Keysight NFA X-Series Noise Figure Analyzers

This manual provides documentation for the following Analyzers:

N8973B NFA Noise Figure Analyzer
N8974B NFA Noise Figure Analyzer
N8975B NFA Noise Figure Analyzer
N8976B NFA Noise Figure Analyzer

KEYSIGHT

SPECIFICATIONS GUIDE

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Trademark Acknowledgments

Manual Part Number

N8973-90007

Edition

Edition 1, February 2024

Supersedes: September 2020

Published by:
Keysight Technologies
1400 Fountaingrove Parkway
Santa Rosa, CA 95403

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Documentation is updated periodically. For the latest information about these products, including instrument software upgrades, application information, and product information, browse to one of the following URLs, according to the name of your product:

http://www.keysight.com/find/nfa

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http://www.keysight.com/find/techsupport

Contents

1 Noise Figure Measurement Application

This chapter contains specifications for the N9069C Noise Figure Measurement Application.

General Specifications

Description	Specifications		Supplemental Information
Noise Figure			Uncertainty Calculator[a]
<10 MHz			See note[b]
10 MHz to internal preamplifier's frequency limit			Internal and External preamplification recommended[c]
Noise Source ENR	**Measurement Range**	**Instrument Uncertainty**[de]	
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. 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. Instrument Uncertainty is nominally the same in this frequency range as in the higher frequency range. However, total uncertainty is higher because the analyzer has poorer noise figure, leading to higher uncertainties as computed by the uncertainty calculator. Also, there is a paucity of available noise sources in this range.

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

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.

e. The instrument uncertainties shown are under best-case sweep time conditions, which is a sweep time near to the period of the power line, such as 20 ms for 50 Hz power sources. The behavior can be greatly degraded (uncertainty increased nominally by 0.12 dB) by setting the sweep time per point far from an integer multiple of the period of the line frequency.

Description	Specifications	Supplemental Information
Gain		
Instrument Uncertainty[a]		DUT Gain Range = –20 to +40 dB
<10 MHz		See note[b]
10 MHz to 3.6 GHz	±0.15 dB	
>3.6 GHz		±0.11 dB additional[c] 95th percentile, 5 minutes after calibration

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

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

c. For frequencies above 3.6 GHz, the analyzer uses a YIG-tuned filter (YTF) as a preselector, which adds uncertainty to the gain. When the Y factor is small, such as with low gain DUTs, this uncertainty can be greatly multiplied and dominate the uncertainty in NF (as the user can compute with the Uncertainty Calculator), as well as impacting gain directly. When the Y factor is large, the effect of IU of Gain on the NF becomes negligible.
When the Y-factor is small, the non-YTF mechanism that causes Instrument Uncertainty for Gain is the same as the one that causes IU for NF with low ENR. Therefore, we would recommend the following practice: When using the Uncertainty Calculator for 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 – 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 is not warranted.

Description	Specifications	Supplemental Information
Noise Figure Uncertainty Calculator[a]		
Instrument Noise Figure Uncertainty	See the Noise Figure table earlier in this chapter	
Instrument Gain Uncertainty	See the Gain table earlier in this chapter	
Instrument Noise Figure		See graphs of "Nominal Instrument Noise Figure"; Noise Figure is DANL + 176.24 dB (nominal)[b] Note on DC coupling[cd]
Instrument Input Match		See graphs: Nominal VSWR Note on DC coupling[c]
Optional NFE Improvement/Internal Cal[e]		See **"Displayed Average Noise Level (DANL) (with Noise Floor Extension) Improvement" on page 87** in the *Option NFE* - Noise Floor Extension chapter.

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

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

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

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

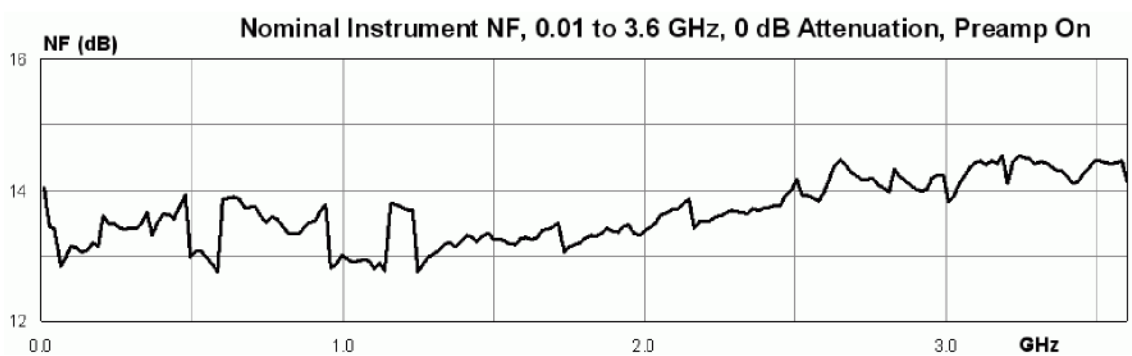
c. The effect of AC coupling is negligible for frequencies above 40 MHz. Below 40 MHz, DC coupling is recommended for the best measurements.

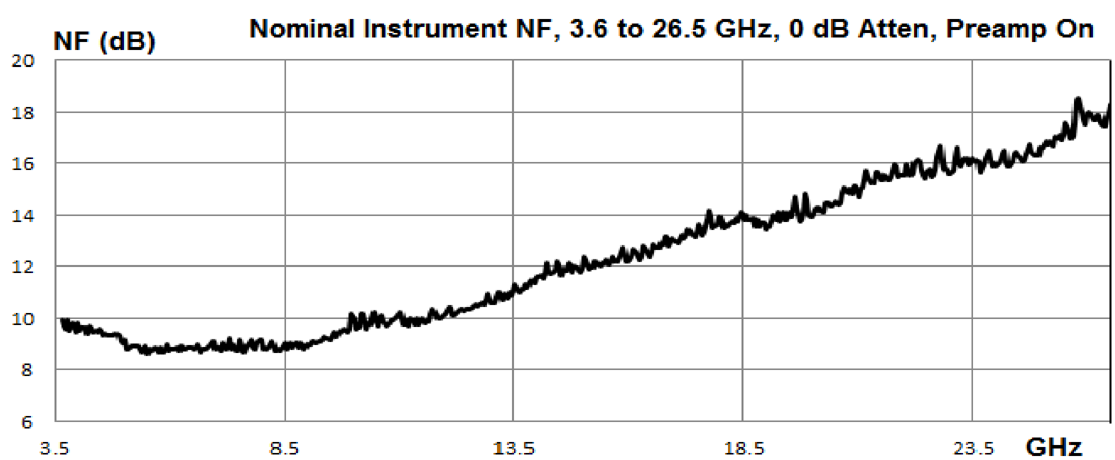
d. The instrument NF nominally degrades by 0.2 dB at 30 MHz and 1 dB at 10 MHz with AC coupling.

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

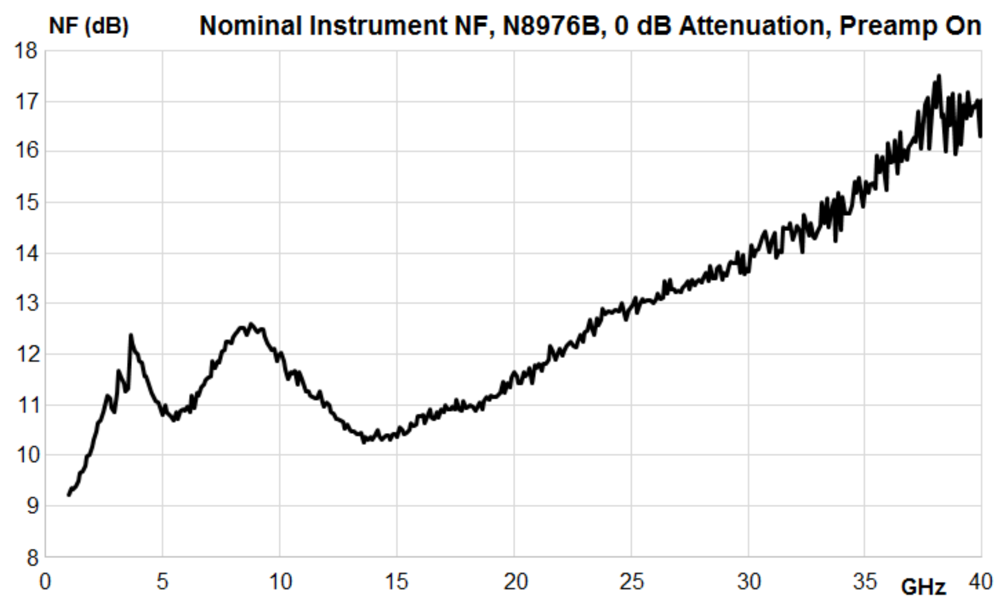
Description	Supplemental Information
Uncertainty versus Calibration Options	
User Calibration	Best uncertainties; Noise Figure Uncertainty Calculator applies
Uncalibrated	Worst uncertainties; noise of the analyzer input acts as a second stage noise on the DUT
Internal Calibration	Good uncertainties without the need of reconnecting the DUT and running a calibration. The uncertainty of the analyzer input noise model adds a second-stage noise power to the DUT that can be positive or negative. Running the Noise Figure Uncertainty Calculator will usually show that internal Calibration achieves 90% of the possible improvement between the Uncalibrated and User Calibration states.

Nominal Instrument Noise Figure, N8973B-N8976B [Plot]

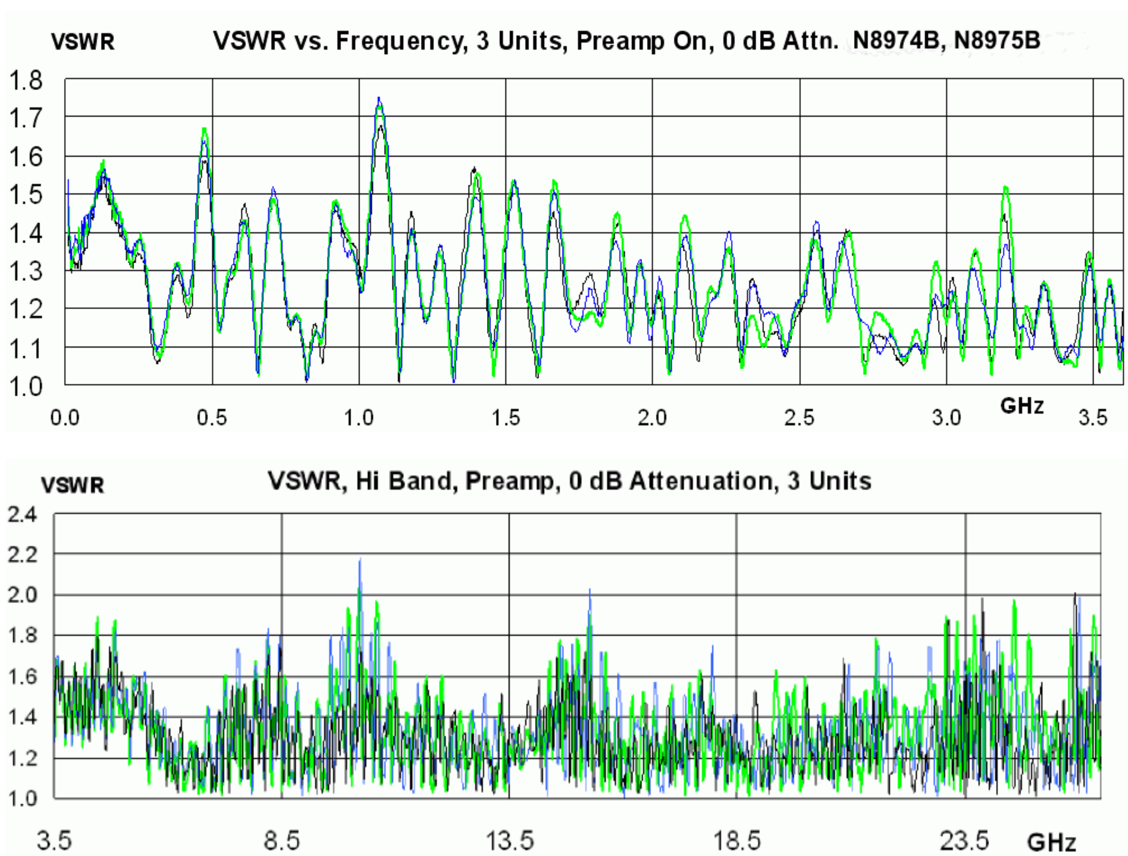




Nominal Instrument Noise Figure, N8973B-N8976B [Plot]



Nominal Instrument Input VSWR, DC Coupled, N8973B-N8975B [Plot]



2 NFA X-Series Noise Figure Analyzer - SA Mode

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

Definitions and Requirements

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

Definitions

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

Conditions Required to Meet Specifications

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

- The analyzer is within its calibration cycle. See the General section of this chapter.
- Under auto couple control, except that Auto Sweep Time Rules = Accy.
- For signal frequencies < 10 MHz, DC coupling applied.
- Any analyzer that has been stored at a temperature range inside the allowed storage range but outside the allowed operating range must be stored at an ambient temperature within the allowed operating range for at least two hours before being turned on.
- The analyzer has been turned on at least 30 minutes with Auto Align set to Normal, or if Auto Align is set to Off or Partial, alignments must have been run recently enough to prevent an Alert message. If the Alert condition is changed from “Time and Temperature” to one of the disabled duration

choices, the analyzer may fail to meet specifications without informing the user. If Auto Align is set to Light, performance is not warranted, and nominal performance will degrade to become a factor of 1.4 wider for any specification subject to alignment, such as amplitude tolerances

Certification

Keysight Technologies certifies that this product met its published specifications at the time of shipment from the factory. Keysight Technologies further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by the Institute’s calibration facility, and to the calibration facilities of other International Standards Organization members.

