Keysight X-Series MXE EMI Receiver

This manual provides documentation for the following:

N9038B MXE EMI Receiver

Specifications Guide (Comprehensive Reference Data)

KEYSIGHT TECHNOLOGIES

Notices

Trademark Acknowledgments

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Contents

1 Keysight MXE EMI Receiver

This chapter contains the specifications for the EMI receiver. The specifications and characteristics for the measurement applications and options are covered in the chapters that follow.

Definitions and Requirements

This book contains EMC receiver 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 = 5° to 50°C, unless otherwise noted).
- 95th percentile values indicate the breadth of the population ($\approx 2\sigma$) 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 receiver to meet its specifications.

- The receiver 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 receiver 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 receiver 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 receiver 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			
RF Input 1			
Option 503	3.6 GHz		
Option 508	8.4 GHz		
Option 526	26.5 GHz		
Option 544	44 GHz		
RF Input 2	1.0 GHz		
Minimum Frequency			
RF Preselector Off	AC Coupled[a]	DC Coupled	
Preamp Off	10 MHz	20 Hz	
Preamp On	10 MHz	100 kHz	
RF Preselector On	AC Coupled[a]	DC Coupled	
Preamp Off	10 MHz	20 Hz	
Preamp On	10 MHz	1 kHz	
Band	**Harmonic Mixing Mode**	**LO Multiple (N[b])**	**Band Overlaps[c]**
0 (20 Hz to 3.6 GHz)	1–	1	*Options 503, 508, 526, 544*
1 (3.5 GHz to 8.4 GHz)	1–	1	*Options 508, 526, 544*
2 (8.3 GHz to 13.6 GHz)	1–	2	*Options 526, 544*
3 (13.5 to 17.1 GHz)	2–	2	*Option 526, 544*
4 (17.0 to 26.5 GHz)	2–	4	*Option 526, 544*
5 (26.4 to 34.5 GHz)	2–	4	*Option 544*
6 (34.4 to 44 GHz)	4–	8	*Option 544*

a. AC Coupled only applicable to Freq *Options 503, 508* and *526*.
b. 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 (5.1225 GHz for band 0, 322.5 MHz for all other bands).

c. In the band overlap regions, for example, 3.5 to 3.6 GHz, the receiver may use either band for measurements, in this example Band 0 or Band 1. The receiver 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 receiver 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 receiver 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 receiver scans 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.

Description	Specifications	Supplemental Information
Standard Frequency Reference		
Accuracy	±[(time since last adjustment × aging rate) + temperature stability + calibration accuracy[b]]	
Temperature Stability		
20 to 30°C	$\pm 2 \times 10^{-6}$	
Full temperature range	$\pm 2 \times 10^{-6}$	
Aging Rate	$\pm 1 \times 10^{-6}$/year[a]	
Achievable Initial Calibration Accuracy	$\pm 1.4 \times 10^{-6}$	
Settability	$\pm 2 \times 10^{-8}$	
Residual FM (Center Frequency = 1 GHz 10 Hz RBW, 10 Hz VBW)		≤10 Hz × N[f] p-p in 20 ms (nominal)
Precision Frequency Reference		
Accuracy	±[(time since last adjustment × aging rate) + temperature stability + calibration accuracy[b]][c]	
Temperature Stability		
20 to 30°C	$\pm 1.5 \times 10^{-8}$	
Full temperature range	$\pm 5 \times 10^{-8}$	
Aging Rate		$\pm 5 \times 10^{-10}$/day (nominal)
Total Aging		
1 Year	$\pm 1 \times 10^{-7}$	
2 Years	$\pm 1.5 \times 10^{-7}$	
Settability	$\pm 2 \times 10^{-9}$	
Warm-up and Retrace[d]		Nominal
300 s after turn on		$\pm 1 \times 10^{-7}$ of final frequency
900 s after turn on		$\pm 1 \times 10^{-8}$ of final frequency
Achievable Initial Calibration Accuracy[e]	$\pm 4 \times 10^{-8}$	

Description	Specifications	Supplemental Information
Standby power to reference oscillator		Not supplied
Residual FM (Center Frequency = 1 GHz 10 Hz RBW, 10 Hz VBW)		≤0.25 Hz × N[f] p-p in 20 ms (nominal)

a. For periods of one year or more.
b. 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.”
c. The specification applies after the receiver has been powered on for four hours.
d. Standby mode does not apply power to the oscillator. Therefore warm-up applies every time the power is turned on. The warm-up reference is one hour after turning the power on. Retracing also occurs every time warm-up occurs. The effect of retracing is included within the “Achievable Initial Calibration Accuracy” term of the Accuracy equation.
e. 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
f. N is the LO multiplication factor.

Description	Specifications	Supplemental Information
Frequency Readout Accuracy	±(marker freq × freq ref accy. + 0.25% × 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 300 kHz for the 0.0.25% × span term, for a total of 355 kHz. In this example, if an instrument had an unusually high RBW centering error of 7% of RBW (77 kHz) and a span error of 0.20% of span (240 kHz), the total actual error (317 kHz) would still meet the computed specification (355 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 50 kHz of error (0.25%) 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 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 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 receiver 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 receiver. 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 receiver 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 receiver, 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		
Swept and FFT		
Option 503	0 Hz, 10 Hz to 3.6 GHz	
Option 508	0 Hz, 10 Hz to 8.4 GHz	
Option 526	0 Hz, 10 Hz to 26.5 GHz	
Option 544	0 Hz, 10 Hz to 44 GHz	
Resolution	2 Hz	
Span Accuracy		
Stepped	±(0.25% × span + horizontal resolution[a])	
Swept	±(0.25% × 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		
Range		
Span = 0 Hz	1 μs to 6000 s	
Span ≥ 10 Hz	1 ms to 4000 s	
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, swept	0 to 500 ms	
Span = 0 Hz or FFT	–150 ms to +500 ms	
Resolution	0.1 μs	

a. Delayed trigger is available with line, video, RF burst and external triggers.

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		–50[b] to –10 dBm plus attenuation (nominal)
Level Accuracy		±2 dB + Absolute Amplitude Accuracy (nominal)
Bandwidth (–10 dB)		
Most cases		16 MHz (nominal)
Sweep Type = FFT; FFT Width = 25 MHz; Span ≥ 8 MHz		30 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.
External Triggers		See “Trigger Inputs (Trigger 1 In, Trigger 2 In)” on page 74

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.

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)	100 ns to 5.0 s	Gate length for the FFT method is fixed at 1.83/RBW, with nominally 2% tolerance.
Gated Frequency and Amplitude Errors		Nominally no additional error for gated measurements when the Gate Delay is greater than the MIN FAST setting
Gate Sources	External 1 External 2 Line RF Burst Periodic	Pos or neg edge triggered

Description	Specifications	Supplemental Information
Number of Frequency Sweep/Step 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)		1 Hz to 8 MHz Bandwidths above 3 MHz are 4, 5, 6, and 8 MHz. 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.	
CISPR Standard Bandwidths		200 Hz, 9 kHz, 120 kHz, 1 MHz	–6 dB, subject to CISPR mask
MIL Standard Bandwidths		10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz	–6 dB
Other Bandwidths		30 Hz, 300 Hz, 3 kHz, 30 kHz, 300 kHz, 3 MHz, 10 MHz	–6 dB
Power bandwidth accuracy[a]			
RBW Range	**CF Range**		
1 Hz to 750 kHz	All	±1.0% (0.044 dB)	
820 kHz to 1.2 MHz	< 3.6 GHz	±2.0% (0.088 dB)	
1.3 to 2.0 MHz	< 3.6 GHz		±0.07 dB (nominal)
2.2 to 3 MHz	< 3.6 GHz		±0.15 dB (nominal)
4 to 8 MHz	< 3.6 GHz		±0.25 dB (nominal)
Accuracy (–3.01 dB bandwidth)[b]			
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 8 MHz RBW CF ≤ 3.6 GHz CF > 3.6 GHz			 ±15% (nominal) ±20% (nominal)
Selectivity (–60 dB/–3 dB)			4.1:1 (nominal)

a. 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 receiver 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 receiver: 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.
b. 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 receiver screen to widen by nominally 6%. This widening declines to 0.6% nominal when the Swp Time Rules key is set to Accuracy instead of Normal. The true bandwidth, which determines the response to impulsive signals and noise-like signals, is not affected by the sweep rate.

Description	Specifications	Supplemental Information
RF Preselector Filters		
Filter Band	**Filter Type**	**6 dB Bandwidth (Nominal)**
20 Hz to 150 kHz	Fixed lowpass	310 kHz
150 kHz to 1 MHz	Fixed bandpass	1.7 MHz
1 to 2 MHz	Fixed bandpass	2.4 MHz
2 to 5 MHz	Fixed bandpass	7.5 MHz
5 to 8 MHz	Fixed bandpass	10 MHz
8 to 11 MHz	Fixed bandpass	9.5 MHz
11 to 14 MHz	Fixed bandpass	9.5 MHz
14 to 17 MHz	Fixed bandpass	10 MHz
17 to 20 MHz	Fixed bandpass	9.5 MHz
20 to 24 MHz	Fixed bandpass	9.5 MHz
24 to 30 MHz	Fixed bandpass	9.0 MHz
30 to 70 MHz	Tracking bandpass	10 MHz
70 to 150 MHz	Tracking bandpass	24 MHz
150 to 300 MHz	Tracking bandpass	28 MHz
300 to 600 MHz	Tracking bandpass	50 MHz
600 MHz to 1 GHz	Tracking bandpass	60 MHz
1 to 2 GHz	Tracking bandpass	180 MHz
2 to 3.6 GHz	Fixed highpass	1.89 GHz (–3 dB corner frequency)

Description	Specifications	Supplemental Information	
Microwave Preselector Bandwidth		Relevant to many options, such as B25 Wide IF Bandwidth, in Bands 1 and higher. Nominal.	
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	53 MHz
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 microwave preselector can have a passband ripple up to 3 dB. To avoid ambiguous results, the –4 dB bandwidth is characterized.

Description	Specification	Supplemental information
Analysis Bandwidth[a]		
Standard	10 MHz	
With *Option B25*	25 MHz	
With *Option B85*	85 MHz	
With *Option B1X*	160 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
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 +30 dBm	
Input Attenuation Range	0 to 70 dB, in 2 dB steps	

Description	Specifications		Supplemental Information
Maximum Safe Input Level	RF Input 1	RF Input 2	Applies with or without preamp
RF Input			
Average Total Power	+30 dBm (1 W)	+30 dBm (1 W)	
Peak Pulse Power	+45 dBm (31.6 W)	+50 dBm (100 W)	(≤10 μs pulse width, ≤1% duty cycle, input attenuation ≥ 30 dB)
Surge Power		2 kW (10 μs pulse width)	
DC voltage			
DC Coupled	±0.2 Vdc	±0.2 Vdc	
AC Coupled	±100 Vdc	±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 503, 508 or 526 (RF/µW)	Option 544 (mmW)	Specifications 20 to 30°C	Specifications 5 to 50°C	Supplemental Information
Frequency Response (Maximum error relative to reference condition (50 MHz) Mechanical attenuator only Non-FFT operation only[b] Preamp off: 10 dB atten Preamp on: 0 dB atten)			RF Input 1: to 44 GHz RF Input 2: to 1 GHz		Refer to the footnote for Band Overlaps on page 14. Modes above 18 GHz[a]
RF Preselector off Preamp off			**20 to 30°C**	5 to 50°C	**95th Percentile** (≈2σ)
3 Hz to 20 Hz	x	x			±0.25 dB (nominal)
20 Hz to 10 MHz	x		±0.60 dB	±0.75 dB	±0.22 dB
20 Hz to 10 MHz		x	±0.60 dB	±0.75 dB	±0.25 dB
10 MHz[c] to 3.6 GHz	x		±0.65 dB	±0.85 dB	±0.22 dB
10 to 50 MHz		x	±0.65 dB	±0.85 dB	±0.21 dB
50 MHz to 3.6 GHz		x	±0.65 dB	±0.85 dB	±0.15 dB
3.5 to 8.4 GHz[de]	x		±1.5 dB	±2.0 dB	±0.47 dB
3.5 to 5.2 GHz[de]		x	±1.6 dB	±3.1 dB	±0.6 dB
5.2 to 8.4 GHz[de]		x	±1.5 dB	±2.0 dB	±0.57 dB
8.3 to 13.6 GHz[de]	x		±1.5 dB	±2.0 dB	±0.46 dB
8.3 to 13.6 GHz[de]		x	±1.5 dB	±2.0 dB	±0.54 dB
13.5 to 17.1 GHz[de]	x		±1.5 dB	±2.1 dB	±0.53 dB
13.5 to 17.1 GHz[de]		x	±1.5 dB	±2.1 dB	±0.64 dB
17.0 to 18.0 GHz[de]	x		±1.5 dB	±2.1 dB	±0.57 dB
18.0 to 22.0 GHz[de]	x		±1.7 dB	±2.6 dB	±0.64 dB
17.0 to 22 GHz[de]		x	±1.7 dB	±2.6 dB	±0.72 dB
22.0 to 26.5 GHz[de]	x		±1.7 dB	±2.6 dB	±0.61 dB
22.0 to 26.5 GHz[de]		x	±1.7 dB	±2.6 dB	±0.71 dB

Description			Specifications		Supplemental Information
26.4 to 34.5 GHz[de]		x	±2.5 dB	±3.5 dB	±0.93 dB
34.4 to 44 GHz[de]		x	±3.2 dB	±4.9 dB	±1.24 dB

a. Signal frequencies above 18 GHz are prone to response errors due to modes in the Type-N connector used. 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. For FFT based measurements, Frequency Response errors are more complicated. One case is where the input signal is at the center frequency of the FFT measurement. In this case, the Frequency Response errors are given by this table. The total absolute amplitude accuracy is given by the combination of the absolute amplitude accuracy at 50 MHz with the Frequency Response from this table. The other case is when the input signal is not at the center frequency of the FFT measurement. In this case, the total frequency response error is computed by adding the RF flatness errors of this table to the IF Frequency Response. The total absolute amplitude accuracy is given by the combination of the absolute amplitude accuracy at 50 MHz with this total frequency response error. An additional error source, the relative error in switching between swept and FFT-based measurements, is nominally ±0.01 dB. The effect of this relative error on absolute measurements is included with the "Absolute Amplitude Accuracy" specifications.
c. 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 show that most instruments meet the specifications, but a few percent of instruments can be expected to have errors exceeding 0.5 dB at 10 MHz at the temperature extreme. The effect at 20 to 50 MHz is negligible, but not warranted.
d. Specifications for frequencies >3.5 GHz apply for sweep rates ≤100 MHz/ms.
e. Microwave preselector centering applied.

Description			Specifications		Supplemental Information
Frequency Response (Maximum error relative to reference condition (50 MHz) Mechanical attenuator only Non-FFT operation only[b] Preamp off: 10 dB atten Preamp on: 0 dB atten)			RF Input 1: to 44 GHz RF Input 2: to 1 GHz		Refer to the footnote for Band Overlaps on page 14. Modes above 18 GHz[a]
		Option 544 (mmW)			
	Option 503, 508 or *526* (RF/μW)				
RF Preselector on Preamp off	↓	↓	**20 to 30°C**	**5 to 50°C**	
					95th Percentile (≈2σ)
3 Hz to 20 Hz	x	x			±0.3dB (nominal)
20 Hz to 300 MHz[c]	x	x	±0.65 dB	±0.9 dB	±0.3 dB
300 MHz to 1 GHz	x	x	±0.65 dB	±0.9 dB	±0.28 dB
1 to 3.6 GHz	x	x	±0.85 dB	±1.3 dB	±0.36 dB
3.5 to 8.4 GHz[de]	x		±1.5 dB	±2.0 dB	±0.47 dB
3.5 to 5.2 GHz[de]		x	±1.6 dB	±3.1 dB	±0.6 dB
5.2 to 8.4 GHz[de]		x	±1.5 dB	±2.0 dB	±0.57 dB
8.3 to 13.6 GHz[de]	x		±1.5 dB	±2.0 dB	±0.46 dB
8.3 to 13.6 GHz[de]		x	±1.5 dB	±2.0 dB	±0.54 dB
13.5 to 17.1 GHz[de]	x		±1.5 dB	±2.1 dB	±0.53 dB
13.5 to 17.1 GHz[de]		x	±1.5 dB	±2.1 dB	±0.64 dB
17.0 to 18.0 GHz[de]	x		±1.5 dB	±2.1 dB	±0.57dB
18.0 to 22.0 GHz[de]	x		±1.7 dB	±2.6 dB	±0.64 dB
17.0 to 22 GHz[de]		x	±1.7 dB	±2.6 dB	±0.72 dB
22.0 to 26.5 GHz[de]	x		±1.7 dB	±2.6 dB	±0.61 dB
22.0 to 26.5 GHz[de]		x	±1.7 dB	±2.6 dB	±0.71 dB
26.4 to 34.5 GHz[de]		x	±2.5 dB	±3.5 dB	±0.93 dB
34.4 to 44 GHz[de]		x	±3.2 dB	±4.9 dB	±1.24 dB

a. Signal frequencies above 18 GHz are prone to response errors due to modes in the Type-N connector used. 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. For FFT based measurements, Frequency Response errors are more complicated. One case is where the input signal is at the center frequency of the FFT measurement. In this case, the Frequency Response errors are given by this table. The total absolute amplitude accuracy is given by the combination of the absolute amplitude accuracy at 50 MHz with the Frequency Response from this table. The other case is when the input signal is not at the center frequency of the FFT measurement. In this case, the total frequency response error is computed by adding the RF flatness errors of this table to the IF Frequency Response. The total absolute amplitude accuracy is given by the combination of the absolute amplitude accuracy at 50 MHz with this total frequency response error. An additional error source, the relative error in switching between swept and FFT-based measurements, is nominally ±0.01 dB. The effect of this relative error on absolute measurements is included with the "Absolute Amplitude Accuracy" specifications.
c. 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 show that most instruments meet the specifications, but a few percent of instruments can be expected to have errors exceeding 0.5 dB at 10 MHz at the temperature extreme. The effect at 20 to 50 MHz is negligible, but not warranted.
d. Specifications for frequencies >3.5 GHz apply for sweep rates ≤100 MHz/ms.
e. Microwave preselector centering applied.

