fIF)/2] ±fIF[b]		–10 dBc (nominal), N = 1, 2, 3, 5, 6, 7
34.4 to 50 GHz	[N(f + fIF)/2] ±fIF[b]		–10 dBc (nominal), N = 1, 2, 3, 5, 6, 7, 9, 10
Second Harmonic Response			
3.5 to 13.6 GHz	f/2		–72 dBc (nominal) for –40 dBm mixer level
13.5 to 34.5 GHz	f/2		–68 dBc (nominal) for –40 dBm mixer level
34.4 to 50 GHz	f/2		–68 dBc (nominal) for –40 dBm mixer level
IF Feedthrough Response			
3.5 to 13.6 GHz	fIF[b]		–100 dBc (nominal)
13.5 to 50 GHz	fIF[b]		–90 dBc (nominal)

a. Dominant spurious responses are described here. Generally, other *Option FBP*-specific spurious responses will be substantially lower than those listed here, but may exceed core specifications.
b. fIF = 322.5 MHz for bandwidth < 25 MHz. Refer to *Option CR3* chapter for fIF at each IF Path.

13 Option ALV - Log Video Out

This chapter contains specifications for *Option ALV*, Log Video Out.

KEYSIGHT TECHNOLOGIES

Specifications Affected by Log Video Out

No other analyzer specifications are affected by the presence or use of this option. New specifications are given in the following pages.

Other Log Video Out Specifications

Aux IF Out Port

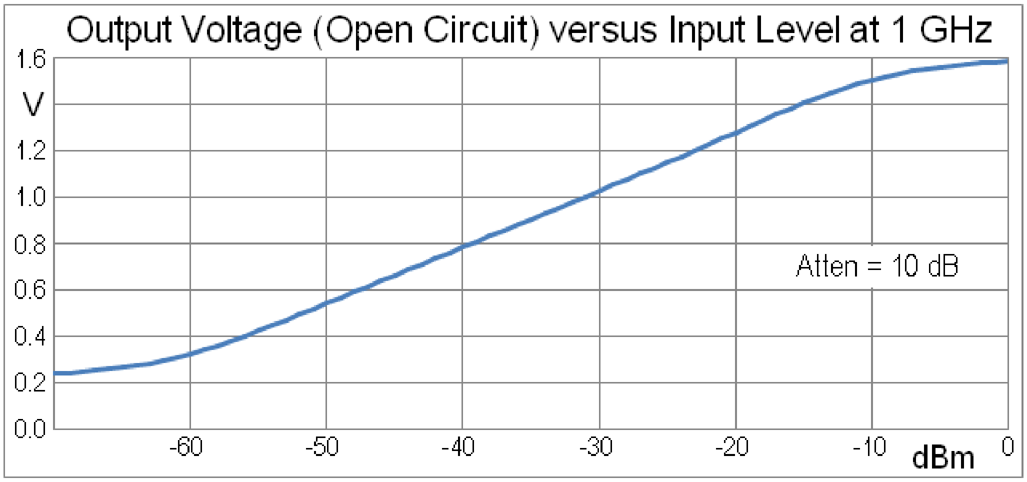
Description	Specifications	Supplemental Information
Connector	SMA female	Shared with other options
Impedance		50Ω (nominal)

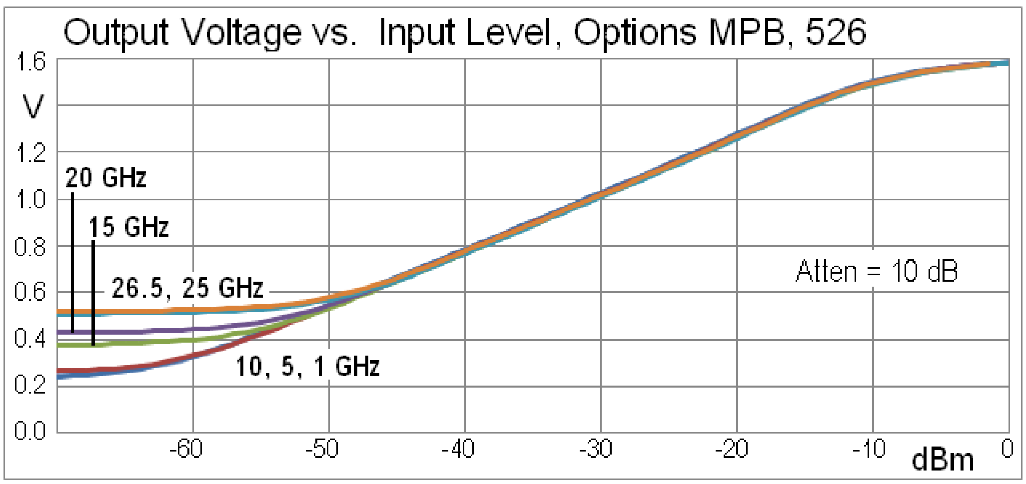
Fast Log Video Output

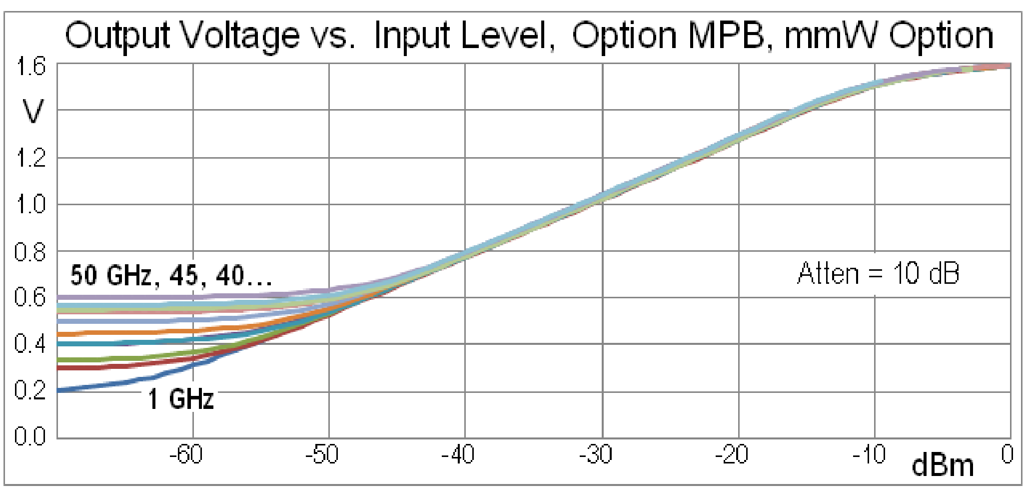
Description	Specifications	Supplemental Information
Fast Log Video Output (Preselector bypassed (*Option MPB*) for Bands 1-4, Preamp Off)		
Output voltage		Open-circuit voltages shown
Maximum		1.6 V at –10 dBm[a] (nominal)
Slope		25 ±1 mV/dB (nominal)
Log Fidelity		
Range		49 dB (nominal) with input frequency at 1 GHz[b]
Accuracy within Range		±1.0 dB (nominal)
Rise Time		15 ns (nominal)
Fall Time		
Bands 1–4 with *Option MPB*		40 ns (nominal)
Other Cases		Depends on bandwidth[c]

a. The signal level which gives an output corresponding to the high end of the log fidelity range, nominally –10 dBm at the mixer, has a band and frequency dependence that is the same as that given in the “Conversion Gain” entry in the specifications for “Second IF Out” on page 91.
b. Refer to the next page for details.
c. The bandwidth will be the same as for the “Second IF Out” on page 91. The bandwidth effects will dominate the fall time in high band with preselection.

Nominal Output Voltage (Open Circuit) versus Input Level [Plot]







14 Option CRP - Connector Rear, Arbitrary IF Output

This chapter contains specifications for *Option CRP*, Connector Rear, Arbitrary IF Output.

Specifications Affected by Connector Rear, Arbitrary IF Output

No other analyzer specifications are affected by the presence or use of this option. New specifications are given in the following pages.

Other Connector Rear, Arbitrary IF Output Specifications

Aux IF Out Port

Description	Specifications	Supplemental Information
Connector	SMA female	Shared with other options
Impedance		50Ω (nominal)

Arbitrary IF Out

Description	Specifications	Supplemental Information
Arbitrary IF Out[a]		
IF Output Center Frequency		
Range	10 to 75 MHz	
Resolution	0.5 MHz	
Conversion Gain at the RF Center Frequency		–1 to +4 dB (nominal) plus RF frequency response[b]
Bandwidth		
Highpass corner frequency		5 MHz (nominal) at –3 dB
Lowpass corner frequency		120 MHz (nominal) at –3 dB
Output at 70 MHz center		
Low band; also, high band with preselector bypassed		100 MHz (nominal)[c]
Preselected bands		Depends on RF center frequency[d]
Lower output frequencies		Subject to folding[e]
Phase Noise		Added noise above analyzer noise[f]
Residual Output Signals		–88 dBm or lower (nominal)[g]

a. Only accessible when 10 MHz, 25 MHz, or 40 MHz IF path enabled.
b. "Conversion Gain" is defined from RF input to IF Output with 0 dB mechanical attenuation and the electronic attenuator off. The nominal performance applies with zero span.
c. The bandwidth shown is in non-preselected bands. The combination with preselection (see footnote d) will reduce the bandwidth.
d. See "Preselector Bandwidth" on page 28.
e. As the output center frequency declines, the lower edge of the passband will fold around zero hertz. This phenomenon is most severe for output frequencies around and below 20 MHz. For more information on frequency folding, refer to *X-Series Spectrum Analyzer User's and Programmer's Reference*.

f. The added phase noise in the conversion process of generating this IF is nominally –88, –106, and –130 dBc/Hz at offsets of 10, 100, and 1000 kHz respectively.
g. Measured from 1 MHz to 150 MHz.

15 Option EA3 - Electronic Attenuator, 3.6 GHz

This chapter contains specifications for the *Option EA3* Electronic Attenuator, 3.6 GHz.

Specifications Affected by Electronic Attenuator

Specification Name	Information
Frequency Range	See “Range (Frequency and Attenuation)” on page 179.
1 dB Gain Compression Point	See “Distortions and Noise” on page 180.
Displayed Average Noise Level	See “Distortions and Noise” on page 180.
Frequency Response	See “Frequency Response” on page 181.
Attenuator Switching Uncertainty	The recommended operation of the electronic attenuator is with the reference setting (10 dB) of the mechanical attenuator. In this operating condition, the Attenuator Switching Uncertainty specification of the mechanical attenuator in the core specifications does not apply, and any switching uncertainty of the electronic attenuator is included within the “Electronic Attenuator Switching Uncertainty” on page 183.
Absolute Amplitude Accuracy,	See .“Absolute Amplitude Accuracy” on page 182.
Second Harmonic Distortion	See “Distortions and Noise” on page 180.
Third Order Intermodulation Distortion	See “Distortions and Noise” on page 180.

Other Electronic Attenuator Specifications

Description	Specifications	Supplemental Information
Range (Frequency and Attenuation)		
Frequency Range	2 Hz to 3.6 GHz	
Attenuation Range		
Electronic Attenuator Range	0 to 24 dB, 1 dB steps	
Calibrated Range	0 to 24 dB, 2 dB steps	Electronic attenuator is calibrated with 10 dB mechanical attenuation
Full Attenuation Range	0 to 94 dB, 1 dB steps	Sum of electronic and mechanical attenuation

Description	Specifications	Supplemental Information
Distortions and Noise		When using the electronic attenuator, the mechanical attenuator is also in-circuit. The full mechanical attenuator range is available[a].
1 dB Gain Compression Point		The 1 dB compression point will be nominally higher with the electronic attenuator “Enabled” than with it not Enabled by the loss,[b] except with high settings of electronic attenuation[c] .
Displayed Average Noise Level		Instrument Displayed Average Noise Level will nominally be worse with the electronic attenuator “Enabled” than with it not Enabled by the loss[b].
Second Harmonic Distortion		Instrument Second Harmonic Distortion will nominally be better in terms of the second harmonic intercept (SHI) with the electronic attenuator “Enabled” than with it not Enabled by the loss[b].
Third-order Intermodulation Distortion		Instrument TOI will nominally be better with the electronic attenuator “Enabled” than with it not Enabled by the loss[b] except for the combination of high attenuation setting and high signal frequency[d].

a. The electronic attenuator is calibrated for its frequency response only with the mechanical attenuator set to its preferred setting of 10 dB.

b. The loss of the electronic attenuator is nominally given by its attenuation plus its excess loss. That excess loss is nominally 2 dB from 0 — 500 MHz and increases by nominally another 1 dB/GHz for frequencies above 500 MHz.

c. An additional compression mechanism is present at high electronic attenuator settings. The mechanism gives nominally 1 dB compression at +20 dBm at the internal electronic attenuator input. The compression threshold at the RF input is higher than that at the internal electronic attenuator input by the mechanical attenuation. The mechanism has negligible effect for electronic attenuations of 0 through 14 dB.

d. The TOI performance improvement due to electronic attenuator loss is limited at high frequencies, such that the TOI reaches a limit of nominally +45 dBm at 3.6 GHz, with the preferred mechanical attenuator setting of 10 dB, and the maximum electronic attenuation of 24 dB. The TOI will change in direct proportion to changes in mechanical attenuation.

Description	Specifications		Supplemental Information
Frequency Response			Mech atten set to default/calibrated setting of 10 dB.
(Maximum error relative to reference condition (50 MHz))			
	20 to 30°C	**Full Range**	**95th Percentile (≈2σ)**
Attenuation = 4 to 24 dB, even steps			
3 Hz to 50 MHz	±0.60 dB	±0.80 dB	±0.30 dB
50 MHz to 3.6 GHz	±0.40 dB	±0.52 dB	±0.20 dB
Attenuation = 0, 1, 2 and odd steps, 3 to 23 dB			
10 MHz to 3.6 GHz			±0.30 dB

Description	Specifications	Supplemental Information
Absolute Amplitude Accuracy		
At 50 MHz[a] 20 to 30°C Full temperature range	 ±0.24 dB ±0.32 dB	 ±0.13 dB (95th percentile)
At all frequencies[a] 20 to 30°C Full temperature range	 ±(0.24 dB + frequency response) ±(0.32 dB + frequency response)	
95th Percentile Absolute Amplitude Accuracy[b]		±0.21 dB
(Wide range of signal levels, RBWs, RLs, etc., 0.01 to 3.6 GHz)		

a. Absolute amplitude accuracy is the total of all amplitude measurement errors, and applies over the following subset of settings and conditions: 1 Hz ≤ RBW ≤ 1 MHz; Input signal –10 to –50 dBm; Input attenuation 10 dB; all settings auto-coupled except Swp Time Rules = Accuracy; combinations of low signal level and wide RBW use VBW ≤ 30 kHz to reduce noise. When using FFT sweeps, the signal must be at the center frequency.
This absolute amplitude accuracy specification includes the sum of the following individual specifications under the conditions listed above: Scale Fidelity, Reference Level Accuracy, Display Scale Switching Uncertainty, Resolution Bandwidth Switching Uncertainty, 50 MHz Amplitude Reference Accuracy, and the accuracy with which the instrument aligns its internal gains to the 50 MHz Amplitude Reference.

b. Absolute Amplitude Accuracy for a wide range of signal and measurement settings, covers the 95th percentile proportion with 95% confidence. Here are the details of what is covered and how the computation is made:
The wide range of conditions of RBW, signal level, VBW, reference level and display scale are discussed in footnote a. There are 44 quasi-random combinations used, tested at a 50 MHz signal frequency. We compute the 95th percentile proportion with 95% confidence for this set observed over a statistically significant number of instruments. Also, the frequency response relative to the 50 MHz response is characterized by varying the signal across a large number of quasi-random verification frequencies that are chosen to not correspond with the frequency response adjustment frequencies. We again compute the 95th percentile proportion with 95% confidence for this set observed over a statistically significant number of instruments. We also compute the 95th percentile accuracy of tracing the calibration of the 50 MHz absolute amplitude accuracy to a national standards organization. We also compute the 95th percentile accuracy of tracing the calibration of the relative frequency response to a national standards organization. We take the root-sum-square of these four independent Gaussian parameters. To that rss we add the environmental effects of temperature variations across the 20 to 30°C range. These computations and measurements are made with the mechanical attenuator, set to the reference state of 10 dB, the electronic attenuator set to all even settings from 4 through 24 dB inclusive.

Description	Specifications	Supplemental Information
Electronic Attenuator Switching Uncertainty		
(Error relative to reference condition: 50 MHz, 10 dB mechanical attenuation, 10 dB electronic attenuation)		
Attenuation = 1 to 24 dB		
3 Hz to 3.6 GHz	See note[a]	
Attenuation = 0 dB		
3 Hz to 3.6 GHz		±0.04 dB (nominal)

a. The specification is ±0.16 dB; typically 0.04 dB. Note that this small relative uncertainty does not apply in estimating absolute amplitude accuracy, because it is included within the absolute amplitude accuracy for measurements done with the electronic attenuator. (Measurements made without the electronic attenuator are treated differently; the absolute amplitude accuracy specification for those measurements does not include attenuator switching uncertainty.)

16 Option EMC - Precompliance EMI Features

This chapter contains specifications for the *Option EMC* (N90EMEMCB) precompliance EMI features.

Frequency

Description	Specifications	Supplemental information
Frequency Range		10 Hz to 3.6, 7, 13.6, or 26.5 GHz depending on the frequency option.
EMI Resolution Bandwidths		See Table 16-1 on page 187 and Table 16-2 on page 187 for CISPR and MIL-STD frequency ranges.
CISPR		Available when the EMC Standard is CISPR.
200 Hz, 9 kHz, 120 kHz, 1 MHz		As specified by CISPR 16-1-1, –6 dB bandwidths, subject to masks
Non-CISPR bandwidths	10, 30, 100, 300 Hz,1, 3, 30, 300 kHz, 3, 10 MHz	–6 dB bandwidths
MIL STD		Available when the EMC Standard is MIL
10, 100 Hz, 1, 10, 100 kHz, 1 MHz		As specified by MIL-STD-461, –6 dB bandwidths
Non-MIL STD bandwidths	30, 300 Hz, 3, 30, 300 kHz, 3, 10 MHz	–6 dB bandwidths

Table 16-1 CISPR Preset Settings

CISPR Band	Frequency Range	CISPR RBW	Data Points
Band A	9 to 150 kHz	200 Hz	1413
Band B	150 kHz to 30 MHz	9 kHz	6637
Band C	30 to 300 MHz	120 kHz	4503
Band D	300 MHz to 1 GHz	120 kHz	11671
Band C/D	30 MHz to 1 GHz	120 kHz	16171
Band E	1 to 18 GHz	1 MHz	34001

Table 16-2 MIL-STD 461D/E/F Frequency Ranges and Bandwidths

Frequency Range	6 dB Bandwidth	Minimum Measurement Time
30 Hz to 1 kHz	10 Hz	0.015 s/Hz
1 kHz to 10 kHz	100 Hz	0.15 s/kHz
10 kHz to 150 kHz	1 kHz	0.015 s/kHz
150 kHz to 30 MHz	10 kHz	1.5 s/MHz
30 MHz to 1 GHz	100 kHz	0.15 s/MHz
Above 1 GHz	1 MHz	15 s/GHz

Amplitude

Description	Specifications	Supplemental Information
EMI Average Detector		Used for CISPR specified average measurements and, with 1 MHz RBW, for frequencies above 1 GHz
Default Average Type		All filtering is done on the linear (voltage) scale even when the display scale is log.
Quasi-Peak Detector		Used with CISPR specified RBWs, for frequencies ≤ 1 GHz
Absolute Amplitude Accuracy for reference spectral intensities		As specified by CISPR 16-1-1
Relative amplitude accuracy versus pulse repetition rate		As specified by CISPR 16-1-1
Quasi-Peak to average response ratio		As specified by CISPR 16-1-1
Dynamic range		
Pulse repetition rates ≥ 20 Hz		As specified by CISPR 16-1-1
Pulse repetition rates ≤ 10 Hz		Does not meet CISPR standards in some cases with DC pulse excitation.
RMS Average Detector		As specified by CISPR 16-1-1

17 Options P08, P13, P26, P44, and P50 - Preamplifiers

This chapter contains specifications for the UXA Signal Analyzer *Options P08, P13, P26, P44, and P50* preamplifiers.

Specifications Affected by Preamp

Specification Name	Information
Nominal Dynamic Range vs. Offset Frequency vs. RBW	The graphic from the core specifications does not apply with Preamp On.
Measurement Range	The measurement range depends on displayed average noise level (DANL). See “Amplitude Accuracy and Range” on page 29.
Gain Compression	See specifications in this chapter.
DANL with NFE (Noise Floor Extension) Off	See specifications in this chapter.
DANL with NFE On	See “Displayed Average Noise Level with Noise Floor Extension Improvement (mmW)” on page 48 of the core specifications.
Frequency Response	See specifications in this chapter.
Absolute Amplitude Accuracy	See “Absolute Amplitude Accuracy” on page 34 of the core specifications.
RF Input VSWR	See plot in this chapter.
Display Scale Fidelity	See Display Scale Fidelity on page 40 of the core specifications. Then, adjust the mixer levels given downward by the preamp gain given in this chapter.
Second Harmonic Distortion	See specifications in this chapter.
Third Order Intermodulation Distortion	See specifications in this chapter.
Other Input Related Spurious	See “Spurious Responses” on page 52 of the core specifications. Preamp performance is not warranted but is nominally the same as non-preamp performance.
Dynamic Range	See plot in this chapter.
Gain	See “Preamp” specifications in this chapter.
Noise Figure	See “Preamp” specifications in this chapter.

Other Preamp Specifications

Description	Specifications	Supplemental Information
Preamp (*Options P08*, *P13*, *P26*, *P44*, *P50*)[a]		
Gain		Maximum[b]
100 kHz to 3.6 GHz		+20 dB (nominal)
3.6 to 26.5 GHz		+35 dB (nominal)
26.5 to 50 GHz		+40 dB (nominal)
Noise figure		
100 kHz to 3.6 GHz		8 to 12 dB (proportional to frequency) (nominal) Note on DC coupling[c]
3.6 to 8.4 GHz		9 dB (nominal)
8.4 to 13.6 GHz		10 dB (nominal)
13.6 to 50 GHz		Noise Figure is DANL + 176.24 dB (nominal)[d]

a. The preamp follows the input attenuator, AC/DC coupling switch, and precedes the input mixer. In low-band, it follows the 3.6 GHz low-pass filter. In high-band, it precedes the preselector.

b. Preamp Gain directly affects distortion and noise performance, but it also affects the range of levels that are free of final IF overload. The user interface has a designed relationship between input attenuation and reference level to prevent on-screen signal levels from causing final IF overloads. That design is based on the maximum preamp gains shown. Actual preamp gains are modestly lower, by up to nominally 5 dB for frequencies from 100 kHz to 3.6 GHz, and by up to nominally 10 dB for frequencies from 3.6 to 50 GHz.

c. The effect of AC coupling is negligible for frequencies above 40 MHz. Below 40 MHz, DC coupling is recommended for the best measurements. The instrument NF nominally degrades by 0.2 dB at 30 MHz and 1 dB at 10 MHz with AC coupling.

d. Nominally, the noise figure of the spectrum analyzer is given by

$$NF = D - (K - L + N + B)$$

where, D is the DANL (displayed average noise level) specification (Refer to page 193 for DANL with Preamp),
K is kTB (–173.98 dBm in a 1 Hz bandwidth at 290 K),
L is 2.51 dB (the effect of log averaging used in DANL verifications)
N is 0.24 dB (the ratio of the noise bandwidth of the RBW filter with which DANL is specified to an ideal noise bandwidth)
B is ten times the base-10 logarithm of the RBW (in hertz) in which the DANL is specified. B is 0 dB for the 1 Hz RBW.
The actual NF will vary from the nominal due to frequency response errors.

Description	Specifications	Supplemental Information
1 dB Gain Compression Point		
(Two-tone)[a]		
(Preamp On *(Options P08, P13, P26, P44, P50.)* Maximum power at the preamp[b] for 1 dB gain compression)		
10 MHz to 3.6 GHz		–14 dBm (nominal)
3.6 to 26.5 GHz		
Tone spacing 100 kHz to 20 MHz		–28 dBm (nominal)
Tone spacing >70 MHz		
RF/μW		–10 dBm (nominal)
mmW		–20 dBm (nominal)
26.5 to 50 GHz		–30 dBm (nominal)

a. Large signals, even at frequencies not shown on the screen, can cause the analyzer to mismeasure on-screen signals because of two-tone gain compression. This specification tells how large an interfering signal must be in order to cause a 1 dB change in an on-screen signal.

b. Total power at the preamp (dBm) = total power at the input (dBm) – input attenuation (dB).

Description			Specifications		Supplemental Information
Displayed Average Noise Level (DANL) (without Noise Floor Extension)[a]			Input terminated Sample or Average detector Averaging type = Log 0 dB input attenuation IF Gain = High 1 Hz Resolution Bandwidth		Refer to the footnote for Band Overlaps on page 17.
Option P08, P13, or P26, P44, or P50	RF/μW ↓	mmW ↓	**20 to 30°C**	**Full range**	**Typical**
100 to 200 kHz	x		–152 dBm	–151 dBm	–159 dBm
100 to 200 kHz		x	–157 dBm	–156 dBm	–159 dBm
200 to 500 kHz	x		–155 dBm	–154 dBm	–161 dBm
200 to 500 kHz		x	–159 dBm	–159 dBm	–161 dBm
500 kHz to 1 MHz	x		–159 dBm	–157 dBm	–164 dBm
500 kHz to 1 MHz		x	–162 dBm	–161 dBm	–164 dBm
1 to 10 MHz	x		–161 dBm	–159 dBm	–166 dBm
1 to 10 MHz		x	–164 dBm	–163 dBm	–166 dBm
10 MHz to 2.1 GHz	x		–165 dBm	–164 dBm	–166 dBm
10 MHz to 2.1 GHz		x	–164 dBm	–163 dBm	–165 dBm
2.1 to 3.6 GHz	x		–163 dBm	–162 dBm	–164 dBm
2.1 to 3.6 GHz		x	–162 dBm	–161 dBm	–164 dBm
3.5 to 8.4 GHz	x		–164 dBm	–162 dBm	–166 dBm
3.5 to 8.4 GHz		x	–161 dBm	–159 dBm	–162 dBm
Option P13, P26, P44, or P50					
8.3 to 13.6 GHz	x		–163 dBm	–161 dBm	–165 dBm
8.3 to 13.6 GHz		x	–161 dBm	–159 dBm	–162 dBm
Option P26, P44, or P50					
13.5 to 16.9 GHz	x		–161 dBm	–159 dBm	–163 dBm
13.5 to 16.9 GHz		x	–161 dBm	–159 dBm	–164 dBm
16.9 to 20.0 GHz	x		–159 dBm	–157 dBm	–161 dBm
16.9 to 20.0 GHz		x	–158 dBm	–157 dBm	–163 dBm
20.0 to 26.5 GHz	x		–155 dBm	–153 dBm	–158 dBm
20.0 to 26.5 GHz		x	–158 dBm	–156 dBm	–161 dBm

Description			Specifications		Supplemental Information
Option P44, or *P50*					
26.4 to 30 GHz		x	–155 dBm	–155 dBm	–160 dBm
30.0 to 34 GHz		x	–155 dBm	–153 dBm	–159 dBm
33.9 to 37 GHz		x	–153 dBm	–151 dBm	–158 dBm
37 to 40 GHz		x	–152 dBm	–150 dBm	–156 dBm
40 to 44 GHz		x	–149 dBm	–147 dBm	–155 dBm
Option P50					
44 to 46 GHz		x	–149 dBm	–147 dBm	–155 dBm
46 to 50 GHz		x	–146 dBm	–144 dBm	–152 dBm

a. DANL for zero span and swept is measured in a 1 kHz RBW and normalized to the narrowest available RBW, because the noise figure does not depend on RBW and 1 kHz measurements are faster.

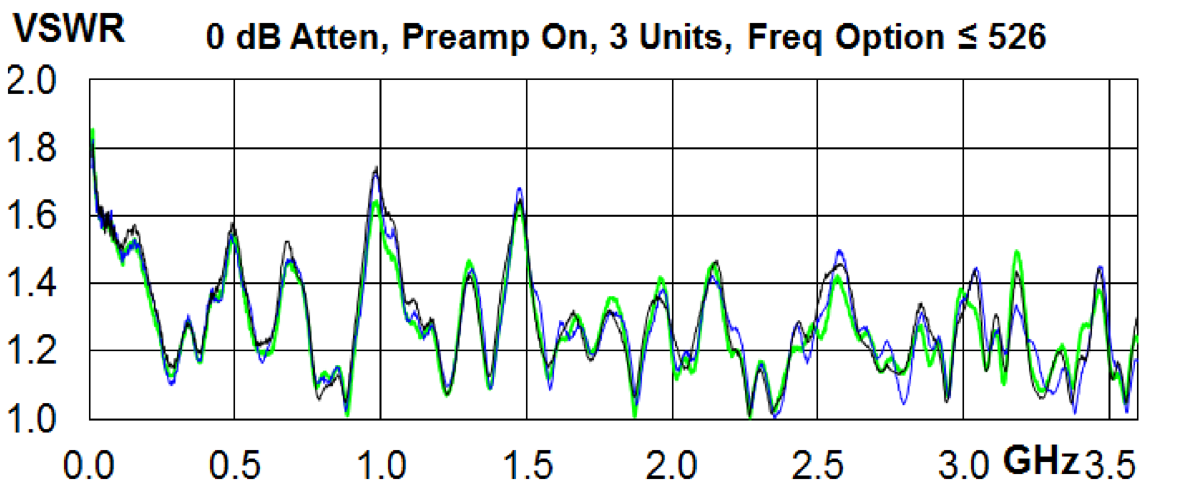
Description	RF/μW	mmW	Specifications 20 to 30°C	Specifications Full range	Supplemental Information
Frequency Response — Preamp On *(Options P08, P13, or P26)* (Maximum error relative to reference condition (50 MHz, with 10 dB attenuation) Input attenuation 0 dB Swept operation[a])					Refer to the footnote for Band Overlaps on page 17. Freq option 526 only: Modes above 18 GHz[b]
	RF/μW ↓	mmW ↓	**20 to 30°C**	**Full range**	**95th Percentile (≈2σ)**
9 kHz to 1 MHz[c]	X				±0.38 dB[d]
9 kHz to 1MHz[c]		X			±0.45 dB
1 to 50 MHz[c]	X		±0.68 dB	±0.75 dB	±0.32 dB
1 to 50 MHz[c]		X	±0.68 dB	±0.80 dB	±0.27 dB
50 MHz to 3.6 GHz[c]	X		±0.55 dB	±0.80 dB	±0.28 dB
50 MHz to 3.6 GHz[c]		X	±0.60 dB	±0.90 dB	±0.29 dB
3.5 to 8.4 GHz[ef]	X		±2.0 dB	±2.7 dB	±0.64 dB
3.5 to 5.2 GHz[ef]		X	±2.0 dB	±3.8 dB	±0.75 dB
5.2 to 8.4 GHz[ef]		X	±2.0 dB	±2.7 dB	±0.52 dB
8.3 to 13.6 GHz[ef]	X	X	±2.3 dB	±2.9 dB	±0.69 dB
13.5 to 17.1 GHz[ef]	X		±2.5 dB	±3.3 dB	±0.84 dB
13.5 to 17.1 GHz[ef]		X	±2.5 dB	±3.3 dB	±0.61 dB
17.0 to 22.0 GHz[ef]	X		±3.0 dB	±3.7 dB	±1.13 dB
17.0 to 22.0 GHz[ef]		X	±3.0 dB	±3.7 dB	±0.73 dB
22.0 to 26.5 GHz[ef]	X		±3.5 dB	±4.5 dB	±1.48 dB
22.0 to 26.5 GHz[ef]		X	±3.5 dB	±4.5 dB	±0.63 dB
26.4 to 34.5 GHz[ef]		X	±3.0 dB	±4.5 dB	±1.11 dB
34.4 to 50 GHz[ef]		X	±4.1 dB	±6.0 dB	±1.47 dB

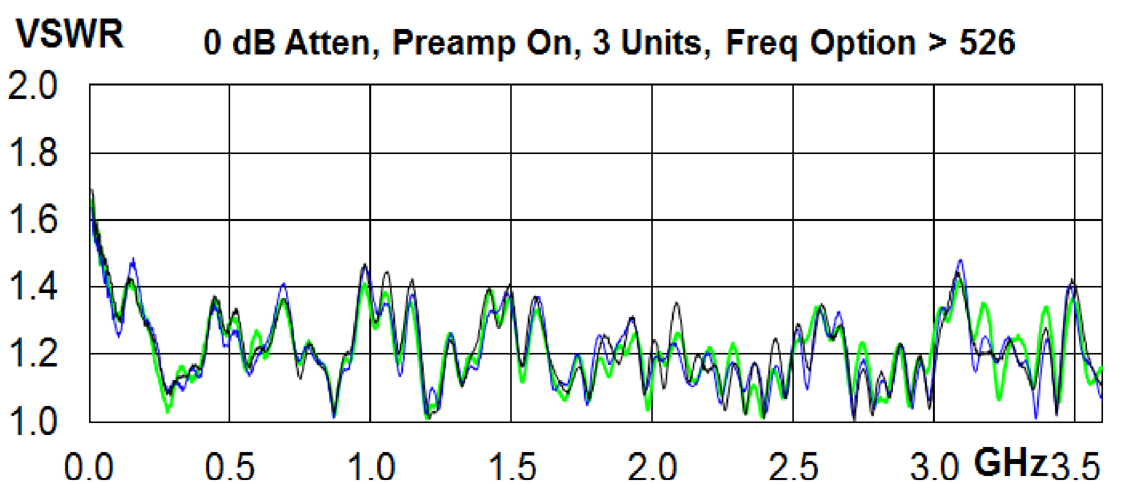
a. For Sweep Type = FFT, add the RF flatness errors of this table to the IF Frequency Response errors. An additional error source, the error in switching between swept and FFT sweep types, is nominally ±0.01 dB and is included within the “Absolute Amplitude Error” specifications.
b. Signal frequencies above 18 GHz are prone to response errors due to modes in the Type-N connector. Only analyzers with frequency *Option 526* that do not also have input connector *Option C35* will have these modes.With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. The effect of these modes with this connector are included within these specifications.
c. Electronic attenuator (Option EA3) may not be used with preamp on.
d. All instruments are tested against a suitable test line limit in factory production but not in field calibration.
e. Specifications for frequencies > 3.5 GHz apply for sweep rates < 100 MHz/ms.
f. Preselector centering applied when preselector is not bypassed. Refer to Option MPB – Microwave Preselector Bypass chapter for performance affected by bypassing the preselector.

