Specifications Guide

Agilent Technologies PSA Series Spectrum Analyzers

This manual provides documentation for the following instruments:

E4440A (3 Hz – 26.5 GHz)
E4443A (3 Hz – 6.7 GHz)
E4445A (3 Hz – 13.2 GHz)
E4446A (3 Hz – 44 GHz)
E4448A (3 Hz – 50 GHz)

Agilent Technologies

Manufacturing Part Numbers: E4440-90062

Supersedes: E4440-90044
Printed in USA
May 2002

Where to Find the Latest Information

Documentation is updated periodically. For the latest information about Agilent PSA spectrum analyzers, including firmware upgrades and application information, see:

http://www.agilent.com/find/psa

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1 E4440A Specifications

Definitions and Requirements

This chapter contains specifications and supplemental information for PSA E444xA spectrum analyzers. 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, unless otherwise noted).
- 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.

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

Conditions Required to Meet Specifications

- The analyzer is within its calibration cycle.
- Under auto couple control, except that **Auto Sweep Time = Accy**.
- For center frequencies < 20 MHz, DC coupling applied.
- At least 2 hours of storage or operation at the operating temperature.
- Analyzer has been turned on at least 30 minutes with **Auto Align On** selected, or
- If **Auto Align Off** is selected, **Align All Now** must be run:
  - Within the last 24 hours, and
  - Any time the ambient temperature changes more than 3°C, and
  - After the analyzer has been at operating temperature at least 2 hours.

Certification

Agilent Technologies certifies that this product met its published specifications at the time of shipment from the factory. Agilent 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

Description	Specifications	Supplemental Information
Frequency Range		
DC Coupled	3 Hz to 26.5 GHz	
AC Coupled	10 MHz to 26.5 GHz	
Internal Mixing Bands		*Harmonic Mixing Mode (N*[a]*)*
0	3 Hz to 3.0 GHz (DC Coupled)	1–
0	20 MHz to 3.0 GHz (AC Coupled)	1–
1	2.85 GHz to 6.6 GHz	1–
2	6.2 GHz to 13.2 GHz	2–
3	12.8 GHz to 19.2 GHz	4–
4	18.7 GHz to 26.5 GHz	4–
Preamp On *(Option 1DS)*	100 kHz to 3.0 GHz[b]	1–

a. N is the harmonic mixing mode. All mixing modes are negative (as indicated by the "–"), where the desired first LO harmonic is higher than the tuned frequency by the first IF (3.9214 GHz for the 3 Hz to 3.0 GHz band, 321.4 MHz for all other bands).

b. The low frequency range of the preamp extends to 100 kHz when the RF coupling is set to DC, and to 10 MHz when RF coupling is set to AC.

Description	Specifications	Supplemental Information
Frequency Reference		
Accuracy	± [(time since last adjustment x aging rate) + temperature stability + calibration accuracy[a]]	
Temperature Stability		
20 to 30°C	$\pm 1 \times 10^{-8}$	
0 to 55°C	$\pm 5 \times 10^{-8}$	
Aging Rate	$\pm 1 \times 10^{-7}$/year[b]	$\pm 5 \times 10^{-10}$/day (nominal)
Settability	$\pm 2 \times 10^{-9}$	
Warm-up and Retrace[c]		.
Within 5 min. after turn on		$\pm 1 \times 10^{-7}$ of final frequency (nominal)
Within 15 min. after turn on		$\pm 5 \times 10^{-8}$ of final frequency (nominal)
Achievable Initial Calibration Accuracy[d]	$\pm 7 \times 10^{-8}$	

a. Calibration accuracy depends on how accurately the frequency standard was adjusted to 10 MHz. If the calibration procedure is followed, the calibration accuracy is given by the specification “Achievable Initial Calibration Accuracy”.

b. For periods of one year or more.

c. Applies only when power is disconnected from instrument. Does not apply when instrument is in standby mode.

d. The achievable calibration accuracy at the beginning of the calibration cycle includes these effects:
1) The temperature difference between the calibration environment and the use environment.
2) The 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 unplugging the instrument.
4) Settability.

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])	see note [c]

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 1 MHz, 3% of RBW from 1.1 MHz 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% x RBW term contributes only 55 kHz to the total frequency readout accuracy, compared to 300 kHz for the 0.25% x 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 trace points. The points are spaced by span/(Npts - 1), where Npts is the number of sweep points. For example, with the factory preset value of 601 sweep points, the horizontal resolution is span/600. However, there is an exception: When both the detector mode is "normal" and the span > 0.25 x (Npts - 1) x RBW, peaks can occur only in even-numbered points, so the effective horizontal resolution becomes doubled, or span/300 for the factory preset case. When the RBW is autocoupled and there are 601 sweep points, that exception occurs only for spans > 450 MHz.

c. Swept (not FFT) spans < 2 MHz show a non-linearity in the frequency location at the right or left edge of the span of up to 1.4% of span per megahertz of span (unless using the “fast tuning” option for phase noise optimization). This non-linearity is corrected in the marker readout. Traces output to a remote computer will show the nonlinear relationship between frequency and trace point number. This non-linearity does not occur if the phase noise optimization is set to Fast Tuning.

Description	Specifications	Supplemental Information
Frequency Counter[a]		
Count Accuracy	± (marker freq. × freq. ref. accy. + 0.100 Hz)	See note[b]
Delta Count Accuracy	± (delta freq. × freq. ref. accy. + 0.141 Hz)	
Resoluti on	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 >1GHz.

Description	Specifications	Supplemental Information
Frequency Span		
Range		
Swept and FFT	0 Hz, 10 Hz to 26.5 GHz	
Resolution	2 Hz	
Span Accuracy		
Swept	± (0.2% x span + horizontal resolution[a])	see note [b]
FFT	± (0.2% x span + horizontal resolution[a])	

Description	Specifications	Supplemental Information
Sweep Time		
Range		
Span = 0 Hz	1 µs to 6000s	
Span ≥ 10 Hz	1 ms to 2000s	
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 Front, External Rear, RF Burst	
Delayed Trigger[c]		
Range		
Span ≥ 10 Hz, swept	1 µs to 500 ms	
Span = 0 Hz or FFT	–150 ms to +500ms	
Resolution	0.1 µs	

a. Horizontal resolution is due to the marker reading out one of the trace points. The points are spaced by span/(Npts - 1), where Npts is the number of sweep points. For example, with the factory preset value of 601 sweep points, the horizontal resolution is span/600. However, there is an exception: When both the detector mode is "normal" and the span > 0.25 x (Npts - 1) x RBW, peaks can occur only in even-numbered points, so the effective horizontal resolution becomes doubled, or span/300 for the factory preset case. When the RBW is autocoupled and there are 601 sweep points, that exception occurs only for spans > 450 MHz.

b. Swept spans < 2 MHz show a nonlinearity in the frequency location at the right or left edge of the span of up to 1.4% of span per megahertz of span (unless using the “fast tuning” option for phase noise optimization). This nonlinearity is corrected in the marker readout. Traces output to a remote computer will show the nonlinear relationship between frequency and trace point number.

c. Delayed trigger is available with line, video, external, and RF Burst triggers.