Description		Specifications	Supplemental Information		
IF Frequency Response[a] (Demodulation and FFT response relative to the center frequency)			Modes above 18 GHz[b]		
Freq (GHz)	**Analysis Width**[c] **(MHz)**	**Max Error**[d] (Exception[e])	**Midwidth Error (95th Percentile)**	**Slope (dB/MHz) (95th Percentile)**	**RMS**[f] **(nominal)**
<3.6[g]	≤10	±0.40 dB	±0.12 dB	±0.10	0.04 dB
≥3.6, ≤ 26.5	≤10 Preselected				0.25 dB
>26.5	≤10 Preselected				0.35 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. 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 specification does not apply for frequencies greater than 3.6 MHz from the center in FFT widths of 7.2 to 8 MHz.
f. 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.
g. The Frequency Response with the RF Preselector on is verified at the analyzer center frequency in zero span. When the RF Preselector is a fixed filter (for frequencies up through 30 MHz), the effect of the RF Preselector is included in this Frequency Response specification. When the RF Preselector is a tracking filter, its effect at analysis frequencies away from the center frequency, such as can be measured with FFT-based measurements, can be significant but is not included in this expression of Frequency Response. The nominal response of the RF Preselector relative to its response at the center frequency is −20× log ((Δf/f0)2+1), where f0 in this equation is half of the −6 dB bandwidth of the RF preselector filter.

Description		Specifications	Supplemental Information	
IF Phase Linearity			Deviation from mean phase linearity Modes above 18 GHz[a] RF preselector off only	
Center Freq (GHz)	**Span (MHz)**		**Nominal**	**RMS** (nominal)[b]
≥0.02, <3.6	≤10		±0.5°	0.2°
≥3.6, ≤26.5	≤10		±1.5°	0.4°
>26.5	≤10		±1.4°	0.4°

a. Signal frequencies above 18 GHz are prone to additional response errors due to modes in the Type-N connector used. With the use 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.

Description	Specifications	Supplemental Information
Absolute Amplitude Accuracy RF Preselector off and on Preamp off	RF Input 1: to 44 GHz RF Input 2: to 1 GHz	
RF Input 1		95th percentile
At 50 MHz[a][b]		
20 to 30°C	±0.33 dB	±0.25 dB
5 to 50°C	±0.42 dB	
At all frequencies[a][b]		
20 to 30°C	±(0.33 dB + frequency response)	
5 to 50°C	±(0.42 dB+ frequency response)	
RF Input 2		
At 50 MHz[a][c]		
20 to 30°C	±0.36 dB	±0.27 dB
5 to 50°C	±0.45 dB	
At all frequencies[a][c]		
20 to 30°C	±(0.36 dB + frequency response)	
5 to 50°C	±(0.45 dB + frequency response)	
CISPR requirements	This instrument meets or exceeds the current CISPR 16-1-1:2019 sine wave accuracy requirements from 15 to 35°C	
Amplitude Reference Accuracy		±0.05 dB (nominal)

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; 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. When using Time Domain scan, only the 95th percentile specification applies.
b. Same settings as footnote a, except that the signal level at the preamp input is –40 to –80 dBm. Total power at the preamp (dBm) = total power at the input (dBm) minus input attenuation (dB).
c. Same settings as footnote a, except that the signal level at the preamp input is –40 to –80 dBm. Total power at the preamp (dBm) = total power at the input (dBm) minus input attenuation (dB) – 9 dB.

Description	Specifications	Supplemental Information
Input Attenuation Switching Uncertainty		Refer to the footnote for Band Overlaps on page 14
Atten >2 dB, preamp off (Relative to 10 dB (reference setting))		
50 MHz (reference setting)	±0.20 dB	±0.08 dB (typical)

Description	Specifications		Supplemental Information
RF Input VSWR	RF Input 1: to 44 GHz		
at tuned frequency	RF Input 2: to 1 GHz		
10 dB Atten, 50 MHz, RF Presel off			1.07:1 (nominal)
RF Preselector off			
Preamp off	Input Attenuation		Typical
	0 dB	**≥ 10 dB**	
DC Coupled			≥ 10 dB Attenuation
9 kHz[a] to 1 GHz	---	---	
1 to 18 GHz	3.0:1	2.0:1	1.8:1
18 to 26.5 GHz[b]	3.0:1	2.0:1	1.8:1
26.5 to 40 GHz	3.0:1	2.5:1	1.8:1
40 to 44 GHz	---	---	2.0:1
AC Coupled (*Option 503, 508*, *526*)			
50 MHz to 1 GHz	---	---	
1 to 18 GHz	3.0:1	2.0:1	1.8:1
18 to 26.5 GHz[b]	3.0:1	2.4:1	2.0:1
RF Preselector on			
Preamp off	Input Attenuation		
	0 dB	**≥ 10 dB**	
DC Coupled			
9 kHz to 1 GHz	2.0:1	1.2:1	
1 to 26.5 GHz[b]	3.0:1	2.0:1	1.8:1
26.5 to 40 GHz	3.0:1	2.5:1	1.8:1
40 to 44 GHz	---	---	2.0:1
AC Coupled (*Option 503, 508*, *526*)			
50 MHz to 1 GHz	2.0:1	1.2:1	
1 to 18 GHz	3.0:1	2.0:1	1.8:1
18 to 26.5 GHz[b]	3.0:1	2.4:1	2.0:1

a. For preamp on case, low frequency is 100 kHz.
b. For *Option 526*, VSWR specifications above 18 GHz apply only with *Option C35* (3.5 mm connector).

Description	Specifications	Supplemental Information
Resolution Bandwidth Switching Uncertainty		Relative to reference BW of 30 kHz
1.0 Hz to 1.5 MHz RBW	±0.05 dB	
1.6 MHz to 3 MHz RBW	±0.10 dB	
Manually selected wide RBWs: 4, 5, 6, 8 MHz	±1.0 dB	

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	

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	*Option 503, 508* or *526* (RF/μW)	*Option 544* (mmW)	Specifications	Supplemental Information
Total Measurement Uncertainty				95th Percentile (≈ 2σ)
Signal level 0 to 90 dB below reference point, RF attenuation 0 to 40 dB, RBW ≤ 1 MHz, 20° to 30° C: AC coupled 10 MHz to 26.5 GHz DC coupled 9 kHz to 44 GHz				
RF Presel off Preamp off				
9 kHz to 2 GHz	x	x		± 0.5 dB
2 to 3.6 GHz	x	x		± 0.6 dB
3.6 to 8 GHz	x			± 0.8 dB
3.6 to 8 GHz		x		± 1.7 dB
8 to 18 GHz	x			± 1.1 dB
8 to 18 GHz		x		± 1.3 dB
18 to 26.5 GHz	x	x		± 1.6 dB
26.5 to 40 GHz		x		± 1.7 dB
40 to 44 GHz		x		± 2.3 dB
RF Presel on Preamp off				
9 kHz to 2 GHz	x	x		± 0.5 dB
2 to 3.6 GHz	x	x		± 0.5 dB
3.6 to 8 GHz	x			± 0.8 dB
3.6 to 8 GHz		x		± 1.7 dB
8 to 18 GHz	x			± 1.1 dB
8 to 18 GHz		x		± 1.3 dB
18 to 26.5 GHz	x	x		± 1.6 dB
26.5 to 40 GHz		x		± 1.7 dB
40 to 44 GHz		x		± 2.3 dB

Description	Specifications	Supplemental Information
Display Scale Fidelity[a][b]		
Absolute Log-Linear Fidelity (Relative to the reference condition for Input 1: –25 dBm input through 10 dB attenuation, thus –35 dBm at the input mixer)		
Input mixer level[c]	**Linearity**	
–80 dBm ≤ ML ≤ –10 dBm	±0.10 dB	
ML < –80 dBm	±0.15 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 ±0.045 dB[e]
instability term		Up to ±0.018 dB
slope term		From equation[f]
prefilter term		Up to ±0.005 dB[g]

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.

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

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 On. Dither increases the noise level by nominally only 0.24 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.

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 ±0.025 dB. The instability term is ±0.018 dB. The slope term evaluates to ±0.050 dB. The prefilter term applies and evaluates to the limit of ±0.005 dB. The sum of all these terms is ±0.098 dB.

e. Errors at high mixer levels will nominally be well within the range of ±0.045 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. Slope error will nominally be well within the range of ±0.0009 × (P1 – P2). P1 and P2 are defined in footnote e.
g. 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
Display Units	dBm, dBμV, dBmV, dBμA, dBmA, Watts, Volts, Amps, dBμV/m, dBμA/m, dBpT, dBG, dBpW	

Description	Specifications	Supplemental Information
Available Detectors	Normal, Peak, Sample, Negative Peak, Average	Average detector works on RMS, Voltage and Logarithmic scales
	Quasi-Peak, EMI-Average, RMS-Average	Meet CISPR 16-1-1:2019 requirements

Description	Specifications	Supplemental Information
Amplitude Probability Distribution		Meets CISPR16-1-1:2019 requirements.
Dynamic Range	> 70 dB	
Amplitude Accuracy		<± 2.7 dB
Maximum Measureable Time Period (no dead time)	2 minutes	
Minimum Measureable Probability	10^{-7}	
Amplitude Level Assignment	1000 levels	
Sampling Rate	≥ 10 MSa/s	Within a 1 MHz RBW
Amplitude Resolution	0.1881 dB	

Dynamic Range

Gain Compression

Description			Specifications	Supplemental Information
1 dB Gain Compression Point (Two-tone)[a,b,c,d]			Maximum power at mixer[e]	
(RF Input 1[f])				
		Option 544 (mmW)		
	Option 503, 508 or *526* (RF/μW)			
RF Preselector on or off, Preamp off				
9 kHz to 10 MHz	x	x		+4 dB (nominal)
10 to 500 MHz	x	x	0 dBm	+3 dBm (typical)
500 MHz to 3.6 GHz	x	x	+1 dBm	+5 dBm (typical)
3.6 to 26.5 GHz	x	x	0 dBm	+4 dBm (typical)
26.4 to 44 GHz		x	–3 dBm	+2 dBm (typical)

a. Large signals, even at frequencies not shown on the screen, can cause the receiver 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. Time Domain scan nominal values verified using a 1 kHz RBW with 50 MHz 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 receivers in a way that makes this receiver more flexible. In other receivers, the RL controlled how the measurement was performed as well as how it was displayed. Because the logarithmic amplifier in these receivers had both range and resolution limitations, this behavior was necessary for optimum measurement accuracy. The logarithmic amplifier in this receiver, however, is implemented digitally such that the range and resolution greatly exceed other instrument limitations. Because of this, the receiver 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. When using Time Domain scan, all indicated values shown here are nominal values.
e. Mixer power level (dBm) = input power (dBm) – input attenuation (dB) (–9 dB for RF Input 2).
f. RF Input 2 operates to 1 GHz. The 1 dB gain compression is nominally 9 dB higher.

Description		Specifications	Supplemental Information
Clipping (ADC Over-range)		Maximum power at mixer[a]	
Any signal offset		–10 dBm	Low frequency exceptions[b]
Signal offset > 5 times IF prefilter bandwidth and IF Gain set to Low			+12 dBm (nominal)
IF Prefilter Bandwidth			
Zero Span or Swept, 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 8 MHz	< 7.99 MHz		10.9 MHz

a. Mixer power level (dBm) = input power (dBm) – input attenuation (dB) (–9 dB for RF Input 2).
b. The ADC clipping level declines at low frequencies (below 50 MHz) when the LO feed through (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.

Displayed Average Noise Level

Description	*Option 503, 508* or *526* (RF/μW)	*Option 544* (mmW)	Specifications		Supplemental Information
Displayed Average Noise Level (DANL)[a] (RF Input 1[b])			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 14.
RF Preselector off, Preamp off			**20 to 30°C**	**5 to 50°C**	Typical DANL including NFE[c]
3 Hz to 10 Hz	x	x			–97dBm (nominal, no NFE)
20 Hz[d]	x	x	–97 dBm	–96 dBm	
100 Hz[d]	x	x	–106 dBm	–105 dBm	
1 kHz[d]	x	x	–118 dBm	–117 dBm	
9 kHz[d]	x	x	–119 dBm	–118 dBm	
100 kHz[d]	x	x	–131 dBm	–130 dBm	
1 MHz[d]	x	x	–150 dBm	–149 dBm	
10 MHz to 2.1 GHz	x	x	–150 dBm	–149 dBm	–158 dBm
2.1 to 3.6 GHz	x	x	–148 dBm	–147 dBm	–157 dBm
3.5 GHz to 8.4 GHz	x		–148 dBm	–147 dBm	–159 dBm
3.5 GHz to 8.4 GHz		x	–145 dBm	–144 dBm	–153 dBm
8.3 GHz to 13.6 GHz	x		–147 dBm	–145 dBm	–158 dBm
8.3 GHz to 13.6 GHz		x	–147 dBm	–145 dBm	–156 dBm
13.5 to 17.1 GHz	x	x	–141 dBm	–139 dBm	–151 dBm
17.0 to 20.0 GHz	x	x	–142 dBm	–140 dBm	–152 dBm
20.0 to 26.5 GHz	x	x	–135 dBm	–133 dBm	–146 dBm
26.4 to 34.5 GHz		x	–141 dBm	–138 dBm	–148 dBm
34.4 to 44 GHz		x	–135 dBm	–132 dBm	–143 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. Does not apply to Time Domain scan.

b. RF Input 2 operates to 1 GHz. The DANL is nominally 11 dB higher for RF Input 2.
c. NFE = Noise Floor Extension. Typical DANL including NFE = (Typical DANL – DANL improvement with NFE).
d. 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 25 kHz, and “Best Wide Offset ϕ Noise" for frequencies above 25 kHz.

Description	Option 503, 508 or 526 (RF/µW)	Option 544 (mmW)	Specifications		Supplemental Information
Displayed Average Noise Level (DANL)[a] (RF Input 1[b])			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 14. Typical DANL including NFE[c]
RF Preselector on, Preamp off			**20 to 30°C**	**5 to 50°C**	
3 Hz to 10 Hz	x	x			–92 dBm (nominal, no NFE)
20 Hz[d]	x	x	–92 dBm	–91 dBm	–100 dBm[e]
100 Hz[d]	x	x	–101 dBm	–100 dBm	–109 dBm[e]
1 kHz[d]	x	x	–114 dBm	–113 dBm	–120 dBm[e]
9 kHz[d]	x	x	–118 dBm	–117 dBm	–132 dBm
100 kHz[d]	x	x	–130 dBm	–129 dBm	–143 dBm
1 to 3 MHz[d]	x	x	–147 dBm	–146 dBm	–158 dBm
3 to 30 MHz[d]	x	x	–150 dBm	–149 dBm	–160 dBm
30 to 300 MHz	x	x	–151 dBm	–150 dBm	–161 dBm
300 to 600 MHz	x	x	–153 dBm	–152 dBm	–164 dBm
600 MHz to 1 GHz	x	x	–151 dBm	–150 dBm	–162 dBm
1 to 2 GHz	x	x	–150 dBm	–148 dBm	–161 dBm
2 to 2.5 GHz	x	x	–152 dBm	–151 dBm	–164 dBm
2.5 to 3 GHz	x	x	–151 dBm	–149 dBm	–163 dBm
3 to 3.6 GHz	x	x	–148 dBm	–147 dBm	–161 dBm
3.5 to 8.4 GHz	x		–148 dBm	–147 dBm	–159 dBm
3.5 to 8.4 GHz		x	–145 dBm	–144 dBm	–153 dBm
8.3 to 13.6 GHz	x		–147 dBm	–145 dBm	–158 dBm
8.3 to 13.6 GHz		x	–147 dBm	–145 dBm	–156 dBm
13.5 to 17.1 GHz	x	x	–141 dBm	–139 dBm	–151 dBm
17.0 to 20.0 GHz	x	x	–142 dBm	–140 dBm	–152 dBm
20.0 to 26.5 GHz	x	x	–135 dBm	–133 dBm	–146 dBm
26.4 to 34.5 GHz		x	–141 dBm	–138 dBm	–148 dBm

Description			Specifications		Supplemental Information
34.4 to 44 GHz		x	–135 dBm	–132 dBm	–143 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. Does not apply to Time Domain scan.
b. RF Input 2 operates to 1 GHz. The DANL is nominally 11 dB higher for RF Input 2.
c. NFE = Noise Floor Extension. Typical DANL including NFE = (Typical DANL – DANL improvement with NFE).
d. 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 25 kHz, and “Best Wide Offset ϕ Noise" for frequencies above 25 kHz.
e. NFE is not part of the difference between warranted and typical specifications at this frequency.