Description	Specifications	Supplemental Information	
RF Input VSWR		DC coupled, 0 dB atten	
(at tuned frequency, DC coupled)			
		95th Percentile[a]	
		RF/μW	mmW
Band 0 (0.01 to 3.6 GHz)		1.56	1.40
Band 1 (3.5 to 8.4 GHz)		1.47	1.53
Band 2 (8.3 to 13.6 GHz)		1.57	1.389
Band 3 (13.5 to 17.1 GHz)		1.72	1.316
Band 4 (17.0 to 26.5 GHz)		1.70	1.337
Band 5 (26.5 to 34.5 GHz)			1.42
Band 6 (34.5 to 50 GHz)			1.62
Nominal VSWR vs. Freq, 0 dB		See plots following	

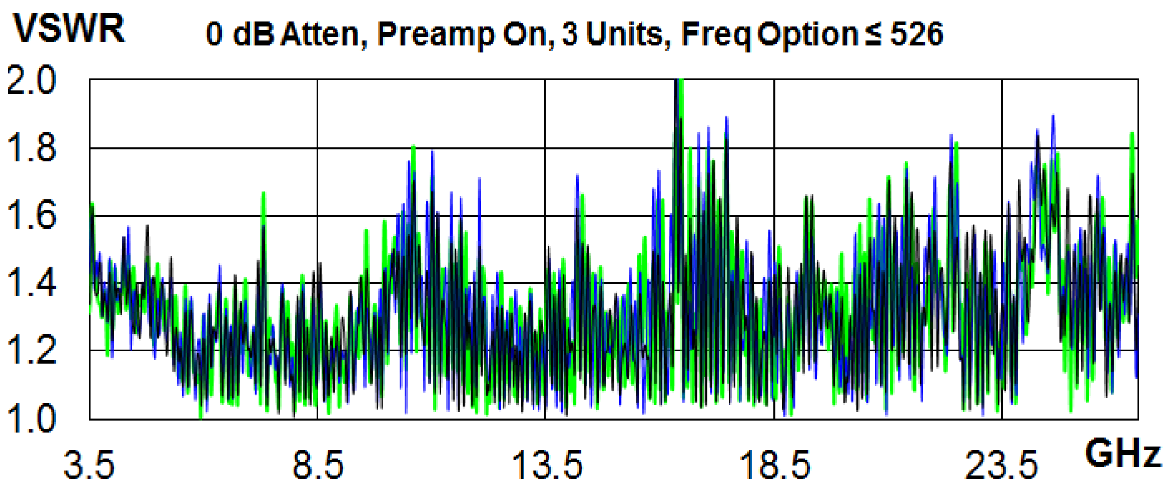
a. X-Series analyzers have a reflection coefficient that is excellently modeled with a Rayleigh probability distribution. Keysight recommends using the methods outlined in Application Note 1449-3 and companion Average Power Sensor Measurement Uncertainty Calculator to compute mismatch uncertainty. Use this 95th percentile VSWR information and the Rayleigh model (Case C or E in the application note) with that process.

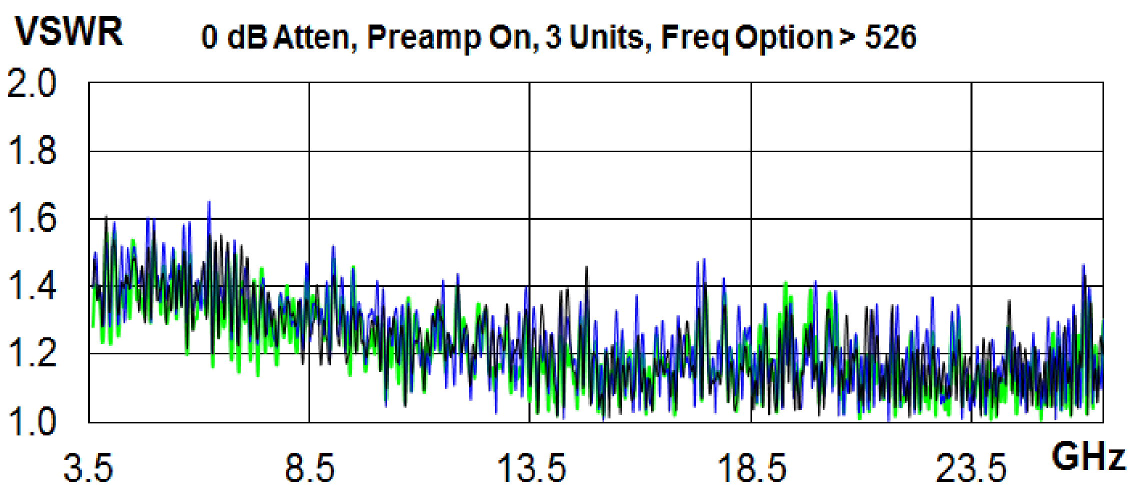
Nominal VSWR – Preamp On Band [Plot]

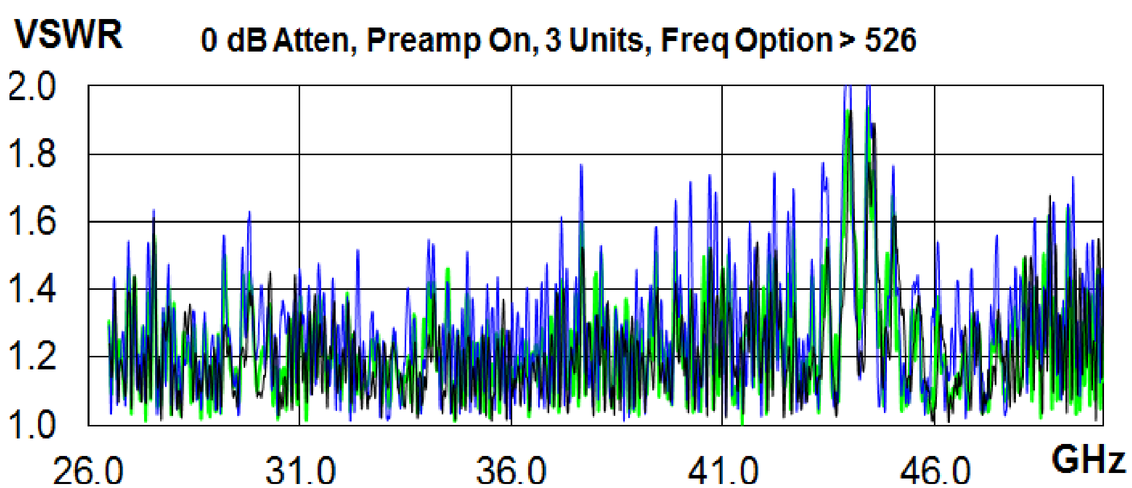




Nominal VSWR – Preamp On Band [Plot]







Description	Specifications	Supplemental Information		
Second Harmonic Distortion		**Preamp Level**[a]	**Distortion** (nominal)	**SHI**[b] (nominal)
Source Frequency				
10 MHz to 1.8 GHz		–45 dBm	–78 dBc	+33 dBm
1.8 to 13.25 GHz		–50 dBm	–60 dBc	+10 dBm
13.25 to 25 GHz		–50 dBm	–50 dBc	0 dBm

a. Preamp Level = Input Level – Input Attenuation.
b. SHI = second harmonic intercept. The SHI is given by the mixer power in dBm minus the second harmonic distortion level relative to the mixer tone in dBc.

Description	Specifications	Supplemental Information		
Third Order Intermodulation Distortion				
(Tone separation 5 times IF Prefilter Bandwidth[a] Sweep type not set to FFT)				
		Preamp Level[b]	**Distortion** (nominal)	**TOI**[c] (nominal)
10 MHz to 500 MHz		–45 dBm	–98 dBc	+4 dBm
500 MHz to 3.6 GHz		–45 dBm	–99 dBc	+4.5 dBm
3.6 to 26.5 GHz		–50 dBm	–70 dBc	–15 dBm

a. See the IF Prefilter Bandwidth table in the specifications for "Gain Compression" on page 42. When the tone separation condition is met, the effect on TOI of the setting of IF Gain is negligible.
b. Preamp Level = Input Level – Input Attenuation.
c. TOI = third order intercept. The TOI is given by the preamplifier input tone level (in dBm) minus (distortion/2) where distortion is the relative level of the distortion tones in dBc.

18 Options RT1, RT2 - Real-time Spectrum Analyzer (RTSA)

This chapter contains specifications for the UXA Signal Analyzer *Options RT1* (N9040RT1B), real-time analysis, basic detection, and *RT2* (N9040RT2B), real-time analysis, optimum detection.

Real-time Spectrum Analyzer Performance

Description	Specs & Nominals		Supplemental Information
General Frequency Domain Characteristics			
Maximum real-time analysis bandwidth (*Option RT1* or *RT2*)			Determined by analysis BW option
With *Option B2X*	255 MHz		
With *Option B5X*	509.47 MHz		
Minimum signal duration with 100% probability of intercept (POI) at full amplitude accuracy	*Opt RT2*	*Opt RT1*	Maximum span: Default window is Kaiser; Viewable on screen
Option B2X, *B5X*			
Spans ≤ 85 MHz	3.7 µs	17.17 µs	
Spans > 85 MHz	3.51 µs	17.17 µs	
Supported Detectors			Peak, Negative Peak, Sample, Average
Number of Traces	6		Clear Write, Max Hold, Min Hold
Resolution Bandwidths (Default window type = Kaiser)			6 RBWs available for each window type[a], Approximate Span: RBW ratio for windows[b]: Flattop = 7 to 212, Gaussian, Blackman-Harris = 13 to 417, Kaiser = 13 to 418, Hanning = 17 to 551
Span	**Min RBW**	**Max RBW**	
100 Hz	240 mHz	7.67 Hz	
255 MHz	574 kHz	18.6 MHz[c]	
509.47 MHz	574 kHz	4.59 MHz	
Window types	Hanning, Blackman-Harris, Rectangular, Flattop, Kaiser, Gaussian		
FFT Rate	292,969/s		Nominal value for maximum sample rate. For all spans greater than 300 kHz.
Supported Triggers			Level, Level with Time Qualified (TQT), Line, External, RF Burst, Frame, Frequency Mask (FMT), FMT with TQT
Number of Markers	12		
Supported Markers			Normal, Delta, Noise, Band Power

Description	Specs & Nominals	Supplemental Information
Amplitude Resolution	0.01 dB	
Frequency Points		
With *Option B2X*	871	
With *Option B5X*	1,742	
Maximum Acquisition Time	104 μs[d]	Value for maximum sample rate

a. Only 4 RBWs available for spans > 255 MHz.
b. Not applicable for spans from 240 to 255 MHz and from 480 to 509.47 MHz.
c. The maximum RBW value applies to all window types. *Option RT1* has a maximum RBW of 10 MHz in early instrument SW.
d. For spectrogram or Normal only. For Density view: 30 ms. For Density & spectrogram: 90 ms.

Description	Specs & Nominals	Supplemental Information
Density View		
Probability range	0 to 100%	
Minimum Span	100 Hz	0.001% steps
Maximum Span		509.47 MHz in real-time. Stitched density supports full frequency of instrument
Persistence duration	10 s	
Color palettes	Cool, Warm, Grayscale, Radar, Fire, Frost	
Spectrogram View		
Maximum number of acquisitions stored	10,000	5,000 with power vs. time combination view
Dynamic range covered by colors	200 dB	

Description	Specs & Nominals	Supplemental Information
Power vs. Time		
Maximum Span	255.2 MHz	
Supported Detectors		Peak, Negative Peak, Sample, Average
Supported Triggers		Level, Level with Time Qualified (TQT), Line, External, RF Burst, Frame, Frequency Mask (FMT), FMT with TQT
Number of Markers	12	
Maximum Time Viewable	40 s	
Minimum Time Viewable	201.38 μs	For span < 255 MHz
Minimum detectable signal For *Option RT2* only; Available with "Multi-view"		
With *Option B2X*, *B5X*	3.33 ns	

Description	Specs & Nominals		Supplemental Information
Frequency Mask Trigger (FMT)			
Trigger Views	Density, Spectrogram, Normal		
Trigger resolution	0.5 dB		
Trigger conditions	Enter, Leave, Inside, Outside, Enter->Leave, Leave->Enter, TQT		
Minimum TQT Duration @ Maximum span (or BW)	3.4133 μs		The minimum TQT duration is inversely proportional to the span (or BW)
Minimum detectable signal duration with >60 dB Signal-to Mask (StM)			Does not include analog front-end effects. For *Option RT2* only
With *Option B2X*, *B5X*	3.33 ns		
Minimum signal duration (in µs) for 100% probability of FMT triggering with various RBW			RBW 1 through 6 can be selected under Bandwidth [BW] Manual.
Option RT1			
Span (MHz)	**509.47**	**255**	
RBW 6	n/a[a]	17.17	
RBW 4	17.49	17.49	
Option RT2			
Span (MHz)	**509.47**	**255**	
RBW 6	n/a[a]	3.62	
RBW 4	3.837	3.837	

a. Only 4 RBWs available for spans >255 MHz.

19 Option YAV - Y-Axis Video Output

This chapter contains specifications for *Option YAV* (Y-Axis Video Output).

KEYSIGHT TECHNOLOGIES

Specifications Affected by Y-Axis Video Output

No other analyzer specifications are affected by the presence or use of this option. New specifications are given in the following pages.

Other Y-Axis Video Output Specifications

General Port Specifications

Description	Specifications	Supplemental Information
Connector	BNC female	Shared with other options
Impedance		50Ω (nominal)

Screen Video

Description	Specifications	Supplemental Information
Operating Conditions		
Display Scale Types	All (Log and Lin)	"Lin" is linear in voltage
Log Scales	All (0.1 to 20 dB/div)	
Modes	Spectrum Analyzer only	
FFT & Sweep	Select sweep type = Swept.	
Gating	Gating must be off.	
Output Signal		Replication of the RF Input Signal envelope, as scaled by the display settings
Differences between display effects and video output		
Detector = Peak, Negative, Sample, or Normal	The output signal represents the input envelope excluding display detection	
Average Detector	The effect of average detection in smoothing the displayed trace is approximated by the application of a low-pass filter	Nominal bandwidth: $LPFBW = \frac{Npoints - 1}{SweepTime \cdot \pi}$
EMI Detectors	The output will not be useful.	
Trace Averaging	Trace averaging affects the displayed signal but does not affect the video output	
Amplitude Range		Range of represented signals
Minimum	Bottom of screen	
Maximum	Top of Screen + Overrange	
Overrange		Smaller of 2 dB or 1 division, (nominal)
Output Scaling[a]	0 to 1.0 V open circuit, representing bottom to top of screen	
Offset		±1% of full scale (nominal)
Gain accuracy		±1% of output voltage (nominal)
Delay		
(RF Input to Analog Out)		114 μs + RBWDelay[b] + 0.159/VBW

a. The errors in the output can be described as offset and gain errors. An offset error is a constant error, expressed as a fraction of the full-scale output voltage. The gain error is proportional to the output voltage. Here's an example. The reference level is –10 dBm, the scale is log, and the scale is 5 dB/division. Therefore, the top of the display is –10 dBm, and the bottom is –60 dBm. Ideally, a –60 dBm signal gives 0 V at the output, and –10 dBm at the input gives 1 V at the output. The maximum error with a –60 dBm input signal is the offset error, ±1% of full scale, or ±10 mV; the gain accuracy does not apply because the output is nominally at 0 V. If the input signal is –20 dBm, the nominal output is 0.8 V. In this case, there is an offset error (±10 mV) plus a gain error (±1% of 0.8 V, or ±8 mV), for a total error of ±18 mV.
b. For RBW ≤ 100 kHz, 2.56/RBW; otherwise, 5.52/RBW.

Continuity and Compatibility

Description	Specifications	Supplemental Information
Continuity and Compatibility		
Output Tracks Video Level		
During sweep		Except band breaks in swept spans
Zero span	Yes	
FFT spans	No	
Swept spans		
≤2.5 MHz	Yes	
>2.5, ≤10 MHz		Sweep segmentation interruptions[a]
>10, ≤100 MHz	Yes	
>100 MHz		Band crossing interruptions possible
Between sweeps	See supplemental information	Before sweep interruption[b] Alignments [c] Auto Align = Partial[de]
External trigger, no trigger[e]	Yes	
HP 8566/7/8 Compatibility[f]		Recorder output labeled “Video”
Continuous output		Alignment differences[g] Band crossing[h] FFTs[i]
Output impedance		Two variants[j]
Gain calibration		LL and UR not supported[k]
RF Signal to Video Output Delay		See footnote[l]

a. In these spans, the sweep is segmented into sub-spans, with interruptions between these subspans. These can be prevented by setting the Phase Noise Optimize key to Fast Tuning.
b. There is an interruption in the tracking of the video output before each sweep. During this interruption, the video output holds instead of tracks for a time period given by approximately 1.8/RBW.
c. There is an interruption in the tracking of the video output during alignments. During this interruption, the video output holds instead of tracking the envelope of the RF input signal. Alignments may be set to prevent their interrupting video output tracking by setting Auto Align to Off.
d. Setting Auto Align to Off usually results in a warning message soon thereafter. Setting Auto Align to Partial results in many fewer and shorter alignment interruptions, and maintains alignments for a longer interval.
e. If video output interruptions for Partial alignments are unacceptable, setting the analyzer to External Trigger without a trigger present can prevent these from occurring, but will prevent there being any on-screen updating. Video output is always active even if the analyzer is not sweeping.

f. This section of specifications shows compatibility of the Screen Video function with HP 8566-Series analyzers. Compatibility with ESA and PSA analyzers is similar in most respects.
g. The HP 8566-series analyzer(s) did not have alignments and interruptions that interrupted video outputs, as discussed above.
h. The location of the boundaries between harmonic mixing bands is different between the HP 8566-series analyzer(s) and this analyzer. Also, this analyzer uses segmented sweeps for spans between 2.5 and 10 MHz.
i. The HP 8566-series analyzer(s) did not have FFT sweeps. This analyzer compatibility is improved if the sweep type is set to Manual and Swept.
j. Early HP 8566-series analyzer(s) had a 140Ω output impedance; later ones had 190Ω. The specification was <475Ω. The Analog Out port has a 50Ω impedance.
k. The HP 8566-series analyzer(s) had LL (lower left) and UR (upper right) controls that could be used to calibrate the levels from the video output circuit. These controls are not available in this option.
l. The delay between the RF input and video output shown in Delay on page 210 is much higher than the delay in the HP 8566-series analyzer(s). The latter has a delay of approximately 0.554/RBW + 0.159/VBW.

Log Video Output

Description	Specifications	Supplemental Information
Amplitude Range (terminated with 50Ω)		
Maximum		1.0 V (nominal) for signal envelope of –10 dBm at the mixer
Scale factor		Output changes 1 V for every 192.66 dB change in signal envelope
Bandwidth	Set by RBW	
Operating Conditions	Select Sweep Type = Swept.	

Linear Video (AM Demod) Output

Description	Specifications	Supplemental Information
Amplitude Range (terminated with 50Ω)		
Maximum		1.0 V (nominal) for signal envelope at the reference level
Minimum		0 V
Scale factor		If carrier level is set to half the reference level in volts, the scale factor is 200%/V
Bandwidth	Set by RBW	
Operating Conditions	Select Sweep Type = Swept.	

20 5G NR Measurement Application

This chapter contains specifications for the N9085EM0E 5G NR (New Radio) measurement application.

Additional Definitions and Requirements

Because digital communications signals are noise-like, all measurements will have variations. The specifications apply only with adequate averaging to remove those variations

The specifications apply in the frequency range documented in the In-band Frequency Range of each application.

Measurements

Description	Specifications	Supplemental Information
Channel Power		
Minimum power at RF Input		–50 dBm (nominal)
Absolute power accuracy		20 to 30°C, Atten = 10 dB
10 MHz to 3.5 GHz (Band 0)	±0.63 dB	±0.19 dB (95th Percentile)
3.5 to 8.4 GHz (Band 1)	±1.78 dB	±0.58 dB (95th Percentile)
26.4 to 34.5 GHz (Band 5) (*Option 544/550*)[a]	±2.78 dB	±1.09 dB (95th Percentile)
34.4 to 50 GHz (Band 6) (*Option 544/550*)[b]	±3.48 dB	±1.44 dB (95th Percentile)
Measurement Floor		In a 100 MHz bandwidth
10 MHz to 8.4 GHz (Band 0/1))		–69.7 dBm (typical)
26.4 to 30 GHz (Band 5) (*Option 544/550*)[a]		–60.7 dBm (typical)
37 to 40 GHz (Band 6) (*Option 544/550*)[b]		–56.7 dBm (typical)

a. Covers NR Operating Band n257 and n258.
b. Covers NR Operating Band n260.

Description	Specifications	Supplemental Information
Spurious Emissions		Table-driven spurious signals; search across regions
Dynamic Range[a], relative (RBW = 1 MHz)		
10 MHz to 3.6 GHz (Band 0)		92.4 dB (nominal)
3.6 to 8.4 GHz (Band 1)		95.1 dB (nominal)
8.3 to 13.6 GHz (Band 2)		91.2 dB (nominal)
13.5 to 17.1 GHz (Band 3)		88.8 dB (nominal)
17 to 26.5 GHz (Band4)		84.2 dB (nominal)
26.4 to 34.5 GHz (Band 5) (*Option 544/550*)		83.3 dB (nominal)
34.4 to 50 GHz (Band 6) (*Option 544/550*)		76.4 dB (nominal)
Sensitivity[b], absolute (RBW = 1 MHz)		
10 MHz to 3.6 GHz (Band 0)	–86.5 dBm	–89.5 dBm (typical)
3.6 to 8.4 GHz (Band 1)	–79.5 dBm	–85.5 dBm (typical)
8.3 to 13.6 GHz (Band 2)	–82.5 dBm	–86.5 dBm (typical)
13.5 to 17.1 GHz (Band 3)	–79.5 dBm	–85.5 dBm (typical)
17 to 26.5 GHz (Band4)	–74.5 dBm	–80.5 dBm (typical)
26.4 to 34.5 GHz (Band 5) (*Option 544/550*)	–73.5 dBm	–80.5 dBm (typical)
34.4 to 50 GHz (Band 6) (*Option 544/550*)	–66.5 dBm	–76.5 dBm (typical)
Accuracy		(Attenuation = 10 dB)
Frequency Range		
20 Hz to 3.6 GHz (Band 0)		±0.19 dB (95th Percentile)
3.6 to 8.4 GHz (Band 1)		±0.56 dB (95th Percentile)
8.3 to 13.6 GHz (Band 2)		±0.64 dB (95th Percentile)
13.5 to 17.1 GHz (Band 3)		±0.62 dB (95th Percentile)
17 to 26.5 GHz (Band4)		±0.80 dB (95th Percentile)
26.4 to 34.5 GHz (Band 5) (*Option 544/550*)		±1.27 dB (95th Percentile)
34.4 to 50 GHz (Band 6) (*Option 544/550*)		±1.76 dB (95th Percentile)

a. The dynamic range is specified at 12.5 MHz offset from the center frequency with the mixer level at a 1 dB compression point. This will degrade the accuracy by 1 dB if the carrier and spurious emissions are within the same band.
b. The sensitivity is specified at the far offset from the carrier, where the phase noise does not contribute. You can derive the dynamic range at the far offset from the 1 dB compression mixer level and the sensitivity.

Description	Specifications			Supplemental Information	
Adjacent Channel Power				Single Carrier	
Minimum power at RF input				–36 dBm (nominal)	
Accuracy	**Channel Bandwidth**				
Adjacent Offset, MS[a]	**20 MHz**	**50 MHz**	**100 MHz**	**ACPR Range for Specification**	
Band 0	±0.12 dB	±0.17 dB	±0.23 dB	–33 to –27 dBc with opt ML(–20, –17, –16 dBm[b])	
Band 1	±0.47 dB	±0.67 dB	±0.87 dB	–33 to –27 dBc with opt ML(–18, –12, –15 dBm[b])	
Band 5 (*Option 544/550*)		±0.90 dB	±1.17 dB	–20 to –14 dBc with opt ML(–20, –17, –15 dBm[b])	
Band 6 (*Option 544/550*)		±1.19 dB	±1.63 dB	–19 to –13 dBc with opt ML(–15, –9, –12 dBm[b])	
Adjacent Offset, BTS[c]					
Band 0	±0.58 dB	±0.90 dB	±1.25 dB	–48 to –42 dBc with opt ML(–15, –13, –12 dBm[b])	
Band 1	±1.04 dB	±1.57 dB	±2.13 dB	–48 to –42 dBc with opt ML(–14, –14, –11 dBm[b])	
Band 5 (*Option 544/550*)		±1.19 dB	±1.58 dB	–31 to –25 dBc with opt ML(–16, –14, –12 dBm[b])	
Band 6 (*Option 544/550*)		±1.69 dB	±2.24 dB	–29 to –23 dBc with opt ML(–13, –11, –9 dBm[b])	
Alternate Offset, BTS[c]					
Band 0	±0.14 dB	±0.20 dB	±0.24 dB	–48 to –42 dBc with opt ML(–4, –1, 0 dBm[b])	
Band 1	±0.57 dB	±0.82 dB	±1.03 dB	–48 to –42 dBc with opt ML(+3, +6, +6 dBm[b])	
Band 5 (*Option 544/550*)		±1.12 dB	±1.43 dB	–31 to –25 dBc with opt ML(–4, –4, +1 dBm[b])	
Band 6 (*Option 544/550*)		±1.51 dB	±1.95 dB	–29 to –23 dBc with opt ML(–1, +2, +4 dBm[b])	
Dynamic Range				Noise Correction On, Noise Floor Extension Off	
Channel Bandwidth: 100 MHz				Dynamic Range (nominal)	Optimum Mixer Level (nominal)
Band 1				78.4 dB	–0.22 dBm
Band 5, Band 6 (*Option 544/550*)				54.5 dB	

a. Measurement bandwidths for mobile stations are 19.095, 48.615 and 98.31 MHz for channel bandwidths of 20, 50 and 100 MHz respectively.
b. The optimum mixer levels for each channel bandwidths of 20, 50 and 100 MHz respectively.
c. Measurement bandwidths for base transceiver stations are 19.08, 48.6 and 98.28 MHz for channel bandwidths of 20, 50 and 100 MHz respectively.

Description	Specifications	Supplemental Information
Spectrum Emission Mask		Offset from CF = (channel bandwidth + measurement bandwidth) / 2; measurement bandwidth = 1.0 MHz
Dynamic Range		
Channel Bandwidth: 20MHz		
Band 0	83.0 dB	86.9 dB (typical)
Band 1	75.0 dB	82.4 dB (typical)
Band 5 (*Option 544/550*)		75.8 dB (nominal)
Band 6 (*Option 544/550*)		73.1 dB (nominal)
Channel Bandwidth: 50 MHz		
Band 0	84.4 dB	88.7 dB (typical)
Band 1	76.4 dB	84.3 dB (typical)
Band 5 (*Option 544/550*)		77.1 dB (nominal)
Band 6 (*Option 544/550*)		77.4 dB (nominal)
Channel Bandwidth: 100 MHz		
Band 0	85.4 dB	89.6 dB (typical)
Band 1 (*Option 544/550*)	77.4 dB	85.3 dB (typical)
Band 5 (*Option 544/550*)		78.0 dB (nominal)
Band 6 (*Option 544/550*)		75.4 dB (nominal)
Sensitivity		
Band 0	–96.5 dBm	–99.5 dBm (typical)
Band 1 (*Option 544/550*)	–89.5 dBm	–95.5 dBm (typical)
Band 5 (*Option 544/550*)	–83.5 dBm	–90.5 dBm (typical)
Band 6 (*Option 544/550*)	–76.5 dBm	–86.5 dBm (typical)
Accuracy		
Relative		
Band 0	±0.11 dB	
Band 1	±0.38 dB	
Band 5 (*Option 544/550*)		±0.52 dB (nominal)
Band 6 (*Option 544/550*)		±0.69 dB (nominal)

Description	Specifications	Supplemental Information
Absolute		
Band 0	±0.62 dB	±0.20 dB (95th Percentile)
Band 1	±1.17 dB	±0.44 dB (95th Percentile)
Band 5 (*Option 544/550*)	±2.27 dB	±0.94 dB (95th Percentile)
Band 6 (*Option 544/550*)	±0.19 dB	±0.19 dB (95th Percentile)

Description	Specifications	Supplemental Information
Power Statistics CCDF		
Histogram Resolution	0.01 dB[a]	

a. The Complementary Cumulative Distribution Function (CCDF) is a reformatting of the histogram of the power envelope. The width of the amplitude bins used by the histogram is the histogram resolution. The resolution of the CCDF will be the same as the width of those bins.