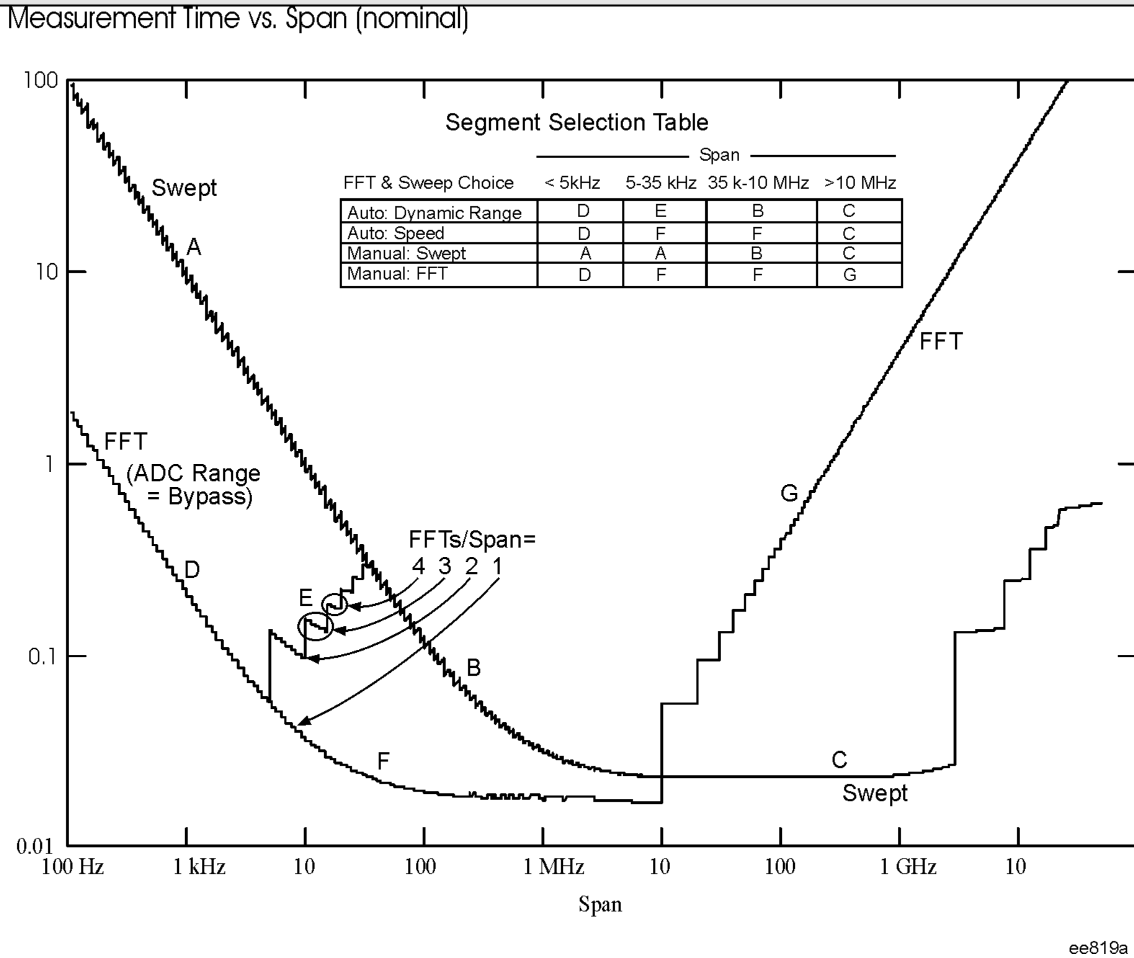
Gated Measurements

Description	Specifications	Supplemental information
Gated FFT[a]		
Maximum Span	10 MHz	
Delay Range	-150 to +500 ms	
Delay Resolution	100 ns or 4 digits, whichever is more	
Gate Duration		1.83/RBW ± 2%

a. Gated measurements (measuring a signal only during a specific time interval) are possible with triggered FFT measurements. The FFT allows analysis during a time interval set by the RBW (within nominally 2% of 1.83/RBW) for spans up to 10 MHz. This time interval is shorter than that of swept gating circuits, allowing higher resolution of the spectrum.

Measurement Time vs. Span

Measurement Time vs. Span (nominal)



Description	Specifications	Supplemental Information
Number of Frequency Display Trace Points (buckets)		
Factory preset	601	
Range:		
Span ≥ 10 Hz	101 to 8192	
Span = 0 Hz	2 to 8192	

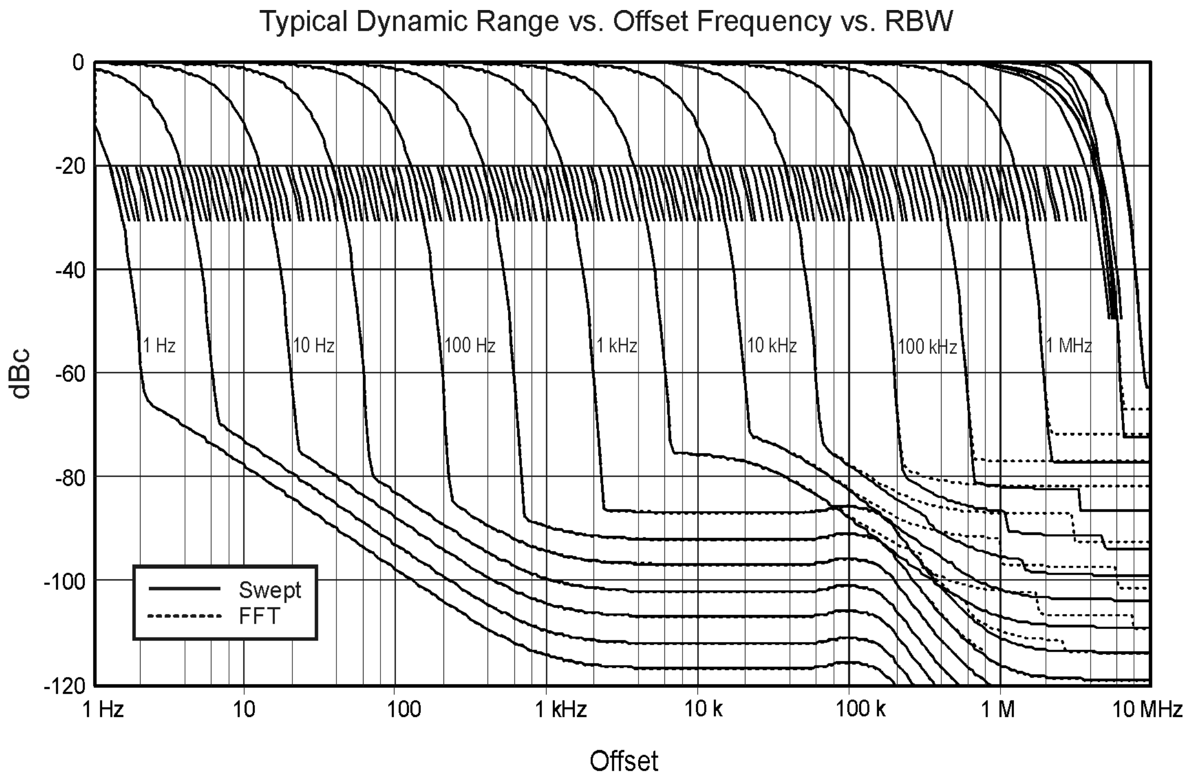
Description	Specifications	Supplemental Information
Resolution Bandwidth (RBW)		
Range (–3.01 dB bandwidth)	1 Hz to 8 MHz. Bandwidths > 3 MHz = 4, 5, 6, and 8 MHz. Bandwidths 1 Hz to 3 MHz are spaced at 10% spacing, 24 per decade: 1.0, 1.1, 1.2, 1.3, 1.5, 1.6, 1.8, 2.0, 2.2, 2.4, 2.7, 3.0, 3.3, 3.6, 3.9, 4.3, 4.7, 5.1, 5.6, 6.2, 6.8, 7.5, 8.2, 9.1, and repeat, times ten to an integer.	
Accuracy (–3.01 dB bandwidth)[a]		
1 Hz to 1.5 MHz RBW		± 2% (nominal)
1.6 MHz to 3 MHz RBW		
(CF ≤ 3 GHz)		± 7% (nominal)
(CF > 3 GHz)		± 8% (nominal)
4 MHz to 8 MHz RBW		
(CF ≤ 3 GHz)		± 15% (nominal)
(CF > 3 GHz)		± 20% (nominal)
Power bandwidth accuracy[b]		
RBW Range / CF Range		
1 Hz – 51 kHz / all	± 0.5%	Equivalent to ± 0.022 dB
82 kHz – 330 kHz / all	± 0.5%	Equivalent to ± 0.022 dB
56 kHz – 75 kHz / all	± 1.0%	Equivalent to ± 0.044 dB
360 kHz – 1.2 MHz / < 3 GHz	± 1.0%	Equivalent to ± 0.044 dB
1.3 MHz – 2.0 MHz / < 3 GHz		± 0.07 dB, nominal
2.2 MHz – 6 MHz / < 3 GHz		± 0.2 dB, nominal
Selectivity (–60 dB/–3 dB)		4.1:1 (nominal)

a. Resolution Bandwidth Accuracy can be observed at slower sweep times than autocoupled 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 **Auto Swp Time** key is set to **Accy** instead of **Norm**. The true bandwidth, which determines the response to impulsive signals and noise-like signals, is not affected by the sweep rate.

b. 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.)

Description	Specification	Supplemental information
Information Bandwidth		
Maximum FFT width	10 MHz	
(Option B7J) I/Q Waveform digital bandwidths	10 MHz	
321.4 MHz rear panel output bandwidth		Nominal
At – 1 dB BW		
Low band (0 to 3 GHz)		30 MHz
High band (2.85 to 26.5 GHz)		20 to 30 MHz[a]
mm band (26.4 to 50 GHz)		30 MHz
At – 3 dB BW		
Low band (0 to 3 GHz)		40 MHz
Highband (2.85 to 26.5 GHz)		30 to 60 MHz
mm bnad (26.5 to 50 GHz)		40 MHz
(Option H70) bandwidth		Same as 321.4 MHz bandwidth

a. The bandwidth in the microwave preselected bands increases monotonically between the lowest and highest tuned frequencies in most, but not all, analyzers.



CF = 1 GHz
Mixer Level = -10 dBm
Only 2/decade of the
24/decade RBW are shown fully
RBWs ≤ 1 kHz shown with
phase noise optimized for fm < 50 kHz
RBWs ≥ 3 kHz shown with
phase noise optimized for fm > 50 kHz

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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=0.1xRBW, four FFTs are averaged to generate one result.