Frequency and Time

Description	Specifications		Supplemental Information
Frequency Range			
Maximum Frequency			
N8973B	3.6 GHz		
N8974B	7 GHz		
N8975B	26.5 GHz		
N8976B	44 GHz		
Preamp *Option P03*	3.6 GHz		
Preamp *Option P07*	7 GHz		
Preamp *Option P26*	26.5 GHz		
Preamp *Option P44*	44 GHz		
Minimum Frequency			
Preamp	AC Coupled[a]	DC Coupled	
Off	10 MHz	10 Hz	
On	10 MHz	100 kHz	
Band	**Harmonic Mixing Mode**	**LO Multiple (N**[b])	Band Overlaps[c]
0 (10 Hz to 3.6 GHz)	1–	1	N8973B-N8976B
1 (3.5 GHz to 7 GHz)	1–	1	N8974B
1 (3.5 GHz to 8.4 GHz)	1–	1	N8975 and N8976B
2 (8.3 GHz to 13.6 GHz)	1–	2	N8974B, N8975B, and N8976B
3 (13.5 to 17.1 GHz)	2–	2	N8975B and N8976B
4 (17.0 to 26.5 GHz)	2–	4	N8975B and N8976B
5 (26.4 GHz to 34.5 GHz)	2–	4	N8976B
6 (34.4 GHz to 44 GHz)	4–	8	N8976B

a. AC Coupled only applicable to Models N8973B, N8974B, and N8975B.

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 analyzer may use either band for measurements, in this example Band 0 or Band 1. The analyzer gives preference to the band with the better overall specifications (which is the lower numbered band for all frequencies below 26 GHz), but will choose the other band if doing so is necessary to achieve a sweep having minimum band crossings. For example, with CF = 3.58 GHz, with a span of 40 MHz or less, the analyzer uses Band 0, because the stop frequency is 3.6 GHz or less, allowing a span without band crossings in the preferred band. If the span is between 40 and 160 MHz, the analyzer uses Band 1, because the start frequency is above 3.5 GHz, allowing the sweep to be done without a band crossing in Band 1, though the stop frequency is above 3.6 GHz, preventing a Band 0 sweep without band crossing. With a span greater than 160 MHz, a band crossing will be required: the analyzer sweeps up to 3.6 GHz in Band 0; then executes a band crossing and continues the sweep in Band 1.
   Specifications are given separately for each band in the band overlap regions. One of these specifications is for the preferred band, and one for the alternate band. Continuing with the example from the previous paragraph (3.58 GHz), the preferred band is band 0 (indicated as frequencies under 3.6 GHz) and the alternate band is band 1 (3.5 to 8.4 GHz). The specifications for the preferred band are warranted. The specifications for the alternate band are not warranted in the band overlap region, but performance is nominally the same as those warranted specifications in the rest of the band. Again, in this example, consider a signal at 3.58 GHz. If the sweep has been configured so that the signal at 3.58 GHz is measured in Band 1, the analysis behavior is nominally as stated in the Band 1 specification line (3.5 to 8.4 GHz) but is not warranted. If warranted performance is necessary for this signal, the sweep should be reconfigured so that analysis occurs in Band 0. Another way to express this situation in this example Band 0/Band 1 crossing is this: The specifications given in the "Specifications" column which are described as "3.5 to 7.0 GHz" represent nominal performance from 3.5 to 3.6 GHz, and warranted performance from 3.6 to 7.0 GHz.

Description	Specifications	Supplemental Information
Precision Frequency Reference		
(*Option PFR* standard)		
Accuracy	±[(time since last adjustment × aging rate) + temperature stability + calibration accuracy[a]][b]	
Temperature Stability		
20 to 30°C	$\pm 1.5 \times 10^{-8}$	Nominally linear[c]
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]	$\pm 4 \times 10^{-8}$	
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. Calibration accuracy depends on how accurately the frequency standard was adjusted to 10 MHz. If the adjustment procedure is followed, the calibration accuracy is given by the specification "Achievable Initial Calibration Accuracy."
b. The specification applies after the analyzer has been powered on for four hours.
c. Narrow temperature range performance is nominally linear with temperature. For example, for 25±3° C, the stability would be only three-fifths as large as the warranted 25±5° C, thus $\pm 0.9 \times 10^{-8}$.
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 analyzer can be exceptionally good. As an example, Keysight has characterized the accuracy of a span commonly used for Electro-Magnetic Compatibility (EMC) testing using a source frequency locked to the analyzer. Ideally, this sweep would include EMC bands C and D and thus sweep from 30 to 1000 MHz. Ideally, the analysis bandwidth would be 120 kHz at −6 dB, and the spacing of the points would be half of this (60 kHz). With a start frequency of 30 MHz and a stop frequency of 1000.2 MHz and a total of 16168 points, the spacing of points is ideal. The detector used was the Peak detector. The accuracy of frequency readout of all the points tested in this span was with ±0.0032% of the span. A perfect analyzer with this many points would have an accuracy of ±0.0031% of span. Thus, even with this large number of display points, the errors in excess of the bucket quantization limitation were negligible.

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

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

Description	Specifications	Supplemental Information
Frequency Span		
Range		
N8973B	0 Hz, 10 Hz to 3.6 GHz	
N8974B	0 Hz, 10 Hz to 7 GHz	
N8975B	0 Hz, 10 Hz to 26.5 GHz	
N8976B	0 Hz, 10 Hz to 44 GHz	
Resolution	2 Hz	
Span Accuracy		
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 and Trigger		
Sweep Time Range		
Span = 0 Hz	1 μs to 6000 s	
Span ≥ 10 Hz	1 ms to 4000 s	
Sweep Time Accuracy		
Span ≥ 10 Hz, swept		±0.01% (nominal)
Span ≥ 10 Hz, FFT		±40% (nominal)
Span = 0 Hz		±0.01% (nominal)
Sweep Trigger	Free Run, Line, Video, External 1, External 2, RF Burst, Periodic Timer	
Delayed Trigger[a]		
Range		
Span ≥ 10 Hz, 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.

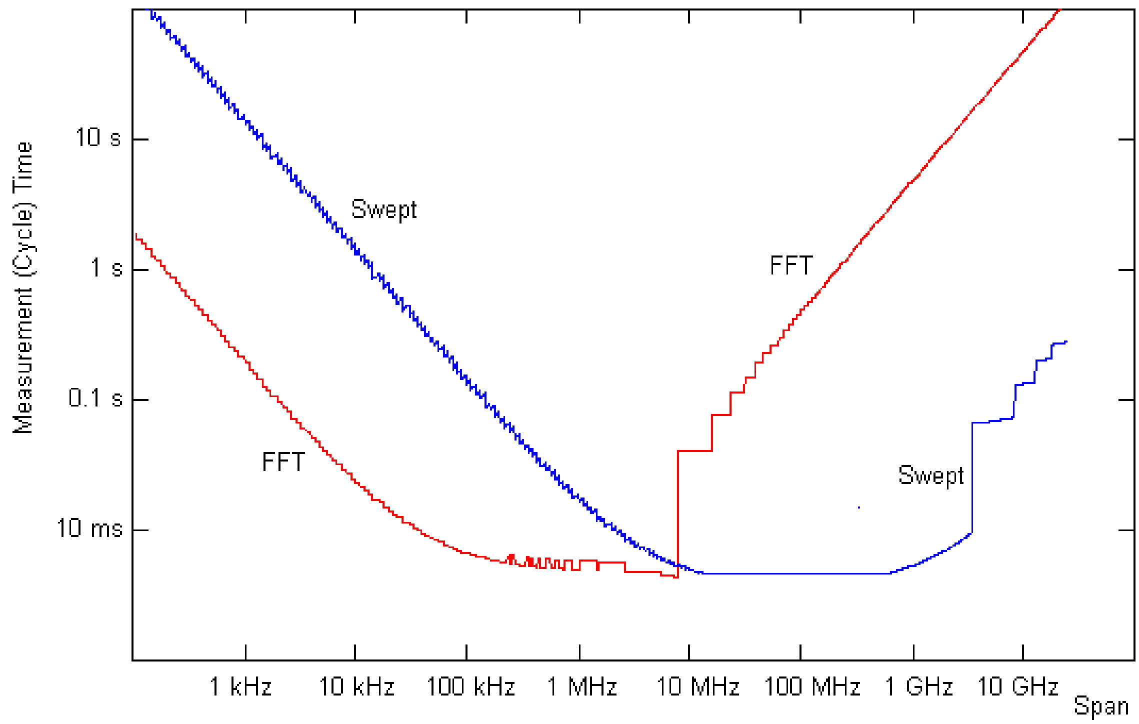
Description	Specifications	Supplemental Information
Triggers		Additional information on some of the triggers and gate sources
Video		Independent of Display Scaling and Reference Level
Minimum settable level	–170 dBm	Useful range limited by noise
Maximum usable level		Highest allowed mixer level[a] + 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		–40 to –10 dBm plus attenuation (nominal)[b]
Level Accuracy		±2 dB + Absolute Amplitude Accuracy (nominal)
Bandwidth (–10 dB)		16 MHz (nominal)
Frequency Limitations		If the start or center frequency is too close to zero, LO feedthrough can degrade or prevent triggering. How close is too close depends on the bandwidth listed above.
External Triggers		See "Trigger Inputs" on page 68
TV Triggers		Triggers on the leading edge of the selected sync pulse of standardized TV signals.
Amplitude Requirements		–65 dBm minimum video carrier power at the input mixer, nominal
Compatible Standards	NTSC-M, NTSC-Japan, NTSC-4.43, PAL-M, PAL-N, PAL-N Combination, PAL-B/-D/-G/-H/-I. PAL-60, SECAM-L	
Field Selection	Entire Frame, Field One, Field Two	
Line Selection	1 to 525, or 1 to 625, standard dependent	

a. The highest allowed mixer level depends on the IF Gain. It is nominally –10 dBm for Preamp Off and IF Gain = Low.
b. Noise will limit trigger level range at high frequencies, such as above 15 GHz.

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 Points (buckets)		
Factory preset	1001	
Range	1 to 100,001	Zero and non-zero spans

Nominal Measurement Time vs. Span [Plot]



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.	
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 to –0.2 dB (nominal)
4 to 8 MHz	<3.6 GHz		0 to –0.4 dB (nominal)
Noise BW to RBW ratio[b]			1.056 ±2% (nominal)
Accuracy (–3.01 dB bandwidth)[c]			
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 analyzer knows this power bandwidth for each RBW with greater accuracy than the RBW width itself, and can therefore achieve lower errors.) The warranted specifications shown apply to the Gaussian RBW filters used in swept and zero span analysis. There are four different kinds of filters used in the spectrum analyzer: Swept Gaussian, Swept Flattop, FFT Gaussian and FFT Flattop. While the warranted performance only applies to the swept Gaussian filters, because only they are kept under statistical process control, the other filters nominally have the same performance.

b. The ratio of the noise bandwidth (also known as the power bandwidth) to the RBW has the nominal value and tolerance shown. The RBW can also be annotated by its noise bandwidth instead of this 3 dB bandwidth. The accuracy of this annotated value is similar to that shown in the power bandwidth accuracy specification.
c. Resolution Bandwidth Accuracy can be observed at slower sweep times than auto-coupled conditions. Normal sweep rates cause the shape of the RBW filter displayed on the analyzer screen to widen 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
Analysis Bandwidth[a]		
Standard	25 MHz	

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

Description	Specifications	Supplemental Information	
Preselector Bandwidth		Relevant to many options, such as B25 Wide IF Bandwidth, in Bands 1 and higher. Nominal.	
Mean Bandwidth at CF[a]		N8973B-N8975B	N8976B
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 preselector can have a significant passband ripple. To avoid ambiguous results, the −4 dB bandwidth is characterized.