Description	Specifications	Supplemental Information
Occupied Bandwidth		
Minimum power at RF Input		–30 dBm (nominal)
Frequency Accuracy	± 200 kHz	RBW = 30 kHz, Number of Points = 1001, Span = 200 MHz

Description	Specifications	Supplemental Information
Modulation Analysis		
EVM for Downlink floor		
Channel Bandwidth: 20 MHz		
Band 0		0.16% (nominal)
Channel Bandwidth: 100 MHz		
Band 1 (5 GHz)		0.29% (nominal)
Band 5 (28 GHz)		0.66% (nominal)
Band 6 (39 GHz)		0.89% (nominal)
Frequency Error		
Lock range		±2.5 × subcarrier spacing = 75 kHz for default 30 kHz subcarrier spacing[a] (nominal)
Accuracy		±1 Hz + tfa[b] (nominal)

a. The specification applies when Extended Freq Range = On.
b. tfa = transmitter frequency × frequency reference accuracy.

Frequency Ranges

Frequency Range: FR1					
NR Operating Band	**Uplink (UL) Operating Band** BS Receive UE Transmit		**Downlink (DL) Operating Band** BS Transmit UE Receive		Duplex Mode
	$F_{UL\_low} – F_{UL\_high}$	Total BW (MHz)	$F_{DL\_low} – F_{DL\_high}$	Total BW (MHz)	
n1	1920 -1980 MHz	60	2110 -2170 MHz	60	FDD
n2	1850 - 1910 MHz	60	1930 - 1990 MHz	60	FDD
n3	1710 - 1785 MHz	75	1805 - 1880 MHz	75	FDD
n5	824 - 849 MHz	25	869 - 894 MHz	25	FDD
n7	2500 - 2570 MHz	70	2620 - 2690 MHz	70	FDD
n8	880 - 915 MHz	35	925 - 960 MHz	35	FDD
n20	832 - 862 MHz	30	791- 821 MHz	30	FDD
n28	703 - 748 MHz	45	758 - 803 MHz	45	FDD
n38	2570 -2620 MHz	50	2570 -2620 MHz	50	TDD
n41	2496 -2690 MHz	194	2496 -2690 MHz	194	TDD
n50	1432 -1517 MHz	85	1432 -1517 MHz	85	TDD
n51	1427 -1432 MHz	5	1427 -1432 MHz	5	TDD
n66	1710 -1780 MHz	70	2110 -2200 MHz	90	FDD
n70	1695 -1710 MHz	15	1995 -2020 MHz	25	FDD
n71	663 - 698 MHz	35	617 - 652 MHz	35	FDD
n74	1427 -1470 MHz	43	1475 -1518 MHz	43	FDD
n75	N/A		1432 -1517 MHz	85	SDL
n76	N/A		1427 -1432 MHz	5	SDL
n78	3300 -3800 MHz	500	3300 - 3800 MHz	500	TDD
n77	3300 - 4200 MHz	900	3300 - 4200 MHz	900	TDD
n79	4400 -5000 MHz	600	4400 - 5000 MHz	600	TDD
n80	1710 -1785 MHz	75	N/A		SUL
n81	880 -915 MHz	35	N/A		SUL
n82	832 -862 MHz	30	N/A		SUL

Frequency Range: FR1					
NR Operating Band	**Uplink (UL) Operating Band** BS Receive UE Transmit		**Downlink (DL) Operating Band** BS Transmit UE Receive		Duplex Mode
	$F_{UL\_low} - F_{UL\_high}$	Total BW (MHz)	$F_{DL\_low} - F_{DL\_high}$	Total BW (MHz)	
n83	703 -748 MHz	45	N/A		SUL
n84	1920 -1980 MHz	60	N/A		SUL

Frequency Range: FR2					
NR Operating Band	**Uplink (UL) Operating Band** BS Receive UE Transmit		**Downlink (DL) Operating Band** BS Transmit UE Receive		Duplex Mode
	$F_{UL\_low} - F_{UL\_high}$	Total BW (MHz)	$F_{DL\_low} - F_{DL\_high}$	Total BW (MHz)	
n257	26500–29500 MHz	3000	26500–29500 MHz	3000	TDD
n258	24250–27500 MHz	3260	24250–27500 MHz	3260	TDD
n260	37000–40000 MHz	3000	37000–40000 MHz	3000	TDD

21 Analog Demodulation Measurement Application

This chapter contains specifications for the N9063EM0E Analog Demodulation Measurement Application.

Additional Definitions and Requirements

The warranted specifications shown apply to Band 0 operation (up to 3.6 GHz), unless otherwise noted, for all analyzers. The application functions, with nominal (non-warranted) performance, at any frequency within the frequency range set by the analyzer frequency options (see table). In practice, the lowest and highest frequency of operation may be further limited by AC coupling; by "folding" near 0 Hz; by DC feedthrough; and by Channel BW needed. Phase noise and residual FM generally increase in higher bands.

Warranted specifications shown apply when Channel BW ≤1 MHz, unless otherwise noted. (Channel BW is an important user-settable control.) The application functions, with nominal (non-warranted) performance, at any Channel BW up to the analyzer's bandwidth options (see table). The Channel BW required for a measurement depends on: the type of modulation (AM, FM, PM); the rate of modulation; the modulation depth or deviation; and the spectral contents (e.g. harmonics) of the modulating tone. Many specifications require that the Channel BW control is optimized: neither too narrow nor too wide.

Many warranted specifications (rate, distortion) apply only in the case of a single, sinusoidal modulating tone without excessive harmonics, non-harmonics, spurs, or noise. Harmonics, which are included in most distortion results, are counted up to the 10th harmonic of the dominant tone, or as limited by SINAD BW or post-demod filters. Note that SINAD will include Carrier Frequency Error (the "DC term") in FM by default; it can be eliminated with a HPF or Auto Carrier Frequency feature.

Warranted specifications apply to results of the software application; the hardware demodulator driving the Analog Out line is described separately.

Warranted specifications apply over an operating temperature range of 20 to 30°C; and mixer level –24 to –18 dBm (mixer level = Input power level – Attenuation). Additional conditions are listed at the beginning of the FM, AM, and PM sections, in specification tables, or in footnotes.

See “Definitions of terms used in this chapter” on page 226.

Definitions of terms used in this chapter

Let P_{signal} (S) = Power of the signal; P_{noise} (N) = Power of the noise; $P_{distortion}$ (D) = Power of the harmonic distortion (P_{H2}+ P_{H3} + ...+ P_{Hi} where Hi is the i^{th} harmonic up to i =10);
P_{total} = Total power of the signal, noise and distortion components.

Term	Short Hand	Definition
Distortion	$\frac{N + D}{S + N + D}$	**$(P_{total} - P_{signal})^{1/2} / (P_{total})^{1/2} \times 100\%$**
THD	$\frac{D}{S}$	**$(P_{distortion})^{1/2} / (P_{signal})^{1/2} \times 100\%$** where THD is the total harmonic distortion
SINAD	$\frac{S + N + D}{N + D}$	**$20 \times \log10 [1/(P_{distortion})]^{1/2} = 20 \times \log10 [(P_{total})^{1/2} / (P_{total} - P_{signal})^{1/2}]$** where SINAD is Signal-to-Noise-And-Distortion ratio
SNR	$\frac{S + N + D}{N}$	**$P_{signal} / P_{noise} \sim (P_{signal} + P_{noise} + P_{distortion}) / P_{noise}$** where SNR is the Signal-to-Noise Ratio. The approximation is per the implementations defined with the HP/Agilent/Keysight 8903A.

NOTE

P_{noise} must be limited to the bandwidth of the applied filters.

The harmonic sequence is limited to the 10^{th} harmonic unless otherwise indicated. P_{noise} includes all spectral energy that is not near harmonic frequencies, such as spurious signals, power line interference, etc.

RF Carrier Frequency and Bandwidth

Description	Specifications	Supplemental Information
Carrier Frequency		
Maximum Frequency		
Option 508	8.4 GHz	RF/μW frequency option
Option 513	13.6 GHz	RF/μW frequency option
Option 526	26.5 GHz	RF/μW frequency option
Option 544	44 GHz	mmW frequency option
Option 550	50 GHz	mmW frequency option
Minimum Frequency		
AC Coupled[a]	10 MHz	
DC Coupled	2 Hz	In practice, limited by the need to keep modulation sidebands from folding, and by the interference from LO feedthrough.
Maximum Information Bandwidth (Info BW)[b]		
Option B25 (standard)	25 MHz	
Option B40	40 MHz	
Option B2X	160 MHz[c]	
Option B5X	160 MHz[c]	
Capture Memory (Sample Rate × Acq Time)	3.6 MSa	Each sample is an I/Q pair. See note [d]

a. AC Coupled is only applicable to frequency *Options 508*, *513*, and *526*.
b. The maximum Info BW indicates the maximum operational BW, which depends on the analysis BW option equipped with the analyzer. However, the demodulation specifications only apply to the Channel BW indicated in the following sections.
c. While *Option B2X* and *B5X* offer 255 MHz and 510 MHz analysis BW in the I/Q Analysis mode, the maximum Info BW is limited by the N9063EM0E Analog Demod Application to 160 MHz.
d. Sample rate is set indirectly by the user, with the Span and Channel BW controls (viewed in RF Spectrum). The Info BW (also called Demodulation BW) is based on the larger of the two; specifically,
Info BW = max [Span, Channel BW]. The sample interval is 1/(1.25 × Info BW); e.g. if Info BW = 200 kHz, then sample interval is 4 us. The sample rate is 1.25 × Info BW, or 1.25 × max [Span, Channel BW]. These values are approximate, to estimate memory usage. Exact values can be queried via SCPI while the application is running.
Acq Time (acquisition time) is set by the largest of 4 controls:
Acq Time = max[2.0 / (RF RBW), 2.0 /(AF RBW), 2.2 × Demod Wfm Sweep Time, Demod Time]

Post-Demodulation

Description	Specifications	Supplemental Information
Maximum Audio Frequency Span		1/2 × Channel BW
Filters		
High Pass	20 Hz	2-Pole Butterworth
	50 Hz	2-Pole Butterworth
	300 Hz	2-Pole Butterworth
	400 Hz	10-Pole Butterworth; used to attenuate sub-audible signaling tones
Low Pass	300 Hz	5-Pole Butterworth
	3 kHz	5-Pole Butterworth
	15 kHz	5-Pole Butterworth
	30 kHz	3-Pole Butterworth
	80 kHz	3-Pole Butterworth
	300 kHz	3-Pole Butterworth
	100 kHz (>20 kHz Bessel)	9-Pole Bessel; provides linear phase response to reduce distortion of square-wave modulation, such as FSK or BPSK
	Manual	Manually tuned by user, range 300 Hz to 20 MHz; 5-Pole Butterworth; for use with high modulation rates
Band Pass	CCITT	ITU-T O.41, or ITU-T P.53; known as "psophometric"
	A-Weighted	ANSI IEC rev 179
	C-Weighted	Roughly equivalent to 50 Hz HPF with 10 kHz LPF
	C-Message	IEEE 743, or BSTM 41004; similar in shape to CCITT, sometimes called "psophometric"
	CCIR-1k Weighted[a]	ITU-R 468, CCIR 468-2 Weighted, or DIN 45 405
	CCIR-2k Weighted[a]	ITU 468 ARM or CCIR/ARM (Average Responding Meter), commonly referred to as "Dolby" filter
	CCIR Unweighted	ITU-R 468 Unweighted[a]

Description	Specifications	Supplemental Information
De-emphasis (FM only)	25 μs	Equivalent to 1-pole LPF at 6366 Hz
	50 μs	Equivalent to 1-pole LPF at 3183 Hz; broadcast FM for most of world
	75 μs	Equivalent to 1-pole LPF at 2122 Hz; broadcast FM for U.S.
	750 μs	Equivalent to 1-pole LPF at 212 Hz; 2-way mobile FM radio.
SINAD Notch[b]		Tuned automatically by application to highest AF response, for use in SINAD, SNR, and Distortion calculations; complies with TI-603 and IT-O.132; stop bandwidth is ±13% of tone frequency.
Signaling Notch[b]		FM only; manually tuned by user, range 50 to 300 Hz; used to eliminate CTCSS or CDCSS signaling tone; complies with TIA-603 and ITU-O.132; stop bandwidth is ±13% of tone frequency.

a. ITU standards specify that CCIR-1k Weighted and CCIR Unweighted filters use Quasi-Peak-Detection (QPD). However, the implementation in N9063EM0E is based on true-RMS detection, scaled to respond as QPD. The approximation is valid when measuring amplitude of Gaussian noise, or SINAD of a single continuous sine tone (e.g. 1 kHz), with harmonics, combined with Gaussian noise. The results may not be consistent with QPD if the input signal is bursty, clicky, or impulsive; or contains non-harmonically related tones (multi-tone, intermods, spurs) above the noise level. Use the AF Spectrum trace to validate these assumptions. Consider using Agilent/Keysight U8903A Audio Analyzer if true QPD is required.

b. The Signaling Notch filter does not visibly affect the AF Spectrum trace.

Frequency Modulation

Conditions required to meet specification

—Peak deviation[1]: ≥ 200 Hz
—Modulation index (ModIndex) = PeakDeviation/Rate = Beta: 0.2 to 2000
—Channel BW: ≤ 1 MHz
—Rate: 20 Hz to 50 kHz
—SINAD bandwidth: (Channel BW)/2
—Single tone - sinusoid modulation
—Center Frequency (CF): 2 MHz to 3.5 GHz (band 0 only)

Description	Specifications	Supplemental Information
FM Measurement Range		
Modulation Rate Range[a][b][c]	1 Hz to (max info BW)/2	
Peak Deviation Range[a][b][c]	< (max info BW)/2	

a. ((Modulation Rate) + (Peak Deviation)) < (max Info BW)/2
b. The measurement range is also limited by max capture memory. Specifically, SamplingRate × AcqTime <3.6 MSa, where SamplingRate = 1.25 × Info BW. For example, if the modulation rate is 1 Hz, then the period of the waveform is 1 second. Suppose AcqTime = 72 seconds, then the max SamplingRate is 50 kHz, which leads to 40 kHz max Info BW. Under such condition, the peak deviation should be less than 20 kHz.
c. Max info BW: See "Maximum Information Bandwidth (Info BW)" on page 227.

1. Peak deviation, modulation index ("beta"), and modulation rate are related by PeakDeviation = ModIndex × Rate. Each of these has an allowable range, but all conditions must be satisfied at the same time. For example, PeakDeviation = 80 kHz at Rate = 20 Hz is not allowed, since ModIndex = PeakDeviation/Rate would be 4000, but ModIndex is limited to 2000. In addition, all significant sidebands must be contained in Channel BW. For FM, an approximate rule-of-thumb is 2 × [PeakDeviation + Rate] < Channel BW; this implies that PeakDeviation might be large if the Rate is small, but both cannot be large at the same time.

Description	Specifications	Supplemental Information
FM Deviation Accuracy[abc]		
0.2 ≤ Modulation Index < 1000	±(0.3% × Reading + 0.1% × Rate)	
Modulation Index ≥ 1000	±(0.35% × Reading)	
FM Rate Accuracy[de]		
0.2 ≤ Modulation Index < 10	±(0.006% × Reading) + rfa	
Modulation Index ≥ 10	±(0.002% × Reading) + rfa	
Carrier Frequency Error[fg]	±(2 ppm × Deviation + 50 ppm × Rate) + tfa	

a. This specification applies to the result labeled "(Pk-Pk)/2".
b. For optimum measurement, ensure that the Channel BW is set wide enough to capture the significant RF energy. Setting the Channel BW too wide will result in measurement errors.
c. Reading is a measured frequency peak deviation in Hz, and Rate is a modulation rate in Hz.
d. Reading is a measured modulation rate in Hz.
e. rfa = modulation rate × frequency reference accuracy.
f. tfa = transmitter frequency × frequency reference accuracy.
g. Deviation is peak frequency deviation in Hz, and Rate is a modulation rate in Hz.

Frequency Modulation

Description	Specifications	Supplemental Information
Post-Demod Distortion Residual[a]		
Distortion (SINAD)[b]	0.4% / $(\text{ModIndex})^{1/2}$ + 0.04%	
THD	0.32% / $(\text{ModIndex})^{1/2}$	
Post-Demod Distortion Accuracy		
(Rate: 1 to 10 kHz, ModIndex: 0.2 to 100)		
Distortion	±(2% × Reading + DistResidual)	
THD	±(2% × Reading + DistResidual)	2^{nd} and 3^{rd} harmonics
AM Rejection[c]	2.8 Hz	
Residual FM[d]	1.2 Hz (rms)	

a. For optimum measurement, ensure that the Channel BW is set wide enough to capture the significant RF energy. Setting the Channel BW too wide will result in measurement errors.
b. SINAD [dB] can be derived by 20 × log10(1 / Distortion).
c. AM rejection describes the instrument's FM reading for an input that is strongly AMed (with no FM); this specification includes contributions from residual FM. AM signal (Rate = 1 kHz, Depth = 50%), HPF=50 Hz, LPF = 3 kHz, Channel BW = 15 kHz
d. Residual FM describes the instrument's FM reading for an input that has no FM and no AM; this specification includes contributions from FM deviation accuracy. HPF = 50 Hz, LPF = 3 kHz, Channel BW = 15 kHz.

Amplitude Modulation

Conditions required to meet specification

–Depth: 1% to 99%
–Channel BW: ≤ 1 MHz
–Channel BW: 15 × Rate (Rate ≤ 50 kHz) or 10 × Rate (50 kHz < Rate ≤ 100 kHz)
–Rate: 50 Hz to 100 kHz
–SINAD bandwidth: (Channel BW)/2
–Single tone - sinusoid modulation
–Center Frequency (CF): 500 kHz to 3.5 GHz, DC coupled for CF < 20 MHz

Description	Specifications	Supplemental Information
AM Measurement Range		
Modulation Rate Range[a]	1 Hz to (max info BW)/2	
Peak Depth Range	0% to 100%	

a. Max info BW: See “Maximum Information Bandwidth (Info BW)” on page 227.

Description	Specifications	Supplemental Information
AM Depth Accuracy[ab]	±(0.1% × Reading + 0.07%)	
AM Rate Accuracy[cd] (Rate: 1 kHz to 100 kHz)	±[(2.5 ppm × Reading) × (100% / Depth%)] + rfa	

a. This specification applies to the result labeled "(Pk-Pk)/2".
b. Reading is a measured AM depth in %, and Rate is a Modulation Rate in Hz.
c. Reading is a modulation rate in Hz and depth is in %.
d. rfa = Modulation Rate × Frequency reference accuracy.

Amplitude Modulation

Description	Specifications	Supplemental Information
Post-Demod Distortion Residual		
Distortion (SINAD)[a]	0.1% × (100% / Depth%) + 0.02%	
THD	0.015% × (100% / Depth%) + 0.05%	
Post-Demod Distortion Accuracy (Rate: 1 to 10 kHz, Depth: 5 to 90%)		
Distortion	±(1% × Reading + DistResidual)	
THD	±(1% × Reading + DistResidual)	2^{nd} and 3^{rd} harmonics
FM Rejection[b]	0.04%	
Residual AM[c]	0.01% (rms)	

a. SINAD [dB] can be derived by 20 × log10(1/ Distortion).
b. FM rejection describes the instrument's AM reading for an input that is strongly FMed (and no AM); this specification includes contributions from residual AM. FM signal (Rate = 1 kHz, Deviation = 50 kHz), HPF = 300 Hz, LPF = 3 kHz, channel BW = 420 kHz.
c. Residual AM describes the instrument's AM reading for an input that has no AM and no FM; this specification includes contributions from AM depth accuracy. HPF = 300 Hz, LPF = 3 kHz, channel BW = 15 kHz.

Phase Modulation

Conditions required to meet specification

—Peak deviation[1]: 0.2 to 100 rad
—Channel BW: ≤ 1 MHz
—HPF = 20 Hz always on (unless otherwise specified)
—Rate: 50 Hz to 50 kHz
—SINAD bandwidth: (Channel BW)/2
—Single tone - sinusoid modulation
—Center Frequency (CF): 2 MHz to 3.5 GHz (band 0 only)

Description	Specifications	Supplemental Information
PM Measurement Range		
Modulation Rate Range[a,b,c]	1 Hz to (max info BW)/2	
Peak Deviation Range[a,b,c]	< (max info BW)/(2 × (modulation rate))	

a. (1+ Peak Deviation)) < (max Info BW)/(2 × (modulation rate)).
b. The measurement range is also limited by max capture memory. Specifically, SamplingRate × AcqTime <3.6 MSa, where SamplingRate = 1.25 × Info BW.
c. Max info BW: See "Maximum Information Bandwidth (Info BW)" on page 227.

1. PeakDeviation (for phase, in rads) and Rate are jointly limited to fit within the Channel BW. For PM, an approximate rule-of-thumb is 2 × [PeakDeviation + 1] × Rate < Channel BW, such that most of the sideband energy is within the Channel BW.

Description	Specifications	Supplemental Information
PM Deviation Accuracy[abc]		
Rate: 100 Hz to 50 kHz	±(0.1% × Reading + 1 mrad)	
PM Rate Accuracy[deb]		
Rate: ≤ 500 Hz	±(0.004 Hz / Deviation) + rfa	
500 Hz < Rate ≤ 50 kHz	±(0.03 Hz / Deviation) + rfa	
Carrier Frequency Error[fgb]	±(8 ppm × Deviation + 2 ppm) × Rate + tfa	

a. This specification applies to the result labeled "(Pk-Pk)/2".
b. For optimum measurement, ensure that the Channel BW is set wide enough to capture the significant RF energy. Setting the Channel BW too wide will result in measurement errors.
c. Reading is the measured peak deviation in radians.
d. Deviation is the peak deviation in radians.
e. rfa = Modulation Rate × Frequency reference accuracy.
f. Rate is a Modulation Rate in Hz.
g. tfa = transmitter frequency × Frequency reference accuracy.

Phase Modulation

Description	Specifications	Supplemental Information
Post-Demod Distortion Residual[a]		
Distortion (SINAD)[bc]	0.2% / Deviation + 0.01%	
THD[b]	0.06% / Deviation + 0.008%	
Post-Demod Distortion Accuracy (Rate: 1 to 10 kHz)		
Distortion	$\pm(2\% \times \text{Reading} + \text{DistResidual})$	
THD	$\pm(2\% \times \text{Reading} + \text{DistResidual})$	2^{nd} and 3^{rd} harmonics
AM Rejection[d]	1.2 mrad (PM peak)	
Residual PM[e]	0.6 mrad (rms)	

a. For optimum measurement, ensure that the Channel BW is set wide enough to capture the significant RF energy. Setting the Channel BW too wide will result in measurement errors.
b. Deviation is a peak deviation in radians.
c. SINAD [dB] can be derived by $20 \times \log10(1 / \text{Distortion})$.
d. AM rejection describes the instrument's PM reading for an input that is strongly AMed (with no PM); this specification includes contributions from residual PM. AM signal (Rate = 1 kHz, Depth = 50%), HPF = 50 Hz, LPF = 3 kHz, Channel BW = 15 kHz
e. Residual PM describes the instrument's PM reading for an input that has no PM and no AM; this specification includes contributions from PM deviation accuracy. HPF = 50 Hz, LPF = 3 kHz, Channel BW = 15 kHz.

Analog Out

The "Analog Out" connector (BNC) is located at the analyzer's rear panel. It is a multi-purpose output, whose function depends on options and operating mode (active application). When the N9063EM0E Analog Demod application is active, this output carries a voltage waveform reconstructed by a real-time hardware demodulator (designed to drive the "Demod to Speaker" function for listening). The processing path and algorithms for this output are entirely separate from those of the N9063EM0E application itself; the Analog Out waveform is not necessarily identical the application's Demod Waveform.

Condition of "Open Circuit" is assumed for all voltage terms such as "Output range".

Description	Specifications	Supplemental Information
Bandwidth		≤ 8 MHz
Output impedance		50Ω (nominal)
Output range		–1V to +1 V (nominal)
AM scaling		
AM scaling factor		5 mV/%AM (nominal)
AM scaling tolerance		±10% (nominal)
AM offset		0 V corresponds to carrier power as measured at setup[a]
FM scaling		
FM scaling factor		2 V/Channel BW (nominal), where Channel BW is settable by the user
FM scaling tolerance		±10% (nominal)
FM scale adjust		User-settable factor, range from 0.5 to 10, default =1, applied to above FM scaling.
FM offset		
HPF off		0 V corresponds to SA tuned frequency, and Carrier Frequency Errors (constant frequency offset) are included (DC coupled)
HPF on		0 V corresponds to the mean of the waveform
PM scaling		
PM scaling factor		(1/π) V/rad (nominal)
PM scaling tolerance		±10% (nominal)
PM offset		0 V corresponds to mean phase

a. For AM, the reference “unmodulated” carrier level is determined by a single “invisible” power measurement, of 2 ms duration, taken at setup. “Setup” occurs whenever a core parameter is changed, such as Center Frequency, modulation type, Demod Time, etc. Ideally, the RF input signal should be un-modulated at this time. However, if the AM modulating (audio) waveform is evenly periodic in 2 ms (i.e. multiples of 500 Hz, such as 1 kHz), the reference power measurement can be made with modulation applied. Likewise, if the AM modulating period is very short compared to 2ms (e.g. >5000 Hz), the reference power measurement error will be small.

FM Stereo/Radio Data System (RDS) Measurements

Description	Specifications	Supplemental Information
FM Stereo Modulation Analysis Measurements		
MXP view	RF Spectrum, AF Spectrum, Demod Waveform, FM Deviation (Hz) (Peak +, Peak–, (Pk-Pk)/2, RMS), Carrier Power (dBm), Carrier Frequency Error (Hz), SINAD (dB), Distortion (% or dB)	MPX consists of FM signal multiplexing with the mono signal (L+R), stereo signal (L–R), pilot signal (at 19 kHz) and optional RDS signal (at 57 kHz). – SINAD MPX BW, default 53 kHz, range from 1 kHz to 58 kHz. – Reference Deviation, default 75 kHz, range from 15 kHz to 150 kHz.
Mono (L+R) / Stereo (L–R) view	Demod Waveform, AF Spectrum, Carrier Power (dBm), Carrier Frequency Error (Hz), Modulation Rate	Mono Signal is Left + Right Stereo Signal is Left – Right
Left / Right view	Demod Waveform, AF Spectrum, Carrier Power (dBm), Carrier Frequency Error (Hz), Modulation Rate, SINAD (dB), Distortion (% or dB), THD (% or dB)	Post-demod settings: – Highpass filter: 20, 50, or 300 Hz – Lowpass filter: 300 Hz, 3, 15, 80, or 300 kHz – Bandpass filter: A-Weighted, CCITT – De-Emphasis: 25, 50, 75 and 750 μs
RDS / RBDS Decoding Results view	BLER basic tuning and switching information, radio text, program item number and slow labeling codes, clock time and date	BLER Block Count default 1E+8, range from 1 to 1E+16
Numeric Result view	MPX, Mono, Stereo, Left, Right, Pilot and RDS with FM Deviation result (Hz) of Peak+, (Pk-Pk/2, RMS, Modulation Rate (Hz), SINAD (% or dB), THD (% or dB), Left to Right (dB), Mono to Stereo (dB), RF Carrier Power (dBm), RF Carrier Frequency Error (Hz), 38 kHz Carrier Phase Error (deg)	

Description	Specifications	Supplemental Information
FM Stereo Modulation Analysis Measurements		FM Stereo with 67.5 kHz audio deviation at 1 kHz modulation rate plus 6.75 kHz pilot deviation.
SINAD		
A-Weighted filter		69 dB (nominal)
CCITT filter		71 dB (nominal)
Left to Right Ratio		
A-Weighted filter		72 dB (nominal)
CCITT filter		76 dB (nominal)

22 Bluetooth Measurement Application

This chapter contains specifications for N9081EM0E Bluetooth measurement application. Three standards, Bluetooth 2.1-basic rate, Bluetooth 2.1-EDR and Bluetooth 2.1-low energy are supported.

Three power classes, class 1, class 2 and class 3 are supported. Specifications for the three standards above are provided separately.

Additional Definitions and Requirements

Because digital communications signals are noise-like, all measurements will have variations. The specifications apply only with adequate averaging to remove those variations. The specifications apply in the frequency range documented in In-Band Frequency Range.

The specifications apply in the frequency range documented in In-Band Frequency Range.

The specifications for this chapter apply only to instruments with Frequency *Option 503*, *508*, *513* or *526*. For Instruments with higher frequency options, the performance is nominal only and not subject to any warranted specifications.

The measurement performance is only slightly different between instruments with the lower and higher frequency options. Because the hardware performance of the analyzers is very similar but not identical, you can estimate the nominal performance of the measurements from the specifications in this chapter.

Basic Rate Measurements

Description	Specifications	Supplemental Information
Output Power		This measurement is a Transmit Analysis measurement and supports average and peak power in conformance with Bluetooth RF test specification 2.1.E.0.5.1.3.
Packet Type		DH1, DH3, DH5, HV3
Payload		PRBS9, BS00, BSFF, BS0F, BS55
Synchronization		RF Burst or Preamble
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
Supported measurements		Average power, peak power
Range[a]		+30 dBm to –70 dBm
Absolute Power Accuracy[b] (20 to 30°C, Atten = 10 dB)		±0.20 dB(95th percentile)
Measurement floor		–70 dBm (nominal)

a. When the input signal level is lower than –40 dBm, the analyzer’s preamp should be turned on and the attenuator set to 0 dB.

b. Absolute power accuracy includes all error sources for in-band signals except mismatch errors and repeatability due to incomplete averaging. It applies when the mixer level is high enough that measurement floor contribution is negligible.

Description	Specifications	Supplemental Information
Modulation Characteristics		This measurement is a Transmit Analysis measurement and supports average and peak power in conformance with Bluetooth RF test specification 2.1.E.0.5.1.9.
Packet Type		DH1, DH3, DH5, HV3
Payload		BS0F, BS55
Synchronization		Preamble
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
Supported measurements		Min/max Δf1avg min Δf2max (kHz) total Δf2max > Δf2max lower limit (%) min of min Δf2avg / max Δf1avg pseudo frequency deviation (Δf1 and Δf2)
RF input level range[a]		+30 dBm to −70 dBm
Deviation range		±250 kHz (nominal)
Deviation resolution		100 Hz (nominal)
Measurement Accuracy[b]		±100 Hz + tfa[c] (nominal)

a. When the input signal level is lower than −40 dBm, the analyzer’s preamp should be turned on and the attenuator set to 0 dB.
b. Example, using 1 ppm as frequency reference accuracy of the analyzer, at frequency of 2.402 GHz, frequency accuracy would be in the range of ±(2.402 GHz × 1 ppm) Hz ± 100 Hz = ±2402 Hz ± 100 Hz = ±2502 Hz.
c. tfa = transmitter frequency × frequency reference accuracy.