Description	*Option 503, 508* or *526* (RF/μW)	*Option 544* (mmW)	Specifications	Supplemental Information
Indicated Noise (Receiver)[a] (RF Input 1[b]) Calculated[c]: Derived from DANL data				Input terminated EMI Average detector 0 dB input attenuation IF Gain = High All indicated RBW are CISPR BW, except as noted.
RF Preselector on, Preamp off				Typical Indicated Noise including NFE[c]
3 Hz to 10 Hz (1 Hz RBW)	x	x		+17 dBμV (nominal)
20 Hz (1 Hz RBW)[d]	x	x		+10 dBμV[e]
100 Hz (10 Hz)[d]	x	x		+10 dBμV[e]
1 kHz (100 Hz)[d]	x	x		+9 dBμV[e]
9 kHz (200 Hz)	x	x		–2 dBμV
100 kHz (200 Hz)	x	x		–13 dBμV
1 to 3 MHz (9 kHz)	x	x		–11 dBμV
3 to 30 MHz (9 kHz)	x	x		–13 dBμV
30 to 300 MHz (120 kHz)	x	x		–3 dBμV
300 to 600 MHz (120 kHz)	x	x		–6 dBμV
600 MHz to 1 GHz (120 kHz)	x	x		–4 dBμV
1 to 2 GHz (1 MHz)	x	x		+6 dBμV
2 to 2.5 GHz (1 MHz)	x	x		+3 dBμV
2.5 to 3 GHz (1 MHz)	x	x		+4 dBμV
3 to 3.6 GHz (1 MHz)	x	x		+6 dBμV
3.5 to 8.4 GHz (1 MHz)	x			+8 dBμV
3.5 to 8.4 GHz (1 MHz)		x		+14 dBμV
8.3 to 13.6 GHz (1 MHz)	x			+9 dBμV
8.3 to 13.6 GHz (1 MHz)		x		+11 dBμV
13.5 to 17.1 GHz (1 MHz)	x	x		+16 dBμV
17.0 to 20.0 GHz (1 MHz)	x	x		+15 dBμV
20.0 to 26.5 GHz (1 MHz)	x	x		+21 dBμV
26.4 to 34.5 GHz (1 MHz)		x		+19 dBμV

Description			Specifications	Supplemental Information
34.4 to 44 GHz (1 MHz)		x		+24 dBμV

a. Does not apply to Time Domain scan.
b. RF Input 2 operates to 1 GHz. The DANL is nominally 11 dB higher for RF Input 2.
c. Typical Indicated Noise including NFE = Typical DANL + RBW correction + Log Detector correction – DANL Improvement with NFE +107.
d. Indicated RBW is a 3 dB bandwidth.
e. NFE is not part of the difference between warranted and typical specifications at this frequency.

Description			Specifications	Supplemental Information
DANL and Indicated Noise Improvement with Noise Floor Extension[a]				95th Percentile (≈ 2 σ)
Option 544 (mmW)				
Option 503, 508 or *526* (RF/μW)				
RF Preselector off				**Preamp off**
RF Input 1	↓	↓		
20 MHz to 3.6 GHz	x	x		7 dB
3.5 to 8.4 GHz	x			8 dB
3.5 to 8.4 GHz		x		6 dB
8.3 to 13.6 GHz	x			8 dB
8.3 to 13.6 GHz		x		8 dB
13.5 to 17.1 GHz	x	x		6 dB
17.0 to 26.5 GHz	x	x		7 dB
26.5 to 34.5 GHz		x		6 dB
34.4 to 44 GHz		x		6 dB
RF Input 2				
20 MHz to 1 GHz	x	x		5 dB
RF Preselector on				
RF Input 1				
9 to 150 kHz	x	x		7 dB
150 kHz to 1 MHz	x	x		7 dB
1 to 2 MHz	x	x		9 dB

Description			Specifications	Supplemental Information
2 to 5 MHz	x	x		10 dB
5 to 8 MHz	x	x		9 dB
8 to 11 MHz	x	x		9 dB
11 to 14 MHz	x	x		9 dB
DANL and Indicated Noise Improvement with Noise Floor Extension (cont.)				
14 to 17 MHz	x	x		9 dB
17 to 20 MHz	x	x		9 dB
20 to 24 MHz	x	x		10 dB
24 to 30 MHz	x	x		10 dB
30 to 70 MHz	x	x		9 dB
70 to 150 MHz	x	x		8 dB
150 to 300 MHz	x	x		9 dB
300 to 600 MHz	x	x		9 dB
600 MHz to 1 GHz	x	x		8 dB
1 to 2 GHz	x	x		9 dB
2 to 3.6 GHz	x	x		10 dB
3.5 to 8.4 GHz	x			8 dB
3.5 to 8.4 GHz		x		6 dB
8.3 to 13.6 GHz	x			8 dB
8.3 to 13.6 GHz		x		8 dB
13.5 to 17.1 GHz	x	x		6 dB
17.0 to 26.5 GHz	x	x		7 dB
26.5 to 34.5 GHz		x		6 dB
34.4 to 44 GHz		x		6 dB

a. This statement on the improvement in DANL is based on the accuracy of the fit of the noise floor model to the measured values of that noise. This measure of the performance correlates well with improvement versus frequency. The improvement actually measured and specified in "Examples of Effective DANL" usually meet these limits as well, but not with the confidence in some cases. Does not apply to Time Domain scan.

Description	Specifications	Supplemental Information
DANL and Indicated Noise Improvement with Noise Floor Extension[a]		95th Percentile (≈ 2 σ)
RF Preselector on		**Preamp off**
RF Input 2		
9 to 150 kHz		6 dB
150 kHz to 1 MHz		7 dB
1 to 2 MHz		10 dB
2 to 5 MHz		9 dB
5 to 8 MHz		8 dB
8 to 11 MHz		9 dB
11 to 14 MHz		9 dB
14 to 17 MHz		10 dB
17 to 20 MHz		9 dB
20 to 24 MHz		10 dB
24 to 30 MHz		10 dB
30 to 70 MHz		9 dB
70 to 150 MHz		9 dB
150 to 300 MHz		9 dB
300 to 600 MHz		9 dB
600 MHz to 1 GHz		9 dB

a. This statement on the improvement in DANL is based on the accuracy of the fit of the noise floor model to the measured values of that noise. This measure of the performance correlates well with improvement versus frequency. The improvement actually measured and specified in "Examples of Effective DANL" usually meet these limits as well, but not with the confidence in some cases. Does not apply to Time Domain scan.

Spurious Responses

Description		Specifications		Supplemental Information
Spurious Responses RF Preselector on and off		RF Input 1: to 44 GHz RF Input 2: to 1 GHz		Preamp Off[a] (see Band Overlaps on page 14)
Residual Responses[bc] 200 kHz to 8.4 GHz (swept) Zero span or FFT or other frequencies		–100 dBm		–100 dBm (nominal)
Image Responses				
Tuned Freq (f)	**Excitation Freq**	**Mixer Level**[d]	**Response**	
10 MHz to 26.5 GHz	f+45 MHz	–10 dBm	–80 dBc	–113 dBc (typical)
10 MHz to 3.6 GHz	f+10245 MHz	–10 dBm	–80 dBc	–107 dBc (typical)
10 MHz to 3.6 GHz	f+645 MHz	–10 dBm	–80 dBc	–108 dBc (typical)
3.5 to 13.6 GHz	f+645 MHz	–10 dBm	–78 dBc	–88 dBc (typical)
13.5 to 17.1 GHz	f+645 MHz	–10 dBm	–74 dBc	–85 dBc (typical)
17.0 to 22 GHz	f+645 MHz	–10 dBm	–70 dBc	–82 dBc (typical)
22 to 26.5 GHz	f+645 MHz	–10 dBm	–68 dBc	–78 dBc (typical)
26.5 to 34.5 GHz	f+645 MHz	–30 dBm	–70 dBc	–94 dBc (typical)
34.4 to 44 GHz	f+645 MHz	–30 dBm	–60 dBc	–79 dBc (typical)
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])	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
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 (f > 600 MHz from carrier 10 MHz to 3.6 GHz)		–10 dBm	–60 dBc + 20 × log(N[f])	–90 dBc + 20 × log(N) (typical)

Description	Specifications	Supplemental Information
Sidebands, offset from CW signal		
≤200 Hz		–76 dBc[h] (nominal)
200 Hz to 3 kHz		–66 dBc[h] (nominal)
3 kHz to 30 kHz		–65 dBc (nominal)
30 kHz to 10 MHz		–58 dBc (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. Mixer Level for RF Input 2 = Input Level – 9 dB – Input Attenuation + Preamp Gain.
b. Input terminated, 0 dB input attenuation.
c. RF Input 2 performance = RF Input 1 performance + 11 dB for Residual Responses.
d. RF Input 1 Mixer Level = Input Level – Input Attenuation. RF Input 2 Mixer Level = Input Level – Input attenuation – 9 dB.
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	*Option 503, 508* or *526* (RF/μW)	*Option 544* (mmW)	Specifications	Supplemental Information
Second Harmonic Distortion[a] (Input power = –9 dBm Input attenuation = 6 dB RF Input 1[b])				
RF Preselector off Preamp off			**SHI**[c]	**Typical**
Source Frequency				
10 MHz to 1.0 GHz	x	x	+45 dBm	+54 dBm
1.0 to 1.8 GHz	x	x	+41 dBm	+50 dBm
1.8 to 6.8 GHz	x		+65 dBm	+68 dBm
1.8 to 3 GHz		x	+58 dBm	+64 dBm
3 to 6.8 GHz		x	+60 dBm	+69 dBm
6.8 to 11 GHz	x	x	+55 dBm	+64 dBm
11 to 13.25 GHz	x	x	+50 dBm	+60 dBm
13.2 to 22 GHz		x	+44 dBm	+51 dBm
RF Preselector on, Preamp off				
Source Frequency				
10 to 30 MHz	x	x	+47 dBm	+50 dBm
30 to 500 MHz	x	x	+57 dBm	+63 dBm
500 MHz to 1 GHz	x	x	+45 dBm	+47 dBm
1 to 1.6 GHz	x	x	+58 dBm	+70 dBm
1.6 to 1.8 GHz	x	x	+46 dBm	+52 dBm

Description			Specifications	Supplemental Information
Second Harmonic Distortion RF Preselector on, Preamp off Source Frequency (cont.)				
1.8 to 6.8 GHz	x		+65 dBm	+68 dBm
1.8 to 3 GHz		x	+58 dBm	+64 dBm
3 to 6.8 GHz		x	+60 dBm	+69 dBm
6.8 to 11 GHz	x	x	+55 dBm	+64 dBm
11 to 13.25 GHz	x	x	+50 dBm	+60 dBm
13.2 to 22 GHz		x	+44 dBm	+51 dBm

a. When using Time Domain scan, all indicated values shown here are nominal values.
b. RF Input 2 operates to 1 GHz. The second harmonic distortion intercept is nominally 9 dB higher for RF Input 2.
c. SHI = second harmonic intercept.

Third Order Intermodulation

Description	Specifications		Supplemental Information
Third Order Intermodulation[a] (Tone separation > 5 times IF Prefilter Bandwidth[b] Verification conditions[c] RF Input 1[d])			
	Intercept[e]		
RF Preselector off, Preamp off	**20 to 30°C**	**5 to 50°C**	**Typical**
10 to 100 MHz	+12 dBm	+10 dBm	+17 dBm
100 to 400 MHz	+15 dBm	+13 dBm	+20 dBm
400 MHz to 1.7 GHz	+16 dBm	+14 dBm	+20 dBm
1.7 to 3.6 GHz	+16 dBm	+14 dBm	+19 dBm
3.5 to 8.4 GHz	+15 dBm	+13 dBm	+18 dBm
8.3 to 13.6 GHz	+15 dBm	+13 dBm	+18 dBm
13.5 to 26.5 GHz	+10 dBm	+8 dBm	+14 dBm
26.4 to 44 GHz	+10 dBm	+8 dBm	+13 dBm
RF Preselector on, Preamp off			
10 to 30 MHz	+12 dBm	+11 dBm	+16 dBm
30 MHz to 1 GHz	+12.5 dBm	+11.5 dBm	+15 dBm
1 to 1.5 GHz	+12.5 dBm	+11.5 dBm	+14 dBm
1.5 to 3.6 GHz	+14.5 dBm	+13.5 dBm	+16 dBm
3.5 to 8.4 GHz	+15 dBm	+13 dBm	+18 dBm
8.3 to 13.6 GHz	+15 dBm	+13 dBm	+18 dBm
13.5 to 26.5 GHz	+10 dBm	+8 dBm	+14 dBm
26.4 to 44 GHz	+10 dBm	+8 dBm	+13 dBm

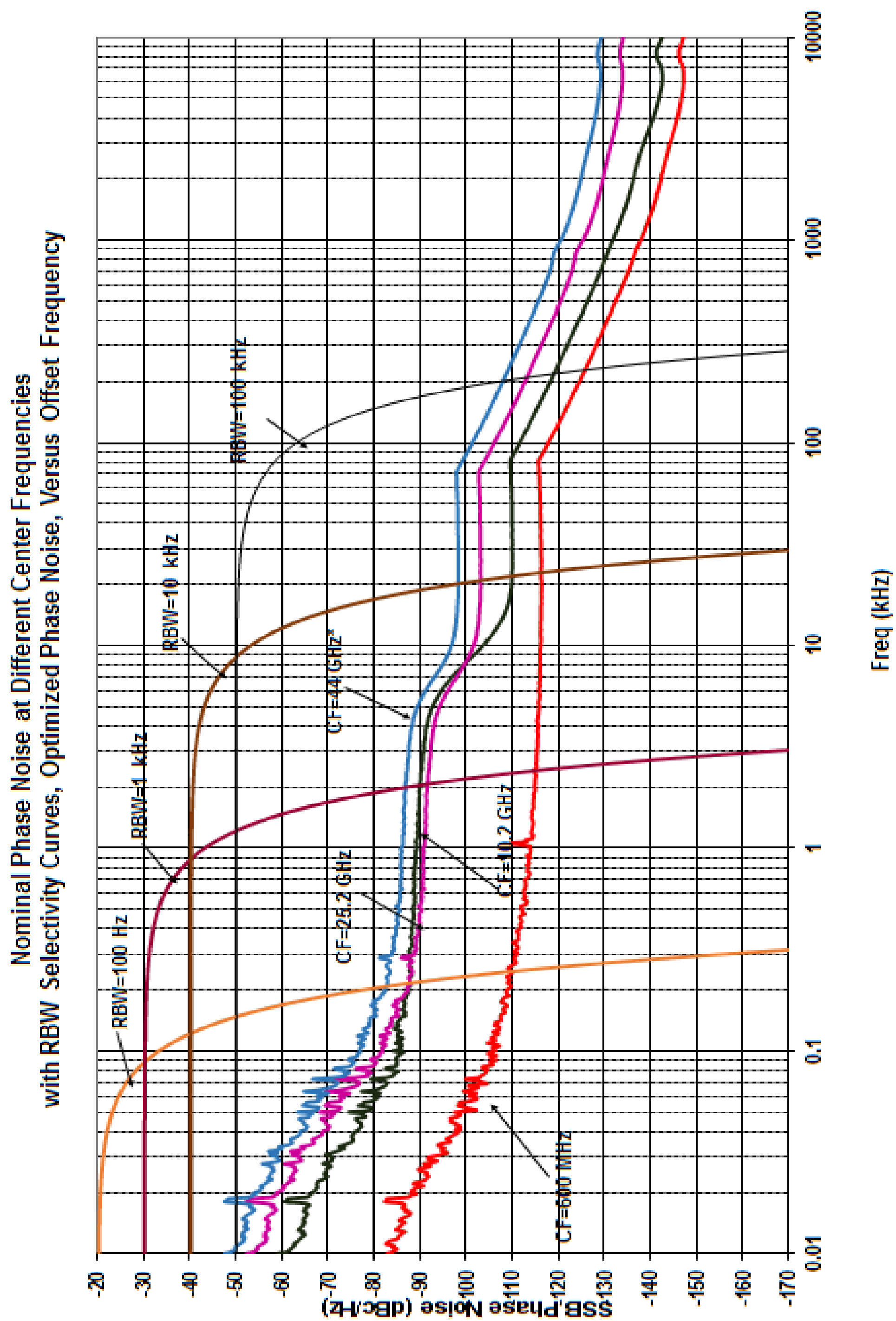
a. When using Time Domain scan, all indicated values shown here are nominal values.
b. See the IF Prefilter Bandwidth table in the Gain Compression specifications on page 43. When the tone separation condition is met, the effect on TOI of the setting of IF Gain is negligible. TOI is verified with IF Gain set to its best case condition, which is IF Gain = Low.
c. TOI is verified with two tones, each at –14 dBm at the input with 4 dB input attenuation, spaced by 100 kHz. Time Domain scan nominal TOI values verified with two tones. each at-14 dBm at the input with 4 dB input attenuation, spaced by 50 MHz.
d. RF Input 2 operates to 1 GHz. The intercept is nominally 9 dB higher for RF Input 2.
e. 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.