Description	Specifications		Supplemental Information	
Stability Noise Sidebands Center Frequency = 1 GHz[a] Best-case Optimization[b]	**20 to 30°C**	**0 to 55°C**	**20 to 30°C**	**20 to 30°C**
Offset			(Typical)	(Nominal)
100 Hz	–91 dBc/Hz	–90 dBc/Hz	–97 dBc/Hz	
1 kHz	–103 dBc/Hz	–100 dBc/Hz	–107 dBc/Hz	
10 kHz	–114 dBc/Hz	–113 dBc/Hz	–117 dBc/Hz	
30 kHz	–114 dBc/Hz	–113 dBc/Hz	–117 dBc/Hz	
100 kHz	–120 dBc/Hz	–119 dBc/Hz	–123 dBc/Hz	
1 MHz	–144 dBc/Hz	–142 dBc/Hz	–146 dBc/Hz[c]	–148 dBc/Hz[c]
6 MHz	–151 dBc/Hz	–150 dBc/Hz	–152 dBc/Hz[c]	–156 dBc/Hz[c]
10 MHz	–151 dBc/Hz	–150 dBc/Hz	–152 dBc/Hz[c]	–157.5 dBc/Hz[c]
Residual FM	<(1 Hz x N[d]) p-p in 1 s			

a. Nominal changes of phase noise sidebands with other center frequencies are shown by some examples in the graphs that follow. To predict the phase noise for other center frequencies, note that phase noise at offsets above approximately 1 kHz increases nominally as 20 X log N, where N is the harmonic mixer mode. For offsets below 1 kHz, and center frequencies above 1 GHz, the phase noise increases nominally as 20 X log CF, where CF is the center frequency in GHz.

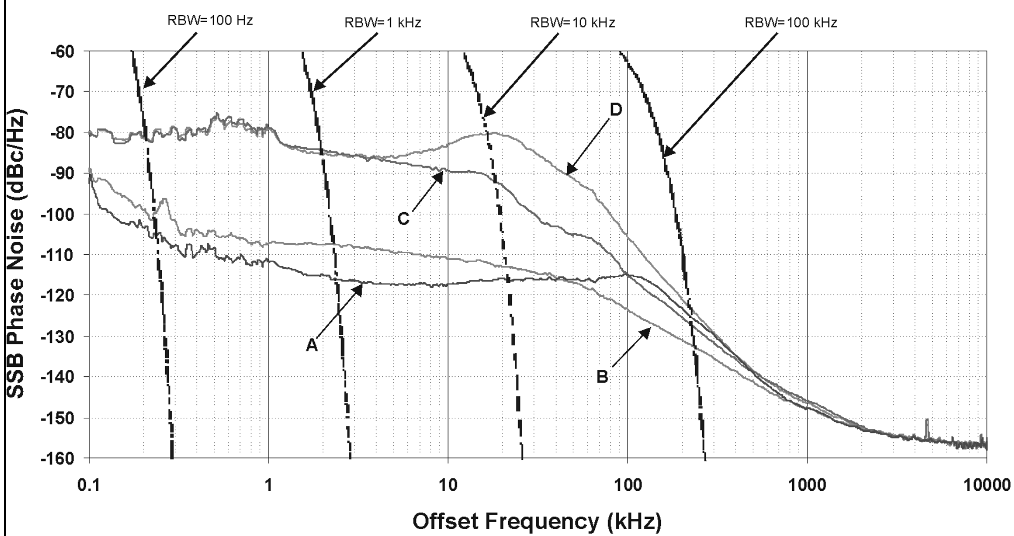
b. Noise sidebands for offsets of 30 kHz and below are shown for phase noise optimization set to optimize $\mathscr{L}(f)$ for f<50 kHz; for offsets of 100 kHz and above, the optimization is set for f > 50 kHz.

c. "Typical" results include the effect of the signal generator used in verifying performance; nominal results show performance observed during development with specialized signal sources.

d. N is the harmonic mixing mode.

Nominal Phase Noise of Different LO Optimizations

Nominal Phase Noise of Different LO Optimizations, with RBW Selectivity Curves, CF = 1 GHz



<table>
<tr><th>Sweep Type</th><th>Span</th><th>Optimize L(f) for f < 50 kHz</th><th>Optimize L(f) for f > 50 kHz</th><th>Optimize LO for fast tuning</th></tr>
<tr><td>FFT</td><td>All</td><td rowspan="2">A (Dual Loop Wideband)</td><td rowspan="2">B (Dual Loop Narrowband)</td><td rowspan="2">D (Single Loop Wideband)</td></tr>
<tr><td rowspan="3">Swept</td><td>< 2 MHz</td></tr>
<tr><td>2 to 50 MHz</td><td colspan="2">C (Single Loop Narrowband)</td><td rowspan="2"></td></tr>
<tr><td>> 50 MHz</td><td colspan="2"></td></tr>
</table>

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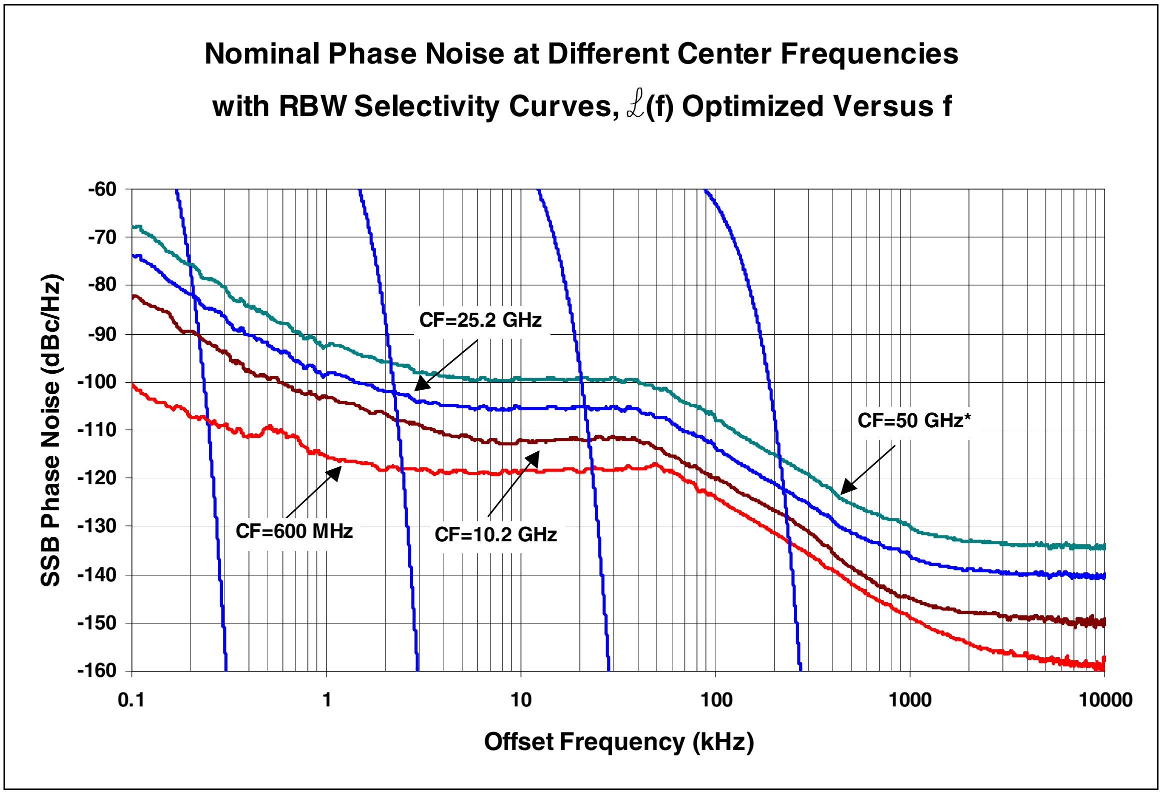
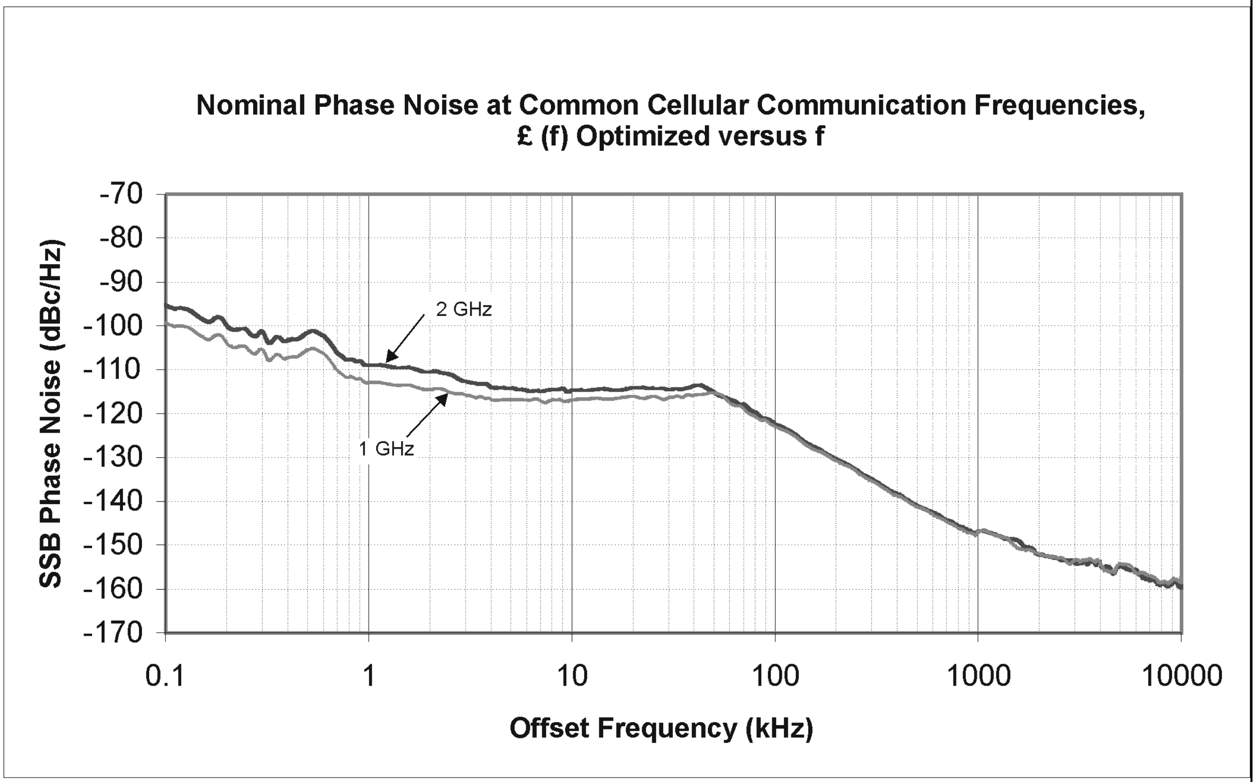
Nominal Phase Noise at Different Center Frequencies