Description	Specifications	Supplemental Information
Initial Carrier Frequency Tolerance		This measurement is a Transmit Analysis measurement and supports average and peak power in conformance with Bluetooth RF test specification 2.1.E.0.5.1.10.
Packet Type		DH1, DH3, DH5, HV3
Payload		PRBS9, BS00, BSFF, BS0F, BS55
Synchronization		Preamble
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
RF input level range[a]		+30 dBm to −70 dBm
Measurement range		Nominal channel freq ± 100 kHz (nominal)
Measurement Accuracy[b]		±100 Hz + tfa[c] (nominal)

a. When the input signal level is lower than −40 dBm, the analyzer's preamp should be turned on and the attenuator set to 0 dB.
b. Example, using 1 ppm as frequency reference accuracy of the analyzer, at frequency of 2.402 GHz, frequency accuracy would be in the range of ±(2.402 GHz × 1 ppm) Hz ± 100 Hz = ±2402 Hz ± 100 Hz = ±2502 Hz.
c. tfa = transmitter frequency × frequency reference accuracy.

Description	Specifications	Supplemental Information
Carrier Frequency Drift		This measurement is a Transmit Analysis measurement and supports average and peak power in conformance with Bluetooth RF test specification 2.1.E.0.5.1.11.
Packet Type		DH1, DH3, DH5, HV3
Payload		PRBS9, BS00, BSFF, BS0F, BS55
Synchronization		Preamble
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
RF input level range[a]		+30 dBm to −70 dBm
Measurement range		±100 kHz (nominal)
Measurement Accuracy[b]		±100 Hz + tfa[c] (nominal)

a. When the input signal level is lower than −40 dBm, the analyzer's preamp should be turned on and the attenuator set to 0 dB.

b. Example, using 1 ppm as frequency reference accuracy of the analyzer, at frequency of 2.402 GHz, frequency accuracy would be in the range of ±(2.402 GHz × 1 ppm) Hz ± 100 Hz = ±2402 Hz ± 100 Hz = ±2502 Hz.
c. tfa = transmitter frequency × frequency reference accuracy.

Description	Specifications	Supplemental Information
Adjacent Channel Power		This measurement is an Adjacent Channel Power measurement and is in conformance with Bluetooth RF test specification 2.1.E.0.5.1.8.
Packet Type		DH1, DH3, DH5, HV3
Payload		PRBS9, BS00, BSFF, BS0F, BS55
Synchronization		None
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
Measurement Accuracy[a]		Dominated by the variance of measurements[b]

a. The accuracy is for absolute power measured at 2.0 MHz offset and other offsets (offset = K MHz, K = 3,...,78).
b. The measurement at these offsets is usually the measurement of noise-like signals and therefore has considerable variance. For example, with 100 ms sweeping time, the standard deviation of the measurement is about 0.5 dB. In comparison, the computed uncertainties of the measurement for the case with CW interference is only ± 0.20 dB.

Low Energy Measurements

Description	Specifications	Supplemental Information
Output Power		This measurement is a Transmit Analysis measurement and supports average and peak power in conformance with Bluetooth RF test specification LE.RF-PHY.TS/0.7d2.6.2.1.
Packet Type		Reference type
Payload		PRBS9, BS00, BSFF, BS0F, BS55
Synchronization		RF Burst or Preamble
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
Supported measurements		Average Power, Peak Power
Range[a]		+30 dBm to –70 dBm
Absolute Power Accuracy[b] (20 to 30°C, Atten = 10 dB)		±0.20 dB(95th percentile)
Measurement floor		–70 dBm (nominal)

a. When the input signal level is lower than –40 dBm, the analyzer’s preamp should be turned on and the attenuator set to 0 dB.

b. Absolute power accuracy includes all error sources for in-band signals except mismatch errors and repeatability due to incomplete averaging. It applies when the mixer level is high enough that measurement floor contribution is negligible.

Description	Specifications	Supplemental Information
Modulation Characteristics		This measurement is a Transmit Analysis measurement and is in conformance with Bluetooth RF test specification LE.RF-PHY.TS/0.7d2.6.2.3.
Packet Type		Reference type
Payload		BS0F, BS55
Synchronization		Preamble
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
Supported measurements		Min/max Δf1avg min Δf2max (kHz) total Δf2max > Δf2max lower limit (%) min of min Δf2avg / max Δf1avg pseudo frequency deviation (Δf1 and Δf2)
RF input level range[a]		+30 dBm to −70 dBm
Deviation range		±250 kHz (nominal)
Deviation resolution		100 Hz (nominal)
Measurement Accuracy[b]		±100 Hz + tfa[c] (nominal)

a. When the input signal level is lower than −40 dBm, the analyzer’s preamp should be turned on and the attenuator set to 0 dB.
b. Example, using 1 ppm as frequency reference accuracy of the analyzer, at frequency of 2.402 GHz, frequency accuracy would be in the range of ±(2.402 GHz × 1 ppm) Hz ± 100 Hz = ±2402 Hz ± 100 Hz = ±2502 Hz.
c. tfa = transmitter frequency × frequency reference accuracy.

Description	Specifications	Supplemental Information
Initial Carrier Frequency Tolerance		This measurement is a Transmit Analysis measurement and is in conformance with Bluetooth RF test specification LE.RF-PHY.TS/0.7d2.6.2.4.
Packet Type		Reference type
Payload		PRBS9, BS00, BSFF, BS0F, BS55
Synchronization		Preamble
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
RF input level range[a]		+30 dBm to −70 dBm
Measurement range		Nominal channel freq ± 100 kHz (nominal)
Measurement Accuracy[b]		±100 Hz + tfa[c] (nominal)

a. When the input signal level is lower than −40 dBm, the analyzer’s preamp should be turned on and the attenuator set to 0 dB.
b. Example, using 1 ppm as frequency reference accuracy of the analyzer, at frequency of 2.402 GHz, frequency accuracy would be in the range of ±(2.402 GHz × 1 ppm) Hz ± 100 Hz = ±2402 Hz ± 100 Hz = ±2502 Hz.
c. tfa = transmitter frequency × frequency reference accuracy.

Description	Specifications	Supplemental Information
Carrier Frequency Drift		This measurement is a Transmit Analysis measurement and is in conformance with Bluetooth RF test specification LE.RF-PHY.TS/0.7d2.6.2.4.
Packet Type		Reference type
Payload		PRBS9, BS00, BSFF, BS0F, BS55
Synchronization		Preamble
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
RF input level range[a]		+30 dBm to −70 dBm
Measurement range		±100 kHz (nominal)
Measurement Accuracy[b]		±100 Hz + tfa[c] (nominal)

a. When the input signal level is lower than −40 dBm, the analyzer's preamp should be turned on and the attenuator set to 0 dB.
b. Example, using 1 ppm as frequency reference accuracy of the analyzer, at frequency of 2.402 GHz, frequency accuracy would be in the range of ±(2.402 GHz × 1 ppm) Hz ± 100 Hz = ±2402 Hz ± 100 Hz = ±2502 Hz.
c. tfa = transmitter frequency × frequency reference accuracy.

Description	Specifications	Supplemental Information
LE In-band Emission		This measurement is an LE in-band emission measurement and is in conformance with Bluetooth RF test specification LE.RF-PHY.TS/0.7d2.6.2.2.
Packet Type		Reference type
Payload		PRBS9, BS00, BSFF, BS0F, BS55
Synchronization		None
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
Measurement Accuracy[a]		Dominated by the variance of measurements[b]

a. The accuracy is for absolute power measured at 2.0 MHz offset and other offsets (offset =2 MHz × K, K = 2,...,39).
b. The measurement at these offsets is usually the measurement of noise-like signals and therefore has considerable variance. For example, with 100 ms sweeping time, the standard deviation of the measurement is about 0.5 dB. In comparison, the computed uncertainties of the measurement for the case with CW interference is only ± 0.20 dB.

Enhanced Data Rate (EDR) Measurements

Description	Specifications	Supplemental Information
EDR Relative Transmit Power		This measurement is a Transmit Analysis measurement and supports average and peak power in conformance with Bluetooth RF test specification 2.1.E.0.5.1.12.
Packet Type		2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3, 3-DH5
Payload		PRBS9, BS00, BSFF, BS55
Synchronization		DPSK synchronization sequence
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
Supported measurements		Power in GFSK header, power in PSK payload, relative power between GFSK header and PSK payload
Range[a]		+30 dBm to –70 dBm
Absolute Power Accuracy[b] (20 to 30°C, Atten = 10 dB)		±0.20 dB(95th percentile)
Measurement floor		–70 dBm (nominal)

a. When the input signal level is lower than –40 dBm, the analyzer’s preamp should be turned on and the attenuator set to 0 dB.
b. Absolute power accuracy includes all error sources for in-band signals except mismatch errors and repeatability due to incomplete averaging. It applies when the mixer level is high enough that measurement floor contribution is negligible.

Description	Specifications	Supplemental Information
EDR Modulation Accuracy		This measurement is a Transmit Analysis measurement and is in conformance with Bluetooth RF test specification 2.1.E.0.5.1.13
Packet Type		2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3, 3-DH5
Payload		PRBS9, BS00, BSFF, BS55
Synchronization		DPSK synchronization sequence
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
Supported measurements		rms DEVM peak DEVM, 99% DEVM
RF input level range[a]		+30 dBm to –70 dBm
RMS DEVM		
Range	0 to 12%	
Floor	1.5%	
Accuracy[b]	1.2%	

a. When the input signal level is lower than –40 dBm, the analyzer's preamp should be turned on and the attenuator set to 0 dB.

b. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows:
error = sqrt(EVMUUT2 + EVMsa2) – EVMUUT, where EVMUUT is the EVM of the UUT in percent, and EVMsa is the EVM floor of the analyzer in percent

Description	Specifications	Supplemental Information
EDR Carrier Frequency Stability		This measurement is a Transmit Analysis measurement and is in conformance with Bluetooth RF test specification 2.1.E.0.5.1.13
Packet Type		2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3, 3-DH5
Payload		PRBS9, BS00, BSFF, BS55
Synchronization		DPSK synchronization sequence
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
Supported measurements		Worst case initial frequency error(ωi) for all packets (carrier frequency stability), worst case frequency error for all blocks (ωo), (ωo + ωi) for all blocks
RF input level range[a]		+30 dBm to −70 dBm
Carrier Frequency Stability and Frequency Error[b]		±100 Hz + tfa[c] (nominal)

a. When the input signal level is lower than −40 dBm, the analyzer's preamp should be turned on and the attenuator set to 0 dB.
b. Example, using 1 ppm as frequency reference accuracy of the analyzer, at frequency of 2.402 GHz, frequency accuracy would be in the range of ±(2.402 GHz × 1 ppm) Hz ± 100 Hz = ±2402 Hz ± 100 Hz = ±2502 Hz.
c. tfa = transmitter frequency × frequency reference accuracy.

Description	Specifications	Supplemental Information
EDR In-band Spurious Emissions		This measurement is an EDR in-band spur emissions and is in conformance with Bluetooth RF test specification 2.1.E.0.5.1.15.
Packet Type		2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3, 3-DH5
Payload		PRBS9, BS00, BSFF, BS55
Synchronization		DPSK synchronization sequence
Trigger		External, RF Burst, Periodic Timer, Free Run, Video
Measurement Accuracy[a]		
Offset Freq = 1 MHz to 1.5 MHz		Dominated by ambiguity of the measurement standards[b]
Offset Freq = other offsets (2 MHz to 78 MHz)		Dominated by the variance of measurements[c]

a. For offsets from 1 MHz to 1.5 MHz, the accuracy is the relative accuracy which is the adjacent channel power (1 MHz to 1.5 MHz offset) relative to the reference channel power (main channel). For other offsets (offset = K MHz, K= 2,...,78), the accuracy is the power accuracy of the absolute alternative channel power.

b. The measurement standards call for averaging the signal across 3.5 µs apertures and reporting the highest result. For common impulsive power at these offsets, this gives a variation of result with the time location of that interference that is 0.8 dB peak-to-peak and changes with a scallop shape with a 3.5 µs period. Uncertainties in the accuracy of measuring CW-like relative power at these offsets are nominally only ±0.03 dB, but observed variations of the measurement algorithm used with impulsive interference are similar to the scalloping error.

c. The measurement at these offsets is usually the measurement of noise-like signals and therefore has considerable variance. For example, with a 1.5 ms packet length, the standard deviation of the measurement of the peak of ten bursts is about 0.6 dB. In comparison, the computed uncertainties of the measurement for the case with CW interference is only ±0.20 dB.

In-Band Frequency Range

Description	Specifications	Supplemental Information
Bluetooth Basic Rate and Enhanced Data Rate (EDR) System	2.400 to 2.4835 GHz (ISM radio band)	f = 2402 + k MHz, k = 0,...,78 (RF channels used by Bluetooth)
Bluetooth Low Energy System	2.400 to 2.4835 GHz (ISM radio band)	f = 2402 + k×2 MHz, k = 0,...,39 (RF channels used by Bluetooth)

23 GSM/EDGE Measurement Application

This chapter contains specifications for the N9071EM0E GSM/EDGE/EDGE Evolution Measurement Application.

Additional Definitions and Requirements

Because digital communications signals are noise-like, all measurements will have variations. The specifications apply only with adequate averaging to remove those variations.

The specifications apply in the frequency range documented in In-Band Frequency Range.

The specifications for this chapter apply only to instruments with Frequency *Option 503*, *508*, *513* or *526*. For Instruments with higher frequency options, the performance is nominal only and not subject to any warranted specifications.

The measurement performance is only slightly different between instruments with the lower and higher frequency options. Because the hardware performance of the analyzers is very similar but not identical, you can estimate the nominal performance of the measurements from the specifications in this chapter.

KEYSIGHT TECHNOLOGIES

Measurements

Description	Specifications	Supplemental Information
EDGE Error Vector Magnitude (EVM)		3π/8 shifted 8PSK modulation, 3π/4 shifted QPSK, π/4 shifted 16QAM, −π/4 shifted 32QAM modulation in NSR/HSR with pulse shaping filter. Specifications based on 200 bursts
Carrier Power Range at RF Input		+24 to –45 dBm (nominal)
EVM[a], rms		
Operating range		0 to 20% (nominal)
Floor (NSR/HSR Narrow/HSR Wide) (all modulation formats)	0.6%	0.4% (nominal)
Accuracy[b] (EVM range 1% to 10% (NSR 8PSK) EVM range 1% to 6% (NSR 16QAM/32QAM) EVM range 1% to 8% (HSR QPSK) EVM range 1% to 5% (HSR 16QAM/32QAM))	±0.5%	
Frequency error[a]		
Initial frequency error range		±80 kHz (nominal)
Accuracy	±5 Hz[c] + tfa[d]	
IQ Origin Offset		
DUT Maximum Offset		–15 dBc (nominal)
Maximum Analyzer Noise Floor		–50 dBc (nominal)
Trigger to T0 Time Offset (Relative accuracy[e])		±5.0 ns (nominal)

a. EVM and frequency error specifications apply when the Burst Sync is set to Training Sequence.
b. The definition of accuracy for the purposes of this specification is how closely the result meets the expected result. That expected result is 0.975 times the actual RMS EVM of the signal, per 3GPP TS 45.005, annex G.
c. This term includes an error due to the software algorithm. The accuracy specification applies when EVM is less than 1.5%.
d. tfa = transmitter frequency × frequency reference accuracy
e. The accuracy specification applies when the Burst Sync is set to Training Sequence, and Trigger is set to External Trigger.

Description	Specifications	Supplemental Information
Power vs. Time *and* **EDGE Power vs. Time**		GMSK modulation (GSM) 3π/8 shifted 8PSK modulation, 3π/4 shifted QPSK, π/4 shifted 16QAM, −π/4 shifted 32QAM modulation in NSR/HSR (EDGE) Measures mean transmitted RF carrier power during the useful part of the burst (GSM method) and the power vs. time ramping. 510 kHz RBW
Minimum carrier power at RF Input for GSM and EDGE		–35 dBm (nominal)
Absolute power accuracy for in-band signal (excluding mismatch error)[a]		–0.11 ±0.19 dB (95th percentile)
Power Ramp Relative Accuracy		Referenced to mean transmitted power
Accuracy	±0.11 dB	
Measurement floor	–95 dBm	

a. The power versus time measurement uses a resolution bandwidth of about 510 kHz. This is not wide enough to pass all the transmitter power unattenuated, leading the consistent error shown in addition to the uncertainty. A wider RBW would allow smaller errors in the carrier measurement, but would allow more noise to reduce the dynamic range of the low-level measurements. The measurement floor will change by 10 × log(RBW/510 kHz). The average amplitude error will be about –0.11 dB × ((510 kHz/RBW)^2). Therefore, the consistent part of the amplitude error can be eliminated by using a wider RBW.

Description	Specifications	Supplemental Information
Phase and Frequency Error		GMSK modulation (GSM) Specifications based on 3GPP essential conformance requirements, and 200 bursts
Carrier power range at RF Input		+27 to –45 dBm (nominal)
Phase error[a], rms		
Floor	0.5°	
Accuracy	±0.3°	Phase error range 1° to 6°
Frequency error[a]		
Initial frequency error range		±80 kHz (nominal)
Accuracy	±5 Hz[b] + tfa[c]	
I/Q Origin Offset		
DUT Maximum Offset		–15 dBc (nominal)
Analyzer Noise Floor		–50 dBc (nominal)
Trigger to T0 time offset (Relative accuracy[d])		±5.0 ns (nominal)

a. Phase error and frequency error specifications apply when the Burst Sync is set to Training Sequence.
b. This term includes an error due to the software algorithm. The accuracy specification applies when RMS phase error is less than 1°.
c. tfa = transmitter frequency × frequency reference accuracy
d. The accuracy specification applies when the Burst Sync is set to Training Sequence, and Trigger is set to External Trigger.

Description	Specifications	Supplemental Information
Output RF Spectrum (ORFS) *and* **EDGE Output RF Spectrum**		GMSK modulation (GSM) 3π/8 shifted 8PSK modulation, 3π/4 shifted QPSK, π/4 shifted 16QAM, −π/4 shifted 32QAM modulation in NSR/HSR (EDGE)
Minimum carrier power at RF Input		–20 dBm (nominal)[a]
ORFS Relative RF Power Uncertainty[b] Due to modulation		
Offsets ≤ 1.2 MHz	±0.09 dB	
Due to switching[c]		±0.09 dB (nominal)
ORFS Absolute RF Power Accuracy[d]		±0.19 dB (95th percentile)

a. For maximum dynamic range, the recommended minimum power is –10 dBm.
b. The uncertainty in the RF power ratio reported by ORFS has many components. This specification does not include the effects of added power in the measurements due to dynamic range limitations, but does include the following errors: detection linearity, RF and IF flatness, uncertainty in the bandwidth of the RBW filter, and compression due to high drive levels in the front end.
c. The worst-case modeled and computed errors in ORFS due to switching are shown, but there are two further considerations in evaluating the accuracy of the measurement: First, Keysight has been unable to create a signal of known ORFS due to switching, so we have been unable to verify the accuracy of our models. This performance value is therefore shown as nominal instead of guaranteed. Second, the standards for ORFS allow the use of any RBW of at least 300 kHz for the reference measurement against which the ORFS due to switching is ratioed. Changing the RBW can make the measured ratio change by up to about 0.24 dB, making the standards ambiguous to this level. The user may choose the RBW for the reference; the default 300 kHz RBW has good dynamic range and speed, and agrees with past practices. Using wider RBWs would allow for results that depend less on the RBW, and give larger ratios of the reference to the ORFS due to switching by up to about 0.24 dB.
d. The absolute power accuracy depends on the setting of the input attenuator as well as the signal-to-noise ratio. For high input levels, the use of the electronic attenuator and “Adjust Atten for Min Clip” will result in high signal-to-noise ratios and Electronic Input Atten > 2 dB, for which the absolute power accuracy is best. At moderate levels, manually setting the Input Atten can give better accuracy than the automatic setting. For GSM and EDGE, “high levels” would nominally be levels above +1.7 dBm and –1.3 dBm, respectively.

Description	Specifications			Supplemental Information		
ORFS and **EDGE ORFS** (continued)						
Dynamic Range, Spectrum due to modulation[a]				5-pole sync-tuned filters[b] Methods: Direct Time[c] and FFT[d]		
Offset Frequency	**GSM (GMSK)**	**EDGE (NSR 8PSK & Narrow QPSK)**	**EDGE (others)[e]**	**GSM (GMSK) (typical)**	**EDGE (NSR 8PSK & Narrow QPSK) (typical)**	**EDGE (others)[e] (typical)**
100 kHz[f]	69.1 dB	69.1 dB	68.9 dB			
200 kHz[f]	73.1 dB	73.0 dB	72.7 dB			
250 kHz[f]	74.4 dB	74.2 dB	73.9 dB			
400 kHz[f]	77.1 dB	76.8 dB	76.1 dB			
600 kHz	82.9 dB	81.8 dB	80.1 dB	86.3 dB	85.1 dB	83.1 dB
1.2 MHz	87.6 dB	85.0 dB	81.9 dB	90.1 dB	87.6 dB	84.6 dB
				GSM (GMSK) (nominal)	**EDGE (NSR 8PSK & Narrow QPSK) (nominal)**	**EDGE (others) (nominal)**
1.8 MHz[g]	88.5 dB	87.2 dB	85.3 dB	91.1 dB	89.9 dB	88.0 dB
6.0 MHz[g]	91.6 dB	89.3 dB	86.5 dB	94.5 dB	92.2 dB	89.4dB
Dynamic Range, Spectrum due to switching[a]	**GSM (GMSK)**	**EDGE (NSR 8PSK & Narrow QPSK)**	**EDGE (others)[e]**	5-pole sync-tuned filters[h]		
Offset Frequency						
400 kHz	75.0 dB		74.7 dB			
600 kHz	80.0 dB		79.2 dB			
1.2 MHz	83.2 dB		81.7 dB			
1.8 MHz	90.7 dB		89.7 dB			

a. Maximum dynamic range requires RF input power above –2 dBm for offsets of 1.2 MHz and below for GSM, and above –5 dBm for EDGE. For offsets of 1.8 MHz and above, the required RF input power for maximum dynamic range is +8 dBm for GSM signals and +5 dBm for EDGE signals.
b. ORFS standards call for the use of a 5-pole, sync-tuned filter; this and the following footnotes review the instrument's conformance to that standard. Offset frequencies can be measured by using either the FFT method or the direct time method. By default, the FFT method is used for offsets of 400 kHz and below, and the direct time method is used for offsets above 400 kHz. The FFT method is faster, but has lower dynamic range than the direct time method.
c. The direct time method uses digital Gaussian RBW filters whose noise bandwidth (the measure of importance to "spectrum due to modulation") is within ±0.5% of the noise bandwidth of an ideal 5-pole sync-tuned filter. However, the Gaussian filters do not match the 5-pole standard behavior at offsets of 400 kHz and below, because they have *lower* leakage of the carrier into the filter. The lower leakage of the Gaussian filters provides a superior measurement because the leakage of the carrier masks the ORFS due to the UUT, so that less masking lets the test be more sensitive to variations in the UUT spectral splatter. But this superior measurement gives a result that does not conform with ORFS standards. Therefore, the default method for offsets of 400 kHz and below is the FFT method.
d. The FFT method uses an exact 5-pole sync-tuned RBW filter, implemented in software.
e. EDGE (others) means NSR 16/32QAM and HSR all formats (QPSK/16QAM/32QAM).
f. The dynamic range for offsets at and below 400 kHz is not directly observable because the signal spectrum obscures the result. These dynamic range specifications are computed from phase noise observations.
g. Offsets of 1.8 MHz and higher use 100 kHz analysis bandwidths.
h. The impulse bandwidth (the measure of importance to "spectrum due to switching transients") of the filter used in the direct time method is 0.8% less than the impulse bandwidth of an ideal 5-pole sync-tuned filter, with a tolerance of ±0.5%. Unlike the case with spectrum due to modulation, the shape of the filter response (Gaussian vs. sync-tuned) does not affect the results due to carrier leakage, so the only parameter of the filter that matters to the results is the impulse bandwidth. There is a mean error of –0.07 dB due to the impulse bandwidth of the filter, which is compensated in the measurement of ORFS due to switching. By comparison, an analog RBW filter with a ±10% width tolerance would cause a maximum amplitude uncertainty of 0.9 dB.

Frequency Ranges

Description	Uplink	Downlink
In-Band Frequency Ranges		
P-GSM 900	890 to 915 MHz	935 to 960 MHz
E-GSM 900	880 to 915 MHz	925 to 960 MHz
R-GSM 900	876 to 915 MHz	921 to 960 MHz
DCS1800	1710 to 1785 MHz	1805 to 1880 MHz
PCS1900	1850 to 1910 MHz	1930 to 1990 MHz
GSM850	824 to 849 MHz	869 to 894 MHz
GSM450	450.4 to 457.6 MHz	460.4 to 467.6 MHz
GSM480	478.8 to 486 MHz	488.8 to 496 MHz
GSM700	777 to 792 MHz	747 to 762 MHz
T-GSM810	806 to 821 MHz	851 to 866 MHz

24 LTE/LTE-A Measurement Application

This chapter contains specifications for the N9080EM0E LTE/LTE-Advanced FDD measurement application and for the N9082EM0E LTE/LTE-Advanced TDD measurement application.

Additional Definitions and Requirements

Because digital communications signals are noise-like, all measurements will have variations. The specifications apply only with adequate averaging to remove those variations.

The specifications apply in the frequency range documented in In-Band Frequency Range.

The specifications apply to the single carrier case only, unless otherwise stated.

The specifications for this chapter apply only to instruments with Frequency *Option 508*, *513* or *526*. For Instruments with higher frequency options, the performance is nominal only and not subject to any warranted specifications.

The measurement performance is only slightly different between instruments with the lower and higher frequency options. Because the hardware performance of the analyzers is very similar but not identical, you can estimate the nominal performance of the measurements from the specifications in this chapter.

Supported Air Interface Features

Description	Specifications	Supplemental Information
3GPP Standards Supported	36.211 V10.7.0 (March 2013) 36.212 V10.7.0 (December 2012) 36.213 V10.9.0 (March 2013) 36.214 V10.12.0 (March 2013) 36.141 V11.4.0 (March 2013) 36.521-1 V10.5.0 (March 2013)	
Signal Structure	FDD Frame Structure Type 1 TDD Frame Structure Type 2 Special subframe configurations 0-8	N9080EM0E only N9082EM0E only N9082EM0E only
Signal Direction	Uplink and Downlink UL/DL configurations 0-6	 N9082EM0E only
Signal Bandwidth	1.4 MHz (6 RB), 3 MHz (15 RB), 5 MHz (25 RB), 10 MHz (50 RB), 15 MHz (75 RB), 20 MHz (100 RB)	
Modulation Formats and Sequences	BPSK; BPSK with I &Q CDM; QPSK; 16QAM; 64QAM; PRS; CAZAC (Zadoff-Chu)	
Component Carrier	1, 2, 3, 4, or 5	
Physical Channels		
Downlink	PBCH, PCFICH, PHICH, PDCCH, PDSCH, PMCH	
Uplink	PUCCH, PUSCH, PRACH	
Physical Signals		
Downlink	P-SS, S-SS, C-RS, P-PS (positioning), MBSFN-RS, CSI-RS	
Uplink	PUCCH-DMRS, PUSCH-DMRS, S-RS (sounding)	

Measurements

Description	Specifications	Supplemental Information
Channel Power		
Minimum power at RF input		–50 dBm (nominal)
Absolute power accuracy[a] (20 to 30°C, Atten = 10 dB)	±0.63 dB	±0.19 dB (95th percentile)
Measurement floor		–79.7 dBm (typical) in a 10 MHz bandwidth

a. Absolute power accuracy includes all error sources for in-band signals except mismatch errors and repeatability due to incomplete averaging. It applies when the mixer level is high enough that the measurement floor contribution is negligible.

Description	Specifications	Supplemental Information
Channel Power		NB-IoT
Minimum power at RF input		–50 dBm (nominal)
Absolute power accuracy[a] (20 to 30°C, Atten = 10 dB)	±0.63 dB	±0.19 dB (95th percentile)
Measurement floor		–96.7 dBm (typical) in a 10 MHz bandwidth

a. Absolute power accuracy includes all error sources for in-band signals except mismatch errors and repeatability due to incomplete averaging. It applies when the mixer level is high enough that the measurement floor contribution is negligible.

Description	Specifications	Supplemental Information
Channel Power		C-V2X Frequency Range: 5855 to 5925 MHz
Minimum power at RF input		–50 dBm (nominal)
Absolute power accuracy[a] (20 to 30°C)	±1.78 dB	±0.52 dB (95th percentile)
Measurement floor		–79.7 dBm (typical) in a 10 MHz bandwidth

a. Absolute power accuracy includes all error sources for in-band signals except mismatch errors and repeatability due to incomplete averaging. It applies when the mixer level is high enough that the measurement floor contribution is negligible.

Description	Specifications	Supplemental Information
Transmit On/Off Power		
Burst Type		Traffic, DwPTS (N9082EM0E only), UpPTS (N9082EM0E only), SRS, PRACH
Transmit power		Min, Max, Mean, Off
Dynamic Range[a]		124.5 dB (nominal)
Average type		Off, RMS, Log
Measurement time		Up to 20 slots
Trigger source		External 1, External 2, Periodic, RF Burst, IF Envelope

a. This dynamic range expression is for the case of Information BW = 5 MHz; for other Info BW, the dynamic range can be derived. The equation is:
Dynamic Range = Dynamic Range for 5 MHz – 10*log10(Info BW/5.0e6)

Description	Specifications	Supplemental Information
Transmit On/Off Power		C-V2X Frequency Range: 5855 to 5925 MHz
Transmit power		Min, Max, Mean, Off
Dynamic Range[a]		124.5 dB (nominal)
Average type		Off, RMS, Log
Measurement time		Up to 20 slots
Trigger source		External 1, External 2, Periodic, RF Burst, IF Envelope

a. This dynamic range expression is for the case of Information BW = 5 MHz; for other Info BW, the dynamic range can be derived. The equation is:
Dynamic Range = Dynamic Range for 5 MHz – 10*log10(Info BW/5.0e6)

Description		Specifications			Supplemental Information	
Adjacent Channel Power					Single Carrier	
Minimum power at RF input					–36 dBm (nominal)	
Accuracy		**Channel Bandwidth**				
Radio	**Offset**	**5 MHz**	**10 MHz**	**20 MHz**	**ACPR Range for Specification**	
MS	Adjacent[a]	±0.08 dB	±0.10 dB	±0.13 dB	–33 to –27 dBc with opt ML[b]	
BTS	Adjacent[c]	±0.30 dB	±0.40 dB	±0.57 dB	–48 to –42 dBc with opt ML[d]	
BTS	Alternate[c]	±0.09 dB	±0.12 dB	±0.18 dB	–48 to –42 dBc with opt ML[e]	
Dynamic Range E-UTRA					Test conditions[f]	
Offset	**Channel BW**				**Dynamic Range (nominal)**	**Optimum Mixer Level (nominal)**
Adjacent	5 MHz				83.5 dB	–8.5 dBm
Adjacent	10 MHz				82.1 dB	–8.3 dBm
Alternate	5 MHz				86.7 dB	–8.5 dBm
Alternate	10 MHz				83.7 dB	–8.3 dBm
Dynamic Range UTRA					Test conditions[f]	
Offset	**Channel BW**				**Dynamic Range (nominal)**	**Optimum Mixer Level (nominal)**
2.5 MHz	5 MHz				86.2 dB	–8.5 dBm
2.5 MHz	10 MHz				84.2 dB	–8.3 dBm
7.5 MHz	5 MHz				87.3 dB	–8.7 dBm
7.5 MHz	10 MHz				87.0 dB	–8.4 dBm

a. Measurement bandwidths for mobile stations are 4.5, 9.0 and 18.0 MHz for channel bandwidths of 5, 10 and 20 MHz respectively.
b. The optimum mixer levels (ML) are –25, –22 and –21 dBm for channel bandwidths of 5, 10 and 20 MHz respectively.
c. Measurement bandwidths for base transceiver stations are 4.515, 9.015 and 18.015 MHz for channel bandwidths of 5, 10 and 20 MHz respectively.
d. The optimum mixer levels (ML) are –19, –17 and –16 dBm for channel bandwidths of 5, 10 and 20 MHz respectively.
e. The optimum mixer level (ML) is –8 dBm.
f. E-TM1.1 and E-TM1.2 used for test. Noise Correction set to On.