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

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

Amplitude Accuracy and Range

Description	Specifications	Supplemental Information
Measurement Range		
Preamp Off	Displayed Average Noise Level to +23 dBm	
Preamp On	Displayed Average Noise Level to +23 dBm	*Option P03, P07, P26, P44*
Input Attenuation Range		
Standard	0 to 60 dB, in 10 dB steps	
With *Option FSA* (standard)	0 to 60 dB, in 2 dB steps	

Description	Specifications	Supplemental Information
Maximum Safe Input Level		Applies with or without preamp *(Option P03, P07, P26, P44)*
Average Total Power	+30 dBm (1 W)	
Peak Pulse Power (≤10 μs pulse width, ≤1% duty cycle, input attenuation ≥ 30 dB)	+50 dBm (100 W)	
DC voltage		
DC Coupled	±0.2 Vdc	
AC Coupled	±100 Vdc	

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

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

Frequency Response

Description	N8973B-N8975B (RF/μW)	N8976B (mmW)	Specifications: 20 to 30°C	Specifications: Full range	Supplemental Information: 95th Percentile (≈2σ)
Frequency Response (Maximum error relative to reference condition (50 MHz) Mechanical attenuator only Swept operation[b] Attenuation 10 dB)					Refer to the footnote for Band Overlaps on page 18. Freq *Option 526* only: Modes above 18 GHz[a]
9 kHz to 10 MHz	x		±0.8 dB	±1.0 dB	±0.40 dB
9 kHz to 10 MHz		x	±0.6 dB	±0.8 dB	±0.28 dB
10 MHz[c] to 3.6 GHz	x		±0.6 dB	±0.65 dB	±0.21 dB
10 to 50 MHz		x	±0.45 dB	±0.57 dB	±0.21 dB
50 MHz to 3.6 GHz		x	±0.45 dB	±0.70 dB	±0.20 dB
3.5 to 7 GHz[de]	x		±2.0 dB	±3.0 dB	±0.69 dB
3.5 to 5.2 GHz[de]		x	±1.7 dB	±3.5 dB	±0.91 dB
5.2 to 8.4 GHz[de]		x	±1.5 dB	±2.7 dB	±0.61 dB
7 to 13.6 GHz	x		±2.5 dB	±3.2 dB	
8.3 to 13.6 GHz[de]		x	±2.0 dB	±2.7 dB	±0.61 dB
13.5 to 22 GHz[de]	x		±3.0 dB	±3.7 dB	
13.5 to 17.1 GHz[de]		x	±2.0 dB	±2.7 dB	±0.67 dB
17.0 to 22 GHz[de]		x	±2.0 dB	±3.0 dB	±0.78 dB
22.0 to 26.5 GHz[de]	x		±3.2 dB	±4.2 dB	
22.0 to 26.5 GHz[de]		x	±2.5 dB	±3.5 dB	±0.72 dB
26.4 to 34.5 GHz[de]		x	±2.5 dB	±3.5 dB	±1.11 dB
34.4 to 44 GHz[de]		x	±3.2 dB	±4.9 dB	±1.42 dB

a. Signal frequencies between 18 and 26.5 GHz are prone to additional response errors due to modes in the Type-N connector used with Model N8975B. 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 Sweep Type = FFT, add the RF flatness errors of this table to the IF Frequency Response errors. An additional error source, the error in switching between swept and FFT sweep types, is nominally ±0.01 dB and is included within the “Absolute Amplitude Error” specifications.
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. 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]		
Center Freq (GHz)	**Span**[c] **(MHz)**	**Preselector**	**Max Error**[d] (Exception[e])	**Midwidth Error (95th Percentile)**	**Slope (dB/MHz) (95th Percentile)**	**RMS**[f] **(nominal)**
<3.6	≤10		±0.40 dB	±0.12 dB	±0.10	0.04 dB
≥3.6, ≤26.5	≤10	On				0.25 dB
≥3.6	≤10	Off	±0.45 dB	±0.12 dB	±0.10	0.04 dB
>26.5	≤10	On				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 between 18 and 26.5 GHz are prone to additional response errors due to modes in the Type-N connector used with Model N8975B. 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.

Description			Specifications	Supplemental Information	
IF Phase Linearity				Deviation from mean phase linearity Modes above 18 GHz[a]	
Center Freq (GHz)	**Span (MHz)**	**Preselector**		**Peak-to-peak (nominal)**	**RMS** (nominal)[b]
≥0.02, <3.6	≤10	n/a		0.4°	0.1°
≥3.6,	≤10	Off		0.4°	0.1°
≥3.6 (*Option ≤ 526*)	≤10	On		1.0°	0.2°

a. Signal frequencies between 18 and 26.5 GHz are prone to additional response errors due to modes in the Type-N connector used with Model N8975B. 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		
At 50 MHz[a]		
20 to 30°C	±0.40 dB	±0.15 dB (95th percentile)
Full temperature range	±0.43 dB	
At all frequencies[a]		
20 to 30°C	±(0.40 dB + frequency response)	
Full temperature range	±(0.43 dB + frequency response)	
95th Percentile Absolute Amplitude Accuracy[b]		±0.27 dB
(Wide range of signal levels, RBWs, RLs, etc., 0.01 to 3.6 GHz, Atten = 10 dB)		
Amplitude Reference Accuracy		±0.05 dB (nominal)
Preamp On[c]		±(0.39 dB + frequency response) (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 (details below); Input attenuation 10 dB; span < 5 MHz (nominal additional error for span ≥ 5 MHz is 0.02 dB); all settings auto-coupled except Swp Time Rules = Accuracy; combinations of low signal level and wide RBW use VBW ≤ 30 kHz to reduce noise. When using FFT sweeps, the signal must be at the center frequency.
This absolute amplitude accuracy specification includes the sum of the following individual specifications under the conditions listed above: Scale Fidelity, Reference Level Accuracy, Display Scale Switching Uncertainty, Resolution Bandwidth Switching Uncertainty, 50 MHz Amplitude Reference Accuracy, and the accuracy with which the instrument aligns its internal gains to the 50 MHz Amplitude Reference.
The only difference between signals within the range ending at −50 dBm and those signals below that level is the scale fidelity. Our specifications show the possibility of increased errors below −80 dBm at the mixer, thus −70 dBm at the input. Therefore, one reasonably conservative approach to estimating the Absolute Amplitude Uncertainty below −70 dBm at the mixer would be to add an additional ±0.10 dB (the difference between the above −80 dBm at the mixer scale fidelity at the lower level scale fidelity) to the Absolute Amplitude Uncertainty.

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

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

Description	Specifications	Supplemental Information
Input Attenuation Switching Uncertainty		Refer to the footnote for Band Overlaps on page 18
50 MHz (reference frequency)	±0.20 dB	±0.08 dB (typical)
Attenuation > 2 dB, preamp off		
(Relative to 10 dB (reference setting))		
9 kHz to 3.6 GHz		±0.3 dB (nominal)
3.5 to 7.0 GHz		±0.5 dB (nominal)
7.0 to 13.6 GHz		±0.7 dB (nominal)
13.5 to 26.5 GHz		±0.7 dB (nominal)
26.5 to 44 GHz		±1.0 dB (nominal)

Description	Specifications	Supplemental Information	
RF Input VSWR		Nominal[a]	
at tuned frequency, DC Coupled			
10 dB attenuation, 50 MHz		1.07:1	
		Input Attenuation	
Frequency		**0 dB**	**≥10 dB**
N8973B-N8975B			
10 MHz to 3.6 GHz		<2.2:1	<1.2:1
3.6 to 26.5 GHz			<1.9:1
N8976B			
10 MHz to 3.6 GHz		<2.2:1	<1.2:1
3.6 to 26.5 GHz			<1.5:1
26.5 to 44 GHz			<1.8:1
RF calibrator (e.g. 50 MHz) is On		Open input	
Alignments running		Open input for some, unless "All but RF" is selected	
Preselector Centering		Open input	

a. The nominal SWR stated is at the worst case RF frequency in three representative instruments.

Description	Specifications	Supplemental Information
Resolution Bandwidth Switching Uncertainty		Relative to reference BW of 30 kHz, verified in low band[a]
1.0 Hz to 3 MHz RBW	±0.10 dB	
Manually selected wide RBWs: 4, 5, 6, 8 MHz	±1.0 dB	

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

Description	Specifications	Supplemental Information
Reference Level		
Range		
Log Units	–170 to +23 dBm, in 0.01 dB steps	
Linear Units	707 pV to3.16 V, with 0.01 dB resolution (0.11%)	
Accuracy	0 dB[a]	

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

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

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

Description	Specifications	Supplemental Information
Display Scale Fidelity[a][b]		
Absolute Log-Linear Fidelity (Relative to the reference condition: –25 dBm input through 10 dB attenuation, thus –35 dBm at the input mixer)		
Input mixer level[c]	**Linearity**	
–80 dBm ≤ ML ≤ –10 dBm	±0.15 dB	
ML < –80 dBm	±0.25 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.

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

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

b. The scale fidelity is warranted with ADC dither set to Medium. Dither increases the noise level by nominally only 0.1 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
Available Detectors	Normal, Peak, Sample, Negative Peak, Average	Average detector works on RMS, Voltage and Logarithmic scales

Dynamic Range

Gain Compression

Description	Specifications	Supplemental Information
1 dB Gain Compression Point (Two-tone)[abc]		Maximum power at mixer[d] (nominal)
20 MHz to 26.5 GHz (N8973B-N8975B)		+9 dBm (nominal)
20 MHz to 26.5 GHz (N8976B)		+6 dBm (nominal)
26.5 to 44 GHz (N8976B)		0 dBm (nominal)
Clipping (ADC Over-range)		
Any signal offset	–10 dBm	Low frequency exceptions[e]
Signal offset > 5 times IF prefilter bandwidth and IF Gain set to Low		+12 dBm (nominal)
IF Prefilter Bandwidth		
Zero Span or Sweep Type = FFT,		–3 dB Bandwidth

a. Large signals, even at frequencies not shown on the screen, can cause the analyzer to incorrectly measure on-screen signals because of two-tone gain compression. This specification tells how large an interfering signal must be in order to cause a 1 dB change in an on-screen signal.
b. Specified at 1 kHz RBW with 100 kHz tone spacing. The compression point will nominally equal the specification for tone spacing greater than 5 times the prefilter bandwidth. At smaller spacings, ADC clipping may occur at a level lower than the 1 dB compression point.
c. Reference level and off-screen performance: The reference level (RL) behavior differs from some earlier analyzers in a way that makes this analyzer more flexible. In other analyzers, the RL controlled how the measurement was performed as well as how it was displayed. Because the logarithmic amplifier in these analyzers had both range and resolution limitations, this behavior was necessary for optimum measurement accuracy. The logarithmic amplifier in this signal analyzer, however, is implemented digitally such that the range and resolution greatly exceed other instrument limitations. Because of this, the analyzer can make measurements largely independent of the setting of the RL without compromising accuracy. Because the RL becomes a display function, not a measurement function, a marker can read out results that are off-screen, either above or below, without any change in accuracy. The only exception to the independence of RL and the way in which the measurement is performed is in the input attenuation setting: When the input attenuation is set to auto, the rules for the determination of the input attenuation include dependence on the reference level. Because the input attenuation setting controls the tradeoff between large signal behaviors (third-order intermodulation, compression, and display scale fidelity) and small signal effects (noise), the measurement results can change with RL changes when the input attenuation is set to auto.
d. Mixer power level (dBm) = input power (dBm) – input attenuation (dB).

e. The ADC clipping level declines at low frequencies (below 50 MHz) when the LO feedthrough (the signal that appears at 0 Hz) is within 5 times the prefilter bandwidth (see table) and must be handled by the ADC. For example, with a 300 kHz RBW and prefilter bandwidth at 966 kHz, the clipping level reduces for signal frequencies below 4.83 MHz. For signal frequencies below 2.5 times the prefilter bandwidth, there will be additional reduction due to the presence of the image signal (the signal that appears at the negative of the input signal frequency) at the ADC.