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

PSA Phase Noise



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Amplitude

Description	Specifications	Supplemental Information
Measurement Range	Displayed Average Noise Level to +30 dBm	
Preamp *(Option 1DS)*	Displayed Average Noise Level to +25 dBm	
Input Attenuator Range	0 to 70 dB, in 2 dB steps	

Description	Specifications	Supplemental Information
Maximum Safe Input Level		Applies with or without preamp *(Option 1DS)*
Average Total Power	+30 dBm (1W)	
Peak Pulse Power <10 μs pulse width; <1% duty cycle; and input attenuation ≥ 30 dB	+50 dBm (100W)	
DC volts		
DC Coupled	± 0.2 Vdc	
AC Coupled (E4443A, E4445A, E4440A)	± 100 Vdc	

Description	Specifications	Supplemental Information	
1 dB Gain Compression Point (Two-tone)[abc]	Maximum power at mixer[d]	Nominal[e]	
20 MHz to 200 MHz	0 dBm	+3 dBm	
200 MHz to 3.0 GHz	+3 dBm	+7 dBm	
3.0 GHz to 6.6 GHz	+3 dBm	+4 dBm	
6.6 GHz to 26.5 GHz	–2 dBm	0 dBm	
Typical Gain Compression (Two-tone)		Mixer Level	Typical[e] Compression
20 MHz to 200 MHz		0 dBm	< 0.5 dB
200 MHz to 6.6 GHz		+3 dBm	< 0.5 dB
6.6 GHz to 26.5 GHz		–2 dBm	< 0.4 dB
Preamp On *(Option 1DS)* Total power at the preamp[f]			
10 MHz to 200 MHz		–30 dBm (nominal)	
200 MHz to 3 GHz		–25 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. Tone spacing > 15 times RBW, with a minimum of 30 kHz of separation

c. See Reference Level footnote (b) on page 41.

d. Mixer power level (dBm) = input power (dBm) – input attenuation (dB).

e. The compression of a small on-screen signal by a large interfering signal can be represented as a curve of compression versus the level of the interfering signal. The specified performance is a level/compression pair. The specification could be verified by finding the level for which the compression is 1 dB, or by finding the compression for the specified level. The latter technique is used. Therefore, the amount of compression is known in production, and the typical compression is known statistically, thus allowing a "typical" listing. The level required to reach 1 dB compression is not monitored in production, thus "nominal" performance is shown for this view of the performance.

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

Description	Specifications			Supplemental Information
Displayed Average Noise Level (DANL)[a]				
Input terminated Sample or Average detector Averaging type = Log Normalized to 0 dB input attenuation				**Nominal**
3 Hz to 1 kHz				–110 dBm
1 kHz to 10 kHz				–130 dBm
	Zerospan & swept Normalized[a] to 1 Hz 20 to 30°C	**Zerospan & swept Normalized[a] to 1 Hz 0 to 55°C**	**FFT Only Actual[b] 1 Hz 20 to 30°C**	**Zerospan & swept Normalized[a] to 1 Hz (typical)**
10 kHz to 100 kHz	–135 dBm	–135 dBm	–135 dBm	–142 dBm
100 kHz to 1 MHz	–145 dBm	–145 dBm	–145 dBm	–149 dBm
1 MHz to 10 MHz	–150 dBm	–150 dBm	–150 dBm	–153 dBm
10 MHz to 1.2 GHz	–155 dBm	–154 dBm	–154 dBm	–156 dBm
1.2 GHz to 2.5 GHz	–154 dBm	–153 dBm	–153 dBm	–155 dBm
2.5 GHz to 3 GHz	–153 dBm	–152 dBm	–152 dBm	–154 dBm
3 GHz to 6.6 GHz	–152 dBm	–151 dBm	–151 dBm	–153 dBm
6.6 GHz to 13.2 GHz	–150 dBm	–149 dBm	–149 dBm	–152 dBm
13.2 GHz to 20 GHz	–147 dBm	–146 dBm	–146 dBm	–149 dBm
20 GHz to 26.5 GHz	–143 dBm	–142 dBm	–143 dBm	–145 dBm
Preamp On *(Option 1DS)*			Nominal FFT	
100 kHz to 10 MHz	–166 dBm	–163 dBm	–168 dBm	–168 dBm
10 MHz to 1.1 GHz	–169 dBm	–168 dBm	–170 dBm	–170 dBm
1.1 GHz to 2.5 GHz	–168 dBm	–167 dBm	–169 dBm	–169 dBm
2.5 GHz to 3.0 GHz	–166 dBm	–166 dBm	–167 dBm	–167 dBm

a. DANL for zero span and swept is normalized in two ways and for two reasons. DANL is measured in a 1 kHz RBW and normalized to the narrowest available RBW, because the narrowest RBWs (1.0 to 1.8 are not usable for signals below –110 dBm but DANL can be a useful figure of merit for the other RBWs. (RBWs this small are usually best used in FFT mode, because sweep rates are very slow in these bandwidths. RBW autocoupling never selects these RBWs in swept mode because of potential errors at low signal levels.) The second normalization is that DANL is measured with 10 dB input attenuation and normalized to the 0 dB input attenuation case, because that makes DANL and third order intermodulation test conditions congruent, allowing accurate dynamic range estimation for the analyzer. Because of these normalizations, this measure of DANL is useful for estimating instrument performance such as TOI to noise range and compression to noise range, but not ultimate sensitivity.

b. DANL for FFT measurements are useful for estimating the ultimate sensitivity of the analyzer for low-level signals. This specification is verified with 0 dB input attenuation and 1 Hz RBW. A limitation of this DANL specification is that some instruments have a center-screen-only spurious signal of nominally –150 dBm, which can be avoided by tuning the analyzer a few hertz away from the frequency of interest.

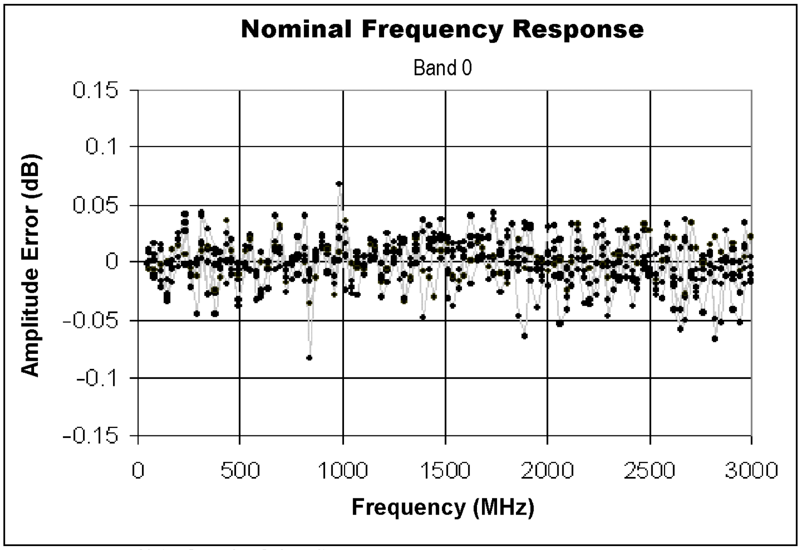
Description	Specifications	Supplemental Information
Display Range		
Log Scale	Ten divisions displayed; 0.1 to 1.0 dB/division in 0.1 dB steps, and 1 to 20 dB/division in 1 dB steps	
Linear Scale	Ten divisions	
Marker Readout[a]		
Log units resolution		
Average off, on-screen	0.01 dB	
Average on or remote	0.001 dB	
Linear units resolution		≤ 1% of signal level

a. See Reference Level footnote (b) on page 41.