Description			Specifications	Supplemental Information	
Adjacent Channel Power				NB-IoT Stand-alone	
Minimum power at RF input				–36 dBm (nominal)	
Accuracy					
Radio	**Offset**			**ACPR Range for Specification**	
MS	200 kHz		±0.02 dB	–23 to –17 dBc with opt ML[a]	
MS	2.5 MHz		±0.11 dB	–40 to –34 dBc with opt ML[b]	
BTS	300 kHz		±0.05 dB	–43 to –37 dBc with opt ML[c]	
BTS	500 kHz		±0.15 dB	–53 to –47 dBc with opt ML[d]	
Dynamic Range				Test conditions[e]	
Radio	**Offset**	**Channel BW**		**Dynamic Range (nominal)**	**Optimum Mixer Level (nominal)**
MS	200 kHz	180 kHz		76.0 dB	–12.0 dBm
MS	2.5 MHz	3.84 MHz		73.0 dB	–12.0 dBm
BTS	300 kHz	180 kHz		76.0 dB	–12.0 dBm
BTS	500 kHz	180 kHz		81.0 dB	–12.0 dBm

a. The optimum mixer levels (ML) is –25 dBm.
b. The optimum mixer levels (ML) is –20 dBm.
c. The optimum mixer levels (ML) is –22 dBm.
d. The optimum mixer levels (ML) is –25 dBm.
e. Noise Correction set to On.

Description		Specifications			Supplemental Information	
Adjacent Channel Power					C-V2X Frequency Range: 5855 to 5925 MHz	
Minimum power at RF input					–36 dBm (nominal)	
Accuracy						
Radio	**Offset**	**5 MHz**	**10 MHz**	**20 MHz**	**ACPR Range for Specification**	
MS	Adjacent[a]	±0.28 dB	±0.36 dB	±0.47 dB	–33 to –27 dBc with opt ML[b]	
Dynamic Range E-UTRA					Test conditions[c]	
Offset	**Channel BW**				**Dynamic Range (nominal)**	**Optimum Mixer Level (nominal)**
Adjacent	5 MHz				83.5 dB	–8.5 dBm
Adjacent	10 MHz				82.1 dB	–8.3 dBm
Alternate	5 MHz				86.7 dB	–8.5 dBm
Alternate	10 MHz				83.7 dB	–8.3 dBm
Dynamic Range UTRA					Test conditions[c]	
Offset	**Channel BW**				**Dynamic Range (nominal)**	**Optimum Mixer Level (nominal)**
2.5 MHz	5 MHz				86.2 dB	–8.5 dBm
2.5 MHz	10 MHz				84.2 dB	–8.3 dBm
7.5 MHz	5 MHz				87.3 dB	–8.7 dBm
7.5 MHz	10 MHz				87.0 dB	–8.4 dBm

a. Measurement bandwidths for mobile stations are 4.5, 9.0 and 18.0 MHz for channel bandwidths of 5, 10 and 20 Hz respectively.
b. The optimum mixer levels (ML) are –25, –22 and –21 dBm for channel bandwidths of 5, 10 and 20 MHz respectively.
c. Noise Correction set to On.

Description	Specification	Supplemental Information
Occupied Bandwidth		
Minimum carrier power at RF Input		–30 dBm (nominal)
Frequency accuracy	±10 kHz	RBW = 30 kHz, Number of Points = 1001, Span = 10 MHz

Description	Specification	Supplemental Information
Occupied Bandwidth		NB-IoT
Minimum carrier power at RF Input		–30 dBm (nominal)
Frequency accuracy	±400 Hz	RBW = 10 kHz, Number of Points = 1001, Span = 400 kHz

Description	Specification	Supplemental Information
Occupied Bandwidth		C-V2X Frequency Range: 5855 to 5925 MHz
Minimum carrier power at RF Input		–30 dBm (nominal)
Frequency accuracy	±10 kHz	RBW = 30 kHz, Number of Points = 1001, Span = 10 MHz

Description	Specification	Supplemental Information
Power Statistics CCDF		
Histogram Resolution[a]	0.01 dB	

a. The Complementary Cumulative Distribution Function (CCDF) is a reformatting of the histogram of the power envelope. The width of the amplitude bins used by the histogram is the histogram resolution. The resolution of the CCDF will be the same as the width of those bins.

Description	Specification	Supplemental Information
Power Statistics CCDF		NB-IoT
Histogram Resolution[a]	0.01 dB	

a. The Complementary Cumulative Distribution Function (CCDF) is a reformatting of the histogram of the power envelope. The width of the amplitude bins used by the histogram is the histogram resolution. The resolution of the CCDF will be the same as the width of those bins.

Description	Specification	Supplemental Information
Power Statistics CCDF		C-V2X Frequency Range: 5855 to 5925 MHz
Histogram Resolution[a]	0.01 dB	

a. The Complementary Cumulative Distribution Function (CCDF) is a reformatting of the histogram of the power envelope. The width of the amplitude bins used by the histogram is the histogram resolution. The resolution of the CCDF will be the same as the width of those bins.

Description	Specifications	Supplemental Information
Spectrum Emission Mask		Offset from CF = (channel bandwidth + measurement bandwidth) / 2; measurement bandwidth = 100 kHz
Dynamic Range		
Channel Bandwidth		
5 MHz	80.9 dB	84.8 dB (typical)
10 MHz	84.6 dB	88.6 dB (typical)
20 MHz	82.4 dB	87.7 dB (typical)
Sensitivity	–96.5 dBm	–99.5 dBm (typical)
Accuracy		
Relative	±0.11 dB	
Absolute, 20 to 30°C	±0.62 dB	±0.20 dB (95th percentile)

Description	Specifications	Supplemental Information
Spectrum Emission Mask		NB-IoT: Stand-alone Offset from CF = (channel bandwidth + measurement bandwidth) / 2 = 115 kHz Channel bandwidth = 200 kHz Measurement bandwidth = 100 kHz
Dynamic Range	73.2 dB	78.2 dB (typical)
Sensitivity	–101.7 dBm	–104.7 dBm (typical)
Accuracy		
Relative	±0.05 dB	
Absolute, 20 to 30°C	±0.62 dB	±0.20 dB (95th percentile)

Description	Specifications	Supplemental Information
Spectrum Emission Mask		C-V2X Frequency Range: 5855 to 5925 MHz Offset from CF = (channel bandwidth + measurement bandwidth) / 2; measurement bandwidth = 100 kHz
Dynamic Range		
Channel Bandwidth		
5 MHz	80.9 dB	84.8 dB (typical)
10 MHz	79.9 dB	83.2 dB (typical)
20 MHz	83.0 dB	86.9 dB (typical)
Sensitivity	–96.5 dBm	–99.5 dBm (typical)
Accuracy		
Relative	±0.38 dB	
Absolute, 20 to 30°C	±1.77 dB	±0.52 dB (95th percentile)

Description	Specifications	Supplemental Information
Spurious Emissions		Table-driven spurious signals; search across regions
Dynamic Range[a], relative (RBW = 1 MHz)		92.4 dB (nominal)
Sensitivity[b], absolute (RBW=1 MHz)	–86.5 dBm	–89.5 dBm (typical)
Accuracy		Attenuation = 10 dB
Frequency Range		
20 Hz to 3.6 GHz		±0.19 dB (95th percentile)
3.5 to 8.4 GHz		±1.13 dB (95th percentile)
8.3 to 13.6 GHz		±1.50 dB (95th percentile)

a. The dynamic range is specified at 12.5 MHz offset from center frequency with mixer level of 1 dB compression point, which will degrade accuracy by 1 dB.
b. The sensitivity is specified at far offset from carrier, where phase noise does not contribute. You can derive the dynamic range at far offset from 1 dB compression mixer level and sensitivity.

Description	Specifications	Supplemental Information
Spurious Emissions		C-V2X Frequency Range: 5855 to 5925 MHz Table-driven spurious signals; search across regions
Dynamic Range[a], relative (RBW = 1 MHz)		92.4 dB (nominal)
Sensitivity[b], absolute (RBW=1 MHz)	–96.5 dBm	–99.5 dBm (typical)
Accuracy		Attenuation = 10 dB
Frequency Range		
20 Hz to 3.6 GHz		±0.19 dB (95th percentile)
3.5 to 8.4 GHz		±1.13 dB (95th percentile)
8.3 to 13.6 GHz		±1.50 dB (95th percentile)

a. The dynamic range is specified at 12.5 MHz offset from center frequency with mixer level of 1 dB compression point, which will degrade accuracy by 1 dB.
b. The sensitivity is specified at far offset from carrier, where phase noise does not contribute. You can derive the dynamic range at far offset from 1 dB compression mixer level and sensitivity.

Description	Specifications	Supplemental Information
Modulation Analysis		% and dB expressions[a]
(Signal level within one range step of overload)		
OSTP/RSTP		
Absolute accuracy[b]		±0.21 dB (nominal)
EVM for Downlink (OFDMA) Floor[c]		
Signal Bandwidth		
5 MHz	0.15% (–56.4 dB)	
10 MHz	0.15% (–56.4 dB)	
20 MHz[d]	0.20% (–53.9 dB)	
EVM Accuracy for Downlink (OFDMA)		
(EVM range: 0 to 8%)[e]		±0.3% (nominal)
EVM for Uplink (SC-FDMA) Floor[c]		
Signal Bandwidth		
5 MHz	0.15% (–56.4 dB)	
10 MHz	0.15% (–56.4 dB)	
20 MHz[gd]	0.20% (–53.9 dB)	
Frequency Error		
Lock range		±2.5 × subcarrier spacing = 37.5 kHz for default 15 kHz subcarrier spacing (nominal)
Accuracy		±1 Hz + tfa[f] (nominal)
Time Offset[g]		
Absolute frame offset accuracy	±20 ns	
Relative frame offset accuracy		±5 ns (nominal)
MIMO RS timing accuracy		±5 ns (nominal)

a. In these specifications, those values with % units are the specifications, while those with decibel units, in parentheses, are conversions from the percentage units to decibels for reader convenience.
b. The accuracy specification applies when EVM is less than 1% and no boost applies for the reference signal.
c. Overall EVM and Data EVM using 3GPP standard-defined calculation. Phase Noise Optimization set to Best Close-in (<600 kHz).
d. Requires Option B25, B40, B2X, or B5X (IF bandwidth above 10 MHz).

e. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows:

   error = [sqrt(EVM_{UUT2} + EVM_{sa}2)] $-EVM_{UUT}$

   where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} is the EVM floor of the analyzer in percent.

f. tfa = transmitter frequency × frequency reference accuracy.

g. The accuracy specification applies when EVM is less than 1% and no boost applies for resource elements

Description	Specifications	Supplemental Information
NB-IoT Modulation Analysis		% and dB expressions[a]
(Signal level within one range step of overload)		Channel bandwidth: 200 kHz
		Downlink: Operation Modes: Inband, guard-band, stand-alone
		Uplink: Operation Modes: Stand-alone Subcarrier spacing: 3.75 kHz, 15 kHz Number of subcarriers: 1, 3, 6, 12 Modulation types: BPSK, QPSK
EVM for Downlink Floor[b]		0.35% (–49.1 dB) (nominal)
EVM for Uplink Floor[b]		
3/6/12 subcarrier signal with 15 kHz subcarrier spacing		0.15% (–56.5 dB) (nominal)
1 subcarrier signal with 15 kHz subcarrier spacing		0.035% (–69.1 dB) (nominal)
3.75 kHz subcarrier spacing		0.035% (–69.1 dB) (nominal)

a. In these specifications, those values with % units are the specifications, while those with decibel units, in parentheses, are conversions from the percentage units to decibels for reader convenience.

b. Overall EVM and Data EVM using 3GPP standard-defined calculation. Phase Noise Optimization set to Best Close-in (<600 kHz).

Description	Specifications	Supplemental Information
C-V2X Modulation Analysis		% and dB expressions[a] Frequency Range: 5855 to 5925 MHz
(Signal level within one range step of overload)		
OSTP/RSTP		
Absolute accuracy[b]		±0.21 dB (nominal)
EVM for Downlink (OFDMA) Floor[c]		
Signal Bandwidth		
5 MHz		0.15% (−56.4 dB) (nominal)
10 MHz		0.15% (−56.4 dB) (nominal)
20 MHz[d]		0.20% (−53.9 dB) (nominal)
Frequency Error		
Lock range		±2.5 × subcarrier spacing = 37.5 kHz for default 15 kHz subcarrier spacing (nominal)
Accuracy		±1 Hz + tfa[e] (nominal)
Time Offset[f]		
Absolute frame offset accuracy	±20 ns	
Relative frame offset accuracy		±5 ns (nominal)
MIMO RS timing accuracy		±5 ns (nominal)

a. In these specifications, those values with % units are the specifications, while those with decibel units, in parentheses, are conversions from the percentage units to decibels for reader convenience.
b. The accuracy specification applies when EVM is less than 1% and no boost applies for the reference signal.
c. Overall EVM and Data EVM using 3GPP standard-defined calculation. Phase Noise Optimization set to Best Close-in (<600 kHz).
d. Requires Option B25, B40, B2X, or B5X (IF bandwidth above 10 MHz).
e. tfa = transmitter frequency × frequency reference accuracy.
f. The accuracy specification applies when EVM is less than 1% and no boost applies for resource elements

In-Band Frequency Range

C-V2X Operating Band	
E-UTRA band 47, TDD	5855 to 5925 MHz

NB-IoT Operating Band	
E-UTRA bands, FDD,1, 2, 3, 4, 5, 8, 11, 12, 13, 14, 17, 18, 19, 20, 25, 26, 28, 31	See LTE FDD operating bands

LTE FDD Operating Band	Uplink	Downlink
1	1920 to 1980 MHz	2110 to 2170 MHz
2	1850 to 1910 MHz	1930 to 1990 MHz
3	1710 to 1785 MHz	1805 to 1880 MHz
4	1710 to 1755 MHz	2110 to 2155 MHz
5	824 to 849 MHz	869 to 894 MHz
6	830 to 840 MHz	875 to 885 MHz
7	2500 to 2570 MHz	2620 to 2690 MHz
8	880 to 915 MHz	925 to 960 MHz
9	1749.9 to 1784.9 MHz	1844.9 to 1879.9 MHz
10	1710 to 1770 MHz	2110 to 2170 MHz
11	1427.9 to 1452.9 MHz	1475.9 to 1500.9 MHz
12	698 to 716 MHz	728 to 746 MHz
13	777 to 787 MHz	746 to 756 MHz
14	788 to798 MHz	758 to 768 MHz
17	704 to 716 MHz	734 to 746 MHz
18	815 to 830 MHz	860 to 875 MHz
19	830 to 845 MHz	875 to 890 MHz
20	832 to 862 MHz	791 to 821 MHz
21	1447.9 to 1462.9 MHz	1495.9 to 1510.9 MHz
22 See note[a]	3410 to 3490 MHz	3510 to 3590 MHz
23	2000 to 2020 MHz	2180 to 2200 MHz
24	1626.5 to 1660.5 MHz	1525 to 1559 MHz
25	1850 to 1915 MHz	1930 to 1995 MHz

LTE FDD Operating Band	Uplink	Downlink
26	814 to 849 MHz	859 to 894 MHz
27	807 to 824 MHz	852 to 869 MHz
28	703 to 748 MHz	758 to 803 MHz
29	N/A	717 to 728 MHz
30	2305 to 2315 MHz	2350 to 2360 MHz
31	452.5 to 457.5 MHz	462.5 to 467.5 MHz
32	N/A	1452 to 1496 MHz

a. ACP measurements and SEM for operating Band 22 (FDD) and 42 (TDD) requires measurement of some spectral energy above the 3.6 GHz maximum for Band 0 in earlier firmware versions. These measurements can be made with the combination of recent firmware, version A.16.17 or later, and calibration of the analyzer in analyzer RF Band 0 extended to 3.7 GHz instead of the 3.6 GHz supported by earlier versions of the firmware. The calibration extension occurs in production of instruments with Frequency *Option 508*, *513* or *526* and SN ≥ US54490126, MY54490690, or SG54490127. Older analyzers with these frequency options and recent firmware can have their Band 0 coverage extended in service centers upon request.
With the combination of recent firmware and extended Band 0 range, the performance in the region above 3.6 GHz is nominally similar to that just below 3.6 GHz but not warranted.

LTE TDD Operating Band	Uplink/Downlink
33	1900 to 1920 MHz
34	2010 to 2025 MHz
35	1850 to 1910 MHz
36	1930 to 1990 MHz
37	1910 to 1930 MHz
38	2570 to 2620 MHz
39	1880 to 1920 MHz
40	2300 to 2400 MHz
41	2496 to 2690 MHz
42 See note[a]	3400 to 3600 MHz
44	703 to 803 MHz

25 Multi-Standard Radio Measurement Application

This chapter contains specifications for the N9083EM0E Multi-Standard Radio (MSR) measurement application.

Additional Definitions and Requirements

The specifications apply in the frequency range documented in In-Band Frequency Range of each application.

The specifications for this chapter apply only to instruments with Frequency *Option 508*, *513* or *526*. For Instruments with higher frequency options, the performance is nominal only and not subject to any warranted specifications.

Measurements

Description	Specifications	Supplemental Information
Channel Power		
Minimum power at RF Input		–50 dBm (nominal)
95th percentile Absolute power accuracy (20 to 30°C, Atten = 10 dB)		±0.19 dB

Description	Specifications	Supplemental Information
Power Statistics CCDF		
Histogram Resolution	0.01 dB[a]	

a. The Complementary Cumulative Distribution Function (CCDF) is a reformatting of the histogram of the power envelope. The width of the amplitude bins used by the histogram is the histogram resolution. The resolution of the CCDF will be the same as the width of those bins.

Description	Specifications	Supplemental Information
Occupied Bandwidth		
Minimum power at RF Input		–30 dBm (nominal)
Frequency Accuracy		± (Span / 1000) (nominal)

Description	Specifications	Supplemental Information
Spurious Emissions		Table-driven spurious signals; search across regions
Accuracy		
(Attenuation = 10 dB)		
Frequency Range		
20 Hz to 3.6 GHz		±0.19 dB (95th percentile)
3.5 to 8.4 GHz		±1.13 dB (95th percentile)
8.3 to 13.6 GHz		±1.50 dB (95th percentile)

Description	Specifications	Supplemental Information
Conformance EVM[a]		
GSM/EDGE[b]		
EVM, rms - floor (EDGE)		0.6% (nominal)
Phase error, rms - floor (GSM)		0.5° (nominal)
W-CDMA[c]		
Composite EVM floor		1.5% (nominal)
LTE FDD[d]		
EVM floor for downlink (OFDMA)		% and dB expression[e]
Signal bandwidths		
5 MHz		0.37% (–48.6 dB) (nominal)
10 MHz		0.24% (–52.3 dB) (nominal)
20 MHz		0.25% (–52.0 dB) (nominal)
NB-IoT		% and dB expression[e] Channel bandwidth 200 kHz
EVM floor for downlink		0.77% (–42.2 dB) (nominal)

a. The signal level is within one range step of overload. The specification for floor do not include signal-to-noise impact which may decrease by increasing the number of carriers. The noise floor can be estimated by DANL + 2.51 + 10 × log10(MeasBW), where DANL is the Display Averaged Noise Level specification in dBm and MeasBW is the measurement bandwidth at the receiver in Hz.
b. Specifications apply when the carrier spacing is 600 kHz and the carrier power of each adjacent channel does not exceed the carrier power of the channel tested for EVM.
c. Specifications apply when the carrier spacing is 5 MHz and the carrier power of each adjacent channel does not exceed the carrier power of the channel tested for EVM.
d. Specifications apply when the carrier spacing is the same as the signal bandwidth and the carrier power of each adjacent channel does not exceed the carrier power of the channel tested for EVM.
e. In LTE FDD specifications, those values with % units are the specifications, while those with decibel units, in parentheses, are conversion from the percentage units to decibels for reader convenience.

In-Band Frequency Range

Refer to the tables of In-Band Frequency Range in GSM/EDGE on page 262, W-CDMA on page 322, and LTE-A on page 278.

26 Noise Figure Measurement Application

This chapter contains specifications for the N9069EM0E Noise Figure Measurement Application.

General Specifications

Description	Specifications		Supplemental Information
Noise Figure			Uncertainty Calculator[a]
<10 MHz			See note[b]
10 MHz to 26.5 GHz and 26.5 to 50 GHz[c]			Internal and External preamplification recommended[d]
Noise Source ENR	**Measurement Range**	**Instrument Uncertainty**[e]	
4 to 6.5 dB	0 to 20 dB	±0.02 dB	
12 to 17 dB	0 to 30 dB	±0.025 dB	
20 to 22 dB	0 to 35 dB	±0.03 dB	

a. The figures given in the table are for the uncertainty added by the X-Series Signal Analyzer instrument only. To compute the total uncertainty for your noise figure measurement, you need to take into account other factors including: DUT NF, Gain and Match, Instrument NF, Gain Uncertainty and Match; Noise source ENR uncertainty and Match. The computations can be performed with the uncertainty calculator included with the Noise Figure Measurement Personality. Go to Mode Setup then select Uncertainty Calculator. Similar calculators are also available on the Keysight web site; go to http://www.keysight.com/find/nfu.

b. Uncertainty performance of the instrument is nominally the same in this frequency range as in the higher frequency range. However, performance is not warranted in this range. There is a paucity of available noise sources in this range, and the analyzer has poorer noise figure, leading to higher uncertainties as computed by the uncertainty calculator.

c. At the highest frequencies, especially above 40 GHz, the only Agilent/Keysight supra-26-GHz noise source, the 346CK01, often will not have enough ENR to allow for the calibration operation. Operation with "Internal Cal" is almost as accurate as with normal calibration, so the inability to use normal calibration does not greatly impact usefulness. Also, if the DUT has high gain, calibration has little effect on accuracy. In those rare cases when normal calibration is required, the Noisecom NC5000 and the NoiseWave NW346V do have adequate ENR for calibration.

d. The NF uncertainty calculator can be used to compute the uncertainty. For most DUTs of normal gain, the uncertainty will be quite high without preamplification.

e. “Instrument Uncertainty” is defined for noise figure analysis as uncertainty due to relative amplitude uncertainties encountered in the analyzer when making the measurements required for a noise figure computation. The relative amplitude uncertainty depends on, but is not identical to, the relative display scale fidelity, also known as incremental log fidelity. The uncertainty of the analyzer is multiplied within the computation by an amount that depends on the Y factor to give the total uncertainty of the noise figure or gain measurement.
See Keysight App Note 57-2, literature number 5952-3706E for details on the use of this specification.
Jitter (amplitude variations) will also affect the accuracy of results. The standard deviation of the measured result decreases by a factor of the square root of the Resolution Bandwidth used and by the square root of the number of averages. This application uses the 4 MHz Resolution Bandwidth as default because this is the widest bandwidth with uncompromised accuracy.

Description	Specifications	Supplemental Information
Gain		
Instrument Uncertainty[a]		DUT Gain Range = –20 to +40 dB
<10 MHz		See note[b]
10 MHz to 3.6 GHz	±0.07 dB	
3.6 to 26.5 GHz		±0.11 dB additional[c] 95th percentile, 5 minutes after calibration
26.5 to 50 GHz		Nominally the same performance as for 3.6 to 26.5 GHz. Also, see footnote c.

a. “Instrument Uncertainty” is defined for gain measurements as uncertainty due to relative amplitude uncertainties encountered in the analyzer when making the measurements required for the gain computation.
See Keysight App Note 57-2, literature number 5952-3706E for details on the use of this specification.
Jitter (amplitude variations) will also affect the accuracy of results. The standard deviation of the measured result decreases by a factor of the square root of the Resolution Bandwidth used and by the square root of the number of averages. This application uses the 4 MHz Resolution Bandwidth as default since this is the widest bandwidth with uncompromised accuracy.
Under difficult conditions (low Y factors), the instrument uncertainty for gain in high band can dominate the NF uncertainty as well as causing errors in the measurement of gain. These effects can be predicted with the uncertainty calculator.

b. Uncertainty performance of the instrument is nominally the same in this frequency range as in the higher frequency range. However, performance is not warranted in this range. There is a paucity of available noise sources in this range, and the analyzer has poorer noise figure, leading to higher uncertainties as computed by the uncertainty calculator.

c. For frequencies above 3.6 GHz, the analyzer uses a YIG-tuned filter (YTF) as a preselector, which adds uncertainty to the gain. When the Y factor is small, such as with low gain DUTs, this uncertainty can be greatly multiplied and dominate the uncertainty in NF (as the user can compute with the Uncertainty Calculator), as well as impacting gain directly. When the Y factor is large, the effect of IU of Gain on the NF becomes negligible.
When the Y-factor is small, the non-YTF mechanism that causes Instrument Uncertainty for Gain is the same as the one that causes IU for NF with low ENR. Therefore, we would recommend the following practice: When using the Uncertainty Calculator for noise figure measurements above 3.6 GHz, fill in the IU for Gain parameter with the sum of the IU for NF for 4 – 6.5 dB ENR sources and the shown “additional” IU for gain for this frequency range. When estimating the IU for Gain for the purposes of a gain measurement for frequencies above 3.6 GHz, use the sum of IU for Gain in the 0.01 to 3.6 GHz range and the “additional” IU shown.
You will find, when using the Uncertainty Calculator, that the IU for Gain is only important when the input noise of the spectrum analyzer is significant compared to the output noise of the DUT. That means that the best devices, those with high enough gain, will have comparable uncertainties for frequencies below and above 3.6 GHz.
The additional uncertainty shown is that observed to be met in 95% of the frequency/instrument combinations tested with 95% confidence. It applies within five minutes of a calibration. It is not warranted.

Description	Specifications	Supplemental Information
Noise Figure Uncertainty Calculator[a]		
Instrument Noise Figure Uncertainty	See the Noise Figure table earlier in this chapter	
Instrument Gain Uncertainty	See the Gain table earlier in this chapter	
Instrument Noise Figure		See graphs of "Nominal Instrument Noise Figure"; Noise Figure is DANL + 176.24 dB (nominal)[b] Note on DC coupling[cd]
Instrument Input Match		See graphs: Nominal VSWR Note on DC coupling[c]
NFE Improvement/Internal Cal[e]		See "Displayed Average Noise Level with Noise Floor Extension Improvement (mmW)" on page 48.

a. The Noise Figure Uncertainty Calculator requires the parameters shown in order to calculate the total uncertainty of a Noise Figure measurement.

b. Nominally, the noise figure of the spectrum analyzer is given by
$NF = D - (K - L + N + B)$
where D is the DANL (displayed average noise level) specification,
K is kTB (–173.98 dBm in a 1 Hz bandwidth at 290 K)
L is 2.51 dB (the effect of log averaging used in DANL verifications)
N is 0.24 dB (the ratio of the noise bandwidth of the RBW filter with which DANL is specified to an ideal noise bandwidth)
B is ten times the base-10 logarithm of the RBW (in hertz) in which the DANL is specified. B is 0 dB for the 1 Hz RBW.
The actual NF will vary from the nominal due to frequency response errors.

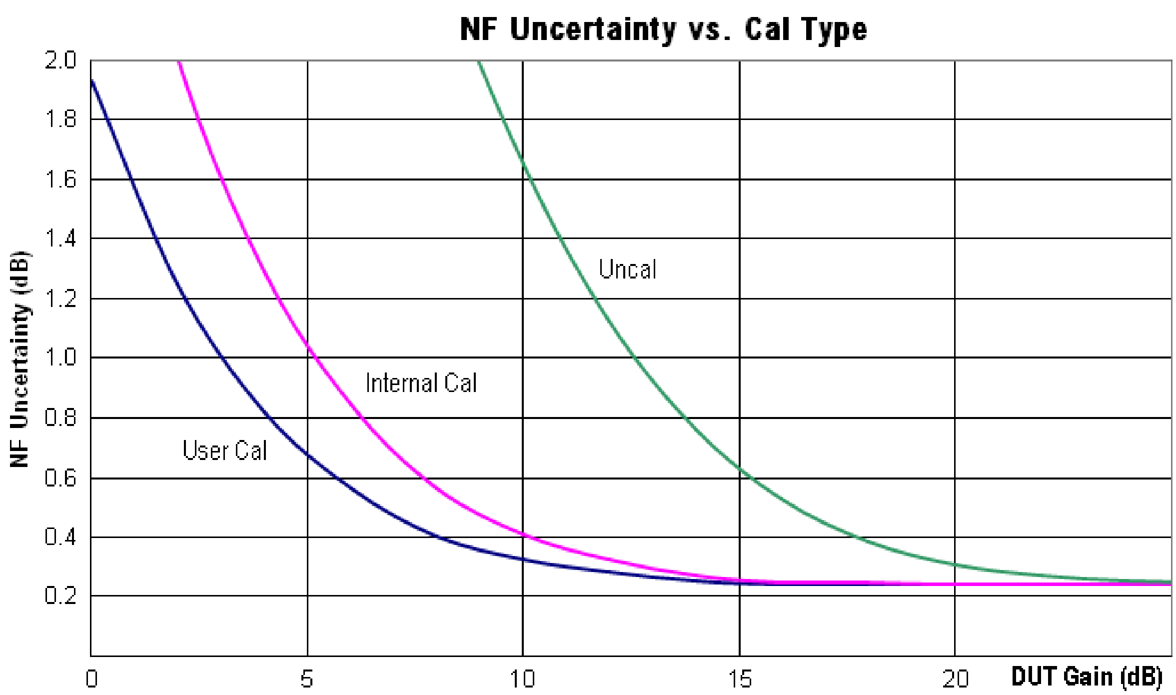
c. The effect of AC coupling is negligible for frequencies above 40 MHz. Below 40 MHz, DC coupling is recommended for the best measurements.

d. The instrument NF nominally degrades by 0.2 dB at 30 MHz and 1 dB at 10 MHz with AC coupling.