Displayed Average Noise Level (DANL)

Description	N8973B-N8975B(RF/µW)	N8976B (mmW)	Specifications 20 to 30°C	Specifications Full range	Supplemental Information
Displayed Average Noise Level (DANL)[a]			Input terminated Sample or Average detector Averaging type = Log 0 dB input attenuation IF Gain = High 1 Hz Resolution Bandwidth		Refer to the footnote for Band Overlaps on page 18.
			20 to 30°C	**Full range**	**Typical**
10 Hz	x	x			–90 dBm (nominal)
20 Hz	x	x			–100 dBm (nominal)
100 Hz	x	x			–110 dBm (nominal)
1 kHz	x	x			–120 dBm (nominal)
9 kHz to 1 MHz	x				–125 dBm (nominal)
9 kHz to 1 MHz		x			–130 dBm
1 to 10 MHz[b]	x		–147 dBm	–145 dBm	–149 dBm
1 MHz to 1.2 GHz		x	–152 dBm	–151 dBm	–155 dBm
10 MHz to 2.1 GHz	x		–148 dBm	–146 dBm	–150 dBm
1.2 to 2.1 GHz		x	–151 dBm	–150 dBm	–154 dBm
2.1 to 3.6 GHz	x		–147 dBm	–145 dBm	–149 dBm
2.1 to 3.6 GHz		x	–149 dBm	–148 dBm	–152 dBm
3.5 to 7 GHz	x		–147 dBm	–145 dBm	–149 dBm
3.5 to 4.2 GHz		x	–144 dBm	–142 dBm	–147 dBm
4.2 to 8.4 GHz		x	–145 dBm	–143 dBm	–150 dBm
7 to 13.6 GHz	x		–143 dBm	–141 dBm	–147 dBm
8.3 to 13.6 GHz		x	–147 dBm	–145 dBm	–150 dBm
13.5 to 20 GHz	x		–137 dBm	–134 dBm	–142 dBm
13.5 to 20 GHz		x	–145 dBm	–143 dBm	–148 dBm

Description			Specifications		Supplemental Information
20 to 26.5 GHz	x		–134 dBm	–130 dBm	–140 dBm
20 to 26.5 GHz		x	–142 dBm	–140 dBm	–145 dBm
26.4 to 34 GHz		x	–140 dBm	–136 dBm	–144 dBm
33.9 to 44 GHz		x	–135 dBm	–131 dBm	–140 dBm
Additional DANL, IF Gain=Low[c]	x	x			–160.5 dBm (nominal)

a. DANL for zero span and swept is measured in a 1 kHz RBW and normalized to the narrowest available RBW, because the noise figure does not depend on RBW and 1 kHz measurements are faster.
b. DANL below 10 MHz is affected by phase noise around the LO feedthrough signal. Specifications apply with the best setting of the Phase Noise Optimization control, which is to choose the “Best Close-in ϕ Noise" for frequencies below 25 kHz, and “Best Wide Offset ϕ Noise" for frequencies above 25 kHz.
c. Setting the IF Gain to Low is often desirable in order to allow higher power into the mixer without overload, better compression and better third-order intermodulation. When the Swept IF Gain is set to Low, either by auto coupling or manual coupling, there is noise added above that specified in this table for the IF Gain = High case. That excess noise appears as an additional noise at the input mixer. This level has sub-decibel dependence on center frequency. To find the total displayed average noise at the mixer for Swept IF Gain = Low, sum the powers of the DANL for IF Gain = High with this additional DANL. To do that summation, compute DANLtotal = 10 × log (10^(DANLhigh/10) + 10^(AdditionalDANL / 10)). In FFT sweeps, the same behavior occurs, except that FFT IF Gain can be set to autorange, where it varies with the input signal level, in addition to forced High and Low settings.

Spurious Responses

Description		Specifications		Supplemental Information
Spurious Responses (see Band Overlaps on page 18)				Preamp Off[a]
Residual Responses[b]				
200 kHz to 8.4 GHz (swept)		–100 dBm		
Zero span or FFT or other frequencies				–100 dBm (nominal)
Image Responses				
Tuned Freq (f)	**Excitation Freq**	**Mixer Level**[c]	**Response**	
10 MHz to 26.5 GHz	f+45 MHz	–10 dBm	–75 dBc	–99 dBc (typical)
10 MHz to 3.6 GHz	f+10245 MHz	–10 dBm	–80 dBc	–103 dBc (typical)
10 MHz to 3.6 GHz	f+645 MHz	–10 dBm	–80 dBc	–107 dBc (typical)
3.5 to 13.6 GHz	f+645 MHz	–10 dBm	–75 dBc	–87 dBc (typical)
13.5 to 17.1 GHz	f+645 MHz	–10 dBm	–71 dBc	–85 dBc (typical)
17.0 to 22 GHz	f+645 MHz	–10 dBm	–68 dBc	–82 dBc (typical)
22 to 26.5 GHz	f+645 MHz	–10 dBm	–66 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[d] (f ≥ 10 MHz from carrier)		–10 dBm	–68 dBc + 20 × log(N[e])	Includes IF feedthrough, LO harmonic mixing responses
Higher RF Order[f] (f ≥ 10 MHz from carrier)		–40 dBm	–80 dBc + 20 × log(N[e])	Includes higher order mixer responses
Carrier Frequency >26.5 GHz				
First RF Order[d] (f ≥ 10 MHz from carrier)		–30 dBm		–90 dBc (nominal)
Higher RF Order[f] (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[g] + 20 × log(N[e])	–90 dBc + 20 × log(N) (typical)

Description	Specifications	Supplemental Information
Sidebands, offset from CW signal		
≤200 Hz		–70 dBc[g] (nominal)
200 Hz to 3 kHz		–73 dBc[g] (nominal)
3 kHz to 30 kHz		–73 dBc (nominal)
30 kHz to 10 MHz		–80 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
b. Input terminated, 0 dB input attenuation.
c. Mixer Level = Input Level – Input Attenuation.
d. 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.
e. N is the LO multiplication factor.
f. RBW=100 Hz. With higher RF order spurious responses, the observed frequency will change at a rate faster than the input frequency.
g. Nominally –40 dBc under large magnetic (0.38 Gauss rms) or vibrational (0.21 g rms) environmental stimuli.

Second Harmonic Distortion

Description	N8973B-N8975B (RF/μW)	N8976B (mmW)	Specifications	Supplemental Information
Second Harmonic Distortion				**SHI[a] (nominal)**
10 MHz to 1.8 GHz	x	x		+45 dBm
1.8 to 7 GHz	x			+65 dBm
1.8 to 6.5 GHz		x		+65 dBm
7 to 11 GHz	x			+55 dBm
6.5 to 10 GHz		x		+60 dBm
11 to 13.25 GHz	x			+50 dBm
10 to 13.25 GHz		x		+55 dBm
13.25 to 22 GHz		x		+50 dBm

a. SHI = second harmonic intercept. The SHI is given by the mixer power in dBm minus the second harmonic distortion level relative to the mixer tone in dBc.

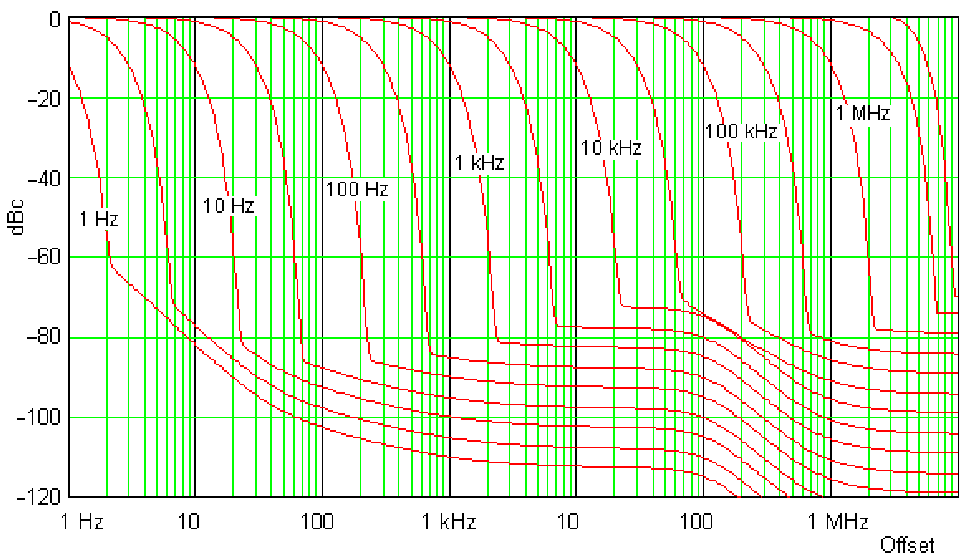
Third Order Intermodulation

Description	N8973B-N8975B (RF/μW)	N8976B (mmW)	Specifications	Supplemental Information
Third Order Intermodulation (Tone separation > 5 times IF Prefilter Bandwidth[a] Verification conditions[b])				Refer to the footnote for Band Overlaps on page 18.
20 to 30°C			**Intercept**[c]	**Intercept** (typical)
10 to 100 MHz		x	+12 dBm	+17 dBm
100 to 400 MHz	x		+13 dBm	+17 dBm
400 MHz to 3.6 GHz	x		+14 dBm	+18 dBm
100 MHz to 3.95 GHz		x	+15 dBm	+19 dBm
3.6 to 13.6 GHz	x		+14 dBm	+18 dBm
3.95 to 8.4 GHz		x	+15 dBm	+18 dBm
8.3 to 13.6 GHz		x	+15 dBm	+18 dBm
13.6 to 26.5 GHz	x		+12 dBm	+16 dBm
13.5 to 17.1 GHz		x	+11 dBm	+17 dBm
17.0 to 26.5 GHz		x	+10 dBm	+17 dBm (nominal)
26.5 to 44 GHz		x		+13 dBm (nominal)
Full temperature range				
10 to 100 MHz		x	+10 dBm	
100 to 400 MHz	x		+10 dBm	
400 MHz to 3.6 GHz	x		+12 dBm	
100 MHz to 3.95 GHz		x	+13 dBm	
3.6 to 13.6 GHz	x		+12 dBm	
3.95 to 8.4 GHz		x	+13 dBm	
8.3 to 13.6 GHz		x	+13 dBm	

Description			Specifications	Supplemental Information
13.6 to 26.5 GHz	x		+10 dBm	
13.5 to 17.1 GHz		x	+9 dBm	
17.0 to 26.5 GHz		x	+8 dBm	

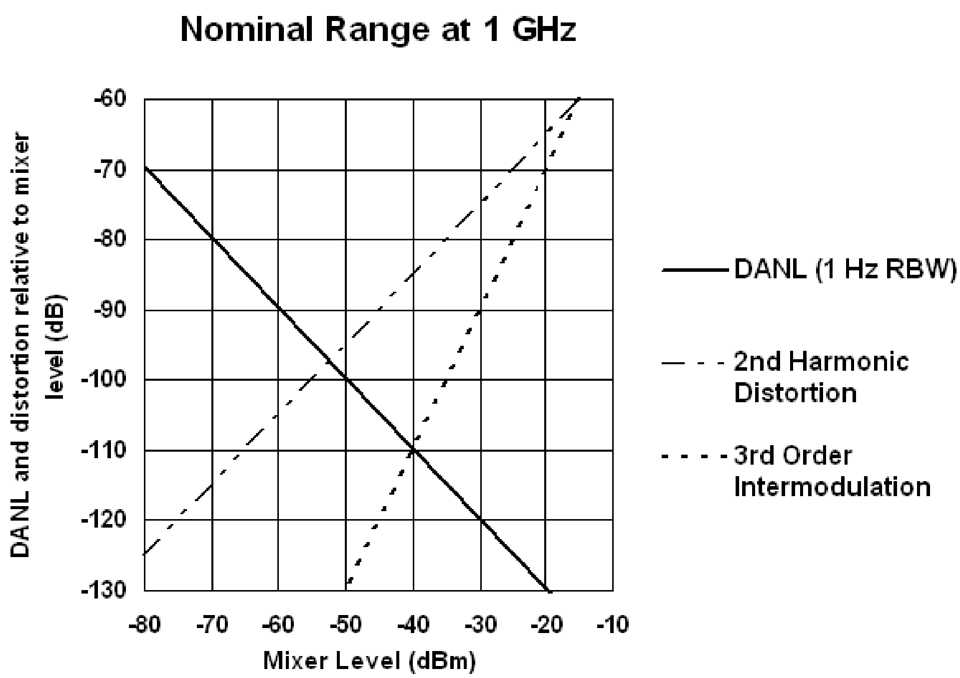
a. See the IF Prefilter Bandwidth table in the Gain Compression specifications on page 41. When the tone separation condition is met, the effect on TOI of the setting of IF Gain is negligible. TOI is verified with IF Gain set to its best case condition, which is IF Gain = Low.
b. TOI is verified with two tones, each at –16 dBm at the mixer, spaced by 100 kHz.
c. Intercept = TOI = third order intercept. The TOI is given by the mixer tone level (in dBm) minus (distortion/2) where distortion is the relative level of the distortion tones in dBc.