Phase Noise

Description	Specifications		Supplemental Information
Phase Noise			Noise Sidebands
(Center Frequency = 1 GHz[a] Best-case Optimization[b] Internal Reference[c])			
Offset Frequency	**20 to 30°C**	**Full range**	
10 Hz			–80 dBc/Hz (nominal)
100 Hz	–91 dBc/Hz	–90 dBc/Hz	–100 dBc/Hz (typical)
1 kHz			–112 dBc/Hz (nominal)
10 kHz	–113 dBc/Hz	–113 dBc/Hz	–114 dBc/Hz (typical)
100 kHz	–116 dBc/Hz	–115 dBc/Hz	–117 dBc/Hz (typical)
1 MHz	–135 dBc/Hz	–134 dBc/Hz	–136 dBc/Hz (typical)
10 MHz[d]			–148 dBc/Hz (nominal)

a. 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 increases by $20 \times \log[(f + 0.3225)/1.3225]$. For mid-offset frequencies such as 10 kHz, band 0 phase noise changes as $20 \times \log[(f + 5.1225)/6.1225]$. For mid-offset frequencies in other bands, phase noise changes as $20 \times \log[(f + 0.3225)/6.1225]$ except f in this expression should never be lower than 5.8. For wide offset frequencies, offsets above about 100 kHz, phase noise increases as $20 \times \log(N)$. N is the LO Multiple as shown on page 14; f is in GHz units in all these relationships; all increases are in units of decibels.
b. Noise sidebands for lower offset frequencies, for example, 10 kHz, apply with the phase noise optimization (PhNoise Opt) set to Best Close-in ϕ Noise. Noise sidebands for higher offset frequencies, for example, 1 MHz, as shown apply with the phase noise optimization set to Best Wide-offset ϕ Noise.
c. 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. The internal 10 MHz reference phase noise is about –120 dBc/Hz at 10 Hz offset; external references with poorer phase noise than this will cause poorer performance than shown.
d. 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 Center Frequencies [Plot]



Power Suite Measurements (RF Preselector off only)

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)	±0.82 dB	±0.23 dB (95th percentile)

a. See "Absolute Amplitude Accuracy" on page 35.
b. See "Frequency and Time" on page 14.
c. Expressed in dB.

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

Description	Specifications	Supplemental Information
Adjacent Channel Power (ACP)		RF Input 1, RF Preselector Off
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	±0.14 dB	At ACPR range of –30 to –36 dBc with optimum mixer level[h]
MS (UE) / 10 MHz	±0.21 dB	At ACPR range of –40 to –46 dBc with optimum mixer level[i]
BTS / 5 MHz	±0.49 dB[h]	At ACPR range of –42 to –48 dBc with optimum mixer level[j]
BTS / 10 MHz	±0.44 dB	At ACPR range of –47 to –53 dBc with optimum mixer level[i]
BTS / 5 MHz	±0.21 dB	At –48 dBc non-coherent ACPR[k]
Dynamic Range		RRC weighted, 3.84 MHz noise bandwidth

Noise Correction	Offset Freq	Method	ACLR (typical)[l]	Optimum ML[m] (Nominal)
Off	5 MHz	Filtered IBW	–73 dB	–8 dBm
Off	5 MHz	Fast	–72 dB	–9 dBm
Off	10 MHz	Filtered IBW	–79 dB	–2 dBm
On	5 MHz	Filtered IBW	–78 dB	–8 dBm
On	5 MHz	Filtered IBW	–78 dB[n]	–8 dBm
On	10 MHz	Filtered IBW	–82 dB	–2 dBm

Description	Specifications	Supplemental Information
RRC Weighting Accuracy[o]		
White noise in Adjacent Channel		0.00 dB nominal
TOI-induced spectrum		0.001 dB nominal
rms CW error		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 –19 dBm, so the input attenuation must be set as close as possible to the average input power – (–19 dBm). For example, if the average input power is –7 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. 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.

m. ML is Mixer Level, which is defined to be the input signal level minus attenuation.

n. All three 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[l] 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 operating region in which the analyzer third-order dynamic range is near its best.

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					RF Input 1, RF Preselector Off	
Case: Radio Std = 3GPP W-CDMA					RRC weighted, 3.84 MHz noise bandwidth	
ACPR Dynamic Range (5 MHz offset, Two carriers)					–70 dB (nominal)	
ACPR Accuracy (Two carriers, 5 MHz offset, –48 dBc ACPR)					±0.42 dB (nominal)	
ACPR Accuracy (4 carriers)						
Radio	**Offset**	**Coher**[a]	**NC**		**UUT ACPR Range**	**MLOpt**[b]
BTS	5 MHz	no	Off	±0.39 dB	–42 to –48 dB	–18 dBm
BTS	5 MHz	no	On	±0.15 dB	–42 to –48 dB	–21 dBm
ACPR Dynamic Range (4 carriers, 5 MHz offset)					**Nominal DR**	Nominal MLOpt[c]
Noise Correction (NC) off Noise Correction (NC) on					–64 dB –72 dB	–18 dBm –21 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.
c. 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] (1 to 3.6 GHz)	96.7 dB	101.7 dB (typical)
Sensitivity, absolute (1 to 3.6 GHz)	–85.4 dBm	
Accuracy		Attenuation = 10 dB
20 Hz to 3.6 GHz		±0.29 dB (95th Percentile)
3.5 to 8.4 GHz		±1.17 dB (95th Percentile)
8.3 to 13.6 GHz		±1.54 dB (95th Percentile)

a. The dynamic range is specified with the mixer level at +3 dBm, where up to 1 dB of compression can occur, degrading accuracy by 1 dB.

Description	Specifications	Supplemental Information
Spectrum Emission Mask		Table-driven spurious signals; measurement near carriers
Case: Radio Std = cdma2000		
Dynamic Range, relative (750 kHz offset[a][b])	78.9 dB	85.0 dB (typical)
Sensitivity, absolute (750 kHz offset[c])	–100.7 dBm	
Accuracy (750 kHz offset)		
Relative[d]	±0.12 dB	
Absolute[e] (20 to 30°C)	±0.88 dB	±0.27 dB (95th Percentile ≈ 2σ)
Case: Radio Std = 3GPP W–CDMA		
Dynamic Range, relative (2.515 MHz offset[a][d])	81.9 dB	88.2 dB (typical)
Sensitivity, absolute (2.515 MHz offset[c])	–100.7 dBm	
Accuracy (2.515 MHz offset)		
Relative[d]	±0.12 dB	
Absolute[e] (20 to 30°C)	±0.86 dB	±0.27 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 35 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.

Option 503:	Frequency range, 3 Hz to 3.6 GHz
Option 508:	Frequency range, 3 Hz to 8.4 GHz
Option 526:	Frequency range, 3 Hz to 26.5 GHz
Option 544:	Frequency range, 3 Hz to 44 GHz
Option B1X:	Analysis bandwidth, 160 MHz
Option B25:	Analysis bandwidth, 25 MHz
Option B85:	Analysis bandwidth, 85 MHz
Option CR3:	Connector Rear, 2nd IF output
Option ESC:	External Source Control
Option EXM:	External Mixing
Option P03:	Preamplifier option
Option P08:	Preamplifier option
Option P26:	Preamplifier option
Option P44:	Preamplifier option
Option PFR:	Precision Frequency Reference
Option RT1	Real Time Analysis up to 160 MHz BW, basic detection license
Option SS1:	Additional removable solid state drive
Option TDS:	Time Domain Scan
Option YAS:	Y-Axis Screen Video output
N9063EMOE:	Analog Demodulation measurement application
N9068EMOE:	Phase Noise measurement application
N9069EMOE:	Noise Figure 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 = 4,500 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%, +40°C (non-condensing) Maximum Relative Humidity (non-condensing): 95%RH up to 40°C, decreases linearly to 45%RH at 55°C

a. The maximum operating temperature derates linearly from altitude of 4,600 m to 2,300 m.

Description	Specifications	Supplemental Information
Environmental		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	Specifications	Supplemental Information
Screening Effectiveness	Instrument meets CISPR16-1-1 requirements for Screening Effectiveness with exceptions at f = finput	

Description	Specification	Supplemental Information
Acoustic Noise		Values given are per ISO 7779 standard in the "Operator Sitting" position
Ambient Temperature		
< 40°C		Nominally under 55 dBA Sound Pressure. 55 dBA is generally considered suitable for use in quiet office environments.
≥ 40°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	
Frequency	50, 60 or 400 Hz	
High Range		
Voltage	220/240 V	
Frequency	50 or 60 Hz	
Power Consumption, On	450 W	Fully loaded with options
Power Consumption, Standby	20 W	Standby power is not supplied to frequency reference oscillator.

Description	Supplemental Information	
Measurement Speed[a]	Nominal	
Local measurement and display update rate[bc]	4 ms (250/s)	
Remote measurement and LAN transfer rate[bc]	5 ms (200/s)	
Marker Peak Search	1.5 ms	
Center Frequency Tune and Transfer (RF)	20 ms	
Center Frequency Tune and Transfer (μW)	47 ms	
Measurement/Mode Switching	39 ms	
W-CDMA ACLR measurement time	See page 60	

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 integer format, markers Off, single sweep, measured with IBM compatible PC with 2.99 GHz Pentium® 4 with 2 GB RAM running Windows® XP, Keysight I/O Libraries Suite Version 14.1, one meter GPIB cable, National Instruments PCI-GPIB Card and NI-488.2 DLL.

Description	Specifications	Supplemental Information
Radio Disturbance Measuring Apparatus	CISPR 16-1-1:2019	The features in this instrument comply with the performance requirements of this basic standard.[a]

a. The use of Noise Floor Extension (NFE) is required to meet the "isolated pulse" test case in Bands B, C, and D. In addition, when making measurements in Band B below 160 k Hz using Time Domain scans or making measurements using meters in Monitor Spectrum, NFE is also required to meet the 1 Hz pulse repetition frequency (p.r.f.) test case for the quasi-peak detector (QPD) and for the 5 Hz p.r.f. test case for the RMS-Average detector.

Description	Specifications	Supplemental Information
Display[a]		
Resolution	1280 × 800	Capacitive multi-touch screen
Size		269 mm (10.6 in) diagonal (nominal)

a. The LCD display is manufactured using high precision technology. However, if a static image is displayed for a lengthy period of time (~2 hours) you might encounter "image sticking" that may last for approximately 2 seconds. This is normal and does not affect the measurement integrity of the product in any way.

Description	Specifications	Supplemental Information
Data Storage		
Internal Total		Removable solid state drive (> 80 GB)
Internal User		> 9 GB available on separate partition for user data

Description	Specifications	Supplemental Information
Weight		Weight without options
Net		24 kg (52 lbs) (nominal)
Shipping		36 kg (79 lbs) (nominal)
Cabinet Dimensions		Cabinet dimensions exclude front and rear protrusions.
Height	177 mm (7 inches)	
Width	426 mm (16.8 inches)	
Length	556 mm (21.9 inches)	

Inputs/Outputs

Front Panel

Description	Specifications	Supplemental Information
RF Input Connector		
RF Input 1	Type-N female (standard)	
	3.5 mm male (Option C35)	*Option C35* is only available with *Option 526*
	2.4 mm male (*Option 544*)	
Impedance		50Ω (nominal)
RF Input 2	Type-N female 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		1.2 A (nominal)
Port not marked with Lightning Bolt	0.5 A	

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: Receiver noise sidebands and spurious response performance may be affected by the quality of the external reference used. See footnote[c] in the Phase Noise specifications within the Dynamic Range section on page 57.
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 (Trigger 1 In, Trigger 2 In)		Either trigger source may be selected
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 VGA compatible		
Connector	15-pin mini D-SUB	
Format		XGA (60 Hz vertical sync rates, non-interlaced) Analog RGB
Monitor Output 2		
Mini DisplayPort		

Description	Specifications	Supplemental Information
Analog Out		Refer to Chapter 11, "Option YAS - Y-Axis Screen Video Output", on page 149 for more information.
Connector	BNC female	
Impedance		<140Ω (nominal)

Description	Specifications	Supplemental Information
Noise Source Drive +28 V (Pulsed)		
Connector	BNC female	
Output voltage on	28.0 ± 0.1 V	60 mA maximum current
Output voltage off	< 1.0 V	

Description	Specifications	Supplemental Information
SNS Series Noise Source		For use with Keysight Technologies SNS Series noise sources

Description	Specifications	Supplemental Information
USB Ports		
Host, Super Speed		2 ports
Compatibilty	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)	

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	RJ45 Ethertwist	1000 BaseT

Description	Specifications	Supplemental Information
Aux I/O Connector	25-pin D-SUB	

Regulatory Information

This product is designed for use in INSTALLATION CATEGORY II and POLLUTION DEGREE 2 and MEASUREMENT CATEGORY NONE 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 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.
ccr.keysight@keysight.com	The Keysight email address is required by EU directives applicable to our product.
ICES/NMB-001	“This ISM device complies with Canadian ICES-001.” “Cet appareil ISM est conforme a la norme NMB du Canada.”
ISM 1-B (GRP.1 CLASS B)	This is a symbol of an Industrial Scientific and Medical Group 1 Class B product. (CISPR 11, Clause 4)
	The CSA mark is a registered trademark of the CSA International.
	The RCM mark is a registered trademark of the Australian Communications and Media Authority.
	This symbol indicates separate collection for electrical and electronic equipment mandated under EU law as of August 13, 2005. All electric and electronic equipment are required to be separated from normal waste for disposal (Reference WEEE Directive 2002/96/EC).
	China RoHS regulations include requirements related to packaging, and require compliance to China standard GB18455-2001.
	This symbol indicates compliance with the China RoHS regulations for paper/fiberboard packaging.
	South Korean Certification (KC) mark; includes the marking’s identifier code which follows this format: R-R-Kst--ZZZZZZZZZZZZZ.

EMC: Complies with the essential requirements of the European EMC Directive 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 B
– 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 40 dB in the range 80 MHz - 6 GHz, above the Spurious Responses, Residual Responses specification of -100 dBm) when in the presence of ambient electromagnetic field of 3V/m.

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

Keysight X-Series MXE EMI Receiver
N9038B

Specification Guide

2 I/Q Analyzer

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

Specifications Affected by I/Q Analyzer:

The specifications in this chapter apply for RF Input 1 and RF Preselector off.

Specification Name	Information
Number of Frequency Display Trace Points (buckets)	Does not apply.
Resolution Bandwidth	See “Frequency” on page 83 in this chapter.
Video Bandwidth	Not available.
Clipping-to-Noise Dynamic Range[a]	See “Clipping-to-Noise Dynamic Range” on page 84 in this chapter.
Resolution Bandwidth Switching Uncertainty	Not specified because it is negligible.
Available Detectors	Does not apply.
Spurious Responses[a]	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[a]	See “IF Frequency Response” 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.
IF Phase Linearity[a]	See “IF Phase Linearity” on page 34 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[a]	See “Data Acquisition” on page 85 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.

a. This specification addresses the performance of the IQ Analyzer using the 10 MHz analysis bandwidth. For IQ Analyzer performance specifications in the optional 25 MHz or 85 MHz analysis bandwidths, see the *Option B25* or *Option B85* chapter.

Frequency

Description	Specifications	Supplemental Information
Frequency Span		
Standard instrument	10 Hz to10 MHz	
Option B25	10 Hz to 25 MHz	
Option B85	10 Hz to 85 MHz	
Option B1X	10 Hz to 160 MHz	
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)		
Standard instrument	10 Hz to 10 MHz	
Option B25	10 Hz to 25 MHz	
Option B85	10 Hz to 85 MHz	
Option B1X	10 Hz to 160 MHz	

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	8,000,000 IQ sample pairs	Waveform Measurement[a]
Sample Rate	100 MSa/s	IF Path ≤25 MHz
Option B85 or *B1X*	400 MSa/s	IF Path ≥ 85 MHz
IQ Pairs		Integer submultiples of 15Mpairs/s depending on the span for spans of 8 MHz or narrower
ADC Resolution	16 Bits	IF Path ≤25 MHz
Option B85 or *B1X*	14 Bits	IF Path ≥ 85 MHz

a. This can also be accessed with the remote programming command of "read:wav0?".