Description	Specifications		Supplemental Information	
Frequency Response				
(10 dB input attenuation)				
Maximum error relative to reference condition (50 MHz)[a]	**20 to 30°C**	**0 to 55°C**	**Typical 20 to 30°C** (at worst observed frequency)	
3 Hz to 3.0 GHz	± 0.38 dB	± 0.58 dB	± 0.10 dB	
3.0 GHz to 6.6 GHz[b]	± 1.50 dB	± 2.00 dB	± 0.5 dB	
6.6 GHz to 13.2GHz[b]	± 2.00 dB	± 2.50 dB	± 1.0 dB	
13.2 GHz to 22.0 GHz[b]	± 2.00 dB	± 2.50 dB	± 1.0 dB	
22.0 GHz to 26.5 GHz[b]	± 2.50 dB	± 3.50 dB	± 1.0 dB	
Additional frequency response error, FFT mode[cd]	± [0.15 dB + (0.1 dB/MHz x FFT width[e])] to a max. of ± 0.40 dB			
100 kHz to 3.0 GHz Preamp On (*Option 1DS*)	± 0.70 dB	± 0.80 dB	< ± 0.2 dB	
Frequency Response at Attenuation ≠ 10 dB			At 0, 2, 4, 6, 20, 30 dB input attenuation steps. Nominal	
10 MHz to 3 GHz			20 to 30°C	0 to 55°C
			± 0.8 dB	± 1.0 dB

a. Specifications for frequencies > 3 GHz apply for sweep rates <100 MHz/ms.
b. Preselector centering applied.
c. FFT frequency response errors are specified relative to swept measurements.
d. This error need not be included in Absolute Amplitude Accuracy error budgets when the difference between the analyzer center frequency and the signal frequency is within ± 1.5% of the span.
e. An FFT width is given by the span divided by the FFTs/Span parameter.

Nominal Frequency Response



Note: Sample of six units.

Description	Specifications	Supplemental Information
Input Attenuation Switching Uncertainty[a,b]		
Attenuator Setting ≥ 2 dB		
Frequency Range		
50 MHz	± 0.2 dB	
3 Hz to 3.0 GHz		± 0.3 dB (nominal)
3.0 to 13.2 GHz		± 0.5 dB (nominal)
13.2 to 26.5 GHz		± 0.7 dB (nominal)
Attenuator Setting = 0 dB		
50 MHz	± 0.3 dB	

Description	Specifications	Supplemental Information
Preamp (*Option* 1DS)[c]		
Gain		+28 dB (nominal)
Noise figure		
10 MHz to 1.5 GHz		6 dB (nominal)
1.5 GHz to 3.0 GHz		7 dB (nominal)

a. Referenced to 10 dB attenuation
b. Specifications also apply to Option 1DS.
c. The preamp is between the input attenuator and the input mixer.

Description	Specifications	Supplemental Information
Absolute Amplitude Accuracy		
At 50 MHz		
20 to 30°C[a]	± 0.24 dB	± 0.06 dB (typical)
0 to 55°C	± 0.28 dB	
Amplitude Reference Accuracy		± 0.05 dB (nominal)
At all frequencies		
20 to 30°C[b]	± (0.24 dB + frequency response)	± (0.06 dB + frequency response) (typical)
0 to 55°C[b]	± (0.28dB + frequency response)	
Freq < 3 GHz 95% Confidence[b]		± 0.24 dB
Preamp On[c] (*Option* 1DS)	± (0.36 dB + frequency response)	± (0.09 dB + frequency response) (typical)

a. Absolute amplitude accuracy is the total of all amplitude measurement errors, and applies over the following subset of settings and conditions: 10 Hz ≤ RBW ≤1 MHz; Input signal −10 to −50 dBm; Input attenuation 10 dB; span <5 MHz (nominal additional error for span ≥ 5 MHz is 0.02 dB); all settings autocoupled except Auto Swp Time = Accy; combinations of low signal level and wide RBW use VBW ≤30 kHz to reduce noise. This absolute amplitude accuracy specification includes the sum of the following individual specifications under the conditions listed above: Scale Fidelity, Reference Level Accuracy, Display Scale Switching Uncertainty, Resolution Bandwidth Switching Uncertainty, 50 MHz Amplitude Reference Accuracy, and the accuracy with which the instrument aligns its internal gains to the 50 MHz Amplitude Reference.

b. Absolute Amplitude Accuracy for frequencies below 3 GHz with 95% confidence applies at all the conditions of footnote b, with an input frequency below 3 GHz, for temperatures of 20 to 30°C. The value given is the result of testing the most recent 113 analyzers as of this writing. It is computed by root-sum-squaring (r.s.s.) the 95th percentiles of these terms: the absolute amplitude accuracy observed at 50 MHz under 44 quasi-random combinations of settings, the frequency response relative to 50 MHz at 102 quasi-random test frequencies, and the measurement uncertainties of all these observations. To that root-sum-squaring result is added the environmental effects of 20 to 30°C variation. The 95th percentiles are determined with a 95% confidence level.

c. Same settings as footnote b, 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). For frequencies from 100 kHz to 3 GHz.

Description	Specifications	Supplemental Information
RF Input VSWR		Nominal
(at tuned frequency)		
10 dB attenuation, 50 MHz		1.07:1
≥ 8 dB *input attenuation*		
50 MHz to 3 GHz		< 1.2:1
3 GHz to 18 GHz		< 1.6:1
18 GHz to 26.5 GHz		< 1.9:1
2 to 6 dB *input attenuation*		
50 MHz to 3 GHz		< 1.6:1
3 GHz to 26.5 GHz		< 1.9:1
0 dB *input attenuation*		
50 MHz to 3 GHz		< 1.9:1
3 GHz to 26.5 GHz		< 1.9:1
Preamp On (*Option 1DS*)		
50 MHz to 3 GHz		
≥ 10 dB input attenuation		< 1.2:1
< 10 dB input attenuation		< 1.5:1
Internal 50 MHz calibrator is on		Open input
Alignments running		Open input

Description	Specifications	Supplemental Information
Resolution Bandwidth Switching Uncertainty[a]		
(relative to reference BW of 30 kHz)		
1.0 Hz to 1.0 MHz RBW	± 0.03 dB	
1.1 MHz to 3 MHz RBW	± 0.05 dB	
Manually selected wide RBWs: 4, 5, 6, 8 MHz	± 1.0 dB	

Description	Specifications	Supplemental Information
Reference Level[b]		
Range		
Log Units	–170 to +30 dBm, in 0.01 dB steps	
Linear Units	707 pV to 7.07V in 0.1% steps	
Accuracy	0 dB[c]	

a. RBW switching is specified and tested in the reference condition: –25 dBm signal input and 10 dB input attenuation. At higher input levels, changing RBW may cause a larger change in result than that specified, because the display scale fidelity can be slightly different for different RBWs. These RBW differences in scale fidelity are nominally within ±0.01 dB in all RBWs even for signals as large as –10 dBm at the input mixer.

b. Reference level and off-screen performance: The reference level (RL) behavior differs from previous analyzers in a way that makes PSA more flexible. In previous analyzers, the RL controlled how the measurement was performed as well as how it was displayed. Because the logarithmic amplifier in previous analyzers had both range and resolution limitations, this behavior was necessary for optimum measurement accuracy. The logarithmic amplifier in PSA, however, is implemented digitally such that the range and resolution greatly exceed other instrument limitations. Because of this, a PSA 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 attenuator setting: When the input attenuator 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.

c. 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[c]	

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[abcd]				
Log-Linear Fidelity (relative to the reference condition of –25 dBm input through the 10 dB attenuator, or –35 dBm at the input mixer.)				
Input mixer level[e]	Linearity			
≤ –20 dBm	± 0.07 dB			
≤ –10 dBm	± 0.13 dB			
Relative Fidelity[f] Equation for error ± A ± (B1 + B2) × ΔP) to a maximum of (C1 + C2))				
Level of larger signal		**A**	**B1**	**C1**
–20 dBm < ML < –12 dBm		0.011 dB	0.007	0.08 dB
–29 dBm < ML < –20 dBm		0.011 dB	0.0015	0.04 dB
Noise < ML < –29 dBm		0.001 dB	0.001	0.04 dB
RBW		**B2**	**C2**	
≥ 10 kHz		0.000	0.000 dB	
≤ 2 kHz		0.0035	0.038 dB	
others (RBW in Hz)		7/RBW	76 dB/RBW	

a. Supplemental information: The amplitude detection linearity specification applies at all levels below –10dBm 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 3sigma level can be reduced proportional to the square root of the number of averages taken.