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

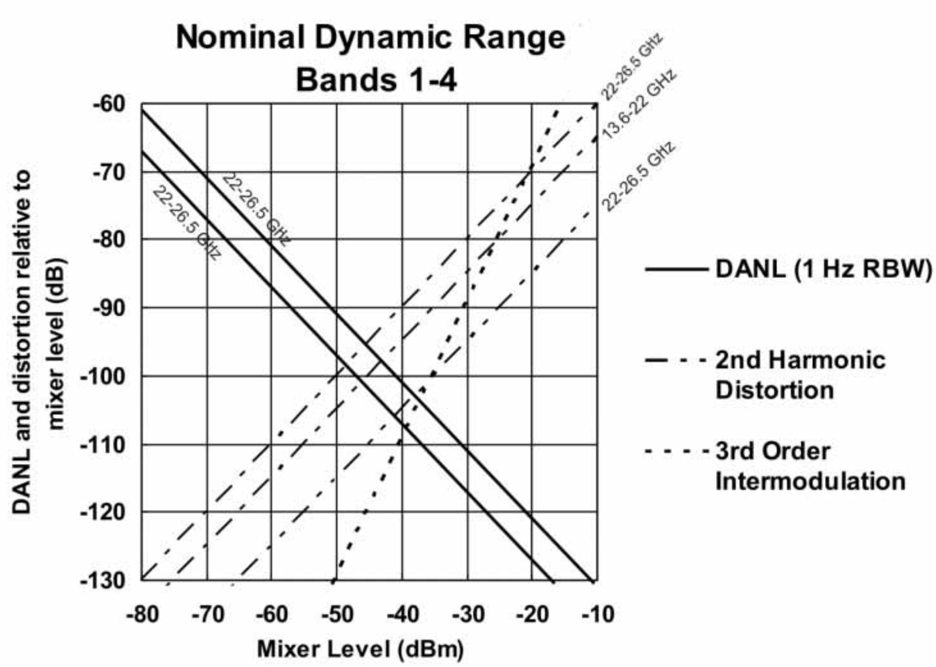


Conditions:
CF = 1 GHz
Mixer Level = –10 dBm
Only 2 per decade of the 24/decade RBWs are shown
RBWs 10 kHz and below are shown with phase noise optimized for fm < 40 kHz
RBWs 30 kHz and above are shown with phase noise optimized for fm > 60 kHz
Average Type = Log

Nominal Dynamic Range at 1 GHz for Models N8973B-N8975B [Plot]



Nominal Dynamic Range Bands 1-4 for Models N8973B-N8975B [Plot]



Phase Noise

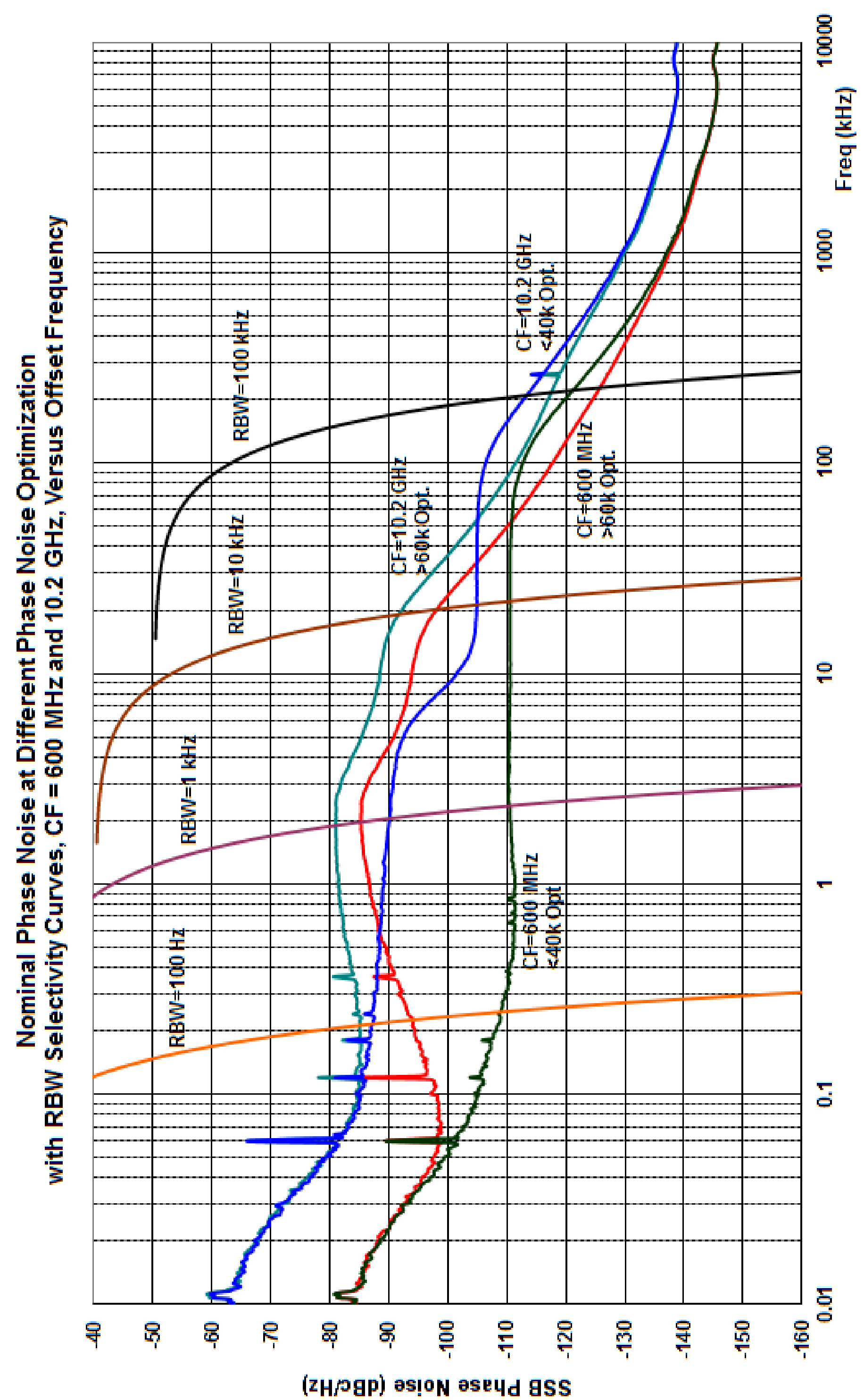
Description	RF/µW *Option* ≤*526*	*Option 532*, or *544* (mmW)	Specifications 20 to 30°C	Specifications Full range	Supplemental Information Typical
Phase Noise (Center Frequency = 1 GHz[a], Best-case Optimization[b], Internal Reference[c])					Noise Sidebands
100 Hz	x	x	–87 dBc/Hz	–86 dBc/Hz	–102 dBc/Hz
1 kHz	x				–110 dBc/Hz (nominal)
1 kHz		x			–110 dBc/Hz (nominal)
10 kHz	x		–107 dBc/Hz	–106 dBc/Hz	–109 dBc/Hz
10 kHz		x	–107 dBc/Hz	–106 dBc/Hz	–109 dBc/Hz
100 kHz	x		–115 dBc/Hz	–114 dBc/Hz	–118 dBc/Hz
100 kHz		x	–115 dBc/Hz	–114 dBc/Hz	–118 dBc/Hz
1 MHz	x		–134 dBc/Hz	–134 dBc/Hz	–136 dBc/Hz
1 MHz		x	–134 dBc/Hz	–134 dBc/Hz	–136 dBc/Hz
10 MHz	x				–147 dBc/Hz (nominal)
10 MHz		x			–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 × log[(f + 0.3225)/1.3225]. For mid-offset frequencies such as 10 kHz, band 0 phase noise increases as 20 × log[(f + 5.1225)/6.1225]. For mid-offset frequencies in other bands, phase noise changes as 20 × 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 × log(N). N is the LO Multiple as shown on page 18; f is in GHz units in all these relationships; all increases are in units of decibels.

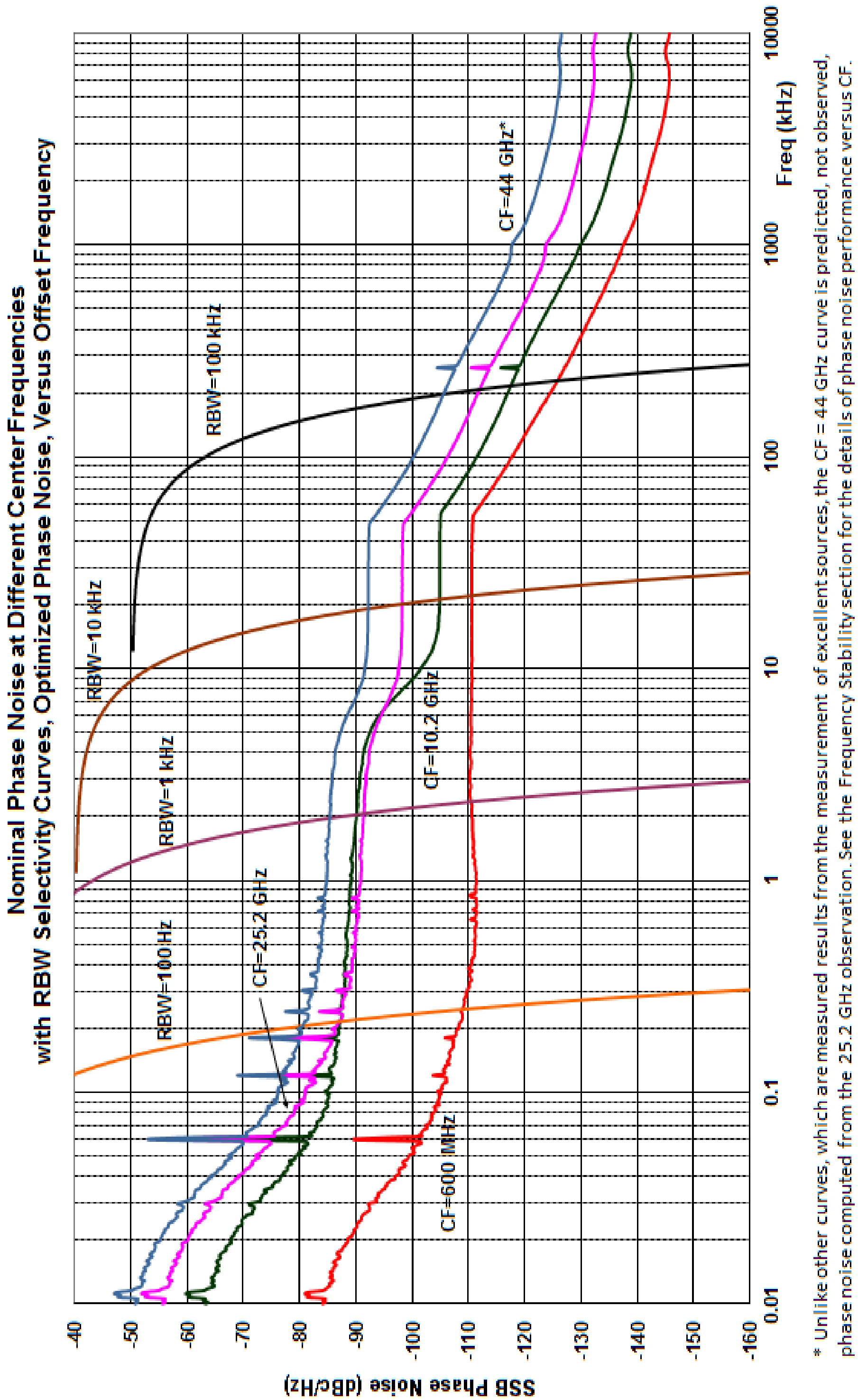
b. Noise sidebands for lower offset frequencies, for example, 10 kHz, apply with the phase noise optimization (PhNoise Opt) set to Best Close-in φ Noise. Noise sidebands for higher offset frequencies, for example, 1 MHz, as shown apply with the phase noise optimization set to Best Wide-offset φ Noise.