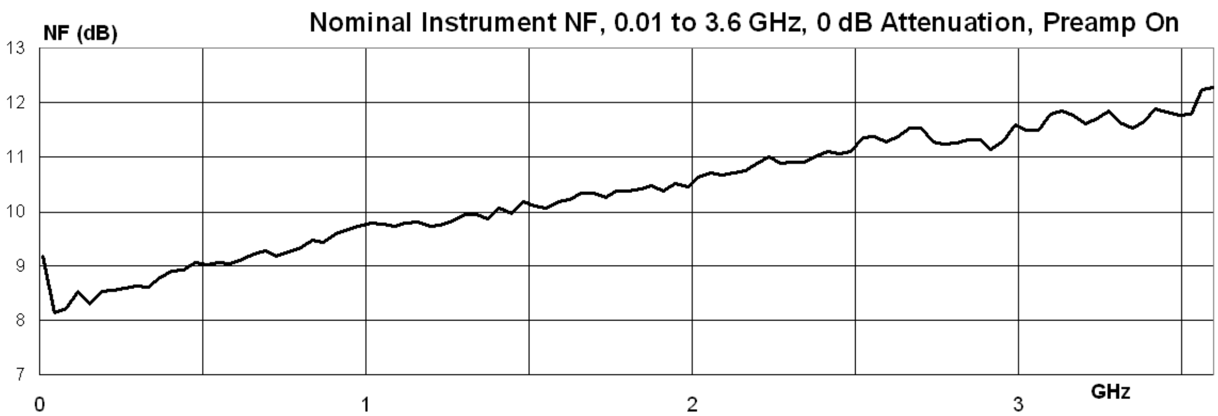
e. Analyzers with NFE (Noise Floor Extension) use that capability in the Noise Figure Measurement Application to allow "Internal Cal" instead of user calibration. With internal calibration, the measurement is much better than an uncalibrated measurement but not as good as with user calibration. Calibration reduces the effect of the analyzer noise on the total measured NF. With user calibration, the extent of this reduction is computed in the uncertainty calculator, and will be on the order of 16 dB. With internal calibration, the extent of reduction of the effective noise level varies with operating frequency, its statistics are given on the indicated page. It is usually about half as effective as User Calibration, and much more convenient. For those measurement situations where the output noise of the DUT is 10 dB or more above the instrument input noise, the errors due to using an internal calibration instead of a user calibration are negligible.

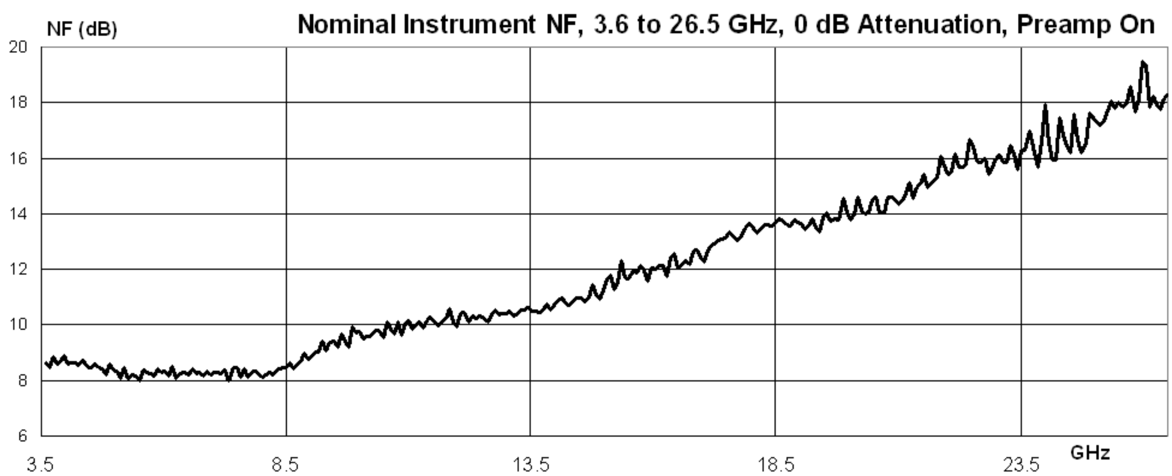
Description	Supplemental Information
Uncertainty versus Calibration Options	
User Calibration	Best uncertainties; Noise Figure Uncertainty Calculator applies
Uncalibrated	Worst uncertainties; noise of the analyzer input acts as a second stage noise on the DUT
Internal Calibration	Good uncertainties without the need of reconnecting the DUT and running a calibration. The uncertainty of the analyzer input noise model adds a second-stage noise power to the DUT that can be positive or negative. See the figure for example uncertainties.

Nominal Noise Figure Uncertainty versus Calibration Used
Assumptions for DUT: NF = 3 dB, Input VSWR = Output VSWR = 1.5:1 Assumptions for Noise Source: Keysight 346B; Uncertainty = 0.20 dB, ENR = 15 dB; VSWR = 1.15 Assumptions for Spectrum Analyzer: UXA operating at 1 GHz. Instrument Uncertainty for NF = 0.03 dB, Instrument Uncertainty for Gain = 0.07 dB, Instrument NF = 10 dB, VSWR = 1.5.

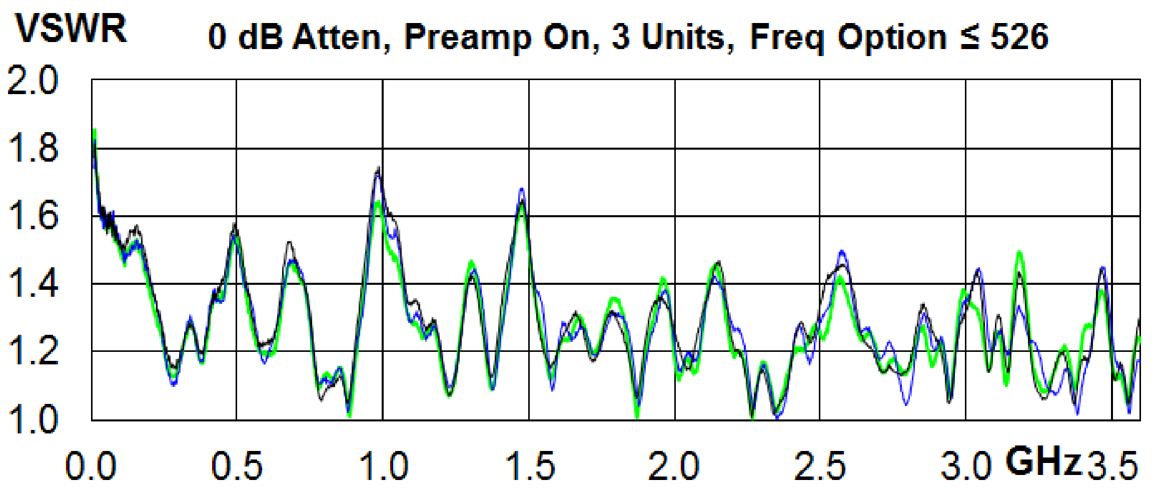


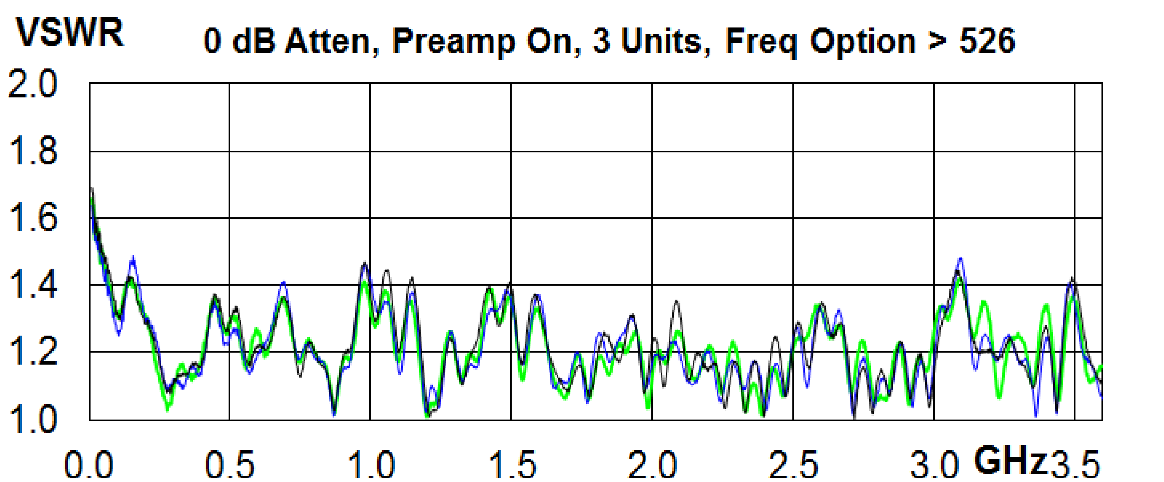
Nominal Instrument Noise Figure



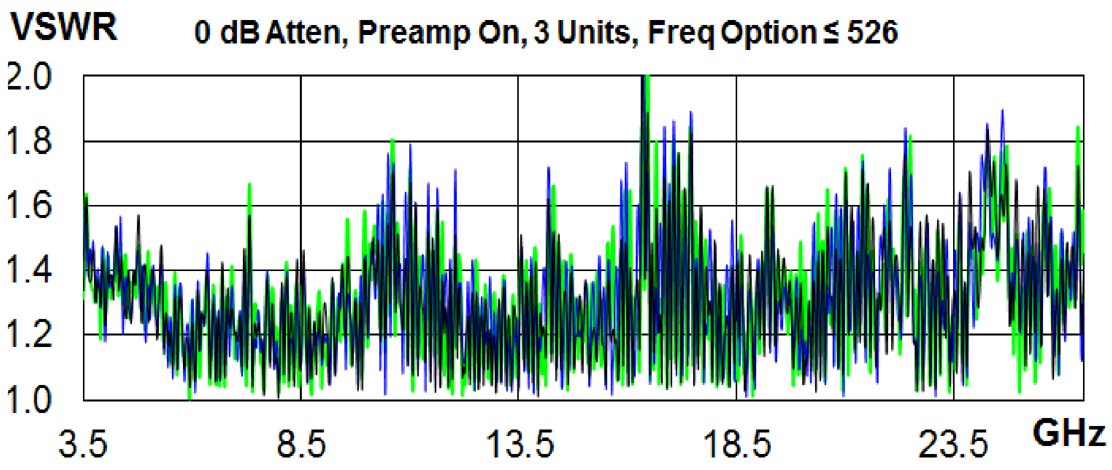


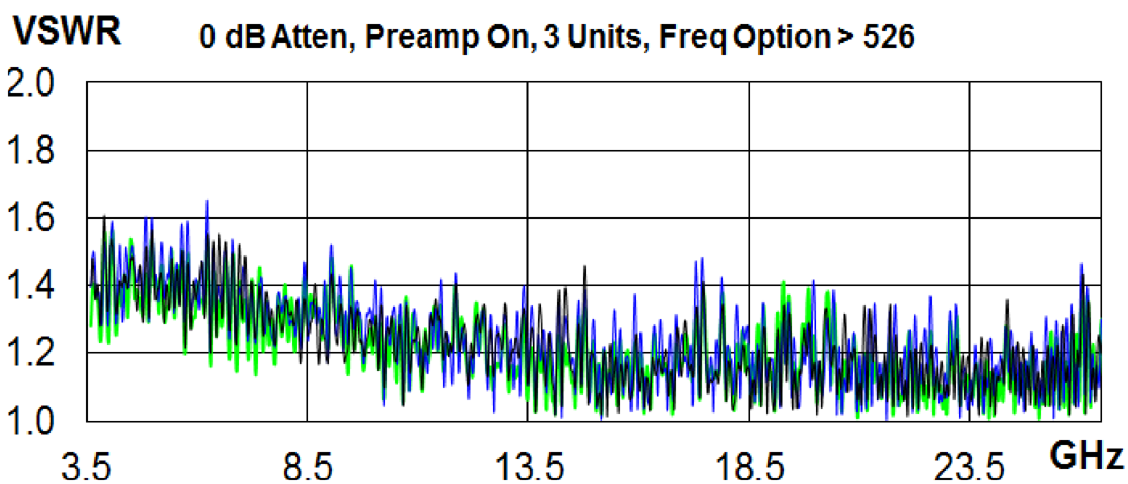
Nominal VSWR – Preamp On Band [Plot]

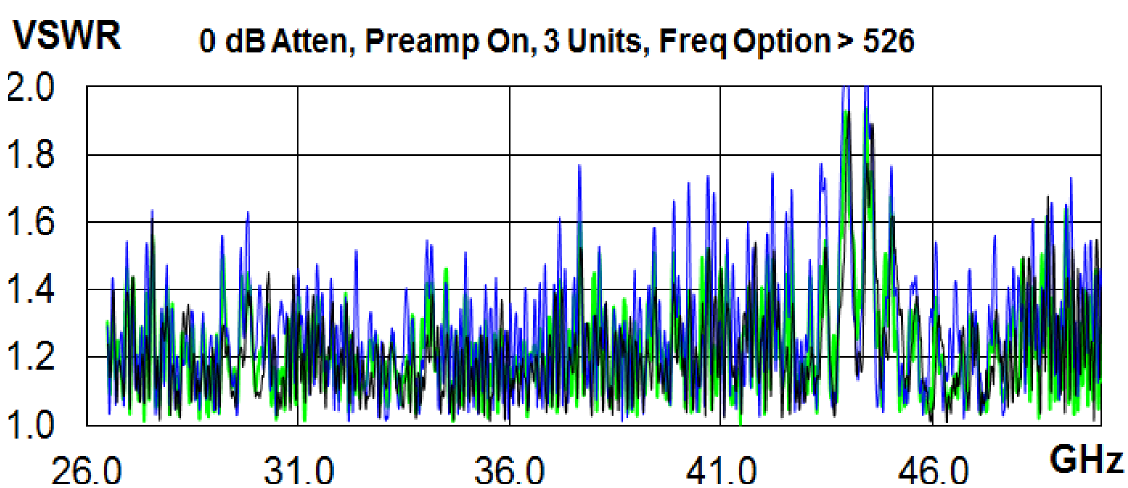




Nominal VSWR – Preamp On Band [Plot]







27 Phase Noise Measurement Application

This chapter contains specifications for the N9068EM0E Phase Noise measurement application.

General Specifications

Description	Specifications	Supplemental Information
Maximum Carrier Frequency		
Option 508	8.4 GHz	
Option 513	13.6 GHz	
Option 526	26.5 GHz	
Option 544	44 GHz	
Option 550	50 GHz	

Description	Specifications	Supplemental Information
Measurement Characteristics		
Measurements	Log plot, RMS noise, RMS jitter, Residual FM, Spot frequency	
Number of trace points	601 (default) or 4801[a]	

a. Requires firmware revision A.16 or later.

Description	Specifications	Supplemental Information
Measurement Accuracy		
Phase Noise Density Accuracy[a][b]		
Offset <1 MHz, CF <3.6 GHz	±0.26 dB	
Offset 1 to 10 MHz, CF <3.6 GHz		
Non-overdrive case[c]	±0.16 dB	
With overdrive		±0.39 dB (nominal)
RMS Markers		See equation[d]

a. This does not include the effect of system noise floor. This error is a function of the signal (phase noise of the DUT) to noise (analyzer noise floor due to phase noise and thermal noise) ratio, SN, in decibels.
The function is: error = $10 \times \log(1 + 10^{-SN/10})$
For example, if the phase noise being measured is 10 dB above the measurement floor, the error due to adding the analyzer's noise to the UUT is 0.41 dB.
b. Offset frequency errors also add amplitude errors. See the Offset frequency section, below.
c. The phase noise density accuracy for the non-overdrive case is derived from warranted analyzer specifications. It applies whenever there is no overdrive. Overdrive occurs only for offsets of 1 MHz and greater, with signal input power greater than –10 dBm, and controls set to allow overdrive. The controls allow overdrive if the electronic attenuator option is licensed, Enable Elect Atten is set to On, Pre-Adjust for Min Clip is set to either Elect Atten Only or Elect-Mech Atten, and the carrier frequency plus offset frequency is <3.6 GHz.
The controls also allow overdrive if (in the Meas Setup > Advanced menu) the Overdrive with Mech Atten is enabled. With the mechanical attenuator only, the overdrive feature can be used with carriers in the high band path (>3.6 GHz). To prevent overdrive in all cases, set the overdrive with Mech Atten to disabled and the Enable Elect Atten to Off.
d. The accuracy of an RMS marker such as "RMS degrees" is a fraction of the readout. That fraction, in percent, depends on the phase noise accuracy, in dB, and is given by $100 \times (10^{PhaseNoiseDensityAccuracy / 20} - 1)$. For example, with +0.30 dB phase noise accuracy, and with a marker reading out 10 degrees RMS, the accuracy of the marker would be +3.5% of 10 degrees, or +0.35 degrees.

Description	Specifications	Supplemental Information
Offset Frequency		
Range (Log Plot) Range (Spot Frequency)	1 Hz to (f_{opt} − f_{CF})[a] 10 Hz up to (f_{opt} − f_{CF})	f_{opt}: Maximum frequency determined by option[b] f_{CF}: Carrier frequency of signal under test
Accuracy		
Offset <1 MHz		Negligible error (nominal)
Offset ≥1 MHz		±(0.5% of offset + marker resolution) (nominal) 0.5% of offset is equivalent to 0.0072 octave[c]

a. Option AFP required for 1 Hz offset.
b. For example, f_{opt} is 26.5 GHz for *Option 526*.
c. The frequency offset error in octaves causes an additional amplitude accuracy error proportional to the product of the frequency error and slope of the phase noise. For example, a 0.01 octave frequency error combined with an 18 dB/octave slope gives 0.18 dB additional amplitude error.

Description	Specifications	Supplemental Information
Amplitude Repeatability (No Smoothing, all offsets, default settings, including averages = 10)		<1 dB (nominal)[a]

a. Standard deviation. The repeatability can be improved with the use of smoothing and increasing the number of averages.

Nominal Phase Noise at Different Center Frequencies
See the plot of core spectrum analyzer Nominal Phase Noise on page 61.

28 Pulse Measurement Software

This chapter contains specifications for the N9067EM0E Pulse measurement software.

Pulse Measurement Accuracy

Description	Specifications	Supplemental Information
Amplitude and Timing		
		Nominal
Top Level[a]		
CW		±0.2 dB + Absolute Amplitude Accuracy
Chirp		±0.2 dB + Absolute Amplitude Accuracy + IF Frequency Response
On Level[a]		
CW		±0.1 dB + Absolute Amplitude Accuracy
Chirp		±0.1 dB + Absolute Amplitude Accuracy + IF Frequency Response
Mean Level[a]		
CW		±0.1 dB + Absolute Amplitude Accuracy
Chirp		±0.1 dB + Absolute Amplitude Accuracy + IF Frequency Response
Peak Level[a]		
CW		±0.2 dB + Absolute Amplitude Accuracy
Chirp		±0.2 dB + Absolute Amplitude Accuracy + IF Frequency Response
Width[a]		±1/Sample Rate
PRI[a]		±1/Sample Rate

a. SNR ≥30 dB, Pulse Width ≥100/Bandwidth.

Frequency and Phase

Description	Specifications	Supplemental Information	
Frequency Error RMS[ab]			
	20 to 30°C	**CW (non-chirp signal)**	**Chirp (Linear chirp signal)**
CF 2 GHz		Nominal	Nominal
Option B2X	±100 kHz	±55 kHz	±65 kHz
Option B5X	±260 kHz	±160 kHz	±160 kHz
Option H1G		±390 kHz	±550 kHz
CF 10 GHz[c]			
Option B2X	±150 kHz	±85 kHz	±85 kHz
Option B5X	±410 kHz	±240 kHz	±250 kHz
Option H1G[d]		±680 kHz	±730 kHz
CF 20 GHz[e]			
Option B2X	±300 kHz	±150 kHz	±140 kHz
Option B5X	±820 kHz	±430 kHz	±400 kHz
Option H1G[d]		±800 kHz	±950 kHz
F**requency/Phase Pulse to Pulse Difference**[fa]			
CF 2 GHz			
Option B2X	±200 kHz, ±0.4°	±65 kHz, ±0.15°	±80 kHz, ±0.2°
Option B5X	±550 kHz ±0.6°	±190 kHz, ±0.2°	±210 kHz, ±0.3°
Option H1G[d]		±480 kHz, ±0.3°	±490 kHz, ±0.35°
CF 10 GHz[c]			
Option B2X	±320 kHz, ±0.65°	±100 kHz, ±0.25°	±120 kHz, ±0.35°
Option B5X	±850 kHz, ±1.0°	±280 kHz, ±0.35°	±320 kHz, ±0.5°
Option H1G[d]		±870 kHz, ±0.5°	±950 kHz, ±0.6°

Description	Specifications	Supplemental Information	
CF 20 GHz[e]			
Option B2X	±630 kHz, ±1.25°	±190 kHz, ±0.4°	±210 kHz, ±0.6°
Option B5X	±1800 kHz, ±1.9°	±520 kHz, ±0.8°	±580 kHz, ±0.9°
Option H1G[d]		±1000 kHz, ±0.65°	±1100 kHz, ±0.7°

a. ATT = 0 dB, IF Gain = Low, LNP = off.
Signal condition:
Pulse on Power = -10 dBm
Pulse Width ≥100/Bandwidth
Modulation Setup:
FM Filter Bandwidth = 10%
b. Frequency/Phase Analysis setup:
Width = 50%
c. Option LNP reduces losses that occur before noise-setting and compressive stages. As a result, the sensitivity improves by about 6 dB, but the maximum signal handling ability falls by the same amount.
d. IF Gain = Low.
e. Footnote c applies except to the extent of 8 dB.
f. Pulse to Pulse Analysis setup:
Reference time = Center
Offset = 0.0 s
Window Length = 0.0 s

29 Short Range Communications Measurement Application

This chapter contains specifications for the N9084EM0E Short Range Communications Measurement Application, which has two major measurement applications:

- ZigBee (IEEE 802.15.4)
- Z-Wave (ITU-T G.9959)

ZigBee (IEEE 802.15.4) Measurement Application

Description	Specifications	Supplemental Information
EVM (Modulation Accuracy)		
ZigBee O-QPSK (2450 MHz)		0.25% Offset EVM (nominal)
ZigBee BPSK (868/950 MHz)		0.50% (nominal)
ZigBee BPSK (915 MHz)		0.50% (nominal)
Frequency Error		
Range		
ZigBee O-QPSK (2450 MHz)		±80 ppm (nominal)
ZigBee BPSK (868/950 MHz)		±50 ppm (nominal
ZigBee BPSK (915 MHz)		±80 ppm (nominal)
Accuracy		
ZigBee O-QPSK (2450 MHz)		±1 Hz+tfa[a] (nominal)
ZigBee BPSK (868/950 MHz)		±1 Hz+tfa[a] (nominal)
ZigBee BPSK (915 MHz)		±1 Hz+tfa[a] (nominal)

a. tfa = transmitter frequency × frequency reference accuracy.

Z-Wave (ITU-T G.9959) Measurement Application

Description	Specifications	Supplemental Information
FSK Error		
Z-Wave R1 FSK (9.6 kbps)		0.58% (nominal)
Z-Wave R2 FSK (40 kbps)		0.78% (nominal)
Z-Wave R3 GFSK (100 kbps)		0.80% (nominal)
Frequency Error		
Range		
Z-Wave R1 FSK (9.6 kbps)		±60 ppm (nominal)
Z-Wave R2 FSK (40 kbps)		±60 ppm (nominal
Z-Wave R3 GFSK (100 kbps)		±60 ppm (nominal)
Accuracy		
Z-Wave R1 FSK (9.6 kbps)		±50 Hz+tfa[a] (nominal)
Z-Wave R2 FSK (40 kbps)		±50 Hz+tfa[a] (nominal
Z-Wave R3 GFSK (100 kbps)		±50 Hz+tfa[a] (nominal)

a. tfa = transmitter frequency × frequency reference accuracy.

30 Vector Modulation Analysis Application

This chapter contains specifications for the N9054C Vector Modulation Analysis Measurement Application. Model numbers of the Vector Modulation Analyzer Mode are N9054EM0E (Flexible Digital Demod) and N9054EM1E (Custom OFDM).

This application supports the following:

PSK formats: BPSK, QPSK, Offset QPSK, Shaped OQPSK, DQPSK, π/4 DQPSK, 8-PSK, π/8 D8PSK, D8PSK;

QAM formats: 16/32/64/128/256/512/1024-QAM;

FSK formats: 2/4/8/16-FSK;

MSK formats: MSK Type 1, MSK Type 2;

ASK formats: 2-ASK;

APSK formats: 16/32 APSK;

VSB formats: 8/16-VSB;

Other formats: CPM (FM), EDGE.

The following measurements are supported in this application:

- Digital Demod
- Monitor Spectrum
- IQ Waveform
- Custom OFDM
- Channel Power
- Occupied BW
- Power Stat CCDF
- Adjacent Channel Power
- Spectrum Emission Mask
- Spurious Emissions

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Frequency

Description	Specifications	Supplemental Information
Range		See “Frequency Range” on page 17.

Measurements

Description	Specifications	Supplemental Information
Modulation Analysis		
Maximum Demodulation BW		
25 MHz (Standard)		
1 GHz (*Option H1G*)		
Residual EVM		Modulation formats include BPSK, QPSK, DQPSK, π/4 DQPSK, 8-PSK, π/8 D8PSK, D8PSK, 16/32/64/128/256/512/1024-QAM; Center Frequency = 1 GHz; Transmit filter is RRC with α = 0.35; Result length set to at least 150 symbols, or 3 × Number of ideal constellation states; Average number = 10.
Symbol Rate[a]		
1 MSa/s		0.50% (nominal)
10 MSa/s		0.50% (nominal)
25 MSa/s		0.70% (nominal)
100 MSa/s		1.00% (nominal)
Residual EVM for MSK		Modulation formats include MSK Type 1 and MSK Type 2; Center Frequency = 1 GHz; Transmit filter is Gaussian with BT = 0.3; Result length set to 150 symbols; Average number = 10.
Symbol Rate[a]		
10 MSa/s		0.50% (nominal)
80 MSa/s		1.40% (nominal)

Description	Specifications	Supplemental Information
Residual EVM for VSB		Modulation formats include 8-VSB and 16-VSB; Transmit filter is RRC with α = 0.115; Center Frequency < 3.6 GHz; Result length = 800; Average number = 10.
Symbol Rate[a]		
10.762 MHz		1.50% (SNR 36 dB) (nominal)

a. Supportable symbol rate is dependent on the analyzer hardware bandwidth option.

31 W-CDMA Measurement Application

This chapter contains specifications for the N9073EM0E W-CDMA/HSPA/HSPA+ measurement application.

Additional Definitions and Requirements

Because digital communications signals are noise-like, all measurements will have variations. The specifications apply only with adequate averaging to remove those variations.

The specifications apply in the frequency range documented in In-Band Frequency Range.

The specifications for this chapter apply only to instruments with Frequency *Option 508*, *513* or *526*. For Instruments with higher frequency options, the performance is nominal only and not subject to any warranted specifications.

The measurement performance is only slightly different between instruments with the lower and higher frequency options. Because the hardware performance of the analyzers is very similar but not identical, you can estimate the nominal performance of the measurements from the specifications in this chapter.

Conformance with 3GPP TS 25.141 Base Station Requirements

3GPP Standard Sections Sub-Clause	Measurement Name	3GPP Required Test Instrument Tolerance (as of 2009-12)	Instrument Tolerance Interval[abc]	Supplemental Information
6.2.1	Maximum Output Power (Channel Power)	±0.7 dB (95%)	±0.19 dB (95%)	
6.2.2	CPICH Power Accuracy (Code Domain)	±0.8 dB (95%)	±0.2 dB (95%)	
6.3	Frequency Error (Modulation Accuracy)	±12 Hz (95%)	±5 Hz (100%)	Excluding timebase error
6.4.2	Power Control Steps[d] (Code Domain)			
	1 dB step	±0.1 dB (95%)	±0.03 dB (100%)	
	Ten 1 dB steps	±0.1 dB (95%)	±0.03 dB (100%)	
6.4.3	Power Dynamic Range	±1.1 dB (95%)	±0.14 dB (100%)	
6.4.4	Total Power Dynamic Range[d] (Code Domain)	±0.3 dB (95%)	±0.06 dB (100%)	
6.5.1	Occupied Bandwidth	±100 kHz (95%)	±10 kHz (100%)	
6.5.2.1	Spectrum Emission Mask	±1.5 dB (95%)	±0.20 dB (95%)	Absolute peak[e]
6.5.2.2	ACLR			
	5 MHz offset	±0.8 dB (95%)	±0.22 dB (100%)	
	10 MHz offset	±0.8 dB (95%)	±0.18 dB (100%)	
6.5.3	Spurious Emissions			
	f ≤ 2.2 GHz	±1.5 dB (95%)	±0.19 dB (95%)	
	2.2 GHz < f ≤ 4 GHz	±2.0 dB (95%)	±1.13 dB (95%)	
	4 GHz < f	±4.0 dB (95%)	±1.50 dB (95%)	
6.7.1	EVM (Modulation Accuracy)	±2.5% (95%)	±0.5% (100%)	EVM in the range of 12.5% to 22.5%
6.7.2	Peak Code Domain Error (Modulation accuracy)	±1.0 dB (95%)	±1.0 dB (100%)	
6.7.3	Time alignment error in Tx Diversity (Modulation Accuracy)	±26 ns (95%) [= 0.1 Tc]	±1.25 ns (100%)	

a. Those tolerances marked as 95% are derived from 95th percentile observations with 95% confidence.
b. Those tolerances marked as 100% are derived from 100% limit tested observations. Only the 100% limit tested observations are covered by the product warranty.

c. The computation of the instrument tolerance intervals shown includes the uncertainty of the tracing of calibration references to national standards. It is added, in a root-sum-square fashion, to the observed performance of the instrument.
d. These measurements are obtained by utilizing the code domain power function or general instrument capability. The tolerance limits given represent instrument capabilities.
e. The tolerance interval shown is for the peak absolute power of a CW-like spurious signal. The standards for SEM measurements are ambiguous as of this writing; the tolerance interval shown is based on Keysight's interpretation of the current standards and is subject to change.

Measurements

Description	Specifications	Supplemental Information
Channel Power		
Minimum power at RF Input		–50 dBm (nominal)
Absolute power accuracy[a] (20 to 30°C, Atten = 10 dB)	±0.61 dB	
95th percentile Absolute power accuracy (20 to 30°C, Atten = 10 dB)		±0.19 dB
Measurement floor		–84.8 dBm (nominal)

a. Absolute power accuracy includes all error sources for in-band signals except mismatch errors and repeatability due to incomplete averaging. It applies when the mixer level is high enough that measurement floor contribution is negligible.