b. Display scale fidelity and resolution bandwidth switching uncertainty interact slightly. See the footnote for RBW switching. RBW switching applies at only one level on the scale fidelity curve, but scale fidelity applies for all RBWs.

c. Scale fidelity is warranted with ADC dither turned on. Turning on ADC dither nominally increases DANL. The nominal increase is highest with the preamp off in the lowest-DANL frequency range, under 1.2 GHz, where the nominal increase is 2.5dB. Other ranges and the preamp-on case will show lower increases in DANL. Turning off ADC dither nominally degrades low-level (signal levels below –60 dBm at the input mixer level) scale fidelity by 0.2 dB.

d. See Reference Level footnote (b) on page 41.

e. Mixer level = Input Level - Input Attenuator

f. 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 –5dBm, using attenuator=10dB and RBW = 3 kHz.
Because the larger signal is –5 dBm with 10 dB attenuation, the mixer level, ML, defined to be input power minus input attenuation, is –15 dBm. The line for this mixer level shows A=0.011 dB, B1=0.007 and C1=0.08 dB. Because the RBW is neither 10 kHz and over, nor2 kHz and under, parameters B2 and C2 are determined by formulas. B2 is 7/3000, or 0.00233. C2 is 76dB/3000, or 0.025 dB. With these values for the parameters, the equation becomes: $\pm 0.011\ \text{dB} \pm (0.0093 \times \Delta P \text{ to a maximum of } 0.105\ \text{dB})$ ΔP is (–5 – (–60)) or 55 dB. Therefore, the maximum error in the power ratio is 0.116 dB.

Description	Specifications			Supplemental Information	
General Spurious Responses	**Mixer Level**[a]	**Distortion**			
f < 10 MHz from carrier	–40 dBm	*< (–73 + 20 log N) dBc*[b]			
f ≥ 10 MHz from carrier	–40 dBm	< (–80 + 20 log N) dBc		< (–90 + 20 log N) dBc (typical)	
Second Harmonic Distortion Source Frequency	**Mixer Level**[a]	**Distortion**	**SHI**[c]	**Distortion** (nominal)	**SHI** (nominal)
10 MHz to 400 MHz	–40 dBm	< –82 dBc	+42dBm		
400 MHz to 1.25 GHz	–40 dBm	< –92 dBc	+52dBm		
1.25 GHz to 1.5 GHz	–40 dBm	< –82 dBc	+42dBm		
1.5 GHz to 2.0 GHz	–10 dBm	< –90 dBc	+80dBm		
2.0 GHz to 13.25 GHz	–10 dBm	< –100 dBc	+90dBm		
Preamp On (Option 1DS) Input preamp level = –45 dBm					
10 MHz to 1.5 GHz				< –60 dBc	+ 15 dBm

a. Mixer level = Input Level – Input Attenuator

b. N = LO mixing harmonic

c. 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. The measurement is made with a –11 dBm tone at the input mixer.

Description	Specifications		Supplemental Information
Third Order Intermodulation Distortion With two –30 dBm tones at input mixer Tone separation >15 kHz	**Distortion**[a]	**TOI**[b] Sweep type not set to FFT	**TOI**[b] (typical)
20 to 30 °C			
10 MHz to 100 MHz	< –88 dBc	+14 dBm	+17 dBm
100 MHz to 400 MHz	< –90 dBc	+15 dBm	+18 dBm
400 MHz to 1.7 GHz	< –92 dBc	+16 dBm	+19 dBm
1.7 GHz to 2.7 GHz	< –94 dBc	+17 dBm	+19 dBm
2.7 GHz to 3 GHz	< –94 dBc	+17 dBm	+20 dBm
3 GHz to 6 GHz	< –90 dBc	+15 dBm	+18 dBm
6 GHz to 16 GHz	< –76 dBc	+8 dBm	+11 dBm
16 GHz to 26.5 GHz	< –84 dBc	+12 dBm	+14 dBm
0 to 55 °C			
10 MHz to 100 MHz	< –86 dBc	+13 dBm	+17 dBm
100 MHz to 400 MHz	< –86 dBc	+13 dBm	+17 dBm
400 MHz to 2.7 GHz	< –90 dBc	+15 dBm	+18 dBm
2.7 GHz to 3 GHz	< –90 dBc	+15 dBm	+18 dBm
3 GHz to 6 GHz	< –90 dBc	+15 dBm	+18 dBm
6 GHz to 16 GHz	< –74 dBc	+7 dBm	+10 dBm
16 GHz to 26.5 GHz	< –82 dBc	+11 dBm	+13 dBm
Preamp On *(Option 1DS)* Input preamp level = –45 dBm			**TOI** (nominal)
10 MHz to 500 MHz			–15 dBm
500 MHz to 3 GHz			–13 dBm
Other Input Related Spurious	**Mixer Level**[a]	**Distortion**	
Image Responses 10 MHz to 26.5 GHz	–10 dBm	< –80 dBc[c]	
Multiples and Out-of-band Responses 10 MHz to 26.5 GHz	–10 dBm	< –80 dBc	
Residual Responses[d]			
200 kHz to 6.6 GHz		< –100 dBm	
6.6 GHz to 26.5 GHz			< –100 dBm (nominal)

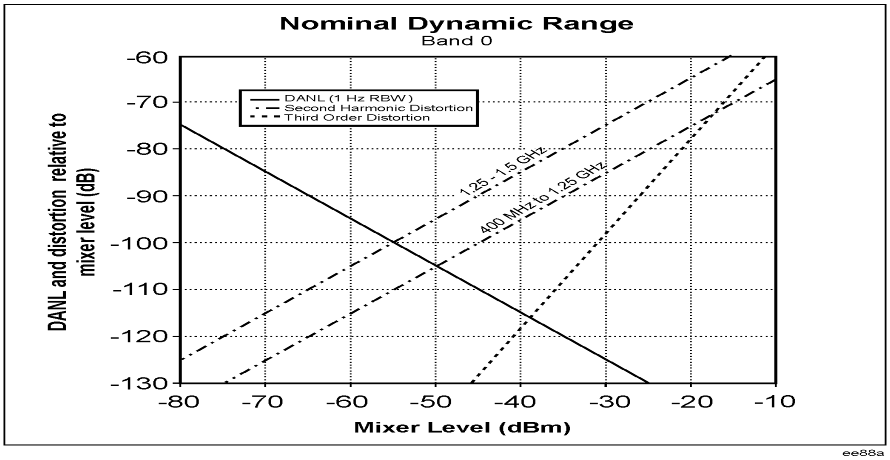
a. Computed from measured TOI.

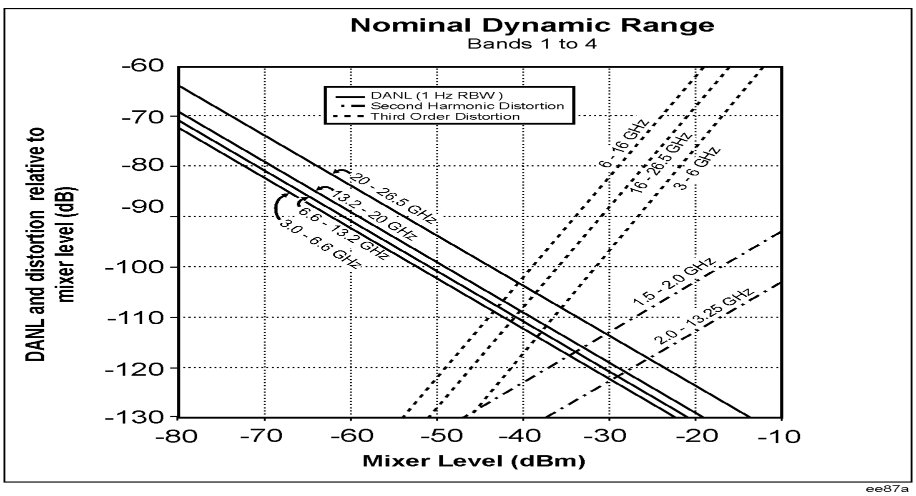
b. TOI = third order intercept. The TOI is given by the mixer tone level (in dBm) minus (distortion/2) where distortion is the relative level of the distortion tones in dBc. The measurement is made with two –18 dBm tones at the input mixer.

c. For frequencies >19 GHz, an image 42.8 MHz below the input signal frequency may be seen, typically –78 dBc or lower.

d. Input terminated, 0 db input attenuation.

Nominal Dynamic Range





Measurement	Specifications	Supplemental Information
Channel Power		
Amplitude Accuracy		Absolute Amplitude Accuracy[a] + Power Bandwidth Accuracy[bc]
Radio Std = 3GPPW-CDMA, or IS-95		
Absolute Power Accuracy 20 to 30°C Mixer level[d] < –20 dBm	±0.68 dB	±0.21 dB (typical)
Occupied Bandwidth		
Frequency Accuracy		± (Span/600) (nominal)

a. See Amplitude section.
b. See Frequency section
c. Expressed in dB
d. Mixer level is the input power minus the input attenuation.