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.

Nominal Phase Noise of Different LO Optimizations [Plot]



Nominal Phase Noise of Different Center Frequencies [Plot]



Power Suite Measurements

The specifications for this section apply only to instruments with N8973B-N8975B. For instruments with higher frequency options, the performance is nominal only and not subject to any warranted specifications.

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)	±01.04 dB	±0.27 dB (95th percentile)

a. See "Absolute Amplitude Accuracy" on page 35.
b. See "Frequency and Time" on page 18.
c. Expressed in dB.

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

Description			Specifications	Supplemental Information	
Adjacent Channel Power (ACP)					
Case: Radio Std = None					
Accuracy of ACP Ratio (dBc)				Display Scale Fidelity[a]	
Accuracy of ACP Absolute Power (dBm or dBm/Hz)				Absolute Amplitude Accuracy[b] + Power Bandwidth Accuracy[cd]	
Accuracy of Carrier Power (dBm), or Carrier Power PSD (dBm/Hz)				Absolute Amplitude Accuracy[b] + Power Bandwidth Accuracy[cd]	
Passband Width[e]			–3 dB		
Case: Radio Std = 3GPP W-CDMA				(ACPR; ACLR)[f]	
Minimum power at RF Input				–36 dBm (nominal)	
ACPR Accuracy[g]				RRC weighted, 3.84 MHz noise bandwidth, method ≠ RBW	
Radio	Offset Freq				
MS (UE)	5 MHz		±0.18 dB	At ACPR range of –30 to –36 dBc with optimum mixer level[h]	
MS (UE)	10 MHz		±0.23 dB	At ACPR range of –40 to –46 dBc with optimum mixer level[i]	
BTS	5 MHz		±0.79 dB	At ACPR range of –42 to –48 dBc with optimum mixer level[j]	
BTS	10 MHz		±0.61 dB	At ACPR range of –47 to –53 dBc with optimum mixer level[i]	
BTS	5 MHz		±0.34 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		–68 dB	–8 dBm
Off	5 MHz	Fast		–67 dB	–9 dBm
Off	10 MHz	Filtered IBW		–74 dB	–2 dBm
On	5 MHz	Filtered IBW		–73 dB	–8 dBm
On	10 MHz	Filtered IBW		–76 dB	–2 dBm

Description	Specifications	Supplemental Information
RRC Weighting Accuracy[n]		
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. 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
Power Statistics CCDF		
Histogram Resolution[a]	0.01 dB	

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

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

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

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

Description	Specifications	Supplemental Information
Spurious Emissions		Table-driven spurious signals; search across regions
Case: Radio Std = 3GPP W-CDMA		
Dynamic Range[a], relative (RBW=1 MHz) (1 to 3.6 GHz)	76.9 dB	77.4 dB (typical)
Sensitivity[b], absolute (RBW=1 MHz) (1 to 3.6 GHz)	–82.5 dBm	–86.5 dBm (typical)
Accuracy		Attenuation = 10 dB
9 kHz to 3.6 GHz		±0.38 dB (95th percentile)
3.5 to 8.4 GHz		±1.22 dB (95th percentile)
8.3 to 13.6 GHz		±1.59 dB (95th percentile)

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

Description	Specifications	Supplemental Information
Spectrum Emission Mask		Table-driven spurious signals; measurement near carriers
Case: Radio Std = cdma2000		
Dynamic Range, relative (750 kHz offset[a][b])	74.3 dB	81.4 dB (typical)
Sensitivity, absolute (750 kHz offset[c])	–97.7 dBm	–101.7 dBm (typical)
Accuracy (750 kHz offset)		
Relative[d]	±0.11 dB	
Absolute[e] (20 to 30°C)	±1.15 dB	±0.31 dB (95th percentile ≈ 2σ)
Case: Radio Std = 3GPP W–CDMA		
Dynamic Range, relative (2.515 MHz offset[a][d])	78.5 dB	84.2 dB (typical)
Sensitivity, absolute (2.515 MHz offset[c])	–97.7 dBm	–101.7 dBm (typical)
Accuracy (2.515 MHz offset)		
Relative[d]	±0.15 dB	
Absolute[e] (20 to 30°C)	±1.15 dB	±0.31 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.

N8973B:	Frequency range, 10 Hz to 3.6 GHz
N8974B:	Frequency range, 10 Hz to 7 GHz
N8975B:	Frequency range, 10 Hz to 26.5 GHz
N8976B:	Frequency range, 10 Hz to 44 GHz
Option B25:	Analysis bandwidth, 25 MHz
Option FSA:	2 dB fine step attenuator
Option NFE:	Noise floor extension, instrument alignment
Option P03:	Preamplifier, 3.6 GHz
Option P07:	Preamplifier, 7 GHz
Option P26:	Preamplifier, 26.5 GHz
Option P44:	Preamplifier, 44 GHz
Option PFR:	Precision frequency reference
N9069C:	Noise Figure measurement application

General

Description	Specifications	Supplemental Information
Calibration Cycle	2 years	

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

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

Description	Specifications	Supplemental Information
Environmental and Military Specifications		Samples of this product have been type tested in accordance with the Keysight Environmental Test Manual and verified to be robust against the environmental stresses of Storage, Transportation and End-use; those stresses include but are not limited to temperature, humidity, shock, vibration, altitude and power line conditions. Test Methods are aligned with IEC 60068-2 and levels are similar to MIL-PRF-28800F Class 3.

Description	Specifications
EMC	Complies with European EMC Directive 2004/108/EC — IEC/EN 61326-1 or IEC/EN 61326-2-1 — CISPR Pub 11 Group 1, class A — AS/NZS CISPR 11[a] — ICES/NMB-001 This ISM device complies with Canadian ICES-001. Cet appareil ISM est conforme a la norme NMB-001 du Canada.

a. The NFA X-Series is in full compliance with CISPR 11, Class A emission limits and is declared as such. In addition, the NFA X-Series has been type tested and shown to meet CISPR 11, Class B emission limits when no USB cable/device connections are made to the front or rear panel. Information regarding the Class B emission performance of the NFA X-Series is provided as a convenience to the user and is not intended to be a regulatory declaration.

Acoustic statement (European Machinery Directive 2002/42/EC, 1.7.4.2u
Acoustic noise emission
LpA <70 dB
Operator position
Normal operation mode

Description	Specification	Supplemental Information
Acoustic Noise--Further Information		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	Specifications
Safety	Complies with European Low Voltage Directive 2006/95/EC — IEC/EN 61010-1 3rd Edition — Canada: CSA C22.2 No. 61010-1-12 — USA: UL 61010-1 3rd Edition

Description	Specification	Supplemental Information
Power Requirements		
Low Range		
Voltage	100 to 120 V	
Frequency	50, 60 or 400 Hz	
High Range		
Voltage	220 to 240 V	
Frequency	50 or 60 Hz	
Power Consumption, On	350 W	Maximum
Power Consumption, Standby	20 W	Standby power is not supplied to frequency reference oscillator.
Typical instrument configuration		Power (nominal)
Base 3.6 GHz instrument (N8973B)		176 W
Base 7 GHz instrument (N8974B)		179 W
Base 26.5 GHz instrument (N8975B)		194 W
Base 44 GHz instrument (N8976B)		225 W

Description	Supplemental Information	
Measurement Speed[a]	Nominal	
	Standard	w/ Option PC4
Local measurement and display update rate[bc]	11 ms (90/s)	4 ms (250/s)
Remote measurement and LAN transfer rate[bc]	6 ms (167/s)	5 ms (200/s)
Marker Peak Search	5 ms	1.5 ms
Center Frequency Tune and Transfer (RF)	22 ms	20 ms
Center Frequency Tune and Transfer (μW)	49 ms	47 ms
Measurement/Mode Switching	75 ms	39 ms
Measurement Time vs. Span	See page 26	

a. Sweep Points = 101.
b. Factory preset, fixed center frequency, RBW = 1 MHz, 10 MHz < span $\leq$ 600 MHz, stop frequency $\leq$ 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
Display[a]		
Resolution	1280×768	WXGA
Size		236 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 (~ 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		
Standard		
Internal Total		Removable solid state drive (≥ 160 GB)
Internal User		≥ 9 GB available for user data

Description	Specifications	Supplemental Information
Weight		Weight without options
Net		16 kg (35 lbs) (nominal)
Shipping		28 kg (62 lbs) (nominal)
Cabinet Dimensions		Cabinet dimensions exclude front and rear protrusions.
Height	177 mm (7.0 in)	
Width	426 mm (16.8 in)	
Length	368 mm (14.5 in)	

Inputs/Outputs

Front Panel

Description	Specifications	Supplemental Information
RF Input		
Connector		
Standard	Type-N female	N8973B-N8975B
	2.4 mm male	N8976B
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 2.0 Ports		See Rear Panel for other ports
Host (2 ports)		
Connector	USB Type “A” (female)	
Output Current		0.5 A (nominal)
Host (1 port)		
Connector	USB Type “A” (female)	
Output Current		1.0 A (nominal)

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

Rear Panel

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

Description	Specifications	Supplemental Information
Ext Ref In		
Connector	BNC female	Note: Analyzer noise sidebands and spurious response performance may be affected by the quality of the external reference used. See footnote c in the Phase Noise specifications within the Dynamic Range section on page 50.
Impedance		50Ω (nominal)
Input Amplitude Range		
sine wave		–5 to +10 dBm (nominal)
square wave		0.2 to 1.5 V peak-to-peak (nominal)
Input Frequency		10 MHz (nominal)
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		
Connector	VGA compatible, 15-pin mini D-SUB	
Format		XGA (60 Hz vertical sync rates, non-interlaced) Analog RGB
Resolution	1024 × 768	

Description	Specifications	Supplemental Information
Analog Out		
Connector	BNC female	
Impedance		
Without DP2 or MPB		50Ω (nominal)
With DP2 or MPB		50Ω (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/Agilent Technologies SNS Series noise sources

Description	Specifications	Supplemental Information
Digital Bus		This port is intended for use with the Agilent/Keysight N5105 and N5106 products only. It is not available for general purpose use.
Connector	MDR-80	

Description	Specifications	Supplemental Information
USB 2.0 Ports		See Front Panel for additional ports
Host (4 ports)		
Connector	USB Type “A” (female)	
Output Current		0.5 A (nominal)
Device (1 port)		
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	1000BaseT

Regulatory Information

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

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

For indoor use only.

CE	The CE mark is a registered trademark of the European Community (if accompanied by a year, it is the year when the design was proven). This product complies with all relevant directives.
ICES/NMB-001	“This ISM device complies with Canadian ICES-001.” “Cet appareil ISM est conforme a la norme NMB du Canada.”
ISM 1-A (GRP.1 CLASS A)	This is a symbol of an Industrial Scientific and Medical Group 1 Class A product. (CISPR 11, Clause 4)
C US	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).
40	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 Class A EMC Declaration A 급 기기 (업무용 방송통신기자재) 이 기기는 업무용 (A 급) 전자파적합기기로서 판 매자 또는 사용자는 이 점을 주의하시기 바라 며 , 가정외의 지역에서 사용하는 것을 목적으 로 합니다 . This equipment is Class A suitable for professional use and is for use in electromagnetic environments outside of the home.

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 Pub 11 Group 1, class A
– AS/NZS CISPR 11
– ICES/NMB-001

This ISM device complies with Canadian ICES-001.

Cet appareil ISM est conforme a la norme NMB-001 du Canada.

South Korean Class A EMC declaration: This equipment is Class A suitable for **professional use** and is for use in electromagnetic environments outside of the home.

(업무용 방송통신기자재)이 기기는 업무용(A급)전자파적합기기로서 판 매자
을 주의하시기 바라며, 가정외의 지역에서 사용하는것을 목적으로 합니다.