3 Option TDS - Time Domain Scan

This chapter contains specifications for the Time Domain Scan measurement application.

Specifications Affected by Time Domain Scan:

Specification Name	Information
Absolute Amplitude Accuracy	See “Absolute Amplitude Accuracy” on page 35 of the core specifications.
Total Measurement Uncertainty	See “Total Measurement Uncertainty” on page 39 of the core specifications.
1dB Gain Compression Point (Two-tone)	See “1 dB Gain Compression Point (Two-tone)” on page 42 of the core specifications.
Displayed Average Noise Level	See “Displayed Average Noise Level” on page 44 of the core specifications
Indicated Noise (Receiver)	See “Indicated Noise (Receiver)” on page 48 of the core specifications.
DANL and Indicated Noise Improvement with Noise Floor Extension	See “DANL and Indicated Noise Improvement with Noise Floor Extension” on page 49 of the core specifications.
Second Harmonic Distortion	See “Second Harmonic Distortion” on page 54 of the core specifications.
Third Order Intermodulation	See “Third Order Intermodulation” on page 56 of the core specifications.

General Specifications

Description	Specifications	Supplemental Information
Frequency Range		
Option 503	20 Hz to 3.6 GHz	
Option 508	20 Hz to 8.4 GHz	
Option 526	20 Hz to 26.5 GHz	
Option 544	20 Hz to 44 GHz	

Description	Specifications	Supplemental Information
Trace Detectors		
Quasi-Peak, Peak, EMI-Average, RMS-Average	Meet CISPR 16-1-1:2019 requirements	
Negative peak, Voltage Average		

Description	Specifications	Supplemental Information
TDS Measurement		
Maximum FFT Bandwidth (Frequency segment processed in parallel)		
20 Hz to 3.6 GHz	8 MHz	
3.6 to 26.5 GHz	12.5 MHz	
FFT overlap	> 92%	
Measurement time	10 ms to 30 s	
Trace Point Range	1 to 4,000,001	
Frequency step size	0.25 × Resolution Bandwidth	

Description	Specification	Supplemental Information
Resolution Bandwidth (RBW)		
EMI Bandwidths (CISPR compliant)	200 Hz, 9 kHz, 120 kHz, 1 MHz	
EMI Bandwidths (MIL-STD-461 compliant)	10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz	
Other Bandwidths (–6 dB)	1 Hz, 30 Hz, 300 Hz, 3 kHz, 30 kHz, 300 kHz, 3 MHz, 10 MHz	

Description	Specification	Supplemental Information
RF Preselector Filters		
Filter Band	Filter type	6 dB Bandwidth (nominal)
20 Hz to 150 kHz	Fixed Lowpass	310 kHz
150 kHz - 1 MHz	Fixed Bandpass	1.7 MHz
1 to 2 MHz	Fixed Bandpass	2.4 MHz
2 to 5 MHz	Fixed Bandpass	7.5 MHz
5 to 8 MHz	Fixed Bandpass	10 MHz
9 to 11 MHz	Fixed Bandpass	9.5 MHz
11 to 14 MHz	Fixed Bandpass	9.5 MHz
14 to 17 MHz	Fixed Bandpass	10 MHz
17 to 20 MHz	Fixed Bandpass	9.5 MHz
20 to 24 MHz	Fixed Bandpass	9.5 MHz
24 to 30 MHz	Fixed Bandpass	9.0 MHz
30 - 70 MHz	Tracking Bandpass	10 MHz
70 - 150 MHz	Tracking Bandpass	24MHz
150 - 300 MHz	Tracking Bandpass	28MHz
300 - 600 MHz	Tracking Bandpass	50 MHz
600 MHz - 1 GHz	Tracking Bandpass	60 MHz
1 to 2 GHz	Tracking Bandpass	180 MHz (–3 dB corner frequency)
2 to 3.6 GHz	Fixed Highpass	1.89 GHz (–3 dB corner frequency)

Description	Specification	Supplemental Information
TDS Measurement Speed		
CISPR band B, 150 kHz to 30 MHz, RBW = 9 kHz, measurement time = 100 ms, Peak Detector		12.1 s (nominal)
CISPR band B, 150 kHz to 30 MHz, RBW = 9 kHz, measurement time = 1 s, Quasi-Peak Detector		181.7 s (nominal)
CISPR band C/D, 30 MHz to 1000 MHz, RBW = 120 kHz, measurement time = 10 ms Peak Detector		3.1 s (nominal)
CISPR band C/D, 30 MHz to 1000 MHz, RBW = 9 kHz, measurement time = 10 ms Peak Detector		18.1 s (nominal)
CISPR band C/D, 30 MHz to 1000 MHz, RBW = 120 kHz, measurement time = 1 s, Quasi-Peak Detector		211.5 s (nominal)

4 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.

The specifications in this chapter apply for RF Input 1 and RF Preselector off.

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				Specifications	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	$(f + f_c + 22.5\ \text{MHz})/2$	–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	$2 \times f_c - f + 45\ \text{MHz}$	–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)				Modes above 18 GHz[b]		
		Max Error[d] (Exceptions[e])		**Midwidth Error (95th Percentile)**	**Slope (dB/MHz) (95th Percentile)**	**RMS**[f] **(nominal)**
Freq (GHz)	**Analysis Width**[c] **(MHz)**	**20 to 30°C**	**Full range**			
≤3.6	10 to ≤25	±0.45 dB	±0.45 dB	±0.12 dB	±0.10	0.051 dB
3.6 to 44	10 to ≤25[g]					0.45 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. 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°. The effect of these modes is not included within the Max Error
specification. The effect on the RMS is negligible, except to note that the modes make the ratio of worst-case error to RMS error unusually high.
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 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 specification does not apply for frequencies greater than 3.6 MHz from the center in FFT widths of 7.2 to 8 MHz.
f. 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.
g. For information on the microwave preselector which affects the passband for frequencies above 3.6 GHz, see “Microwave Preselector Bandwidth” on page 26.

Description			Specifications	Supplemental Information	
IF Phase Linearity				Deviation from mean phase linearity	
Center Freq (GHz)	**Span (MHz)**	**Microwave Preselector**		**Nominal**	**RMS** (nominal)[a]
≥0.02, <3.6	≤25	N/A		±0.5°	0.2°
≥3.6, ≤44	≤25	Off		±1.5°	0.4°

a. 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.

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 4		–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 (IQ pairs)			
IQ Analyzer	8,000,000 IQ sample pairs		Waveform Measurement[a]
89600 VSA software	**32-bit Data Packing**	**64-bit Data Packing**	**Memory**
	536 MSa (2^{29} Sa)	268 MSa (2^{28} Sa)	256 MB
Sample Rate	90 MSa/s		
ADC Resolution	14 bits		

a. This can also be accessed with the remote programming command of "read:wav0?".

5 Option B85/B1X - 85/160 MHz Analysis Bandwidth

This chapter contains specifications for the *Option B85/B1X*, 85/160 MHz Analysis Bandwidth, and are unique to this IF Path.

Specifications Affected by Analysis Bandwidth

The specifications in this chapter apply when the 85 or 160 MHz path is in use. In IQ Analyzer, this will occur when the IF Path is set to 85 or 160 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 B85/B1X* on spurious responses. Most of the warranted elements of the Spurious Responses on page 52 still apply without changes, but the revised-for-B85/B1X table 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.
Displayed Average Noise Level	See specifications in this chapter.
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 35.)
Frequency Range Over Which Specifications Apply	Specifications on this bandwidth only apply with center frequencies of 100 MHz and higher.

Other Analysis Bandwidth Specifications

Description	Specifications	Supplemental Information
SFDR (Spurious-Free Dynamic Range)		For 85 MHz analysis BW, Test conditions[a]
Signal Frequency and spurious response anywhere within 85 MHz BW		–76 dBc (nominal)

a. Signal level is –6 dB relative to full scale at the center frequency. See the Full Scale table.

Description	Specifications	Supplemental Information
SFDR (Spurious-Free Dynamic Range)		For 160 MHz analysis BW, Test conditions[a]
Signal Frequency within ±12 MHz of center		–72 dBc (nominal)
Signal Frequency anywhere within 160 MHz analysis BW		
Spurious response within ±63 MHz of center		-71 dBc (nominal)
Response anywhere within 160 MHz analysis BW		-69 dBc (nominal)

a. Signal level is –6 dB relative to full scale at the center frequency. See the Full Scale table.

Description		Specifications		Supplemental Information
Spurious Responses[a] (see Band Overlaps on page 14)				Preamp Off[b]
Residual Responses[c]				–100 dBm (nominal)
Image Responses				
Tuned Freq (f)	**Excitation Freq**	**Mixer Level**[d]	**Response**	
10 MHz to 3.6 GHz	f+10200 MHz	–10 dBm	–77 dBc	–121 dBc (nominal)
10 MHz to 3.6 GHz	f+600 MHz	–10 dBm	–77 dBc	–124 dBc (nominal)
3.5 to 13.6 GHz	f+600 MHz	–10 dBm	–75 dBc	–93 dBc (nominal)
13.5 to 17.1 GHz	f+600 MHz	–10 dBm	–71 dBc	–88 dBc (nominal)
17.0 to 22 GHz	f+600 MHz	–10 dBm	–67 dBc	–88 dBc (nominal)
22 to 26.5 GHz	f+600 MHz	–10 dBm	–65 dBc	–85 dBc (nominal)
26.5 to 34.5 GHz	f+600 MHz	–30 dBm	–60 dBc	–80 dBc (nominal)
34.4 to 44 GHz	f+600 MHz	–30 dBm	–57 dBc	–80 dBc (nominal)
Other Spurious Responses Carrier Frequency ≤ 26.5 GHz				
First RF Order[e] (f ≥ 10 MHz from carrier)		–10 dBm	$-80\text{ dBc} + 20 \times \log(N^f)$	–116 dBc (nominal)
Higher RF Order[g] (f ≥ 10 MHz from carrier)		–40 dBm	$-75\text{ dBc} + 20 \times \log(N^f)$	–103 dBc (nominal)
Carrier Frequency >26.5 GHz First RF Order[e] (f ≥ 10 MHz from carrier)		–30 dBm		–101 dBc (nominal)
Higher RF Order[g] (f ≥ 10 MHz from carrier)		–30 dBm		–100 dBc (nominal)
LO-Related Spurious Response Offset from carrier 200 Hz to 10 MHz		–10 dBm		–97 dBc (nominal)
Line-Related Spurious Responses				$-73\text{ dBc} + 20 \times \log(N^f)$ (nominal)

a. Microwave 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.

Description	Specifications	Supplemental Information
IF Residual Responses		Relative to full scale; see the Full Scale table for details.
Band 0		–96 dBFS (nominal)

Description			Specifications	Supplemental Information	
IF Frequency Response[a]				Relative to center frequency Modes above 18 GHz[b]	
Center Freq (GHz)	**Span (MHz)**	**Microwave Preselector**		**Typical**	**RMS** (nominal)[c]
≥0.15, <3.6	≤85	n/a	±0.6 dB	±0.17 dB	0.05 dB
≥0.15, <3.6	≤160	n/a		±0.2 dB (nominal)	0.07 dB
>3.6		On		See note[d]	

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. 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. The passband shape will be greatly affected by the microwave preselector. See “Microwave Preselector Bandwidth” on page 26.

Description			Specifications	Supplemental Information	
IF Phase Linearity				Deviation from mean phase linearity	
Center Freq (GHz)	**Span (MHz)**	**Microwave Preselector**		**Peak-to-peak (nominal**)	**RMS** (nominal)[a]
≥0.03, <3.6	≤85	n/a		1.6°	0.54°
	≤160	n/a		4.7°	1.23°

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.

Description	Specification	Supplemental Information
Full Scale (ADC Clipping)[a]		
Default settings, signal at CF		
(IF Gain = Low; IF Gain Offset = 0 dB)		
Band 0		–8 dBm mixer level[b] (nominal)
Band 1 through 6		–7 dBm mixer level[b] (nominal)
High Gain setting, signal at CF		
(IF Gain = High; IF Gain Offset = 0 dB)		
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]
IF Gain Offset ≠ 0 dB, signal at CF		See formula[d], 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.
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		Two tones of equal level 1 MHz tone separation Each tone –11 dB relative to full scale (ADC clipping) IF Gain = High IF Gain Offset = 0 dB
		Freq Option ≤ 526
Band 0		–77 dBc (nominal)
Band 1		–75 dBc (nominal)
Band 2		–74 dBc (nominal)
Band 3		–76 dBc (nominal)
Band 4		–74 dBc (nominal)

Description		Specifications	Supplemental Information
Noise Density			0 dB attenuation
Band	**Freq (GHz)**[a]	**IF Gain**[b] **= Low**	
0	1.80	–146 dBm/Hz	

a. 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.
b. 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		140 dB nominal, log averaged, 1 Hz RBW, IF Gain = Low, IF Gain Offset = 0 dB

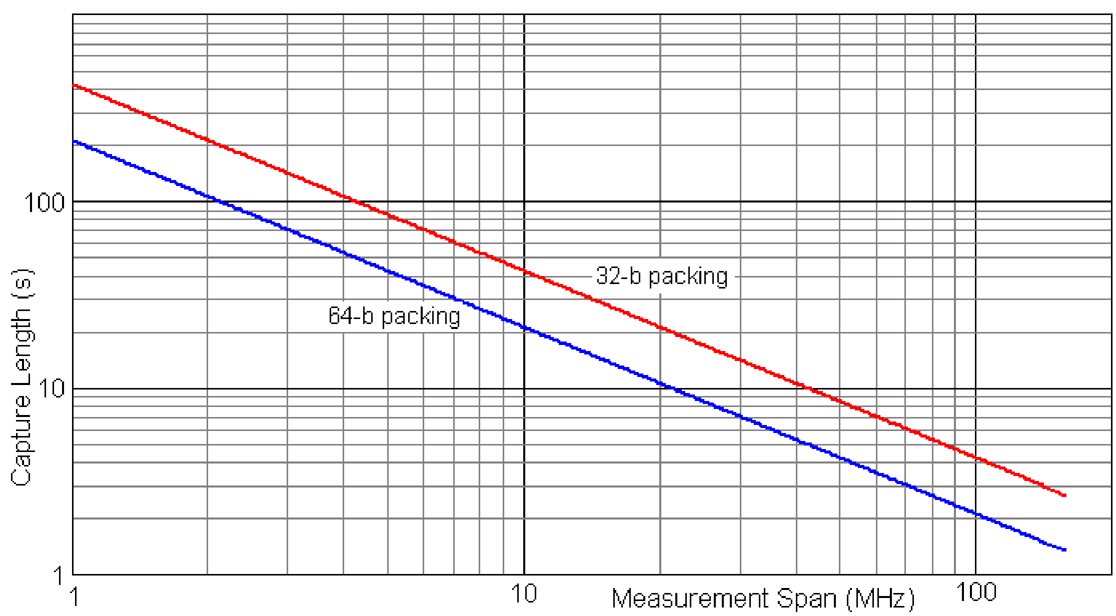
a. For the clipping level, see the table above, "Full Scale." Note that the clipping level is not a warranted specification, and has particularly high uncertainty at high microwave frequencies.
b. The noise level is specified in the table above, "Displayed Average Noise Level." Please consider these 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 is 2.27 dB above the DANL. 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	8,000,000 IQ sample pairs		Waveform Measurement[a]
Advanced Tools	Data Packing		89600 VSA software
	32-bit	64-bit	
Length (IQ sample pairs)	536 MSa (2^{29} Sa)	268 MSa (2^{28} Sa)	2 GB total memory
Sample Rate (IQ Pairs)	1.25 x IFBW		
ADC Resolution	14 bits		

a. This can also be accessed with the remote programming command of "read:wav0?".

Capture Time [Plot]



NOTE This plot is based on the full access to the 2 GB deep capture memory which requires either the 89600 VSA.

6 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 page.

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, EMI Receiver Mode		322.5 MHz
I/Q Analyzer Mode		
IF Path ≤ 25 MHz		322.5 MHz
IF Path 85 or 160 MHz		300 MHz
Conversion Gain at 2nd IF output center frequency		−1 to +4 dB (nominal) plus RF frequency response[a]
Bandwidth		
Low band		Up to 140 MHz (nominal)[b]
High band		
With microwave preselector		Depends on RF center frequency[c]
Residual Output Signals		−94 dBm or lower (nominal)

a. “Conversion Gain” is defined from RF input to IF Output 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.
c. The YIG-tuned microwave 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. (Refer to page 23 for details.) The microwave preselector effect will dominate the passband width.