Description			Specifications	Supplemental Information	
Adjacent Channel Power (ACPR; ACLR)[a]					
Single Carrier					
Minimum power at RF Input				–36 dBm (nominal)	
ACPR Accuracy[bc]				RRC weighted, 3.84 MHz noise bandwidth, method = IBW or Fast[d]	
Radio	Offset Freq				
MS (UE)	5 MHz		±0.08 dB	At ACPR range of –30 to –36 dBc with optimum mixer level[e]	
MS (UE)	10 MHz		±0.09 dB	At ACPR range of –40 to –46 dBc with optimum mixer level[f]	
BTS	5 MHz		±0.22 dB	At ACPR range of –42 to –48 dBc with optimum mixer level[g]	
BTS	10 MHz		±0.18 dB	At ACPR range of –47 to –53 dBc with optimum mixer level[f]	
BTS	5 MHz		±0.10 dB	At –48 dBc non-coherent ACPR[h]	
Dynamic Range				RRC weighted, 3.84 MHz noise bandwidth	
Noise Correction[i]	Offset Freq	Method		Typical[j] Dynamic Range	Optimum ML (nominal)
off	5 MHz	Filtered IBW		–81.0 dB	–8 dBm
off	5 MHz	Fast		–81.0 dB	–8 dBm
off	10 MHz	Filtered IBW		–87.0 dB	–8 dBm
on	5 MHz	Filtered IBW		–82.5 dB	–8 dBm
on	5 MHz	Filtered IBW		–88 dB (note[k])	–8 dBm
on	10 MHz	Filtered IBW		–89.0 dB	–4 dBm
RRC Weighting Accuracy[l]					
White noise in Adjacent Channel				0.00 dB (nominal)	
TOI-induced spectrum				0.001 dB (nominal)	
rms CW error				0.012 dB (nominal)	

Description	Specifications	Supplemental Information	
Multiple Carriers		RRC weighted, 3.84 MHz noise bandwidth. All specifications apply for 5 MHz offset.	
Two Carriers			
ACPR Dynamic Range		–83 dB, NC on (nominal)	
ACPR Accuracy		±0.20 dB (nominal)	
Four Carriers		Dynamic range (nominal)	Optimum ML[m] (nominal)
ACPR Dynamic Range			
Noise Correction (NC) and NFE off		–69 dB	–8 dBm
Noise Correction (NC) on		–79 dB	–12 dBm
ACPR Accuracy, BTS, Incoherent TOI[n]		UUT ACPR Range	
Noise Correction (NC) off[o]	±0.18 dB	–42 to –48 dB	–12 dBm
Noise Correction (NC) on	±0.09 dB	–42 to –48 dB	–15 dBm

a. Most versions of adjacent channel power measurements use negative numbers, in units of dBc, to refer to the power in an adjacent channel relative to the power in a main channel, in accordance with ITU standards. The standards for W-CDMA analysis include ACLR, a positive number represented in dB units. In order to be consistent with other kinds of ACP measurements, this measurement and its specifications will use negative dBc results, and refer to them as ACPR, instead of positive dB results referred to as ACLR. The ACLR can be determined from the ACPR reported by merely reversing the sign.

b. The accuracy of the Adjacent Channel Power Ratio will depend on the mixer drive level and whether the distortion products from the analyzer are coherent with those in the UUT. These specifications apply even in the worst case condition of coherent analyzer and UUT distortion products. For ACPR levels other than those in this specifications table, the optimum mixer drive level for accuracy is approximately –37 dBm – (ACPR/3), where the ACPR is given in (negative) decibels.

c. Accuracy is specified without NC or NFE. NC or NFE will make the accuracy even better.

d. The Fast method has a slight decrease in accuracy in only one case: for BTS measurements at 5 MHz offset, the accuracy degrades by ±0.01 dB relative to the accuracy shown in this table.

e. To meet this specified accuracy when measuring mobile station (MS) or user equipment (UE) within 3 dB of the required –33 dBc ACPR, the mixer level (ML) must be optimized for accuracy. This optimum mixer level is –22 dBm, so the input attenuation must be set as close as possible to the average input power – (–22 dBm). For example, if the average input power is –6 dBm, set the attenuation to 16 dB. This specification applies for the normal 3.5 dB peak-to-average ratio of a single code. Note that if the mixer level is set to optimize dynamic range instead of accuracy, accuracy errors are nominally doubled.

f. ACPR accuracy at 10 MHz offset is warranted when the input attenuator is set to give an average mixer level of –14 dBm

g. In order to meet this specified accuracy, the mixer level must be optimized for accuracy when measuring node B Base Transmission Station (BTS) within 3 dB of the required –45 dBc ACPR. This optimum mixer level is –18 dBm so the input attenuation must be set as close as possible to the average input power – (–18 dBm). For example, if the average input power is –4 dBm, set the attenuation to14 dB. This specification applies for the normal 10 dB peak-to-average ratio (at 0.01% probability) for Test Model 1. Note that, if the mixer level is set to optimize dynamic range instead of accuracy, accuracy errors are nominally doubled.

h. Accuracy can be excellent even at low ACPR levels assuming that the user sets the mixer level to optimize the dynamic range, and assuming that the analyzer and UUT distortions are incoherent. When the errors from the UUT and the analyzer are incoherent, optimizing dynamic range is equivalent to minimizing the contribution of analyzer noise and distortion to accuracy, though the higher mixer level increases the display scale fidelity errors. This incoherent addition case is commonly used in the industry and can be useful for comparison of analysis equipment, but this incoherent addition model is rarely justified. This derived accuracy specification is based on a mixer level of –14 dBm.
i. The dynamic range shown with Noise Correction = Off applies with Noise Floor Extension On. (Noise Correction is the process within the measurement of making a calibration of the noise floor at the exact analyzer settings used for the measurement. Noise Floor Extension is the factory calibration of the noise floor.)
j. Keysight measures 100% of the signal analyzers for dynamic range in the factory production process. This measurement requires a near-ideal signal, which is impractical for field and customer use. Because field verification is impractical, Keysight only gives a typical result. More than 80% of prototype instruments met this “typical” specification; the factory test line limit is set commensurate with an on-going 80% yield to this typical.
The ACPR dynamic range is verified only at 2 GHz, where Keysight has the near-perfect signal available. The dynamic range is specified for the optimum mixer drive level, which is different in different instruments and different conditions. The test signal is a 1 DPCH signal.
The ACPR dynamic range is the observed range. This typical specification includes no measurement uncertainty.
k. All three early production units hand-measured had performance better than 88 dB with a test signal even better than the "near-ideal" one used for statistical process control in production mentioned in the footnote[j] above. Therefore, this value can be considered "Nominal," not "Typical," by the definitions used within this document. These observations were done near 2 GHz, because that is a common W-CDMA operation region. It is also a region in which the analyzer third-order dynamic range is near its best.
l. 3GPP requires the use of a root-raised-cosine filter in evaluating the ACLR of a device. The accuracy of the passband shape of the filter is not specified in standards, nor is any method of evaluating that accuracy. This footnote discusses the performance of the filter in this instrument. The effect of the RRC filter and the effect of the RBW used in the measurement interact. The analyzer compensates the shape of the RRC filter to accommodate the RBW filter. The effectiveness of this compensation is summarized in three ways:
– White noise in Adj Ch: The compensated RRC filter nominally has no errors if the adjacent channel has a spectrum that is flat across its width.
– TOI-induced spectrum: If the spectrum is due to third-order intermodulation, it has a distinctive shape. The computed errors of the compensated filter are –0.001 dB for the 100 kHz RBW used for UE testing with the IBW method and also used for all testing with the Fast method, and 0.000 dB for the 27 kHz RBW filter used for BTS testing with the IBW method. The worst error for RBWs between 27 kHz and 390 kHz is 0.05 dB for a 330 kHz RBW filter.
– rms CW error: This error is a measure of the error in measuring a CW-like spurious component. It is evaluated by computing the root of the mean of the square of the power error across all frequencies within the adjacent channel. The computed rms error of the compensated filter is 0.012 dB for the 100 kHz RBW used for UE testing with the IBW method and also used for all testing with the Fast method, and 0.000 dB for the 27 kHz RBW filter used for BTS testing. The worst error for RBWs between 27 kHz and 470 kHz is 0.057 dB for a 430 kHz RBW filter.
m. Optimum mixer level (MLOpt). The mixer level is given by the average power of the sum of the four carriers minus the input attenuation.
n. Incoherent TOI means that the specified accuracy only applies when the distortions of the device under test are not coherent with the third-order distortion of the analyzer. Incoherence is often the case with advanced multicarrier amplifiers built with compensations and predistortions that mostly eliminate coherent third-order affects in the amplifier.
o. Accuracy is specified without NFE. With NFE, the accuracy will be closer to that with NC, and the optimum mixer level will be close to that for NC.

Description	Specifications	Supplemental Information
Power Statistics CCDF		
Histogram Resolution	0.01 dB[a]	

a. The Complementary Cumulative Distribution Function (CCDF) is a reformatting of the histogram of the power envelope. The width of the amplitude bins used by the histogram is the histogram resolution. The resolution of the CCDF will be the same as the width of those bins.

Description	Specifications	Supplemental Information
Occupied Bandwidth		
Minimum power at RF Input		–30 dBm (nominal)
Frequency Accuracy	±10 kHz	RBW = 30 kHz, Number of Points = 1001, span = 10 MHz

Description	Specifications	Supplemental Information
Spectrum Emission Mask		
Dynamic Range, relative (2.515 MHz offset[ab])	86.8 dB	91.3 dB (typical)
Sensitivity, absolute (2.515 MHz offset[c])	–103.7 dBm	–105.7 dBm (typical)
Accuracy (2.515 MHz offset)		
Relative[d]	±0.08 dB	
Absolute[e] (20 to 30°C)	±0.62 dB	±0.20 dB (95th percentile)

a. The dynamic range specification is the ratio of the channel power to the power in the offset specified. The dynamic range depends on the measurement settings, such as peak power or integrated power. Dynamic range specifications are based on default measurement settings, with detector set to average, and depend on the mixer level. Default measurement settings include 30 kHz RBW.
b. This dynamic range specification applies for the optimum mixer level, which is about –13 dBm. Mixer level is defined to be the average input power minus the input attenuation.
c. The sensitivity is specified with 0 dB input attenuation. It represents the noise limitations of the analyzer. It is tested without an input signal. The sensitivity at this offset is specified in the default 30 kHz RBW, at a center frequency of 2 GHz.
d. The relative accuracy is a measure of the ratio of the power at the offset to the main channel power. It applies for spectrum emission levels in the offsets that are well above the dynamic range limitation.
e. The absolute accuracy of SEM measurement is the same as the absolute accuracy of the spectrum analyzer. See "Absolute Amplitude Accuracy" on page 34 for more information. The numbers shown are for 0 to 3.6 GHz, with attenuation set to 10 dB.

Description	Specifications	Supplemental Information
Spurious Emissions		Table-driven spurious signals; search across regions
Dynamic Range[a], relative (RBW=1 MHz)		93.0 dB (nominal)
Sensitivity[b], absolute (RBW=1 MHz)	–88.5 dBm	–90.5 dBm (typical)
Accuracy		
(Attenuation = 10 dB)		
Frequency Range		
20 Hz to 3.6 GHz		±0.19 dB (95th percentile)
3.5 to 8.4 GHz		±1.13 dB (95th percentile)
8.3 to 13.6 GHz		±1.50 dB (95th percentile)

a. The dynamic range is specified at 12.5 MHz offset from center frequency with mixer level of 1 dB compression point, which will degrade accuracy by 1 dB.
b. The sensitivity is specified at far offset from carrier, where phase noise does not contribute. You can derive the dynamic range at far offset from 1 dB compression mixer level and sensitivity.

Description	Specifications	Supplemental Information
Code Domain		RF input power and attenuation are set to meet the Mixer Level range.
(BTS Measurements		
–25 dBm ≤ ML[a] ≤ –15 dBm 20 to 30°C)		
Code domain power		
Absolute accuracy[b]		±0.20 dB (95th percentile)
(–10 dBc CPICH, Atten = 10 dB)		
Relative accuracy		
Code domain power range		
0 to –10 dBc	±0.015 dB	
–10 to –30 dBc	±0.06 dB	
–30 to –40 dBc	±0.07 dB	
Power Control Steps		
Accuracy		
0 to –10 dBc	±0.03 dB	
–10 to –30 dBc	±0.12 dB	
Power Dynamic Range		
Accuracy	±0.14 dB	
(0 to –40 dBc)		
Symbol power vs. time		
Relative accuracy		
Code domain power range		
0 to –10 dBc	±0.015 dB	
–10 to –30 dBc	±0.06 dB	
–30 to –40 dBc	±0.07 dB	
Symbol error vector magnitude		
Accuracy		±1.0% (nominal)
(0 to –25 dBc)		

a. ML (mixer level) is RF input power minus attenuation.
b. Code Domain Power Absolute accuracy is calculated as sum of 95% Confidence Absolute Amplitude Accuracy and Code Domain relative accuracy at Code Power level.

Description	Specifications	Supplemental Information
QPSK EVM		
(–25 dBm ≤ ML[a] ≤ –15 dBm 20 to 30°C)		RF input power and attenuation are set to meet the Mixer Level range.
EVM		
Range		0 to 25% (nominal)
Floor	1.5%	
Accuracy[b]	±1.0%	
I/Q origin offset		
DUT Maximum Offset		–10 dBc (nominal)
Analyzer Noise Floor		–50 dBc (nominal)
Frequency error		
Range		±30 kHz (nominal)[c]
Accuracy	±5 Hz + tfa[d]	

a. ML (mixer level) is RF input power minus attenuation.

b. The accuracy specification applies when the EVM to be measured is well above the measurement floor and successfully synchronized to the signal. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows:

$$error = sqrt(EVMUUT^2 + EVMsa^2) - EVMUUT,$$

where EVMUUT is the EVM of the UUT in percent, and EVMsa is the EVM floor of the analyzer in percent.

c. This specifies a synchronization range with CPICH for CPICH only signal.

d. tfa = transmitter frequency × frequency reference accuracy

Description	Specifications	Supplemental Information
Modulation Accuracy (Composite EVM)		
(BTS Measurements –25 dBm ≤ ML[a] ≤ –15 dBm 20 to 30°C)		RF input power and attenuation are set to meet the Mixer Level range.
Composite EVM		
Range	0 to 25%	
Floor	1.5%	
Floor (with *Option BBA*)		1.5% (nominal)
Accuracy[b]		
Overall	±1.0%[c]	
Limited circumstances (12.5% ≤ EVM ≤ 22.5%, No 16QAM nor 64QAM codes)	±0.5%	
Peak Code Domain Error		
Accuracy	±1.0 dB	
I/Q Origin Offset		
DUT Maximum Offset		–10 dBc (nominal)
Analyzer Noise Floor		–50 dBc (nominal)
Frequency Error		
Range		±3 kHz (nominal)[d]
Accuracy	±5 Hz + tfa[e]	
Time offset		
Absolute frame offset accuracy	±20 ns	
Relative frame offset accuracy		±5.0 ns (nominal)
Relative offset accuracy (for STTD diff mode)[f]	±1.25 ns	

a. ML (mixer level) is RF input power minus attenuation.
b. For 16 QAM or 64 QAM modulation, the relative code domain error (RCDE) must be better than –16 dB and –22 dB respectively.

c. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows:

   error = [sqrt(EVMUUT^2 + EVMsa^2)] – EVMUUT,

   where EVMUUT is the EVM of the UUT in percent, and EVMsa is the EVM floor of the analyzer in percent. For example, if the EVM of the UUT is 7%, and the floor is 2.5%, the error due to the floor is 0.43%.
d. This specifies a synchronization range with CPICH for CPICH only signal.
e. tfa = transmitter frequency × frequency reference accuracy
f. The accuracy specification applies when the measured signal is the combination of CPICH (antenna–1) and CPICH (antenna–2), and where the power level of each CPICH is –3 dB relative to the total power of the combined signal. Further, the range of the measurement for the accuracy specification to apply is ±0.1 chips.

Description	Specifications	Supplemental Information
Power Control		
Absolute power measurement accuracy		Using 5 MHz resolution bandwidth
0 to –20 dBm		±0.7 dB (nominal)
–20 to –60 dBm		±1.0 dB (nominal)
Relative power measurement accuracy		
Step range ±1.5 dB		±0.1 dB (nominal)
Step range ±3.0 dB		±0.15 dB (nominal)
Step range ±4.5 dB		±0.2 dB (nominal)
Step range ±26.0 dB		±0.3 dB (nominal)

In-Band Frequency Range

Operating Band	UL Frequencies UE transmit, Node B receive	DL Frequencies UE receive, Node B transmit
I	1920 to 1980 MHz	2110 to 2170 MHz
II	1850 to 1910 MHz	1930 to 1990 MHz
III	1710 to 1785 MHz	1805 to 1880 MHz
IV	1710 to 1755 MHz	2110 to 2155 MHz
V	824 to 849 MHz	869 to 894 MHz
VI	830 to 840 MHz	875 to 885 MHz
VII	2500 to 2570 MHz	2620 to 2690 MHz
VIII	880 to 915 MHz	925 to 960 MHz
IX	1749.9 to 1784.9 MHz	1844.9 to 1879.9 MHz
X	1710 to 1770 MHz	2110 to 2170 MHz
XI	1427.9 to 1452.9 MHz	1475.9 to 1500.9 MHz
XII	698 to 716 MHz	728 to 746 MHz
XIII	777 to 787 MHz	746 to 756 MHz
XIV	788 to 798 MHz	758 to 768 MHz

32 WLAN Measurement Application

This chapter contains specifications for the N9077EM0E/EM1E WLAN measurement application.

Additional Definitions and Requirements

Because digital communications signals are noise-like, all measurements will have variations. The specifications apply only with adequate averaging to remove the variations.

The specifications apply in the frequency range documented in In-Band Frequency Range.

Different IEEE radio standard requires relative minimum hardware bandwidth for OFDM analysis:

802.11a/b/g/p, or 11n (20 MHz), 11ac (20 MHz) or 11ax (20 MHz) requires N9040B-B25 or above.

802.11n (40 MHz), 11ac (40 MHz) or 11ax (40 MHz) requires N9040B-B40 or above.

802.11ac (80 MHz) or 802.11ax (80 MHz) requires N9040B-B2X or above.

802.11ac (160 MHz) or 802.11ax (160 MHz) requires N9040B-B2X or above.

802.11ah 1M/2M/4M/8M/16M requires N9040B-B25 or above.

802.11af 6M/7M/8M requires N9040B-B25 or above.

.

KEYSIGHT TECHNOLOGIES

Measurements

Description	Specifications		Supplemental Information	
Channel Power 20 MHz Integration BW			Radio standards are: 802.11a/g/j/p (OFDM) or 802.11g (DSSS-OFDM) or 802.11n (20 MHz) or 802.11ac (20 MHz), 5 GHz band or 802.11ax (20 MHz) 2.4 GHz band and 5 GHz band	
Minimum power at RF Input			–50 dBm (nominal)	
	Center Freq		**Center Freq**	
	2.4 GHz	**5.0 GHz**	**2.4 GHz**	**5.0 GHz**
Absolute Power Accuracy[a] (20 to 30°C)	±0.63 dB	±1.78 dB	±0.19 dB (95th percentile)	±0.52 dB (95th percentile)
Measurement floor			–77.7 dBm (typical)	–76.7 dBm (typical)

a. Absolute power accuracy includes all error sources for in-band signals except mismatch errors and repeatability due to incomplete averaging. It applies when the mixer level is high enough that the measurement floor contribution is negligible.

Description	Specifications		Supplemental Information	
Channel Power 40 MHz Integration BW			Radio standard is: 802.11n (40 MHz) or 802.11ac (40 MHz), 5 GHz band or 802.11ax (40 MHz) 2.4 GHz band and 5 GHz band	
Minimum power at RF Input			–50 dBm (nominal)	
	Center Freq		**Center Freq**	
	2.4 GHz	**5.0 GHz**	**2.4 GHz**	**5.0 GHz**
Absolute Power Accuracy[a] (20 to 30°C)	±0.63 dB	±1.78 dB	±0.19 dB (95th percentile)	±0.52 dB (95th percentile)
Measurement floor			–74.7 dBm (typical)	–73.7 dBm (typical)

a. Absolute power accuracy includes all error sources for in-band signals except mismatch errors and repeatability due to incomplete averaging. It applies when the mixer level is high enough that the measurement floor contribution is negligible.

Description	Specifications	Supplemental Information
Channel Power 22 MHz Integration BW		Radio standard is: 802.11b/g (DSSS/CCK/PBCC) Center Frequency in 2.4 GHz Band
Minimum power at RF Input		–50 dBm (nominal)
Absolute Power Accuracy[a] (20 to 30°C)	±0.63 dB	±0.19 dB (95th percentile)
Measurement floor		–77.3 dBm typical)

a. Absolute power accuracy includes all error sources for in-band signals except mismatch errors and repeatability due to incomplete averaging. It applies when the mixer level is high enough that the measurement floor contribution is negligible.

Description	Specifications	Supplemental Information
Channel Power 80 MHz Integration BW		Radio standards are: 802.11ac (80 MHz) or 802.11ax (80 MHz) Center Frequency in 5.0 GHz Band
Minimum power at RF Input		–50 dBm (nominal)
Absolute Power Accuracy[a] (20 to 30°C)	±1.78 dB	±0.52 dB (95th percentile)
Measurement floor		–70.7 dBm (typical)

a. Absolute power accuracy includes all error sources for in-band signals except mismatch errors and repeatability due to incomplete averaging. It applies when the mixer level is high enough that the measurement floor contribution is negligible.

Description	Specifications	Supplemental Information
Channel Power 80 MHz Integration BW		Radio standard is: 802.11ax (80 MHz) Center Frequency in 2.4 GHz Band
Minimum power at RF Input		–50 dBm (nominal)
Absolute Power Accuracy[a] (20 to 30°C)		
Measurement floor		–71.7 dBm (typical)

a. Absolute power accuracy includes all error sources for in-band signals except mismatch errors and repeatability due to incomplete averaging. It applies when the mixer level is high enough that the measurement floor contribution is negligible.

Description	Specifications	Supplemental Information
Channel Power 80 MHz Integration BW		Radio standards is: 802.11ax (160 MHz) Center Frequency in 2.4 GHz Band
Minimum power at RF Input		–50 dBm (nominal)
Absolute Power Accuracy[a] (20 to 30°C)		
Measurement floor		–68.7 dBm (typical)

a. Absolute power accuracy includes all error sources for in-band signals except mismatch errors and repeatability due to incomplete averaging. It applies when the mixer level is high enough that the measurement floor contribution is negligible.

Description	Specifications	Supplemental Information
Channel Power 160 MHz Integration BW		Radio standards are 802.11ac (160 MHz) or 802.11ax (160 MHz) Center Frequency in 5.0 GHz Band
Minimum power at RF Input		–50 dBm (nominal)
Absolute Power Accuracy[a] (20 to 30°C)	±1.78 dB	±0.52 dB (95th percentile)
Measurement floor		–67.7 dBm (typical)

a. Absolute power accuracy includes all error sources for in-band signals except mismatch errors and repeatability due to incomplete averaging. It applies when the mixer level is high enough that the measurement floor contribution is negligible.

Description	Specifications	Supplemental Information
Channel Power		Radio standard is: 802.11af 6M/7M/8M –50 dBm (nominal)
Minimum power at RF Input		
Integration BW		
802.11af 6M	6 MHz	
802.11af 7M	7 MHz	
802.11af 8M	8 MHz	
Absolute Power Accuracy[a] (20 to 30°C) for 802.11af 6M/7M/8M	±0.63 dB	±0.19 dB (95th percentile)
Measurement floor		**Typical**
802.11af 6M		– 82.96 dBm
802.11af 7M		– 82.29 dBm
802.11af 8M		– 81.71 dBm

a. Absolute power accuracy includes all error sources for in-band signals except mismatch errors and repeatability due to incomplete averaging. It applies when the mixer level is high enough that the measurement floor contribution is negligible.

Description	Specifications	Supplemental Information
Channel Power		Radio standard is: 802.11ah
Integration BW		
802.11ah 1M	1 MHz	
802.11ah 2M	2 MHz	
802.11ah 4M	4 MHz	
802.11ah 8M	8 MHz	
802.11ah 16M	16 MHz	
Minimum power at RF Input 802.11ah 1M/2M/4M/8M/16M		– 50 dBm (nominal)
Absolute Power Accuracy[a] (20 to 30°C) for 802.11ah 1M/2M/4M/8M/16M	±0.63 dB	±0.19 dB (95th percentile)
Measurement floor		**Typical**
802.11ah 1M		– 90.7 dBm
802.11ah 2M		– 87.7 dBm
802.11ah 4M		– 84.7 dBm
802.11ah 8M		– 81.7 dBm
802.11ah 16M		– 78.7 dBm

a. Absolute power accuracy includes all error sources for in-band signals except mismatch errors and repeatability due to incomplete averaging. It applies when the mixer level is high enough that the measurement floor contribution is negligible.

Description	Specifications	Supplemental Information
Power Statistics CCDF		Radio standards are: 802.11a/g/j/p (OFDM), 802.11g (DSSS-OFDM), 802.11/b/g (DSSS/CCK/PBCC), 802.11n (20 MHz), 802.11n (40 MHz), 802.11ac (20 MHz) or 802.11ax (20 MHz) 802.11ac (40 MHz) or 802.11ax (40 MHz) 802.11ac (80 MHz) 802.11ac (160 MHz) Center Frequency in 2.4 GHz Band or 5.0 GHz Band
Minimum power at RF Input		–50 dBm (nominal)
Histogram Resolution	0.01 dB[a]	

a. The Complementary Cumulative Distribution Function (CCDF) is a reformatting of a histogram of the power envelope. The width of the amplitude bins used by the histogram is the histogram resolution. The resolution of the CCDF will be the same as the width of those bins.

Description	Specifications	Supplemental Information
Power Statistics CCDF		Radio standards are: 802.11 af 6M/7M/8M
Minimum power at RF Input		–50 dBm (nominal)
Histogram Resolution	0.01 dB[a]	

a. The Complementary Cumulative Distribution Function (CCDF) is a reformatting of a histogram of the power envelope. The width of the amplitude bins used by the histogram is the histogram resolution. The resolution of the CCDF will be the same as the width of those bins.

Description	Specifications	Supplemental Information
Power Statistics CCDF		Radio standards are: 802.11 ah 1M/2M/4M/8M/16M
Minimum power at RF Input		–50 dBm (nominal)
Histogram Resolution	0.01 dB[a]	

a. The Complementary Cumulative Distribution Function (CCDF) is a reformatting of a histogram of the power envelope. The width of the amplitude bins used by the histogram is the histogram resolution. The resolution of the CCDF will be the same as the width of those bins.

Description	Specifications	Supplemental Information
Occupied Bandwidth		Radio standards are: 802.11a/g/j/p (OFDM), 802.11g (DSSS-OFDM), 802.11/b/g (DSSS/CCK/PBCC), 802.11n (20 MHz), 802.11n (40 MHz), 802.11ac (20 MHz), 802.11ac (40 MHz), 802.11ac (80 MHz) or 802.11ax (80 MHz) 802.11ac (160 MHz) or 802.11ax (160 MHz)
		Center Frequency in 2.4 GHz Band or 5.0 GHz Band
Minimum power at RF Input		–30 dBm (nominal)
Frequency accuracy	±25 kHz	RBW = 100 kHz Number of Points = 1001 Span = 25 MHz

Description	Specifications	Supplemental Information
Occupied Bandwidth		Radio standards are: 802.11af 6M/7M/8M
Minimum power at RF Input		–30 dBm (nominal)
Frequency accuracy	±10 kHz	RBW = 100 kHz Number of Points = 1001 Span = 10 MHz

Description	Specifications	Supplemental Information
Occupied Bandwidth		Radio standards are: 802.11ah 1M/2M/4M/8M/16M
Minimum power at RF Input		–30 dBm (nominal)
Frequency accuracy	±20 kHz	RBW = 10 kHz Number of Points = 1001 Span = 20 MHz

Description	Specifications	Supplemental Information
Power vs. Time		Radio standard is: 802.11/b/g (DSSS/CCK/PBCC) Center Frequency in 2.4 GHz Band
Measurement results type		Min, Max, Mean
Average Type	0.01 dB	Off, RMS, Log
Measurement Time		Up to 88 ms
Dynamic Range		63.0 dB (nominal)

Description	Specifications	Supplemental Information
Spectrum Emission Mask (18 MHz Transmission BW RBW = 100 kHz 11.0 MHz offset)		Radio standards are: 802.11a/g/j/p (OFDM) 802.11g (DSSS-OFDM) or 802.11n (20 MHz) Center Frequency in 2.4 GHz Band
Dynamic Range, relative[a][b]	84.0 dB	86.0 dB (typical)
Sensitivity, absolute[c]	–98.5 dBm	–100.5 dBm (typical)
Accuracy		
Relative[d]	±0.11 dB	
Absolute (20 to 30°C)	±0.62 dB	±0.20 dB (95th percentile)

a. The dynamic range specification is the ratio of the channel power to the power in the offset specified. The dynamic range depends on the measurement settings, such as peak power or integrated power. Dynamic range specifications are based on default measurement settings, with detector set to average, and depend on the mixer level. Default measurement settings include 100 kHz RBW.
b. This dynamic range specification applies for the optimum mixer level, which is about –14 dBm. Mixer level is defined to be the average input power minus the input attenuation.
c. The sensitivity is specified with 0 dB input attenuation. It represents the noise limitations of the analyzer. It is tested without an input signal. The sensitivity at this offset is specified in the default 100 kHz RBW, at a center frequency of 2.412 GHz.
d. The relative accuracy is a measure of the ratio of the power at the offset to the main channel power. It applies for spectrum emission levels in the offsets that are well above the dynamic range limitation.

Description	Specifications	Supplemental Information
Spectrum Emission Mask (18 MHz Transmission BW RBW = 100 kHz 11.0 MHz offset)		Radio standards are: 802.11a/g (OFDM), 802.11n (20 MHz) or 802.11ac (20 MHz) Center Frequency in 5.0 GHz Band
Dynamic Range, relative[ab]	81.0 dB	85.3 dB (typical)
Sensitivity, absolute[c]	–95.5 dBm	–99.5 dBm (typical)
Accuracy		
Relative[d]	±0.39 dB	
Absolute (20 to 30°C)	±1.77 dB	±0.52 dB (95th percentile)

a. The dynamic range specification is the ratio of the channel power to the power in the offset specified. The dynamic range depends on the measurement settings, such as peak power or integrated power. Dynamic range specifications are based on default measurement settings, with detector set to average, and depend on the mixer level. Default measurement settings include 100 kHz RBW.
b. This dynamic range specification applies for the optimum mixer level, which is about –14 dBm. Mixer level is defined to be the average input power minus the input attenuation.
c. The sensitivity is specified with 0 dB input attenuation. It represents the noise limitations of the analyzer. It is tested without an input signal. The sensitivity at this offset is specified in the default 100 kHz RBW, at a center frequency of 5.18 GHz.
d. The relative accuracy is a measure of the ratio of the power at the offset to the main channel power. It applies for spectrum emission levels in the offsets that are well above the dynamic range limitation.

Description	Specifications		Supplemental Information	
Spectrum Emission Mask (19.5 MHz Transmission BW RBW = 100 kHz 10.25 MHz offset)			Radio standard is: 802.11ax (20 MHz) Center Frequency in 2.4 GHz and 5 GHz band	
	Center Freq		**Center Freq**	
	2.4 GHz	**5.0 GHz**	**2.4 GHz**	**5.0 GHz**
Dynamic Range, relative[a][b]	84.0 dB	81.0 dB	86.3 dB (typical)	85.3 dB (typical)
Sensitivity, absolute[c]	–98.5 dBm	–95.5 dBm	–100.5 dBm (typical)	–99.5 dBm (typical)
Accuracy				
Relative[d]	±0.11 dB	±0.39 dB		
Absolute (20 to 30°C)	±0.62 dB	±1.77 dB	±0.20 dB (95th percentile)	±0.52 dB (95th percentile)

a. The dynamic range specification is the ratio of the channel power to the power in the offset specified. The dynamic range depends on the measurement settings, such as peak power or integrated power. Dynamic range specifications are based on default measurement settings, with detector set to average, and depend on the mixer level. Default measurement settings include 100 kHz RBW.

b. This dynamic range specification applies for the optimum mixer level, which is about –14 dBm. Mixer level is defined to be the average input power minus the input attenuation.

c. The sensitivity is specified with 0 dB input attenuation. It represents the noise limitations of the analyzer. It is tested without an input signal. The sensitivity at this offset is specified in the default 100 kHz RBW, at a center frequency of 2.412 GHz.

d. The relative accuracy is a measure of the ratio of the power at the offset to the main channel power. It applies for spectrum emission levels in the offsets that are well above the dynamic range limitation.