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

3 I/Q Analyzer

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

Specifications Affected by I/Q Analyzer

Specification Name	Information
Number of Frequency Display Trace Points (buckets)	Does not apply.
Resolution Bandwidth	See “Frequency” on page 75 in this chapter.
Video Bandwidth	Not available.
Clipping-to-Noise Dynamic Range	See “Clipping-to-Noise Dynamic Range” on page 76 in this chapter.
Resolution Bandwidth Switching Uncertainty	Not specified because it is negligible.
Available Detectors	Does not apply.
Spurious Responses	The “Spurious Responses” on page 45 of core specifications still apply. Additional bandwidth-option-dependent spurious responses are given in the Analysis Bandwidth chapter for any optional bandwidths in use.
IF Amplitude Flatness	See “IF Frequency Response” on page 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	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	See “Data Acquisition” on page 77 in this chapter for the 10 MHz bandwidth. Specifications for wider bandwidths are given in the Analysis Bandwidth chapter for any optional bandwidths in use.

Frequency

Description	Specifications	Supplemental Information
Frequency Span		
Standard instrument	10 Hz to 25 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 25 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 (DANL)” on page 43.

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 (DANL)” on page 43, gives a line entry on the excess noise added by using IF Gain = Low, and a footnote explaining how to combine the IF Gain noise with the DANL.

e. DANL is specified for log averaging, not power averaging, and thus is 2.51 dB lower than the true noise density. It is also specified in the narrowest RBW, 1 Hz, which has a noise bandwidth slightly wider than 1 Hz. These two effects together add up to 2.25 B.

f. As an example computation, consider this: For the case where DANL = –151 dBm in 1 Hz, IF Gain is set to low, and the “Additional DANL” is –160 dBm, the total noise density computes to –148.2 dBm/Hz and the Clipping-to-noise ratio for a –10 dBm clipping level is –138.2 dBFS/Hz.

Data Acquisition

Description	Specifications	Supplemental Information
Time Record Length (IQ pairs)		
IQ Analyzer	5,000,000 IQ sample pairs	
Sample Rate		
At ADC		
Option DP2 or MPB	100 MSa/s	IF Path ≤ 25 MHz
None of the above	90 MSa/s	
IQ Pairs		Integer submultiple of 15 Mpairs/s depending on the span for spans of 8 MHz or narrower.
ADC Resolution		
Standard	14 bits	

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.

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 45 still apply. Further, bandwidth-option-dependent spurious responses are contained within this chapter.
Displayed Average Noise Level, Third-Order Intermodulation and Phase Noise	The performance of the analyzer will degrade by an unspecified extent when using this bandwidth option. This extent is not substantial enough to justify statistical process control.

Other Analysis Bandwidth Specifications

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

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

Description			Specifications		Supplemental Information		
IF Frequency Response[a] (Demodulation and FFT response relative to the center frequency)					Modes above 18 GHz[b]		
Center Freq (GHz)	**Span**[c] **(MHz)**	**Preselector**	**Max Error**[d] (Exceptions[e]) 20 to 30°C	Full range	**Midwidth Error (95th Percentile)**	**Slope (dB/MHz) (95th Percentile)**	**RMS**[f] **(nominal)**
≤3.6	10 to ≤25	n/a	±0.45 dB	±0.45 dB	±0.12 dB	±0.10	0.051 dB
>3.6	10 to ≤25[g]	On					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 between 18 and 26.5 GHz are prone to additional response errors due to modes in the Type-N connector used with Model N8975B. With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to –0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
c. This column applies to the instantaneous analysis bandwidth in use. In the Spectrum analyzer Mode, this would be the FFT width. For Span < 10 MHz. see “IF Frequency Response” on page 33.
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 preselector which affects the passband for frequencies above 3.6 GHz when *Option MPB* is not in use, see “Preselector Bandwidth” on page 28.

Description			Specifications	Supplemental Information	
IF Phase Linearity				Deviation from mean phase linearity Modes above 18 GHz[a]	
Center Freq (GHz)	**Span (MHz)**	**Preselector**		**Peak-to-peak (nominal)**	**RMS (nominal)**[b]
≥0.02, <3.6	≤25	n/a		0.6°	0.14°
≥3.6(N8973B-N8976B)	≤25	On		4.5°	1.2°

a. Signal frequencies between 18 and 26.5 GHz are prone to additional response errors due to modes in the Type-N connector used with Model N8975B. With the use of Type-N to APC 3.5 mm adapter part number 1250-1744, there are nominally six such modes. These modes cause nominally up to –0.35 dB amplitude change, with phase errors of nominally up to ±1.2°.
b. The listed performance is the standard deviation of the phase deviation relative to the mean phase deviation from a linear phase condition, where the RMS is computed across the span shown.

Description	Specifications	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 levelb (nominal)
High Gain setting, signal at CF		
(IF Gain = High)		
Band 0		–18 dBm mixer levelb (nominal), subject to gain limitations[c]
Band 1 through 6		–17 dBm mixer levelb (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	5,000,000 IQ sample pairs	
89600 VSA software	**32-bit Data Packing**	Memory
	5,000,000 Sa (independent of data packing)	
Sample Rate		
At ADC	90 MSa/s	
IQ Pairs		Span dependent
ADC Resolution	14 bits	

5 Option NFE - Noise Floor Extension

This chapter contains specifications for *Option NFE*, Noise Floor Extension. This option is licensed in the instrument as N897xB-NF2, Noise Floor Extension, instrument alignment.

Specifications Affected by Noise Floor Extension

The only analyzer specifications affected by the presence or use of this option are noise specifications when the option is used. The additional specifications are given in the following pages.

Displayed Average Noise Level

Description	N8973B-N8975B (RF/uW)	N8976B (mmW)	Specifications	Supplemental Information	
Displayed Average Noise Level (DANL) (with Noise Floor Extension) Improvement[a]				**95th Percentile (≈2σ)**[b]	
				Preamp Off	**Preamp On**[c]
Band 0, f > 20 MHz[d]	x			9 dB	9 dB
Band 0, f > 20 MHz		x		7 dB	9 dB
Band 1	x			9 dB	8 dB
Band 1		x		8 dB	7 dB
Band 2	x			9 dB	9 dB
Band 2		x		8 dB	7 dB
Band 3	x			11dB	9 dB
Band 3		x		8 dB	7 dB
Band 4	x			9 dB	8 dB
Band 4		x		8 dB	6 dB
Band 5		x		9 dB	6 dB
Band 6		x		9 dB	5 dB
Improvement for CW Signals[e]				3.5 dB (nominal)	
Improvement, Pulsed-RF Signals[f]				10.8 dB (nominal)	
Improvement, Noise-Like Signals				9.1 dB (nominal)	

a. This statement on the improvement in DANL is based on a statistical observation of the effective noise floor across the entire band. The improvement actually measured and specified at the specific frequencies in "Examples of Effective DANL" usually meet these limits as well, but the percentage confidence will be higher in some cases and lower in others. NFE calibrations and verifications are done with 10 dB attenuation. Attenuations from 2 dB through the maximum show the expected effects from the attenuation.

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

c. DANL of the preamp is specified with a 50Ω source impedance. Like all amplifiers, the noise varies with the source impedance. When NFE compensates for the noise with an ideal source impedance, the variation in the remaining noise level with the actual source impedance is greatly multiplied in a decibel sense.
d. NFE does not apply to the low frequency sensitivity. At frequencies below about 2 MHz, the sensitivity is dominated by phase noise surrounding the LO feedthrough. The NFE is not designed to improve that performance. At frequencies between 2 and 20 MHz the NFE effectiveness increases from nearly none to near its maximum.
e. Improvement in the uncertainty of measurement due to amplitude errors and variance of the results is modestly improved by using NFE. The nominal improvement shown was evaluated for a 2 dB error with 250 traces averaged. For extreme numbers of averages, the result will be as shown in the "Improvement for Noise-like Signals" and DANL sections of this table.
f. Pulsed-RF signals are usually measured with peak detection. Often, they are also measured with many “max hold” traces. When the measurement time in each display point is long compared to the reciprocal of the RBW, or the number of traces max held is large, considerable variance reduction occurs in each measurement point. When the variance reduction is large, NFE can be quite effective; when it is small, NFE has low effectiveness. For example, in Band 0 with 100 pulses per trace element, in order to keep the error within ±3 dB error 95% of the time, the signal can be 10.8 dB lower with NFE than without NFE.

Description	N8973B-N8975B (RF/uW)	N8976B (mmW)	Specifications	Supplemental Information	
DANL by Band with NFE				**95th Percentile (≈2σ)**[a]	
				Preamp Off	**Preamp On**[bc]
Band 0 (1.8 GHz)[d]	x			–158 dBm	–170 dBm
Band 0 (1.8 GHz)[d]		x		–160 dBm	–170 dBm
Band 1 (5.9 GHz)[d]	x			–157 dBm	–168 dBm
Band 1 (5.9 GHz)		x		–158 dBm	–168 dBm
Band 2 (10.95 GHz)	x			–157 dBm	–168 dBm
Band 2 (10.95 GHz)		x		–158 dBm	–170 dBm
Band 3 (15.3 GHz)	x			–151 dBm	–168 dBm
Band 3 (15.3 GHz)		x		–159 dBm	–170 dBm
Band 4 (21.75 GHz)	x			–144 dBm	–163 dBm
Band 4 (21.75 GHz)		x		–154 dBm	–168 dBm
Band 5 (30.4 GHz)		x		–153 dBm	–166 dBm
Band 6 (42.7 GHz)		x		–147 dBm	–158 dBm

a. Unlike other 95th percentiles, these table values do not include delta environment effects. NFE is aligned in the factory at room temperature. For best performance, in an environment that is different from room temperature, such as an equipment rack with other instruments, we recommend running the "Characterize Noise Floor" operation after the first time the analyzer has been installed in the environment, and given an hour to stabilize.
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.
c. NFE performance can give results below theoretical levels of noise in a termination resistor at room temperature, about –174 dBm/Hz. this is intentional and usually desirable. NFE is not designed to report the noise at the input of the analyzer; it reports how much more noise is at the input of the analyzer than was present in its alignment. And its alignment includes the noise of a termination at room temperature. So it can often see the added noise below the theoretical noise. Furthermore, DANL is defined with log averaging in a 1 Hz RBW, which is about 2.3 dB lower than the noise density (power averaged) in a 1 Hz noise bandwidth.
d. NFE does not apply to the low frequency sensitivity. At frequencies below about 2 MHz, the sensitivity is dominated by phase noise surrounding the LO feedthrough. The NFE is not designed to improve that performance. At frequencies between 2 and 20 MHz the NFE effectiveness increases from nearly none to near its maximum.

6 Option P03, P07, P26, and P44 - Preamplifier

This chapter contains specifications for the NFA X-Series Analyzers Standard *Option P03, P07, 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 30.
Gain Compression	See specifications in this chapter.
DANL with *Option NFE* and NFE On	See "Displayed Average Noise Level" on page 87
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 39 of the core specifications. Then, adjust the mixer levels given downward by the preamp gain given in this chapter.
Second Harmonic Distortion	SHI with preamplifiers is not specified.
Third Order Intermodulation Distortion	See specifications in this chapter.
Other Input Related Spurious	See "Spurious Responses" on page 45 of the core specifications. Preamp performance is not warranted but is nominally the same as non-preamp performance.
Dynamic Range	See plot in this chapter.
Gain	See "Preamp" specifications in this chapter.
Noise Figure	See "Preamp" specifications in this chapter.

Other Preamp Specifications

Description	Specifications	Supplemental Information
Preamp (*Options P03, P07, P26, and P44***)**[a]		
Gain		Maximum[b]
100 kHz to 3.6 GHz		+20 dB (nominal)
3.6 to 26.5 GHz		+35 dB (nominal)
26.5 to 44 GHz		+40 dB (nominal)
Noise figure		
100 kHz to 3.6 GHz		8 to 12 dB (proportional to frequency) (nominal) Note on DC coupling[c]
3.6 to 8.4 GHz		9 dB (nominal)
8.4 to 13.6 GHz		10 dB (nominal)
13.6 to 44 GHz		Noise Figure is DANL + 176.24 dB (nominal)[d]

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

b. Preamp Gain directly affects distortion and noise performance, but it also affects the range of levels that are free of final IF overload. The user interface has a designed relationship between input attenuation and reference level to prevent on-screen signal levels from causing final IF overloads. That design is based on the maximum preamp gains shown. Actual preamp gains are modestly lower, by up to nominally 5 dB for frequencies from 100 kHz to 3.6 GHz, and by up to nominally 10 dB for frequencies from 3.6 to 44 GHz.

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

d. Nominally, the noise figure of the spectrum analyzer is given by
$NF = D - (K - L + N + B)$
where, D is the DANL (displayed average noise level) specification (Refer to page 95 for DANL with Preamp),
K is kTB (–173.98 dBm in a 1 Hz bandwidth at 290 K),
L is 2.51 dB (the effect of log averaging used in DANL verifications)
N is 0.24 dB (the ratio of the noise bandwidth of the RBW filter with which DANL is specified to an ideal noise bandwidth)
B is ten times the base-10 logarithm of the RBW (in hertz) in which the DANL is specified. B is 0 dB for the 1 Hz RBW.
The actual NF will vary from the nominal due to frequency response errors.