Description	Specifications	Supplemental Information
Adjacent Channel Power (ACP)		
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	
Radio Std = 3GPP W-CDMA (ACPR; ACLR)[f]		
Minimum power at RF Input		–36 dBm (nominal)
ACPR Accuracy[g] Radio Offset Freq		RRC weighted, 3.84 MHz noise bandwidth.
MS (UE) 5 MHz	±0.12 dB	At ACPR range of –30 to –36 dBc with optimum mixer level[h]
MS (UE) 10 MHz	±0.17 dB	At ACPR range of –40 to –46 dBc with optimum mixer level[i]
BTS 5 MHz	±0.22 dB	At ACPR range of –42 to –48 dBc with optimum mixer level[j]
BTS 10 MHz	±0.22 dB	At ACPR range of –47 to –53 dBc with optimum mixer level[i]
BTS 5 MHz	±0.17 dB	At –48 dBc non-coherent ACPR[k]
Dynamic Range Noise Correction Offset Freq		RRC weighted, 3.84 MHz noise bandwidth
off 5 MHz		–74.5 dB (typical)[lm]
off 10 MHz		–82 dB (typical)[lm]
on 5 MHz		–81 dB (typical)[ln]
on 10 MHz		–88 dB (typical)[lm]
RRC Weighting Accuracy[o]		
White noise in Adjacent Channel TOI-induced spectrum r.m.s. CW error		0.00 dB nominal 0.004 dB nominal 0.023 dB nominal
Radio Std = IS-95 or J-STD-008		
Method		RBW method[p]
ACPR Relative Accuracy		
Offsets < 1300 kHz[q]	±0.10 dB	
Offsets > 1.85 MHz[rs]	±0.10 dB	

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 section

c. See Frequency section

d. Expressed in decibels

e. The passband of response for the adjacent channels is given by the convolution of two functions: a rectangle of width given by the programmed Ref BW parameter, and the power response of the RBW filter used. Therefore, the 3 dB bandwidth of the passband function will be equal to the Ref BW. 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 $x - 0.572 \times \text{RBW}$.

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 –26dBm, so the input attenuation must be set as close as possible to the average input power - (–26 dBm). For example, if the average input power is –6 dBm, set the attenuation to 20 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 Bbase Transmission Station (BTS) within 3 dB of the required –45 dBc ACPR. 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 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.

l. Agilent measures 100% of PSAs 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, Agilent only gives a typical result. More than 80% of prototype PSAs 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 Agilent 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. The optimum mixer drive level will be approximately –12 dBm.

n. The optimum mixer drive level will be approximately –15 dBm.

o. 3GPP requires the use of a root-raised-cosine filter in evaluating the ACLR of a device. The accuracy of the passband shape of the filter is not specified in standards, nor is any method of evaluating that accuracy. This footnote discusses the performance of the filter in this instrument. The effect of the RRC filter and the effect of the RBW used in the measurement interact. The analyzer compensates the shape of the RRC filter to accommodate the RBW filter. The effectiveness of this compensation is summarized in three ways:
– White noise in Adj Ch: The compensated RRC filter nominally has no errors if the adjacent channel has a spectrum that is flat across its width.
– TOI-induced spectrum: If the spectrum is due to third-order intermodulation, it has a distinctive shape. The computed errors of the compensated filter are –0.004 dB for the 470 kHz RBW used for UE testing, and 0.000 dB for the 30 kHz RBW filter used for BTS testing. The worst error for RBWs between these extremes is 0.05 dB for a 330 kHz RBW filter. r.m.s.
– 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 r.m.s. error of the compensated filter is 0.023 dB for the 470 kHz RBW used for UE

testing, and 0.000 dB for the 30 kHz RBW filter used for BTS testing. The worst error for RBWs between these extremes is 0.057 dB for a 430 kHz RBW filter.

p. The RBW method measures the power in the adjacent channels within the defined resolution bandwidth. The noise bandwidth of the RBW filter is nominally 1.055 times the 3.01 dB bandwidth. Therefore, the RBW method will nominally read 0.23 dB higher adjacent channel power than would a measurement using the integration bandwidth method, because the noise bandwidth of the integration bandwidth measurement is equal to that integration bandwidth. For cmdaOne ACPR measurements using the RBW method, the main channel is measured in a 3 MHz RBW, which does not respond to all the power in the carrier. Therefore, the carrier power is compensated by the expected under-response of the filter to a full width signal, of 0.15 dB. But the adjacent channel power is not compensated for the noise bandwidth effect.

The reason the adjacent channel is not compensated is subtle. The RBW method of measuring ACPR is very similar to the preferred method of making measurements for compliance with FCC requirements, the source of the specifications for the cdmaOne Spur Close specifications. ACPR is a spot measurement of Spur Close, and thus is best done with the RBW method, even though the results will disagree by 0.23 dB from the measurement made with a rectangular passband.

q. The specified ACPR accuracy applies if the measured ACPR substantially exceeds the analyzer dynamic range at the specified offset. When this condition is not met, there are additional errors due to the addition of analyzer spectral components to UUT spectral components. In the worst case at these offsets, the analyzer spectral components are all coherent with the UUT components; in a more typical case, one third of the analyzer spectral power will be coherent with the distortion components in the UUT. Coherent means that the phases of the UUT distortion components and the analyzer distortion components are in a fixed relationship, and could be perfectly in-phase. This coherence is not intuitive to many users, because the signals themselves are usually pseudo-random; nonetheless, they can be coherent.

When the analyzer components are 100% coherent with the UUT components, the errors add in a voltage sense. That error is a function of the signal (UUT ACPR) to noise (analyzer ACPR dynamic range limitation) ratio, SN, in decibels.

The function is error = 20 × log(1 + 10^(–SN/20))

For example, if the UUT ACPR is –62 dB and the measurement floor is –82 dB, the SN is 20 dB and the error due to adding the analyzer's distortion to that of the UUT is 0.83 dB.

r. As in the previous footnote, the specified ACPR accuracy applies if the ACPR measured substantially exceeds the analyzer dynamic range at the specified offset. When this condition is not met, there are additional errors due to the addition of analyzer spectral components to UUT spectral components. Unlike the situation in footnote p, though, the spectral components from the analyzer will be noncoherent with the components from the UUT. Therefore, the errors add in a power sense. The error is a function of the signal (UUT ACPR) to noise (analyzer ACPR dynamic range limitation) ratio, SN, in decibels.

The function is error = 10 × log(1 + 10^(–SN/10)).

For example, if the UUT ACPR is –75 dB and the measurement floor is –85 dB, the SN ratio is 10 dB and the error due to adding the analyzer's noise to that of the UUT is 0.41 dB.

Measurement	Specifications	Supplemental Information
Multi-Carrier Power		
Radio Std = 3GPP W-CDMA		
ACPR Dynamic Range (two carriers)		RRC weighted, 3.84 MHz noise bandwidth
5 MHz offset		–70 dB (nominal)
10 MHz offset		–75 dB (nominal)
ACPR Accuracy (two carriers)		
5 MHz offset, –48 dBc ACPR		±0.38 dB (nominal)
Power Statistics CCDF		
Histogram Resolution[a]	0.1 dB	
Intermod (TOI)		Measure the third-order intercept from a signal with two dominant tones.
Harmonic Distortion		
Maximum harmonic number	10^{th}	
Results	Fundamental power (dBm) Relative harmonics power (dBc)	
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	

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.

Measurement	Specifications	Supplemental Information
Spurious Emissions		Table-driven spurious signals; search across regions
Radio Std = cdma2000 or 3GPP W-CDMA		
Dynamic Range, relative 1980 MHz region[a]	–80.6 dB	–82.4 dB (typical)
Sensitivity, absolute 1980 MHz region[b]	–89.7 dBm	–91.7 dBm (typical)
Spectrum Emission Mask		Table-driven spurious signals; measurement near carriers
Radio Std = cdma2000		
Dynamic Range, relative 750 kHz offset[cd]	–85.3 dB	–88.3 dB (typical)
Sensitivity, absolute 750 kHz offset[e]	–105.7 dBm	–107 dBm (typical)
Accuracy, relative 750 kHz offset[f]	±0.09 dB	
Radio Std = 3GPP W-CDMA		
Dynamic Range, relative 2.515 MHz Offset[cg]	–87.3 dB	–89.5 dB (typical)
Sensitivity, absolute 2.515 MHz Offset[e]	–105.7 dBm	–107.7 dBm (typical)
Accuracy, relative 2.515 MHz Offset[f]	±0.10 dBm	

a. The dynamic range specification is the ratio of the channel power to the power in the region specified. The dynamic range depends on the many measurement settings. These specifications are based on the detector being set to average, the default RBW (1200 kHz), and depend on the mixer level. Mixer level is defined to be the input power minus the input attenuation. This dynamic range specification applies for a mixer level of –8 dBm. Higher mixer levels can give up to 5 dB better dynamic range, but at the expense of compression in the input mixer, which reduces accuracy. The compression behavior of the input mixer is specified in the amplitude section of these specifications.

b. The sensitivity for this region is specified in the default 1200 kHz bandwidth, at a center frequency of 1 GHz.

c. 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.

d. This dynamic range specification applies for the optimum mixer level, which is about –18 dBm. Mixer level is defined to be the input power minus the input attenuation.

e. 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.

f. 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.

g. This dynamic range specification applies for the optimum mixer level, which is about –16 dBm. Mixer level is defined to be the average input power minus the input attenuation.