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Specification Guide

7 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		
Mixer Bias			
Bias Current			Short circuit current
Range	±10 mA		
Resolution	10 μA		
Accuracy			±20 μA (nominal)
Output impedance			477Ω (nominal)
Bias Voltage			Open circuit
Range			±3.7 V (nominal)
IF Input			
Maximum Safe Level	+7 dBm		
Center Frequency			
IF BW ≤25 MHz	322.5 MHz		includes swept
IF BW = 85 MHz	300.0 MHz		
IF BW = 160 MHz	300.0 MHz		
Bandwidth			Supports all optional IFs
ADC Clipping Level[a]			−14.5 ±2.0 dBm (nominal)
1 dB Gain Compression[a]			−2 dBm (nominal)
Gain Accuracy[b]	20 to 30°C	Full Range	
Standard (or Option B25)	±1.2 dB	±2.5 dB	Swept and narrowband
Option B85/B1X			±1.2 dB (nominal)

Description		Specifications	Supplemental Information
IF Frequency Response			RMS (nominal)
CF	**Width**		
322.5 MHz	±5 MHz		0.05 dB
322.5 MHz	±12.5 MHz		0.07 dB
300 MHz	±80 MHz		0.5 dB
Noise Figure (322.5 MHz, swept operation)			9 dB (nominal)
VSWR			1.3:1 (nominal)

a. These specifications apply at the IF input port. The on-screen and mixer-input levels scale with the conversion loss and corrections values.
b. 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.

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 7.0 GHz[b]	+15.0 to 18.0 dBm	+14.5 to 18.5 dBm	
7.0 to 8.72 GHz[b]	+15.0 to 18.0 dBm	+13.5 to 18.8 dBm	
7.8 to 14.1 GHz[c]	+14.0 to 18.5 dBm	Not specified	
Second Harmonic			–20 dB (nominal)
Fundamental Feedthrough and Undesired Harmonics[c]			–15 dB (nominal)
VSWR			< 2.2:1 (nominal)

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 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 7.0 GHz.

8 Options P03, P08, P26, P44 - Preamplifiers

This chapter contains the specifications for the EMI Receiver *Options P03, P08*, *P26* and *P44* 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 27.
Gain Compression	See specifications in this chapter.
DANL with NFE Off	See specifications in this chapter.
DANL with NFE (Noise Floor Extension)	See “DANL and Indicated Noise Improvement with Noise Floor Extension” on page 49 of the core specifications.
Frequency Response	See specifications in this chapter.
Absolute Amplitude Accuracy	See “Absolute Amplitude Accuracy” on page 35 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 Specification

Description	Specifications	Supplemental Information
Preamp Gain		
RF Preselector off[a]		Maximum[b]
100 kHz to 3.6 GHz		+20 dB (nominal)
3.6 to 26.5 GHz		+35 dB (nominal)
26.5 to 44 GHz		+40 dB (nominal)
RF Preselector on		
1 kHz to 3.6 GHz		+20 dB (nominal)
3.6 to 26.5 GHz		+35 dB (nominal)
26.5 to 44 GHz		+40 dB (nominal)

a. The preamp follows the input attenuator, AC/DC coupling switch, and precedes the input mixer. In low band, it follows the RF Preselector. In high band, it precedes the microwave preselector.

b. Preamp Gain directly affect 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 26.5 GHz.

Description	Option 503, 508 or 526 (RF/μW)	Option 544 (mmW)	Specifications	Supplemental Information
1 dB Gain Compression Point (Two-tone)[abcd]			Maximum power at mixer[e]	
(RF Input 1[f])				
RF Preselector off, Preamp on[g]				
10 MHz to 3.6 GHz	x			–13 dBm (nominal)
10 MHz to 3.6 GHz		x		–13 dBm (nominal)
3.6 to 26.5 GHz				
Tone spacing 100 kHz to 20 MHz	x			–26 dBm (nominal)
Tone spacing 100 kHz to 20 MHz		x		–30 dBm (nominal)
Tone spacing > 70 MHz	x	x		–16 dBm (nominal)
26.4 to 44 GHz		x		–30 dBm (nominal)
RF Preselector on, Preamp on[g]				
9 kHz to 10 MHz	x	x		–16 dBm (nominal)
10 MHz to 2 GHz	x			–18 dBm (typical)
10 MHz to 2 GHz		x		–21 dBm (typical)
2 to 3.6 GHz	x			–16 dBm (typical)
2 to 3.6 GHz		x		–17 dBm (typical)
3.6 to 26.5 GHz				
Tone spacing 100 kHz to 20 MHz	x			–26 dBm (nominal)
Tone spacing 100 kHz to 20 MHz		x		–30 dBm (nominal)
Tone spacing > 70 MHz	x	x		–16 dBm (nominal)
26.4 to 44 GHz		x		–30 dBm (nominal)

a. Large signals, even at frequencies not shown on the screen, can cause the receiver 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. Time Domain scan nominal values verified using a 1 kHz RBW with 50 MHz 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 receivers in a way that makes this receiver more flexible. In other receivers, the RL controlled how the measurement was performed as well as how it was displayed. Because the logarithmic amplifier in these receivers had both range and resolution limitations, this behavior was necessary for optimum measurement accuracy. The logarithmic amplifier in this receiver, however, is implemented digitally such that the range and resolution greatly exceed other instrument limitations. Because of this, the receiver 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. When using Time Domain scan, all indicated values shown here are nominal values.
e. Mixer power level (dBm) = input power (dBm) – input attenuation (dB) (–9 dB for RF Input 2).
f. RF Input 2 operates to 1 GHz. The 1 dB gain compression is nominally 9 dB higher.
g. Total power at the preamp (dBm) = total power at the input (dBm) – input attenuation (dB).

Description	Specifications	Supplemental Information
Absolute Amplitude Accuracy RF Preselector off and on Preamp on	RF Input 1: to 44 GHz RF Input 2: to 1 GHz	
RF Input 1		95th percentile
At 50 MHz[ab] 20 to 30°C 5 to 50°C	 ±0.33 dB ±0.42 dB	 ±0.25 dB
At all frequencies[ab] 20 to 30°C 5 to 50°C	 ±(0.33 dB + frequency response) ±(0.42 dB+ frequency response)	
RF Input 2		
At 50 MHz[ac] 20 to 30°C 5 to 50°C	 ±0.36 dB ±0.45 dB	±0.27 dB
At all frequencies[ac] 20 to 30°C 5 to 50°C	 ±(0.36 dB + frequency response) ±(0.45 dB + frequency response)	
CISPR requirements	This instrument meets or exceeds the current CISPR 16-1-1:2019 sine wave accuracy requirements from 15 to 35°C	
Amplitude Reference Accuracy		±0.05 dB (nominal)

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; 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. When using Time Domain scan, only the 95th percentile specification applies.

b. Same settings as footnote a, except that the signal level at the preamp input is –40 to –80 dBm. Total power at the preamp (dBm) = total power at the input (dBm) minus input attenuation (dB).

c. Same settings as footnote a, except that the signal level at the preamp input is –40 to –80 dBm. Total power at the preamp (dBm) = total power at the input (dBm) minus input attenuation (dB) – 9 dB.

Description			Specifications		Supplemental Information
Frequency Response (Maximum error relative to reference condition (50 MHz) Mechanical attenuator only Non-FFT operation only[b] Preamp off: 10 dB atten Preamp on: 0 dB atten)			RF Input 1: to 44 GHz RF Input 2: to 1 GHz		Refer to the footnote for Band Overlaps on page 14. Modes above 18 GHz[a]
Option 544 (mmW)		↓			
Option 503, 508 or *526* (RF/µW)	↓				
RF Preselector off Preamp on			**20 to 30°C**	5 to 50°C	**95th Percentile** (≈2σ)
100 kHz to 3.6 GHz	X		±0.75 dB	±1.0 dB	±0.29 dB
100 kHz to 10 MHz		X	±0.75 dB	±1.0 dB	±0.43 dB
10[c] to 50 MHz		X	±0.75 dB	±1.0 dB	±0.29 dB
50 MHz to 3.6 GHz		X	±0.75 dB	±1.0 dB	±0.31 dB
3.5 to 8.4 GHz[d,e]	X		±1.85 dB	±2.5 dB	±0.63 dB
3.5 to 5.2 GHz[d,e]		X	±2.2 dB	±3.4 dB	±0.9 dB
5.2 to 8.4 GHz[d,e]		X	±1.85 dB	±2.5 dB	±0.7 dB
8.3 to 13.6 GHz[d,e]	X		±1.95 dB	±2.4 dB	±0.64 dB
8.3 to 13.6 GHz[d,e]		X	±1.95 dB	±2.4 dB	±0.79 dB
13.5 to 17.1 GHz[d,e]	X		±1.8 dB	±2.4 dB	±0.81 dB
13.5 to 17.1 GHz[d,e]		X	±1.8 dB	±2.4 dB	±0.88 dB
17.0 to 18.0 GHz[d,e]	X		±2.0 dB	±2.5 dB	±0.95 dB
18.0 to 22.0 GHz[d,e]	X		±2.85 dB	±3.75 dB	±1.23 dB
17.0 to 22 GHz[d,e]		X	±2.85 dB	±3.75 dB	±1.07 dB
22.0 to 26.5 GHz[d,e]	X		±2.6 dB	±3.55 dB	±1.37 dB
22.0 to 26.5 GHz[d,e]		X	±2.6 dB	±3.55 dB	±1.03 dB
26.4 to 34.5 GHz[d,e]		X	±3.0 dB	±4.5 dB	±1.35 dB
34.4 to 44 GHz[d,e]		X	±4.1 dB	±6.0 dB	±1.69 dB

a. Signal frequencies above 18 GHz are prone to response errors due to modes in the Type-N connector used. 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. For FFT based measurements, Frequency Response errors are more complicated. One case is where the input signal is at the center frequency of the FFT measurement. In this case, the Frequency Response errors are given by this table. The total absolute amplitude accuracy is given by the combination of the absolute amplitude accuracy at 50 MHz with the Frequency Response from this table. The other case is when the input signal is not at the center frequency of the FFT measurement. In this case, the total frequency response error is computed by adding the RF flatness errors of this table to the IF Frequency Response. The total absolute amplitude accuracy is given by the combination of the absolute amplitude accuracy at 50 MHz with this total frequency response error. An additional error source, the relative error in switching between swept and FFT-based measurements, is nominally ±0.01 dB. The effect of this relative error on absolute measurements is included with the "Absolute Amplitude Accuracy" specifications.
c. 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 show that most instruments meet the specifications, but a few percent of instruments can be expected to have errors exceeding 0.5 dB at 10 MHz at the temperature extreme. The effect at 20 to 50 MHz is negligible, but not warranted.
d. Specifications for frequencies >3.5 GHz apply for sweep rates ≤100 MHz/ms.
e. Microwave preselector centering applied.

Description			Specifications		Supplemental Information
Frequency Response (Maximum error relative to reference condition (50 MHz) Mechanical attenuator only Non-FFT operation only[b] Preamp off: 10 dB atten Preamp on: 0 dB atten)			RF Input 1: to 44 GHz RF Input 2: to 1 GHz		Refer to the footnote for Band Overlaps on page 14. Modes above 18 GHz[a]
	Option 544 (mmW)	*Option 503, 508* or *526* (RF/µW)			
RF Preselector on Preamp on	↓	↓	**20 to 30°C**	5 to 50°C	**95th Percentile** (≈2σ)
1 kHz to 30 MHz[c]	x	x	±0.8 dB	±0.95 dB	±0.36 dB
30[c] to 300 MHz	x	x	±0.7 dB	±1.0 dB	±0.29 dB
300 MHz to 1 GHz	x	x	±0.65 dB	±0.9 dB	±0.3 dB
1 to 2.75 GHz	x	x	±0.95 dB	±1.2 dB	±0.45 dB
2.75 to 3.6 GHz	x	x	±1.15 dB	±1.8 dB	±0.55 dB
3.5 to 8.4 GHz	x		±1.85 dB	±2.5 dB	±0.63 dB
3.5 to 5.2 GHz[de]		x	±2.2 dB	±3.4 dB	±0.9 dB
5.2 to 8.4 GHz[de]		x	±1.85 dB	±2.5 dB	±0.70 dB
8.3 to 13.6 GHz[de]	x		±1.95 dB	±2.4 dB	±0.64 dB
8.3 to 13.6 GHz[de]		x	±1.95 dB	±2.4dB	±0.79 dB
13.5 to 17.1 GHz[de]	x		±1.8 dB	±2.4 dB	±0.81 dB
13.5 to 17.1 GHz[de]		x	±1.8 dB	±2.4 dB	±0.88 dB
17.0 to 18.0 GHz[de]	x		±2.0 dB	±2.5 dB	±0.95 dB
18.0 to 22.0 GHz[de]	x		±2.85 dB	±3.75 dB	±1.23 dB
17.0 to 22 GHz[de]		x	±2.85 dB	±3.75 dB	±1.07 dB
22.0 to 26.5 GHz[de]	x		±2.6 dB	±3.55 dB	±1.37 dB
22.0 to 26.5 GHz[de]		x	±2.6 dB	±3.55 dB	±1.03 dB
26.4 to 34.5 GHz[de]		x	±3.0 dB	±4.5 dB	±1.35 dB
34.4 to 44 GHz[de]		x	±4.1 dB	±6.0 dB	±1.69 dB

a. Signal frequencies above 18 GHz are prone to response errors due to modes in the Type-N connector used. 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. For FFT based measurements, Frequency Response errors are more complicated. One case is where the input signal is at the center frequency of the FFT measurement. In this case, the Frequency Response errors are given by this table. The total absolute amplitude accuracy is given by the combination of the absolute amplitude accuracy at 50 MHz with the Frequency Response from this table. The other case is when the input signal is not at the center frequency of the FFT measurement. In this case, the total frequency response error is computed by adding the RF flatness errors of this table to the IF Frequency Response. The total absolute amplitude accuracy is given by the combination of the absolute amplitude accuracy at 50 MHz with this total frequency response error. An additional error source, the relative error in switching between swept and FFT-based measurements, is nominally ±0.01 dB. The effect of this relative error on absolute measurements is included with the "Absolute Amplitude Accuracy" specifications.
c. 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 show that most instruments meet the specifications, but a few percent of instruments can be expected to have errors exceeding 0.5 dB at 10 MHz at the temperature extreme. The effect at 20 to 50 MHz is negligible, but not warranted.
d. Specifications for frequencies >3.5 GHz apply for sweep rates ≤100 MHz/ms.
e. Microwave preselector centering applied.

Description	Specifications		Supplemental Information
RF Input VSWR	RF Input 1: to 44 GHz		
at tuned frequency	RF Input 2: to 1 GHz		
10 dB Atten, 50 MHz, RF Presel off			1.07:1 (nominal)
RF Preselector off			
Preamp on	Input Attenuation		Typical
	0 dB	≥ **10 dB**	
DC Coupled			≥ 10 dB Attenuation
9 kHz[a] to 1 GHz	---	---	
1 to 18 GHz	3.0:1	2.0:1	1.8:1
18 to 26.5 GHz[b]	3.0:1	2.0:1	1.8:1
26.5 to 40 GHz	3.0:1	2.5:1	1.8:1
40 to 44 GHz	---	---	2.0:1
AC Coupled (*Option 503, 508*, *526*)			
50 MHz to 1 GHz	---	---	
1 to 18 GHz	3.0:1	2.0:1	1.8:1
18 to 26.5 GHz[b]	3.0:1	2.4:1	2.0:1
RF Preselector on			
Preamp on	Input Attenuation		
	0 dB	≥ **10 dB**	
DC Coupled			
9 kHz to 1 GHz	2.0:1	1.2:1	
1 to 26.5 GHz[b]	3.0:1	2.0:1	1.8:1
26.5 to 40 GHz	3.0:1	2.5:1	1.8:1
40 to 44 GHz	---	---	2.0:1
AC Coupled (*Option 503, 508*, *526*)			
50 MHz to 1 GHz	2.0:1	1.2:1	
1 to 18 GHz	3.0:1	2.0:1	1.8:1
18 to 26.5 GHz[b]	3.0:1	2.4:1	2.0:1

a. For preamp on case, low frequency is 100 kHz.
b. For *Option 526*, VSWR specifications above 18 GHz apply only with *Option C35* (3.5 mm connector).