Description	Specifications	Supplemental Information
1 dB Gain Compression Point		
(Two-tone)[a]		
(Preamp On *(Option P03, P07, P26, and P44)* Maximum power at the preamp[b] for 1 dB gain compression)		
10 MHz to 3.6 GHz		–14 dBm (nominal)
3.6 to 26.5 GHz		
Tone spacing 100 kHz to 20 MHz		–28 dBm (nominal)
Tone spacing > 70 MHz		–20 dBm (nominal)
>26.5 GHz		–30 dBm (nominal)

a. Large signals, even at frequencies not shown on the screen, can cause the analyzer to mismeasure on-screen signals because of two-tone gain compression. This specification tells how large an interfering signal must be in order to cause a 1 dB change in an on-screen signal.
b. Total power at the preamp (dBm) = total power at the input (dBm) – input attenuation (dB).

Description	N8973B-N8975B (RF/μW)	N8976B (mmW)	Specifications		Supplemental Information
Displayed Average Noise Level (DANL) Preamp On[a]			Input terminated Sample or Average detector Averaging type = Log 0 dB input attenuation IF Gain = High 1 Hz Resolution Bandwidth		Refer to the footnote for Band Overlaps on page 18.
Option P03, P07, P26, P44			**20 to 30°C**	**Full range**	**Typical**
100 kHz to 1 MHz[b]	x				–146 dBm (nominal)
100 kHz to 1 MHz		x	–145 dBm	–144 dBm	–148 dBm
1 to 10 MHz	x				–161 dBm (nominal)
1 to 10 MHz		x	–161 dBm	–159 dBm	–165 dBm
10 MHz to 2.1 GHz	x		–161 dBm	–159 dBm	–163 dBm
10 MHz to 1.2 GHz		x	–164 dBm	–162 dBm	–165 dBm
1.2 to 2.1 GHz		x	–163 dBm	–161 dBm	–164 dBm
2.1 to 3.6 GHz	x		–160 dBm	–158 dBm	–162 dBm
2.1 to 3.6 GHz		x	–162 dBm	–160 dBm	–163 dBm
Option P07, P26, P44					
3.5 to 7.0 GHz	x		–160 dBm	–158 dBm	–162 dBm
3.5 to 7.0 GHz		x	–160 dBm	–158 dBm	–162 dBm
Option P26, P44					
7 to 13.6 GHz	x		–160 dBm	–157 dBm	–163 dBm
13.5 to 17.1 GHz	x		–157 dBm	–155 dBm	–160 dBm
17.0 to 20.0 GHz	x		–155 dBm	–151 dBm	–159 dBm
7.0 to 20 GHz		x	–160 dBm	–158 dBm	–162 dBm

Description			Specifications		Supplemental Information
20 to 26.5. GHz	x		–150 dBm	–147 dBm	–156 dBm
20 to 26.5 GHz		x	–158 dBm	–156 dBm	–160 dBm
26.4 to 32 GHz		x	–156 dBm	–153 dBm	–159 dBm
Option P44					
32 to 34 GHz		x	–156 dBm	–153 dBm	–159 dBm
33.9 to 40 GHz		x	–153 dBm	–150 dBm	–155 dBm
40 to 44 GHz		x	–149 dBm	–146 dBm	–153 dBm

a. DANL is measured in a 1 kHz RBW and normalized to the narrowest available RBW, because the noise figure does not depend on RBW and 1 kHz measurements are faster.
b. Specifications apply only when the Phase Noise Optimization control is set to “Best Wide-offset Phase Noise.”

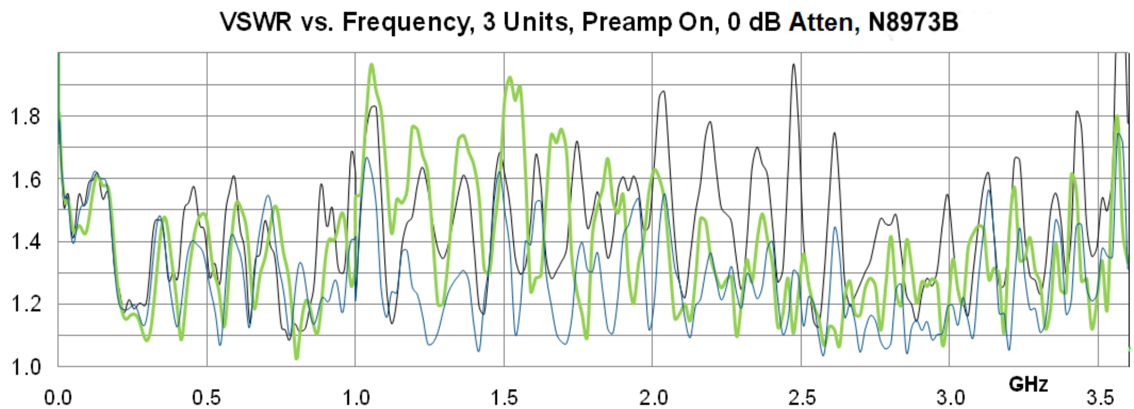
Description	Specifications	Supplemental Information
Frequency Response – **Preamp On** *(Options P03, P07, P26, P44)* (Maximum error relative to reference condition (50 MHz, with 10 dB attenuation) Input attenuation 0 dB Swept operation[a])		
100 kHz to 3.6 GHz		±0.28 dB (nominal)
3.5 to 8.4 GHz		±0.67 dB (nominal)
8.3 to 26.5 GHz		±0.8 dB (nominal)
26.4 to 44 GHz		±0.8 dB (nominal)

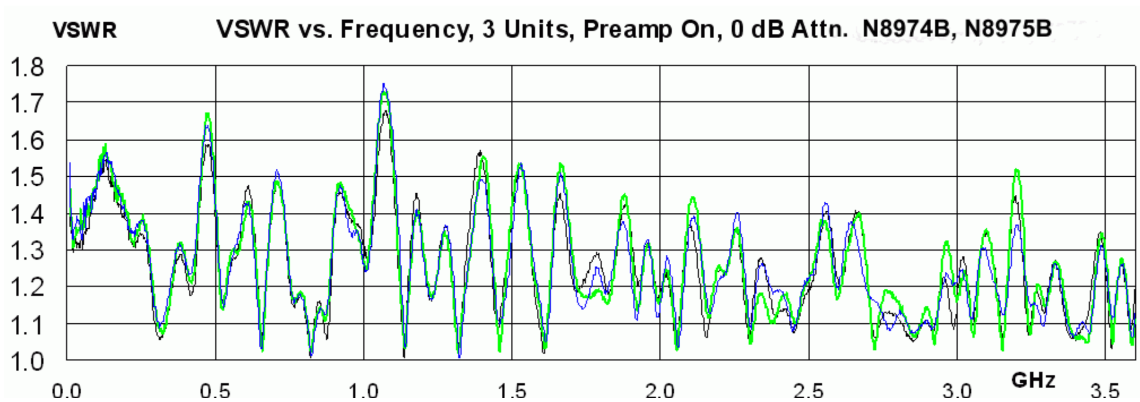
a. For Sweep Type = FFT, add the RF flatness errors of this table to the IF Frequency Response errors. An additional error source, the error in switching between swept and FFT sweep types, is nominally ±0.01 dB and is included within the “Absolute Amplitude Error” specifications.

Description	Specifications	Supplemental Information
RF Input VSWR		DC coupled, 0 dB atten
(at tuned frequency, Models N8973B-N8975B)		
		95th Percentile[a]
Band 0 (0.01 to 3.6 GHz)		
N8973B		1.80
N8974B, N8975B		1.77
Band 1 (3.5 to 8.4 GHz)		1.68
Band 2 (8.3 to 13.6 GHz)		1.69
Band 3 (13.5 to 17.1 GHz)		1.66
Band 4 (17.0 to 26.5 GHz)		1.66
Nominal VSWR vs. Freq.		See plots following

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

Nominal VSWR – Preamp On, N8973B-N8975B [Plot]

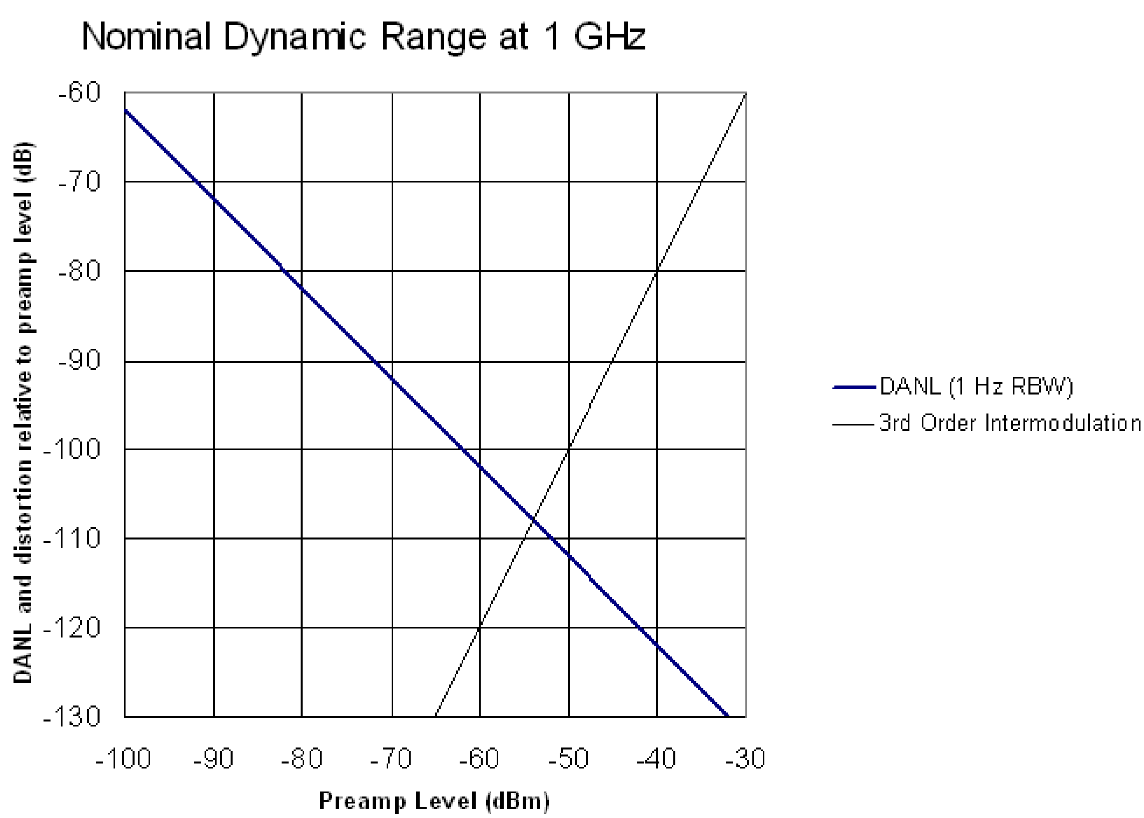




Description	Specifications	Supplemental Information		
Third Order Intermodulation Distortion (Tone separation 5 times IF Prefilter Bandwidth[a] Sweep type not set to FFT)				
		Preamp Level[b]	**Distortion** (nominal)	**TOI**[c] (nominal)
30 MHz to 3.6 GHz		–45 dBm	–90 dBc	0 dBm
3.6 to 26.5 GHz		–50 dBm	–64 dBc	–18 dBm

a. See the IF Prefilter Bandwidth table in the specifications for “Gain Compression” on page 41. When the tone separation condition is met, the effect on TOI of the setting of IF Gain is negligible.
b. Preamp Level = Input Level – Input Attenuation.
c. TOI = third order intercept. The TOI is given by the preamplifier input tone level (in dBm) minus (distortion/2) where distortion is the relative level of the distortion tones in dBc.

Nominal Dynamic Range at 1 GHz, Preamp On, N8973B-N8975B [Plot]



7 Option PFR - Precision Frequency Reference

This chapter contains specifications for the *Option PFR*, Precision Frequency Reference.

Specifications Affected by Precision Frequency Reference

Specification Name	Information
Precision Frequency Reference	See "Precision Frequency Reference" on page 20 in the core specifications.

Edition 1, February 2024

N8973-90007

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