Description	Specifications	Supplemental Information
Spectrum Emission Mask (22 MHz Transmission BW RBW = 100 kHz 11.0 MHz offset)		Radio standard is: 802.11b/g (DSSS/CCK/PBCC) Center Frequency in 2.4 GHz Band
Dynamic Range, relative[a][b]	84.1 dB	86.0 dB (typical)
Sensitivity, absolute[c]	–98.5 dBm	–100.5 dBm (typical)
Accuracy		
Relative[d]	±0.11 dB	
Absolute (20 to 30°C)	±0.62 dB	±0.20 dB (95th percentile)

a. The dynamic range specification is the ratio of the channel power to the power in the offset specified. The dynamic range depends on the measurement settings, such as peak power or integrated power. Dynamic range specifications are based on default measurement settings, with detector set to average, and depend on the mixer level. Default measurement settings include 100 kHz RBW.
b. This dynamic range specification applies for the optimum mixer level, which is about –14 dBm. Mixer level is defined to be the average input power minus the input attenuation.
c. The sensitivity is specified with 0 dB input attenuation. It represents the noise limitations of the analyzer. It is tested without an input signal. The sensitivity at this offset is specified in the default 100 kHz RBW, at a center frequency of 2.412 GHz.
d. The relative accuracy is a measure of the ratio of the power at the offset to the main channel power. It applies for spectrum emission levels in the offsets that are well above the dynamic range limitation.

Description	Specifications		Supplemental Information	
Spectrum Emission Mask (38 MHz Transmission BW RBW = 100 kHz 21.0 MHz offset)			Radio standard is: 802.11n (40 MHz) or 802.11ac (40 MHz) 5.0 GHz Band	
	Center Freq		**Center Freq**	
	2.4 GHz	**5.0 GHz**	**2.4 GHz**	**5.0 GHz**
Dynamic Range, relative[a][b]	84.2 dB	81.2 dB	86.4 dB (typical)	85.4 dB (typical)
Sensitivity, absolute[c]	–98.5 dBm	–95.5 dBm	–100.5 dBm (typical)	–99.5 dBm (typical)
Accuracy				
Relative[d]	±0.10 dB	±0.48 dB		
Absolute (20 to 30°C)	±0.62 dB	±1.77 dB	±0.20 dB (95th percentile)	±0.52 dB (95th percentile)

a. The dynamic range specification is the ratio of the channel power to the power in the offset specified. The dynamic range depends on the measurement settings, such as peak power or integrated power. Dynamic range specifications are based on default measurement settings, with detector set to average, and depend on the mixer level. Default measurement settings include 100 kHz RBW.

b. This dynamic range specification applies for the optimum mixer level, which is about –14 dBm. Mixer level is defined to be the average input power minus the input attenuation.

c. The sensitivity is specified with 0 dB input attenuation. It represents the noise limitations of the analyzer. It is tested without an input signal. The sensitivity at this offset is specified in the default 100 kHz RBW, at a center frequency of 2.412 GHz.

d. The relative accuracy is a measure of the ratio of the power at the offset to the main channel power. It applies for spectrum emission levels in the offsets that are well above the dynamic range limitation.

Description	Specifications		Supplemental Information	
Spectrum Emission Mask (39.0 MHz Transmission BW RBW = 100 kHz 20.5 MHz offset)			Radio standard is: 802.11ax (40 MHz) Center Frequency in 2.4 GHz and 5 GHz band	
	Center Freq		**Center Freq**	
	2.4 GHz	**5.0 GHz**	**2.4 GHz**	**5.0 GHz**
Dynamic Range, relative[a,b]	84.2 dB	81.2 dB	86.4 dB (typical)	85.4 dB (typical)
Sensitivity, absolute[c]	–98.5 dBm	–95.5 dBm	–100.5 dBm (typical)	–99.5 dBm (typical)
Accuracy				
Relative[d]	±0.10 dB	±0.48 dB		
Absolute (20 to 30°C)	±0.62 dB	±1.77 dB	±0.20 dB (95th percentile)	±0.52 dB (95th percentile)

a. The dynamic range specification is the ratio of the channel power to the power in the offset specified. The dynamic range depends on the measurement settings, such as peak power or integrated power. Dynamic range specifications are based on default measurement settings, with detector set to average, and depend on the mixer level. Default measurement settings include 100 kHz RBW.

b. This dynamic range specification applies for the optimum mixer level, which is about –14 dBm. Mixer level is defined to be the average input power minus the input attenuation.

c. The sensitivity is specified with 0 dB input attenuation. It represents the noise limitations of the analyzer. It is tested without an input signal. The sensitivity at this offset is specified in the default 100 kHz RBW, at a center frequency of 2.412 GHz.

d. The relative accuracy is a measure of the ratio of the power at the offset to the main channel power. It applies for spectrum emission levels in the offsets that are well above the dynamic range limitation.

Description	Specifications	Supplemental Information
Spectrum Emission Mask (78 MHz Transmission BW RBW = 100 kHz 41.0 MHz offset)		Radio standard is: 802.11ac (80 MHz) Center Frequency in 5.0 GHz Band
Dynamic Range, relative[a][b]	81.3 dB	85.4 dB (typical)
Sensitivity, absolute[c]	–95.5 dBm	–99.5 dBm (typical)
Accuracy		
Relative[d]	±0.60 dB	
Absolute (20 to 30°C)	±1.77 dB	±0.52 dB (95th percentile)

a. The dynamic range specification is the ratio of the channel power to the power in the offset specified. The dynamic range depends on the measurement settings, such as peak power or integrated power. Dynamic range specifications are based on default measurement settings, with detector set to average, and depend on the mixer level. Default measurement settings include 100 kHz RBW.

b. This dynamic range specification applies for the optimum mixer level, which is about –14 dBm. Mixer level is defined to be the average input power minus the input attenuation.

c. The sensitivity is specified with 0 dB input attenuation. It represents the noise limitations of the analyzer. It is tested without an input signal. The sensitivity at this offset is specified in the default 100 kHz RBW, at a center frequency of 2.412 GHz.

d. The relative accuracy is a measure of the ratio of the power at the offset to the main channel power. It applies for spectrum emission levels in the offsets that are well above the dynamic range limitation.

Description	Specifications		Supplemental Information	
Spectrum Emission Mask (79.0 MHz Transmission BW RBW = 100 kHz 40.5 MHz offset)			Radio standard is: 802.11ax (80 MHz) Center Frequency in 2.4 GHz and 5 GHz band	
	Center Freq		**Center Freq**	
	2.4 GHz	**5.0 GHz**	**2.4 GHz**	**5.0 GHz**
Dynamic Range, relative[a][b]	84.3 dB	81.3 dB	86.4 dB (typical)	85.4 dB (typical)
Sensitivity, absolute[c]	–98.5 dBm	–95.5 dBm	–100.5 dBm (typical)	–99.5 dBm (typical)
Accuracy				
Relative[d]	±0.15 dB	±0.60 dB		
Absolute (20 to 30°C)	±0.63 dB	±1.77 dB	±0.21 dB (95th percentile)	±0.52 dB (95th percentile)

a. The dynamic range specification is the ratio of the channel power to the power in the offset specified. The dynamic range depends on the measurement settings, such as peak power or integrated power. Dynamic range specifications are based on default measurement settings, with detector set to average, and depend on the mixer level. Default measurement settings include 100 kHz RBW.

b. This dynamic range specification applies for the optimum mixer level, which is about –14 dBm. Mixer level is defined to be the average input power minus the input attenuation.

c. The sensitivity is specified with 0 dB input attenuation. It represents the noise limitations of the analyzer. It is tested without an input signal. The sensitivity at this offset is specified in the default 100 kHz RBW, at a center frequency of 2.412 GHz.

d. The relative accuracy is a measure of the ratio of the power at the offset to the main channel power. It applies for spectrum emission levels in the offsets that are well above the dynamic range limitation.

Description	Specifications	Supplemental Information
Spectrum Emission Mask (158 MHz Transmission BW RBW = 100 kHz 81.0 MHz offset)		Radio standard is: 802.11ac (160 MHz) Center Frequency in 5.0 GHz Band
Dynamic Range, relative[ab]	81.4 dB	85.4 dB (typical)
Sensitivity, absolute[c]	–95.5 dBm	–99.5 dBm (typical)
Accuracy		
Relative[d]	±0.75 dB	
Absolute (20 to 30°C)	±1.77 dB	±0.52 dB (95th percentile)

a. The dynamic range specification is the ratio of the channel power to the power in the offset specified. The dynamic range depends on the measurement settings, such as peak power or integrated power. Dynamic range specifications are based on default measurement settings, with detector set to average, and depend on the mixer level. Default measurement settings include 100 kHz RBW.

b. This dynamic range specification applies for the optimum mixer level, which is about –14 dBm. Mixer level is defined to be the average input power minus the input attenuation.

c. The sensitivity is specified with 0 dB input attenuation. It represents the noise limitations of the analyzer. It is tested without an input signal. The sensitivity at this offset is specified in the default 100 kHz RBW, at a center frequency of 2.412 GHz.

d. The relative accuracy is a measure of the ratio of the power at the offset to the main channel power. It applies for spectrum emission levels in the offsets that are well above the dynamic range limitation.

Description	Specifications		Supplemental Information	
Spectrum Emission Mask (159.0 MHz Transmission BW RBW = 100 kHz 80.5 MHz offset)			Radio standard is: 802.11ax (160 MHz) Center Frequency in 2.4 GHz and 5 GHz band	
	Center Freq		**Center Freq**	
	2.4 GHz	**5.0 GHz**	**2.4 GHz**	**5.0 GHz**
Dynamic Range, relative[ab]	84.4 dB	81.4 dB	86.4 dB (typical)	85.4 dB (typical)
Sensitivity, absolute[c]	–98.5 dBm	–95.5 dBm	–100.5 dBm (typical)	–99.5 dBm (typical)
Accuracy				
Relative[d]	±0.18 dB	±0.75 dB		
Absolute (20 to 30°C)	±0.63 dB	±1.77 dB	±0.21 dB (95th percentile)	±0.52 dB (95th percentile)

a. The dynamic range specification is the ratio of the channel power to the power in the offset specified. The dynamic range depends on the measurement settings, such as peak power or integrated power. Dynamic range specifications are based on default measurement settings, with detector set to average, and depend on the mixer level. Default measurement settings include 100 kHz RBW.

b. This dynamic range specification applies for the optimum mixer level, which is about –14 dBm. Mixer level is defined to be the average input power minus the input attenuation.

c. The sensitivity is specified with 0 dB input attenuation. It represents the noise limitations of the analyzer. It is tested without an input signal. The sensitivity at this offset is specified in the default 100 kHz RBW, at a center frequency of 2.412 GHz.

d. The relative accuracy is a measure of the ratio of the power at the offset to the main channel power. It applies for spectrum emission levels in the offsets that are well above the dynamic range limitation.

Description	Specifications	Supplemental Information
Spectrum Emission Mask		Radio standard is: 802.11af 6M/7M/8M
Transmission BW		
802.11af 6M	5.70 MHz	
802.11af 7M	6.65 MHz	
802.11af 8M	7.60 MHz	
RBW for 802.11af 6M/7M/8M	100 kHz	
Offset		
802.11af 6M	3.15 MHz	
802.11af 7M	3.675 MHz	
802.11af 8M	4.2 MHz	
Relative Dynamic Range[a][b]		**Typical**
802.11af 6M	83.1 dB	85.9 dB
802.11af 7M	83.3 dB	86.0 dB
802.11af 8M	83.4 dB	86.1 dB
Absolute Sensitivity[c]	–98.5 dB	–100.5 dB
Relative Accuracy[d] (20 to 30°C)		
802.11af 6M	±0.09 dB	
802.11af 7M	±0.09 dB	
802.11af 8M	±0.09 dB	
Absolute Accuracy (20 to 30°C) for 802.11af 6M/7M/8M	±0.62 dB	±0.20 dB (typical)

a. The dynamic range specification is the ratio of the channel power to the power in the offset specified. The dynamic range depends on the measurement settings, such as peak power or integrated power. Dynamic range specifications are based on default measurement settings, with detector set to average, and depend on the mixer level. Default measurement settings include 10 kHz RBW.
b. This dynamic range specification applies for the optimum mixer level, which is about –14 dBm. Mixer level is defined to be the average input power minus the input attenuation.
c. The sensitivity is specified with 0 dB input attenuation. It represents the noise limitations of the analyzer. It is tested without an input signal. The sensitivity at this offset is specified in the default 10 kHz RBW.
d. The relative accuracy is a measure of the ratio of the power at the offset to the main channel power. It applies for spectrum emission levels in the offsets that are well above the dynamic range limitation.

Description	Specifications	Supplemental Information
Spectrum Emission Mask		Radio standard is: 802.11ah
Transmission BW		
802.11ah 1M	0.9 MHz	
802.11ah 2M	1.8 MHz	
802.11ah 4M	3.8 MHz	
802.11ah 8M	7.8 MHz	
802.11ah 16M	15.8 MHz	
RBW for 802.11ah 1M/2M/4M/8M/16M	10 kHz	
Offset		
802.11ah 1M	0.6 MHz	
802.11ah 2M	1.1 MHz	
802.11ah 4M	2.1 MHz	
802.11ah 8M	4.1 MHz	
802.11ah 16M	8.1 MHz	
Relative Dynamic Range[ab]		**Typical**
802.11ah 1M	88.6 dB	93.1 dB
802.11ah 2M	91.3 dB	95.1 dB
802.11ah 4M	92.6 dB	95.7 dB
802.11ah 8M	93.4 dB	96.1 dB
802.11ah 16M	93.9 dB	96.3 dB
Absolute Sensitivity[c]	–108.5 dB	–110.5 dB
Relative Accuracy[d] (20 to 30°C)		
802.11ah 1M	±0.08 dB	
802.11ah 2M	±0.08 dB	
802.11ah 4M	±0.09 dB	
802.11ah 8M	±0.10 dB	
802.11ah 16M	±0.11 dB	

Description	Specifications	Supplemental Information
Absolute Accuracy (20 to 30°C) for 802.11ah 1M/2M/4M/8M/16M	±0.62 dB	±0.20 dB (typical)

a. The dynamic range specification is the ratio of the channel power to the power in the offset specified. The dynamic range depends on the measurement settings, such as peak power or integrated power. Dynamic range specifications are based on default measurement settings, with detector set to average, and depend on the mixer level. Default measurement settings include 10 kHz RBW.

b. This dynamic range specification applies for the optimum mixer level, which is about –14 dBm. Mixer level is defined to be the average input power minus the input attenuation.

c. The sensitivity is specified with 0 dB input attenuation. It represents the noise limitations of the analyzer. It is tested without an input signal. The sensitivity at this offset is specified in the default 10 kHz RBW.

d. The relative accuracy is a measure of the ratio of the power at the offset to the main channel power. It applies for spectrum emission levels in the offsets that are well above the dynamic range limitation.

Description	Specifications		Supplemental Information	
Spurious Emission (ML = 3 dBm,0 to 55° C RBW = 100 kHz)			Radio standards are: 802.11a/g/j/p (OFDM), 802.11b/g (DSSS/CCK/PBCC), 802.11g (DSSS-OFDM), 802.11n (20 MHz), 802.11n (40 MHz), 802.11ac (20 MHz) 5.0 GHz Band, 802.11ac (40 MHz) 5.0 GHz Band, 802.11ac (80 MHz) 5.0 GHz Band 802.11ac (160 MHz) 5.0 GHz Band 802.11ax (20 MHz) in 2.4 GHz and 5 GHz Band 802.11ax (40 MHz) in 2.4 GHz and 5 GHz Band 802.11ax (80 MHz) in 2.4 GHz and 5 GHz Band 802.11ax (160 MHz) in 2.4 GHz and 5 GHz Band	
	Center Freq		**Center Freq**	
	2.4 GHz	**5.0 GHz**	**2.4 GHz**	**5.0 GHz**
Dynamic Range[a], relative (RBW= 1 MHz)	88.8 dB	84.9 dB	91.1 dB (typical)	88.7 dB (typical)
Sensitivity[b], absolute (RBW= 1 MHz)	–88.5 dBm	–85.5 dBm	–90.5 dBm (typical)	–89.5 dBm (typical)
Accuracy, absolute			(95th percentile)	(95th percentile)
20 Hz to 3.6 GHz			±0.19 dB	±0.19 dB
3.5 to 8.4 GHz			±1.13 dB	±1.13 dB
8.3 to 13.6 GHz			±1.41 dB	±1.41 dB

a. The dynamic range is specified at 12.5 MHz offset from center frequency with mixer level of 1 dB compression point, which will degrade accuracy 1 dB.
b. The sensitivity is specified at far offset from carrier, where phase noise does not contribute. You can derive the dynamic range at far offset from 1 dB compression mixer level and sensitivity.

Description	Specifications	Supplemental Information
Spurious Emission (ML = 3 dBm,0 to 55° C RBW = 100 kHz)		Radio standard is: 802.11af 6M/7M/8M
Dynamic Range[a], relative	88.8 dB	91.1 dB (typical)
Sensitivity[b], absolute	–88.5 dBm	–90.5 dBm (typical)
Accuracy, absolute		
20 Hz to 3.6 GHz		±0.19 dB (95th percentile)
3.5 to 8.4 GHz		±1.13 dB (95th percentile)
8.3 to 13.6 GHz		±1.41 dB (95th percentile)

a. The dynamic range is specified at 12.5 MHz offset from center frequency with mixer level of 1 dB compression point, which will degrade accuracy 1 dB.
b. The sensitivity is specified at far offset from carrier, where phase noise does not contribute. You can derive the dynamic range at far offset from 1 dB compression mixer level and sensitivity.

Description	Specifications	Supplemental Information
Spurious Emission (ML = 3 dBm,0 to 55° C RBW = 10 kHz)		Radio standard is: 802.11ah 1M/2M/4M/8M/16M
Dynamic Range[a], relative	88.8 dB	91.1 dB (typical)
Sensitivity[b], absolute	–88.5 dBm	–90.5 dBm (typical)
Accuracy, absolute		
20 Hz to 3.6 GHz		±0.19 dB (95th percentile)
3.5 to 8.4 GHz		±1.13 dB (95th percentile)
8.3 to 13.6 GHz		±1.41 dB (95th percentile)

a. The dynamic range is specified at 12.5 MHz offset from center frequency with mixer level of 1 dB compression point, which will degrade accuracy 1 dB.
b. The sensitivity is specified at far offset from carrier, where phase noise does not contribute. You can derive the dynamic range at far offset from 1 dB compression mixer level and sensitivity.

Description	Specifications	Supplemental Information	
64QAM EVM (RF Input Level = –10 dBm, Optimize EVM, 20 to 30°C)		Radio standards are: 802.11a/g/j/p (OFDM), 802.11g (DSSS-OFDM), 802.11n (20 MHz)[a] or 802.11ac (20 MHz) 5.0 GHz Band Code Rate: 3/4 EQ Training: Channel Est Seq Only Track Phase On Track Amp Off Track Timing Off	
		Center Freq	
		2.4 GHz (nominal)	**5.0 GHz (nominal)**
EVM			
Floor[bcd]		–56.2 dB (0.16%)	–54.1 dB (0.20%)
Accuracy[e]		±0.30%	±0.30%
(EVM Range:0 to 8.0%)			
Frequency Error			
Range		±100 kHz	±100 kHz
Accuracy		±10 Hz + tfa[f]	±10 Hz + tfa[f]

a. Requires *Option B25*, *B40*, *B2X,* or *B5X* (IF bandwidth above 10 MHz).
b. In these specifications, those values with dB units are the specifications, while those with % units, in parentheses, are conversions from the dB units to % for reader convenience.
c. The EVM Floor specification applies when Phase Noise Optimization is set to Wide-offset (>800 kHz)
d. The EVM Floor specification applies when the signal path is set to the μW Preselector Bypass (Option MPB enabled) for center frequencies above 3.6 GHz.
e. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows:

$$error = [sqrt(EVM_{UUT}^2 + EVM_{sa}^2)] - EVM_{UUT}$$

where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} is the EVM floor of the analyzer in percent.
f. tfa = transmitter frequency × frequency reference accuracy.

Description	Specifications	Supplemental Information	
64QAM EVM (RF Input Level = –10 dBm, Optimize EVM, 20 to 30°C)		Radio standard is: 802.11n (40 MHz) or 802.11ac (40MHz) 5.0 GHz Band[a] Code Rate: 3/4 EQ Training: Channel Est Seq Only Track Phase On Track Amp Off Track Timing Off	
		Center Freq	
		2.4 GHz (nominal)	**5.0 GHz (nominal)**
EVM			
Floor[bcd]		–54.2 dB (0.20%)	–52.0 dB (0.25%)
Accuracy[e]		±0.30%	±0.30%
(EVM Range:0 to 8.0%)			
Frequency Error			
Range		±100 kHz	±100 kHz
Accuracy		±10 Hz + tfa[f]	±10 Hz + tfa[f]

a. Requires *Option B40*, *B2X,* or *B5X* (IF bandwidth above 10 MHz).
b. In these specifications, those values with dB units are the specifications, while those with % units, in parentheses, are conversions from the dB units to % for reader convenience.
c. The EVM Floor specification applies when Phase Noise Optimization is set to Wide-offset (>800 kHz)
d. The EVM Floor specification applies when the signal path is set to μW Preselector Bypass (*Option MPB* enabled) for center frequencies above 3.6 GHz.
e. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows:

$$\text{error} = [\text{sqrt}(EVM_{UUT}^2 + EVM_{sa}^2)] - EVM_{UUT}$$

where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} is the EVM floor of the analyzer in percent.
f. tfa = transmitter frequency × frequency reference accuracy.

Description	Specifications	Supplemental Information
64QAM EVM (RF Input Level = –10 dBm, Optimize EVM, 20 to 30°C)		Radio standards is: 802.11ac (80 MHz), Center Frequency in 5.0 GHz Band Code Rate: 3/4 EQ Training: Channel Est Seq Only Track Phase On Track Amp Off Track Timing Off
EVM		
Floor[abcd]		–51.0 dB (0.28%)
Accuracy[e]		
(EVM Range:0 to 8.0%)		±0.30% (nominal)
Frequency Error		
Range		±100 kHz (nominal)
Accuracy		±10 Hz + tfa[f] (nominal)

a. In these specifications, those values with dB units are the specifications, while those with % units, in parentheses, are conversions from the dB units to % for reader convenience.
b. The EVM Floor specification applies when Phase Noise Optimization is set to Wide-offset (>800 kHz)
c. The EVM Floor specification applies when *Option B2X or B5X* is available.
d. The EVM Floor specification applies when µW Path Control is set to µW Preselector Bypass.
e. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows:

$$error = [sqrt(EVM_{UUT}^2 + EVM_{sa}^2)] - EVM_{UUT}$$

where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} is the EVM floor of the analyzer in percent.
f. tfa = transmitter frequency × frequency reference accuracy.

Description	Specifications	Supplemental Information
64QAM EVM (RF Input Level = −10 dBm, Optimize EVM, 20 to 30°C)		Radio standards is: 802.11ac (160 MHz), Center Frequency in 5.0 GHz Band Code Rate: 3/4 EQ Training: Channel Est Seq Only Track Phase On Track Amp Off Track Timing Off
EVM		
Floor[abcd]		–49.0 dB (0.35%)
Accuracy[e]		
(EVM Range:0 to 8.0%)		±0.30% (nominal)
Frequency Error		
Range		±100 kHz (nominal)
Accuracy		±10 Hz + tfa[f] (nominal)

a. In these specifications, those values with dB units are the specifications, while those with % units, in parentheses, are conversions from the dB units to % for reader convenience.
b. The EVM Floor specification applies when Phase Noise Optimization is set to Wide-offset (>800 kHz)
c. The EVM Floor specification applies when *Option B2X* or *B5X* is available.
d. The EVM Floor specification applies when μW Path Control is set to μW Preselector Bypass.
e. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows:

$$error = [sqrt(EVM_{UUT}^2 + EVM_{sa}^2)] - EVM_{UUT}$$

where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} is the EVM floor of the analyzer in percent.
f. tfa = transmitter frequency × frequency reference accuracy.

Description	Specifications	Supplemental Information
256QAM EVM RF Input Level = –10 dBm, Optimize EVM, Code Rate: 3/4 EQ training: Channel Est Seq Only Track Phase: On Track Amp: Off Track Timing: Off		Radio standard is: 802.11ah 1M/2M/4M/8M/16M
EVM floor[a][b]		**Nominal**
802.11ah 1M	–60.9 dB (0.09%)	–65.7 dB (0.052%)
802.11ah 2M	–60.9 dB (0.09%)	–65.0 dB (0.056%)
802.11ah 4M	–60.9 dB (0.09%)	–63.9 dB (0.064%)
802.11ah 8M	–59.7 dB (0.10%)	–62.2 dB (0.078%)
802.11ah 16M	–58.6 dB (0.12%)	–61.1dB (0.088%)
EVM Accuracy[c]		
(EVM Range:0 to 8.0%) for 802.11ah 1M/2M/4M/8M/16M		±0.3%
Frequency Error		
Range for 802.11ah 1M/2M/4M/8M/16M		±10 kHz (nominal)
Accuracy for 802.11ah 1M/2M/4M/8M/16M		±10 Hz + tfa[d] (nominal)

a. In these specifications, those values with dB units are the specifications, while those with % units, in parentheses, are conversions from the dB units to % for reader convenience.
b. The EVM Floor Specifications applies when Phase Noise Optimization is set to Wide-offset (>800 kHz).
c. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows:

$$error = [sqrt(EVM_{UUT}^2 + EVM_{sa}^2)] - EVM_{UUT}$$

where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} is the EVM floor of the analyzer in percent.
d. tfa = transmitter frequency × frequency reference accuracy.

Description	Specifications	Supplemental Information
256QAM EVM RF Input Level = –10 dBm, Optimize EVM, Code Rate: 3/4 EQ training: Channel Est Seq Only Track Phase: On Track Amp: Off Track Timing: Off		Radio standard is: 802.11af 6M/7M/8M
EVM floor[a][b]		**Nominal**
802.11af 6M		–49.7 dB (0.33%)
802.11af 7M		–49.7 dB (0.33%)
802.11af 8M		–49.4 dB (0.34%)
EVM Accuracy[c]		
(EVM Range:0 to 8.0%) for 802.11af 6M/7M/8		±0.3%
Frequency Error		
Range for 802.11af 6M/7M/8M		±20 kHz (nominal)
Accuracy for 802.11af 6M/7M/8M		±10 Hz + tfa[d] (nominal)

a. In these specifications, those values with dB units are the specifications, while those with % units, in parentheses, are conversions from the dB units to % for reader convenience.
b. The EVM Floor Specifications applies when Phase Noise Optimization is set to Wide-offset (>800 kHz).
c. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows:

$$error = [sqrt(EVM_{UUT}^2 + EVM_{sa}^2)] - EVM_{UUT}$$

where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} is the EVM floor of the analyzer in percent.
d. tfa = transmitter frequency × frequency reference accuracy.

Description	Specifications	Supplemental Information	
1024QAM EVM (RF Input Level = –10 dBm, Optimize EVM[a], 20 to 30°C)		Radio standard is: 802.11ax in 2.4 GHz and 5.0 GHz Band MCS: 11 EQ Training: Channel Est Seq Only Track Phase On Track Amp Off Track Timing On Freq Sync: Preamble, Pilot & Data	
		Center Freq	
EVM floor		**2.4 GHz (nominal)**	**5.0 GHz (nominal)**
802.11ax 20 MHz[bc]		–55.3 dB (0.17%)[d]	–53.4 dB (0.21%)
802.11ax 40 MHz		–55.2 dB (0.17%)	–53.0 dB (0.22%)
802.11ax 80 MHz		–52.0 dB (0.25%)	–50.5 dB (0.30%)
802.11ax 160 MHz		–47.8 dB (0.41%)	–47.0 dB (0.45%)
Accuracy[e]			
(EVM Range:0 to 8.0%)		±0.30%	±0.30%
Frequency Error			
Range		±100 kHz	
Accuracy		±10 Hz + tfa[f]	

a. The EVM Specifications are based on EVM optimization.
b. Phase Noise Optimization left at its default setting (Best Wide-offset Φ Noise >800 kHz).
c. The EVM Floor specification applies when the signal path is set to μW Preselector Bypass (*Option MPB* enabled) for center frequencies above 3.6 GHz.
d. In these specifications, those values with dB units are the specifications, while those with % units, in parentheses, are conversions from the dB units to % for reader convenience.
e. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows:

$$error = [sqrt(EVM_{UUT}^2 + EVM_{sa}^2)] - EVM_{UUT}$$

where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} is the EVM floor of the analyzer in percent.
f. tfa = transmitter frequency × frequency reference accuracy.

Description	Specifications	Supplemental Information
CCK 11Mbps (RF Input Level = –10 dBm, Attenuation = 10 dB, 20 to 30°C)		Radio standard is: 802.11/b/g (DSSS/CCK/PBCC) Center Frequency in 2.4 GHz Band Reference Filter: Gaussian
EVM		
Floor[ab](EQ Off)		–41.9 dB (0.80%) (nominal)
Floor(EQ7 On)		–54.0 dB (0.20%) (nominal)
Accuracy[c]		
(EVM Range: 0 to 2.0%)		±0.90% (nominal)
(EVM Range: 2 to 20.0%)		±0.40% (nominal)
Frequency Error		
Range		±100 kHz (nominal)
Accuracy		±10 Hz + tfa[d] (nominal)

a. In these specifications, those values with dB units are the specifications, while those with 5 units, in parentheses, are conversions from the dB units to % for reader convenience.
b. The EVM Floor specification applies when Phase Noise Optimization is set to Wide-offset (>800 kHz)
c. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows:

$$error = [sqrt(EVM_{UUT}^2 + EVM_{sa}^2)] - EVM_{UUT}$$

where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} is the EVM floor of the analyzer in percent.
d. tfa = transmitter frequency × frequency reference accuracy.

In-Band Frequency Range for Warranted Specifications

Description	Spectrum Range	Supplemental Information
Radio standard is 802.11b/g (DSSS/CCK/PBCC)	2.4 GHz Band	Channel center frequency = 2407 MHz + 5 × k MHz, k = 1,...,13
Radio standards are: 802.11a/g/j/p (OFDM), 802.11g (DSSS-OFDM), 802.11n (20 MHz), 802.11n (40 MHz) 802.11ac (20 MHz), or 802.11ac (40 MHz),	2.4 GHz Band	Channel center frequency = 2407 MHz + 5 × k MHz, k = 1,...,13
Radio standards are: 802.11a/g/j/p (OFDM), 802.11g (DSSS-OFDM), 802.11n (20 MHz) or 802.11n (40 MHz), 802.11ac (20 MHz) or 802.11ac (40 MHz), 802.11ac (80 MHz) or 802.11ac (160 MHz)	5.0 GHz Band	Channel center frequency = 5000 MHz + 5 × k MHz, k = 0, 1, 2, ..., 200
Radio standards are: 802.11 ah 1M/2M/4M/8M/16M	700 MHz ~ 1 GHz	Channel center frequency = Channel starting frequency + 0.5 MHz × Channel center frequency Index[a]

a. Channel center frequency, Channel starting frequency and Channel Center Frequency Index are given by the operating class (Annex E) in IEEE P802.11ah TM/D2.1.

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