Description			Specifications	Supplemental Information
Total Measurement Uncertainty				95th Percentile (≈ 2σ)
Signal level 0 to 90 dB below reference point, RF attenuation 0 to 40 dB, RBW ≤ 1 MHz, 20° to 30° C: AC coupled 10 MHz to 26.5 GHz DC coupled 9 kHz to 44 GHz				
		Option 544 (mmW)		
	Option 503, 508 or *526* (RF/µW)			
RF Presel off Preamp on	↓	↓		
100 kHz to 2 GHz	x	x		± 0.6 dB
2 to 3.6 GHz	x	x		± 0.6 dB
3.6 to 8 GHz	x			± 1.1 dB
3.6 to 8 GHz		x		± 1.8 dB
8 to 18 GHz	x	x		± 1.3 dB
18 to 26.5 GHz	x	x		± 1.9 dB
26.5 to 40 GHz		x		± 1.9 dB
40 to 44 GHz		x		± 2.4 dB
RF Presel on Preamp on				
9 kHz to 2 GHz	x	x		± 0.5 dB
2 to 3.6 GHz	x	x		± 0.7 dB
3.6 to 8 GHz	x			± 1.1 dB
3.6 to 8 GHz		x		± 1.8 dB
8 to 18 GHz	x	x		± 1.3 dB
18 to 26.5 GHz	x	x		± 1.9 dB
26.5 to 40 GHz		x		± 1.9 dB
40 to 44 GHz		x		± 2.4 dB

Description	Option 503, 508 or 526 (RF/μW)	Option 544 (mmW)	Specifications		Supplemental Information
Displayed Average Noise Level (DANL)[a] (RF Input 1[b])			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 14.
RF Preselector off, Preamp on			**20 to 30°C**	**5 to 50°C**	Typical DANL including NFE[c]
100 kHz[d]	x	x	–144 dBm	–143 dBm	
1 MHz[d]	x	x	–162 dBm	–161 dBm	
10 MHz to 2.1 GHz	x	x	–163 dBm	–162 dBm	–174 dBm
2.1 to 3.6 GHz	x	x	–161 dBm	–160 dBm	–173 dBm
3.6 GHz to 8.4 GHz	x		–164 dBm	–163 dBm	–172 dBm
3.5 GHz to 8.4 GHz		x	–161 dBm	–159 dBm	–166 dBm
8.3 GHz to 13.6 GHz	x		–162 dBm	–161 dBm	–173 dBm
8.3 GHz to 13.6 GHz		x	–161 dBm	–160 dBm	–170 dBm
13.5 to 17.1 GHz	x	x	–160 dBm	–159 dBm	–171 dBm
17.0 to 20.0 GHz	x	x	–158 dBm	–157 dBm	–165 dBm
20.0 to 26.5 GHz	x	x	–155 dBm	–153 dBm	–162 dBm
26.4 to 34.5 GHz		x	–156 dBm	–153 dBm	–164 dBm
34.4 to 44 GHz		x	–150 dBm	–147 dBm	–158 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. Does not apply to Time Domain scan.
b. RF Input 2 operates to 1 GHz. The DANL is nominally 11 dB higher for RF Input 2.
c. NFE = Noise Floor Extension. Typical DANL including NFE = (Typical DANL – DANL improvement with NFE).
d. 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 25 kHz, and “Best Wide Offset ϕ Noise" for frequencies above 25 kHz.

Description	Option 503, 508 or 526 (RF/µW)	Option 544 (mmW)	Specifications		Supplemental Information
Displayed Average Noise Level (DANL)[a] (RF Input 1[b])			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 14.
RF Preselector on, Preamp on			**20 to 30°C**	**5 to 50°C**	Typical Indicated Noise including NFE[c]
1 kHz[d]	x	x	−119 dBm	−118 dBm	−133 dBm[e]
9 kHz[d]	x	x	−143 dBm	−142 dBm	−154 dBm
100 kHz[d]	x	x	−154 dBm	−153 dBm	−165 dBm
1 to 2 MHz[d]	x	x	−166 dBm	−165 dBm	−174 dBm
2 to 30 MHz[d]	x	x	−158 dBm	−157 dBm	−167 dBm
30 to 600 MHz	x	x	−159 dBm	−158 dBm	−166 dBm
600 to 800 MHz	x	x	−157 dBm	−156 dBm	−166 dBm
800 MHz to 1 GHz	x	x	−158 dBm	−157 dBm	−167 dBm
1 to 2 GHz	x	x	−156 dBm	−155 dBm	−164 dBm
2 to 2.75 GHz	x	x	−160 dBm	−159 dBm	−168 dBm
2.75 to 3.6 GHz	x	x	−157 dBm	−156 dBm	−165 dBm
3.5 to 8.4 GHz	x		−164 dBm	−163 dBm	−172 dBm
3.5 to 8.4 GHz		x	−161 dBm	−159 dBm	−166 dBm
8.3 to 13.6 GHz	x		−162 dBm	−161 dBm	−173 dBm
8.3 to 13.6 GHz		x	−161 dBm	−159 dBm	−170 dBm
13.5 to 17.1 GHz	x	x	−160 dBm	−159 dBm	−171 dBm
17.0 to 20.0 GHz	x	x	−158 dBm	−157 dBm	−165 dBm
20.0 to 26.5 GHz	x	x	−155 dBm	−153 dBm	−162 dBm
26.4 to 34.5 GHz		x	−156 dBm	−153 dBm	−164 dBm
34.4 to 44 GHz		x	−150 dBm	−147 dBm	−158 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.Does not apply to Time Domain scan.
b. RF Input 2 operates to 1 GHz. The DANL is nominally 11 dB higher for RF Input 2.
c. NFE = Noise Floor Extension. Typical DANL including NFE = (Typical DANL – DANL improvement with NFE).
d. 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 25 kHz, and “Best Wide Offset ϕ Noise" for frequencies above 25 kHz.
e. NFE is not part of the difference between warranted and typical specifications at this frequency.

Description	Option 503, 508 or 526 (RF/μW)	Option 544 (mmW)	Specifications	Supplemental Information
Indicated Noise (Receiver)[a] (RF Input 1[b]) Calculated[c]: Derived from DANL data				Input terminated EMI Average detector 0 dB input attenuation IF Gain = High All indicated RBW are CISPR BW, except as noted.
RF Preselector on, Preamp on				Typical Indicated Noise including NFE[c]
1 kHz (100 Hz RBW)[d]	x	x		−4 dBμV[e]
9 kHz (200 Hz)	x	x		−24 dBμV
100 kHz (200 Hz)	x	x		−35 dBμV
1 to 2 MHz (9 kHz)	x	x		−31 dBμV
2 to 30 MHz (9 kHz)	x	x		−20 dBμV
30 to 600 MHz (120 kHz)	x	x		−8 dBμV
600 to 800 MHz (120 kHz)	x	x		−8 dBμV
800 MHz to 1 GHz (120 kHz)	x	x		−9 dBμV
1 to 2 GHz (1 MHz)	x	x		+3 dBμV
2 to 2.75 GHz (1 MHz)	x	x		−1 dBμV
2.75 to 3.6 GHz (1 MHz)	x	x		+2 dBμV
3.5 to 8.4 GHz (1 MHz)	x			−5 dBμV
3.5 to 8.4 GHz (1 MHz)		x		−1 dBμV
8.3 to 13.6 GHz (1 MHz)	x			−6 dBμV
8.3 to 13.6 GHz (1 MHz)		x		−4 dBμV
13.5 to 17.1 GHz (1 MHz)	x	x		−4 dBμV
17.0 to 20.0 GHz (1 MHz)	x	x		+2 dBμV
20.0 to 26.5 GHz (1 MHz)	x	x		+5 dBμV
26.4 to 34.5 GHz (1 MHz)		x		+3 dBμV
34.4 to 44 GHz (1 MHz)		x		+9 dBμV

a. Does not apply to Time Domain scan.
b. RF Input 2 operates to 1 GHz. The DANL is nominally 11 dB higher for RF Input 2.

c. Typical Indicatied Noise including NFE = Typical DANL + RBW correction + Log Detector correction – DANL Improvement with NFE +107.
d. Indicated RBW is a 3 dB bandwidth.
e. NFE is not part of the difference between warranted and typical specifications at this frequency.

Description	Option 503, 508 or 526 (RF/μW)	Option 544 (mmW)	Specifications	Supplemental Information
DANL and Indicated Noise Improvement with Noise Floor Extension[a]				95th Percentile (≈ 2 σ)
RF Preselector off				**Preamp on**[b]
RF Input 1				
20 MHz to 3.6 GHz	x	x		10 dB
3.5 to 8.4 GHz	x			6 dB
3.5 to 8.4 GHz		x		4 dB
8.3 to 13.6 GHz	x			9 dB
8.3 to 13.6 GHz		x		8 dB
13.5 to 17.1 GHz	x	x		9 dB
17.0 to 26.5 GHz	x	x		5 dB
26.5 to 34.5 GHz		x		6 dB
34.4 to 44 GHz		x		5 dB
RF Input 2				
20 MHz to 1 GHz	x	x		10 dB
RF Preselector on				
RF Input 1				
9 to 150 kHz	x	x		6 dB
150 kHz to 1 MHz	x	x		2 dB
1 to 2 MHz	x	x		10 dB
2 to 5 MHz	x	x		9 dB
5 to 8 MHz	x	x		10 dB
8 to 11 MHz	x	x		10 dB
11 to 14 MHz	x	x		9 dB

Description			Specifications	Supplemental Information
DANL and Indicated Noise Improvement with Noise Floor Extension (cont.)				
14 to 17 MHz	x	x		8 dB
17 to 20 MHz	x	x		9 dB
20 to 24 MHz	x	x		9 dB
24 to 30 MHz	x	x		10 dB
30 to 70 MHz	x	x		6 dB
70 to 150 MHz	x	x		10 dB
150 to 300 MHz	x	x		8 dB
300 to 600 MHz	x	x		8 dB
600 MHz to 1 GHz	x	x		7 dB
1 to 2 GHz	x	x		7 dB
2 to 3.6 GHz	x	x		6 dB
3.5 to 8.4 GHz	x			6 dB
3.5 to 8.4 GHz		x		4 dB
8.3 to 13.6 GHz	x			9 dB
8.3 to 13.6 GHz		x		8 dB
13.5 to 17.1 GHz	x	x		9 dB
17.0 to 26.5 GHz	x	x		5 dB
26.5 to 34.5 GHz		x		6 dB
34.4 to 44 GHz		x		5 dB

a. This statement on the improvement in DANL is based on the accuracy of the fit of the noise floor model to the measured values of that noise. This measure of the performance correlates well with improvement versus frequency. The improvement actually measured and specified in "Examples of Effective DANL" usually meet these limits as well, but not with the confidence in some cases. Does not apply to Time Domain scan.

b. 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.

Description	Specifications	Supplemental Information
DANL and Indicated Noise Improvement with Noise Floor Extension[a]		95th Percentile (≈ 2 σ)
RF Preselector on		**Preamp on**[b]
RF Input 2		
9 to 150 kHz		6 dB
150 kHz to 1 MHz		2 dB
1 to 2 MHz		10 dB
2 to 5 MHz		10 dB
5 to 8 MHz		9 dB
8 to 11 MHz		9 dB
11 to 14 MHz		10 dB
14 to 17 MHz		10 dB
17 to 20 MHz		10 dB
20 to 24 MHz		10 dB
24 to 30 MHz		10 dB
30 to 70 MHz		8 dB
70 to 150 MHz		9 dB
150 to 300 MHz		9 dB
300 to 600 MHz		7 dB
600 MHz to 1 GHz		7 dB

a. This statement on the improvement in DANL is based on the accuracy of the fit of the noise floor model to the measured values of that noise. This measure of the performance correlates well with improvement versus frequency. The improvement actually measured and specified in "Examples of Effective DANL" usually meet these limits as well, but not with the confidence in some cases. Does not apply to Time Domain scan.

b. 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.

Description	Option 503, 508 or 526 (RF/μW)	Option 544 (mmW)	Specifications	Supplemental Information
Second Harmonic Distortion[a] (Input power = –9 dBm Input attenuation = 6 dB RF Input 1[b])				
RF Preselector off Preamp on			**SHI**[c]	**Typical**
Source Frequency				
10 MHz to 1.8 GHz (preamp level = –45 dBm)	x	x		+33 dBm (nominal)
1.8 to 13.25GHz (preamp level = –50 dBm)	x	x		+10 dBm (nominal)
13.2 to 22 GHz		x		+0 dBm (nominal)
RF Preselector on, Preamp on[d]				
Source Frequency (Input power = –9 dBm RF input attenution = 26 dB)				
10 to 300 MHz	x	x		+53 dBm (nominal)
300 to 500 MHz	x	x		+58 dBm (nominal)
500 MHz to 1 GHz	x	x		+47 dBm (nominal)
1 to 1.6 GHz	x	x		+53 dBm (nominal)
1.6 to 1.8 GHz	x	x		+30 dBm (nominal)
1.8 to 13.25 GHz (preamp level = –50 dBm)	x	x		+10 dBm (nominal)
13.2 to 22 GHz		x		+0 dBm (nominal)

a. When using Time Domain scan, all indicated values shown here are nominal values.
b. RF Input 2 operates to 1 GHz. The second harmonic distortion intercept is nominally 9 dB higher for RF Input 2.
c. SHI = second harmonic intercept.
d. Preamp level = Input level – Input Attenuation

Description	Specifications		Supplemental Information
Third Order Intermodulation[a] (Tone separation > 5 times IF Prefilter Bandwidth[b] Verification conditions[c] RF Input 1[d])			
	Intercept[e]		
RF Preselector off, Preamp on			
10 to 500 MHz[f]			+4 dBm (nominal)
500 MHz to 3.6 GHz[f]			+5 dBm (nominal)
3.6 to 26.5 GHz[g]			–15 dBm (nominal)
26.4 to 44 GHz			–17dBm (nominal)
RF Preselector on, Preamp on			
10 to 30 MHz[h]	–9 dBm	–10 dBm	–5 dBm
30 MHz to 1 GHz[h]	–9 dBm	–10 dBm	–4 dBm
1 to 2 GHz[h]	–4 dBm	–5 dBm	–2 dBm
2 to 3.6 GHz[h]	–6 dBm	–7 dBm	–3 dBm
3.6 to 26.5 GHz[g]			–15 dBm (nominal)
26.4 to 44 GHz			–17dBm (nominal)

a. When using Time Domain scan, all indicated values shown here are nominal values.
b. See the IF Prefilter Bandwidth table in the Gain Compression specifications on page 30. 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.
c. TOI is verified with two tones, each at –14 dBm at the input with 4 dB input attenuation, spaced by 100 kHz. Time Domain scan nominal TOI values verified with two tones. each at-14 dBm at the input with 4 dB input attenuation, spaced by 50 MHz.
d. RF Input 2 operates to 1 GHz. The intercept is nominally 9 dB higher for RF Input 2.
e. 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.
f. TOI is verified with two tones, each at –45 dBm at the preamp, spaced by 100 kHz.
g. TOI is verified with two tones, each at –50 dBm at the preamp, spaced by 100 kHz.
h. TOI is verified with two tones, each at –14 dBm at the input with 22 dB input attenuation, spaced by 100 kHz.

9 Option ESC - External Source Control

This chapter contains specifications for the *Option ESC*, External Source Control.

General Specifications

Description	Specification	Supplemental Information
Frequency Range		
SA Operating range	20 Hz to 3.6 GHz 20 Hz to 8.4 GHz 20 Hz to 26.5 GHz 20 Hz to 44 GHz	N9038B-503 N9038B-508 N9038B-526 N9038B-544
Source Operating range	9 kHz to 3 GHz 9 kHz to 6 GHz	N5171B/72B/81B/82B-503 N5171B/72B/81B/82B-506
	100 kHz to 3 GHz 100 kHz to 6 GHz 100 kHz to 20 GHz 100 kHz to 31.8 GHz 100 kHz to 40 GHz	N5161A/N5162A/N5181A/N5182A-503 N5161A/N5162A/N5181A/N5182A-506 N5183A-520 N5183A-532 N5183A-540
	9 kHz to 20 GHz 9kHz to 31.8 GHz 9 kHz to 40 GHz	N5173B/N5183B-520 N5173B/N5183B-532 N5173B/N5183B-540
Span Limitations		
Span limitations due to source range		Limited by the source and SA operating range
Offset Sweep		
Sweep offset setting range		Limited by the source and SA operating range
Sweep offset setting resolution	1 Hz	
Harmonic Sweep		
Harmonic sweep setting range[a] Multiplier numerator Multiplier denominator		 N = 1 to 1000 N = 1 to 1000
Sweep Direction[b]		Normal, Reversed

a. Limited by the frequency range of the source to be controlled.
b. The analyzer always sweeps in a positive direction, but the source may be configured to sweep in the opposite direction. This can be useful for analyzing negative mixing products in a mixer under test, for example.

Description		Specification	Supplemental Information
Dynamic Range			Dynamic Range =
(10 MHz to 3 GHz, Input terminated, sample detector, average type = log, 20 to 30°C)			–10 dBm – DANL – 10 × log (RBW)[a]
SA span	**SA RBW**		
1 MHz	2 kHz	105.0 dB	
10 MHz	6.8 kHz	99.7 dB	
100 MHz	20 kHz	95.0 dB	
1000 MHz	68 kHz	89.7 dB	
Amplitude Accuracy			Multiple contributors[b] Linearity[c] Source and Analyzer Flatness[d] YTF Instability[e] VSWR effects[f]

a. The dynamic range is given by this computation: –10 dBm – DANL – 10×log(RBW) where DANL is the displayed average noise level specification, normalized to 1 Hz RBW, and the RBW used in the measurement is in hertz units. The dynamic range can be increased by reducing the RBW at the expense of increased sweep time.

b. The following footnotes discuss the biggest contributors to amplitude accuracy.

c. One amplitude accuracy contributor is the linearity with which amplitude levels are detected by the analyzer. This is called "scale fidelity" by most spectrum analyzer users, and "dynamic amplitude accuracy" by most network analyzer users. This small term is documented in the Amplitude section of the Specifications Guide. It is negligibly small in most cases.

d. The amplitude accuracy versus frequency in the source and the analyzer can contribute to amplitude errors. This error source is eliminated when using normalization in low band (0 to 3.6 GHz). In high band the gain instability of the YIG-tuned microwave preselector in the analyzer keeps normalization errors nominally in the 0.25 to 0.5 dB range.

e. In the worst case, the center frequency of the YIG-tuned microwave preselector can vary enough to cause very substantial errors, much higher than the nominal 0.25 to 0.5 dB nominal errors discussed in the previous footnote. In this case, or as a matter of good practice, the microwave preselector should be centered. See the user's manual for instructions on centering the microwave preselector.

f. VSWR interaction effects, caused by RF reflections due to mismatches in impedance, are usually the dominant error source. These reflections can be minimized by using 10 dB or more attenuation in the analyzer, and using well-matched attenuators in the measurement configuration.

Description	Specification	Supplemental Information
Power Sweep Range		Limited by source amplitude range

Description	Specification	Supplemental Information	
Measurement Time		Nominal[a]	
(RBW setting of the SA determined by the default for *Option ESC*)			
		RF MXG (N5181A/N5182A)[b]	
		Band 0	**Band 1**
201 Sweep points (default setting)		450 ms	1.1s
601 Sweep points		1.1 s	3.3 s
		μW MXG (N5183A)[b]	
		Band 0	**Band 1**
201 Sweep points (default setting)		470 ms	1.2 s
601 Sweep points		1.1 s	3.9 s

a. These measurement times were observed with a span of 100 MHz, RBW of 20 kHz and the point triggering method being set to EXT TRIG1. The measurement times will not change significantly with span when the RBW is automatically selected. If the RBW is decreased, the sweep time increase would be approximately 23.8 times Npoints/RBW.
b. Based on MXG firmware version A.01.80 and *Option UNZ* installed.

Description	Specification	Supplemental Information
Supported External Sources[a]		
Keysight EXG		N5171B/72B/73B
Keysight MXG		N5161A/62A N5181A/82A/83A N5181B/82B/83B
IO interface connection between:		
EXG/MXG and MXE		LAN, GPIB, or USB

a. Firmware revision A.19.50 or later is required for the signal analyzer.

10 Option RT1 - Real-time Spectrum Analyzer (RTSA)

This chapter contains specifications for the MXE Signal Analyzer *Options RT1*, real-time analysis up to 160 MHz maximum analysis bandwidth, basic detection.

Specifications Affected by Real-Time Spectrum Analyzer

Specification Name	Information
IF Frequency Response	Refer to "IF Frequency Response" on page 104 in the *Option B85* chapter.
Spurious Responses	The "Spurious Responses" on page 52 still apply. Additional bandwidth-option-dependent spurious responses are given in the B85 Analysis Bandwidth chapter.
Absolute Amplitude Accuracy	Nominally 0.5 dB degradation from the base instrument absolute amplitude accuracy. (Refer to "Absolute Amplitude Accuracy" on page 35.)
Spur-free Dynamic Range	Refer to "SFDR (Spurious-Free Dynamic Range)" on page 107 in the *Option B85* chapter.

Real-time Spectrum Analyzer Performance

Description	Specs & Nominals		Supplemental Information
General Frequency Domain Characteristics			
Maximum real-time analysis bandwidth (*Option RT1*)			
With *Option B85*			
≤ 3.6 GHz	85 MHz		
> 3.6 GHz	40 MHz		
With *Option B1X*			
≤ 3.6 GHz	160 MHz		
> 3.6 GHz	40 MHz		
Minimum signal duration with 100% probability of intercept (POI) at full amplitude accuracy			Maximum span: Default window is Kaiser; Viewable on screen
With *Option B85*	3.7 μs		
With *Option B1X*			
Span = 85 MHz	3.7 μs		
Span > 85 MHz	17.3 μs		
Supported Detectors			Peak, Negative Peak, Sample, Average
Number of Traces	6		Clear Write, Max Hold, Min Hold
Resolution Bandwidths			6 RBWs available for each window type, Nominal Span:RBW ratio for windows: Flattop = 6.7 to 212, Gaussian, Blackman-Harris = 13 to 417, Kaiser = 13 to 418, Hanning = 17 to 551
Span	**Min RBW**	**Max RBW**	
160 MHz	383 kHz	12.2 MHz[a]	
100 MHz	239 kHz	7.6 MHz	
85 MHz	204 kHz	6.25 MHz	
50 MHz	120 kHz	3.8 MHz	
10 MHz	23.9 kHz	763 kHz	
1 MHz	2.39 kHz	76.3 kHz	

Description	Specs & Nominals	Supplemental Information
100 kHz	239 Hz 7.6 kHz	
Window types	Hanning, Blackman-Harris, Rectangular, Flattop, Kaiser, Gaussian	
Maximum Sample Rate		
With *Option B85*	106 MSa/s	
With *Option B1X*	200 MSa/s	
FFT Rate	292,969/s	Nominal value for maximum sample rate. For all spans greater than 300 kHz.
FFT Length	1024	
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
Amplitude resolution	0.01 dB	
Frequency points	821	
Minimum acquisition time	104 μs[b]	Value for maximum sample rate

a. This maximum RBW value applies to all window types.
b. For spectrogram only. For Density view: 30 ms. For Density & spectrogram: 90 ms.

Description	Specs & Nominals	Supplemental Information
Density View		
Probability range	0-100%	
Minimum Span	100 Hz	0.001% steps
Maximum Span		85 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		

Description	Specs & Nominals	Supplemental Information
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		
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	215 μs	

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 @ 160 MHz span (or BW)	**5.12 μs**				The minimum TQT duration is inversely proportional to the span (or BW)
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)	**160**	**85**	**40**	**20**	
RBW 6	17.23	17.38	17.72	18.44	
RBW 5	17.39	17.68	18.36	19.72	
RBW 4	17.71	18.28	19.64	22.28	
RBW 3	18.35	19.49	22.20	27.40	
RBW 2	19.63	21.90	27.32	37.64	
RBW 1	22.19	26.72	37.56	58.12	

11 Option YAS - Y-Axis Screen Video Output

This chapter contains specifications for *Option YAS*, Y-Axis Screen Video Output.

Specifications Affected by Y-Axis Screen 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 Screen Video Output Specifications

General Port Specifications

Description	Specifications	Supplemental Information
Connector	BNC female	Shared with other options
Impedance		<140Ω (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 respectively	
Offset		±1% of full scale (nominal)
Gain accuracy		±1% of output voltage (nominal)

Description	Specifications	Supplemental Information
Delay		
RF Input to Analog Out		
Without Option DP2, or MPB		1.67 μs + 2.56/RBW + 0.159/VBW (nominal)

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.

Continuity and Compatibility

Description	Specifications	Supplemental Information
Continuity and Compatibility		
Output Tracks Video Level		
During sweep	Yes	Except band breaks in swept spans
Between sweeps	See supplemental information	Before sweep interruption[a] Alignments [b] Auto Align = Partial[cd]
External trigger, no trigger[d]	Yes	
HP 8566/7/8 Compatibility[e]		Recorder output labeled “Video”
Continuous output		Alignment differences[f]
Output impedance		Two variants[g]
Gain calibration		LL and UR not supported[h]
RF Signal to Video Output Delay		See footnote[i]

a. 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.
b. 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.
c. 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.
d. 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.
e. Compatibility with the HP/Keysight 8560 and 8590 families, and the ESA and PSA, is similar in most respects.
f. The HP 8566 family did not have alignments and interruptions that interrupted video outputs, as discussed above.
g. Early HP 8566-family spectrum analyzers had a 140Ω output impedance; later ones had 190Ω. The specification was <475Ω. The Analog Out port has a 50Ω impedance if the analyzer has *Option DP2*, or *MPB.* Otherwise, the Analog Out port impedance is nominally 140Ω.
h. The HP 8566 family 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.
i. The delay between the RF input and video output shown in Delay on page 153 is much higher than the delay in the HP 8566 family spectrum analyzers. The latter has a delay of approximately 0.554/RBW + 0.159/VBW.

Keysight X-Series MXE EMI Receiver
N9038B

Specification Guide

12 Analog Demodulation Measurement Application

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

Pre-Demodulation

Description	Specifications	Supplemental Information
Carrier Frequency		
Maximum Frequency		
Option 503	3.6 GHz	
Option 508	8.4 GHz	
Option 526	26.5 GHz	
Option 544	44 GHz	
Minimum Frequency		
AC Coupled[a]	10 MHz	
DC Coupled	20 Hz	In practice, limited by the need to keep modulation sidebands from folding, and by the interference from LO feedthrough.
Demodulation Bandwidth	8 MHz	
Capture Memory *(sample rate * demod time)*	250 kSa	Each sample is an I/Q pair.

a. AC Coupled only applicable to Freq *Options 503*, *508*, *513*, and *526*.

Post-Demodulation

Description	Specifications	Supplemental Information
Maximum Audio Frequency Span		4 MHz
Filters		
Low Pass	300 Hz, 3 kHz, 15 kHz, 30 kHz, 80 kHz, 300 kHz	
High Pass	20 Hz, 50 Hz, 300 Hz	
Band Pass	CCITT	
De-emphasis	25 μs, 50 μs, 75 μs, 750 μs	FM only

Frequency Modulation - Level and Carrier Metrics

Description	Specifications	Supplemental Information
FM Deviation Accuracy (Rate: 1 kHz - 1 MHz, Deviation: 1 - 100 kHz[a])		±(1% of (rate + deviation) + 20 Hz) (nominal)
FM Rate Accuracy (Rate: 1 kHz - 1 MHz[a][b])		±0.2 Hz (nominal)
Carrier Frequency Error		±0.5 Hz (nominal) + tfa[c] Assumes signal still visible in channel BW with offset
Carrier Power		Same as Absolute Amplitude Accuracy at all frequencies (nominal).

a. For optimum measurement of rate and deviation, ensure that the channel bandwidth is set wide enough to capture the significant RF energy (as visible in the RF Spectrum window). Setting the channel bandwidth too wide will result in measurement errors.
b. Rate accuracy at high channel bandwidths assumes that the deviation is sufficiently large to overcome channel noise.
c. tfa = transmitter frequency × frequency reference accuracy

Frequency Modulation - Distortion

Description	Specifications	Supplemental Information
Residual		
(Rate: 1 - 10 kHz, Deviation: 5 kHz)		
THD Distortion SINAD		0.1% (nominal) 1.3% (nominal) 37.7 dB (nominal)
Absolute Accuracy		
(Rate: 1 - 10 kHz, Deviation: 5 kHz)		
THD		± (2% of measured value + residual) (nominal) Measured 2nd and 3rd harmonics
Distortion		±2% of measured value + residual (nominal)
SINAD		±0.4 dB + effect of residual (nominal)
AM Rejection		24 Hz (nominal)
(AF 100 Hz to 15 kHz, 50% Modulation Depth)		
Residual FM		13 Hz (nominal)
(RF 500 kHz - 10 GHz)		
Measurement Range		
(Rate: 1 to 10 kHz, Deviation: 5 kHz)		
THD		Residual to 100% (nominal)That would be an Element, not a Measured 2nd and 3rd harmonics Measurement includes at most 10 harmonics
Distortion		Residual to 100% (nominal)
SINAD		0 dB to residual (nominal)

Amplitude Modulation - Level and Carrier Metrics

Description	Specifications	Supplemental Information
AM Depth Accuracy (Rate: 1 kHz to 1 MHz)		±0.2% + 0.002 × measured value (nominal)
AM Rate Accuracy (Rate: 1 kHz to 1 MHz)		±0.05 Hz (nominal)
Carrier Power		Same as Absolute Amplitude Accuracy at all frequencies (nominal).

Amplitude Modulation - Distortion

Description	Specifications	Supplemental Information
Residual		
(Depth: 50%, Rate: 1 to 10 kHz)		
THD Distortion SINAD		0.16% (nominal) 0.17% (nominal) 55.5 dB (nominal)
Absolute Accuracy		
(Depth: 50%, Rate: 1 to 10 kHz)		
THD		±1% of measured value + residual (nominal) Measured 2nd and 3rd harmonics
Distortion		±1% of measured value + residual (nominal)
SINAD		±0.05 dB + effect of residual (nominal)
FM Rejection		0.5% (nominal)
(AF + deviation < 0.5 × channel BW, AF < 0.1 × channel BW)		
Residual AM		0.03% (nominal)
(RF 500 kHz to 20 GHz)		
Measurement Range		
(Depth: 50% Rate: 1 to 10 kHz)		
THD		Residual to 100% (nominal) Measured 2nd and 3rd harmonics Measurement includes at most 10 harmonics
Distortion		Residual to 100% (nominal)
SINAD		0 dB to residual (nominal)

Phase Modulation - Level and Carrier Metrics

Description	Specifications	Supplemental Information
PM Deviation Accuracy (Rate: 1 to 20 kHz Deviation: 0.2 to 6 rad)		±(1 rad × (0.005 + (rate/1 MHz))) (nominal)
PM Rate Accuracy (Rate: 1 to 10 kHz[a])		±0.2 Hz (nominal)
Carrier Frequency Error		±0.02 Hz (nominal) + tfa[b] Assumes signal still visible in channel BW with offset.
Carrier Power		Same as Absolute Amplitude Accuracy at all frequencies (nominal).

a. For optimum measurement of PM rate and deviation, ensure that the channel bandwidth is set wide enough to capture the significant RF energy (as visible in the RF Spectrum window). Setting the channel bandwidth too narrow or too wide will result in measurement errors.
b. tfa = transmitter frequency × frequency reference accuracy.

Phase Modulation - Distortion

Description	Specifications	Supplemental Information
Residual		
(Rate: 1 to 10 kHz, Deviation: 628 mrad)		
THD		0.1% (nominal)
Distortion		0.5% (nominal)
SINAD		45 dB (nominal)
Absolute Accuracy		
(Rate: 1 to 10 kHz, Deviation: 628 mrad)		
THD Distortion SINAD		±1% of measured value + residual (nominal) ±1% of measured value + residual (nominal) ±0.1 dB + effect of residual (nominal)
AM Rejection (AF 1 kHz to 15 kHz, 50% Modulation Depth)		3 mrad (nominal)
Residual PM (RF = 1 GHz, highpass filter 300 Hz)		2 mrad (nominal)
Measurement Range		
(Rate: 1 to 10 kHz, Deviation: 628 mrad)		
THD		Residual to 100% (nominal) Measured 2nd and 3rd harmonics Measurement includes at most 10 harmonics
Distortion		Residual to 100% (nominal)
SINAD		0 dB to residual (nominal)

13 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[b]			
10 MHz to 26.5 GHz and 26.5 to 44 GHz[c]			Using internal preamp (such as *Option P26*) and RBW = 4 MHz
Noise Source ENR	**Measurement Range**	**Instrument Uncertainty**[d]	
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 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 series and the NoiseWave NW346V do have adequate ENR for calibration.

d. “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[b]		
10 MHz to 3.6 GHz	±0.10 dB	
3.6 to 26.5 GHz		±0.11 dB additional[c] 95th percentile, 5 minutes after calibration
26.5 to 44 GHz		Nominally the same performance as for 3.6 to 26.5 GHz. Also, see footnote c.page 166.

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 microwave 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]		With user calibration
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		Noise Figure is: DANL + 176.24 dB (nominal)[b] Note on DC coupling[c]
Instrument Input Match		For best accuracy, we recommend that you measure the return loss performance of your MXE. See “RF Input VSWR” on page 37 for specific VSWR data.
NFE Improvement/Internal Cal[d]		See “DANL and Indicated Noise Improvement with Noise Floor Extension” on page 59.

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

d. 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.

14 Phase Noise Measurement Application

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

The specifications in this chapter apply for RF Input 1 and RF Preselector off.

General Specifications

Description	Specifications	Supplemental Information
Maximum Carrier Frequency		
Option 503	3.6 GHz	
Option 508	8.4 GHz	
Option 526	26.5 GHz	
Option 544	44 GHz	

Description	Specifications	Supplemental Information
Measurement Characteristics		
Measurements	Log plot, RMS noise, RMS jitter, Residual FM, Spot frequency	

Description	Specifications	Supplemental Information
Measurement Accuracy		
Phase Noise Density Accuracy[a][b]		
Offset < 1 MHz	±0.30 dB	
Offset ≥ 1 MHz		
Non-overdrive case[c]	±0.30 dB	
With Overdrive		±0.48 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 "Overdriv (MAtn)" control is set to Auto (in the Meas Setup > Advanced menu) and the "Pre-Adjust for Min Clip" control (in the Amplitude menu under Attenuation) is not set to Off, and the Electronic Attenuator is licensed and set to On. The controls also allow overdrive if the "Overdriv (MAtn)" control is set to On. To prevent overdrive in all cases, set the Overdriv control to Auto and set the Electronic Attenuator (if licensed) 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 $100 \times (10^{\mathrm{PhaseNoiseDensityAccuracy}/20} - 1)$. 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	3 Hz to ($f_{opt} - f_{CF}$)	f_{opt}: Maximum frequency determined by option 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[a]

a. 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 receiver Nominal Phase Noise on page 172.

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