Options

The following options affect instrument specifications.[a]

Option BJ7:	Digital demod hardware
Option 1DS:	Preamplifier
Option 202:	GSM with EDGE Personality
Option B78:	cdma2000 Personality
Option BAC:	cdmaOne Personality
Option BAE:	NADC, PDC Personalities
Option BAF:	W-CDMA Personality

a. For instrument personality specifications, refer to the User's Guide for that personality.

General

Description	Specifications	Supplemental Information
Temperature Range		
Operating	0 to 55°C	Floppy disk 10 to 40°C Maximum temperature: 40°C Maximum humidity: 80% relative (non-condensing)
Storage	–40 to 75°C	Temperature: -40 to +71°C Maximum humidity: 90% relative (non-condensing)
Altitude	2,000 meters	Approximately 6,562 feet

Description	Specifications	Supplemental Information
Display		
Resolution	640 x 480	
Scale		
Log Scale	0.1, 0.2, 0.3...1.0, 2.0, 3.0...20 dB per division	
Linear Scale	10% of reference level per division	
Acoustic Emissions (ISO 7779)		LNPE < 5.0 Bels at 25°C
Military Specification	Has been type tested to the environmental specifications of MIL-PRF-28800F class 3.	
EMI Compatibility	Conducted emission is in compliance with CISPR Pub. 11/1990 Group 1 Class A. Radiated emission is in compliance with CISPR Pub. 11/1990 Group 1 Class B.	

Description	Specifications	Supplemental Information
Immunity Testing		
Radiated Immunity		Testing was done at 3 V/m according to IEC 61000-4-3/1995. When the analyzer tuned frequency is identical to the immunity test signal frequency, there may be signals of up to –60 dBm displayed on the screen.
Electrostatic Discharge		Air discharges of up to 8 kV were applied according to IEC 61000-4-2/1995. Discharges to center pins of any of the connectors may cause damage to the associated circuitry.

Description	Specifications	Supplemental Information
Power Requirements		
Voltage, Frequency	100 to 132 Vrms, 47 to 66 Hz/360 to 440 Hz	
	195 to 250 Vrms, 47 to 66 Hz	
Power Consumption, On	Base <260W; Fully Loaded <450W	
Power Consumption, Standby	<20W	
Measurement Speed		
Local Measurement and Display Update rate[a]		
Sweep points = 601		≥ 50/s (nominal)
Remote Measurement and GPIB Transfer Rate		
Sweep points = 601		≥ 22/s (nominal)

a. Factory preset, fixed center frequency, RBW = 1 MHz, and span >10 MHz and ≤ 600 MHz, and stop frequency ≤ 3 GHz.

Description	Specifications	Supplemental Information
Data Storage		
Internal		2 MB
Floppy Drive (10 to 40°C)		3.5" 1.44 MB, MS-DOS® compatible
Weight		
(without options)		
Net E4440A, E4443A, E4445A		23 kg (nominal) 50 lbs (nominal)
Net E4446A, E4448A		24 kg (nominal) 53 lbs (nominal)
Shipping		33 kg (nominal) 73 lb (nominal)
Cabinet Dimensions		Cabinet dimensions exclude front and rear protrusions.
Height	177 mm (7.0 in)	
Width	426 mm (16.8 in)	
Length	483 mm (19 in)	

Inputs and Outputs

Front Panel

Description	Specifications	Supplemental Information
RF INPUT		Nominal
Connector	Type-N female	
(Option BAB)	APC 3.5 male	
Impedance		50Ω
First LO Emission Level[a]		Band 0: < –120 dBm; Band ≥ 1: < –100 dBm

Description	Specifications	Supplemental Information
PROBE POWER		
Voltage/Current		+15 Vdc, ±7% at 150 mA max (nominal) –12.6 Vdc, ±10% at 150 mA max (nominal) GND
EXT TRIGGER INPUT		
Connector	BNC female	
Impedance		10 kΩ (nominal)
Trigger Level		5V TTL

a. With 10 dB attenuation

Rear Panel

Description	Specifications	Supplemental Information
10 MHz OUT (Switched)		Switchable On/Off
Connector	BNC female	
Impedance		50Ω (nominal)
Output Amplitude		≥ 0 dBm (nominal)
Frequency Accuracy	10 MHz ± (10 MHz x frequency reference accuracy)	
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.
Impedance		50Ω (nominal)
Input Amplitude Range		–5 to +10 dBm (nominal)
Frequency		1 to 30 MHz (nominal) (settable to 1 Hz resolution)
Frequency lock range	$\pm 5 \times 10^{-6}$ of specified external reference input frequency	
Trigger In		
Connector	BNC female	
External Trigger Input		Configurable Front or Rear
Impedance		>10 kΩ (nominal)
Trigger Level		5V TTL (nominal)
Keyboard		
Connector	6-pin mini-DIN (PS2)	
Trigger 1 and Trigger 2 Outputs		
Connector	BNC female	
Trigger 1 Output		HSWP (High = sweeping)
Impedance		50Ω (nominal)
Level		5V TTL
Trigger 2 Output		Reserved for future applications

Description	Specifications	Supplemental Information
Monitor Output		
Connector	VGA compatible, 15-pin mini D-SUB	
Format		VGA (31.5 kHz horizontal, 60Hz vertical sync rates, non-interlaced) Analog RGB
Resolution	640 x 480	
PRE-SEL TUNE OUT		
Connector	BNC female	
Load Impedance (dc Coupled)		110Ω (nominal)
Range		0 to 10V (nominal)
Sensitivity External Mixer		1.5 V/GHz of tuned L.O. frequency (nominal)
Remote Programming[a]		
GPIB Interface		
Connector	IEEE-488 bus connector	
GPIB Codes		SH1, AH1, T6, SR1, RL1, PP0, DC1, C1, C2, C3 and C28, DT1, L4, C0
Serial Interface		
Connector	9-pin D-SUB male	Factory use only
Parallel Interface		
Connector	25-pin D-SUB female	Printer port only
LAN TCP/IP Interface	RJ45 Ethertwist	
321.4 MHz IF Output		
Connector	SMA female	
Impedance		50Ω (nominal)
Frequency		321.4 MHz (nominal)
Conversion Gain[b]		+2 to +4 dB (nominal)
SCSI Interface		
Connector	Mini D 50, female	Factory use only

a. Control languages - SCPI version 1992.0

b. Conversion gain is measured from RF input to 321.4 MHz IF output, with 0 dB input attenuation. The 321.4 MHz IF output is located in the RF chain at a point where all of the frequency response corrections are *not* applied. Conversion gain varies nominally ± 3dB as a function of tune frequency.

Regulatory Information

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

This product has been designed and tested in accordance with IEC Publication 61010, Safety Requirements for Electronic Measuring Apparatus, 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.

	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).
	The CSA mark is the Canadian Standards Association safety mark.
ISM 1-A	This is a symbol of an Industrial Scientific and Medical Group 1 Class A product. (CISPR 11, Clause 4)

Declaration of Conformity

DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014

Manufacturer's Name: Agilent Technologies, Inc.

Manufacturer's Address: 1400 Fountaingrove Parkway
Santa Rosa, CA 95403-1799
USA

Declares that the product

Product Name: PSA Performance Spectrum Analyzer

Model Number: E4440A, E4443A, E4445A, E4446A, E4448A

Product Options: This declaration covers all options of the above product.

Conforms to the following product specifications:

EMC: IEC 61326-1:1997+A1:1998 / EN 61326-1:1997+A1:1998

Standard	Limit
CISPR 11:1990 / EN 55011-1991	Group 1, Class A
IEC 61000-4-2:1995+A1998 / EN 61000-4-2:1995	4 kV CD, 8 kV AD
IEC 61000-4-3:1995 / EN 61000-4-3:1995	3 V/m, 80 - 1000 MHz
IEC 61000-4-4:1995 / EN 61000-4-4:1995	0.5 kV sig., 1 kV power
IEC 61000-4-5:1995 / EN 61000-4-5:1996	0.5 kV L-L, 1 kV L-G
IEC 61000-4-6:1996 / EN 61000-4-6:1998	3 V, 0.15 – 80 MHz
IEC 61000-4-11:1994 / EN 61000-4-11:1998	1 cycle, 100%

Safety: IEC 61010-1:1990 + A1:1992 + A2:1995 / EN 61010-1:1993 +A2:1995
CAN/CSA-C22.2 No. 1010.1-92

Supplementary Information:
The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the CE-marking accordingly.

Santa Rosa, CA, USA 6 May, 2002

Greg Pfeiffer/Quality Engineering Manager

For further information, please contact your local Agilent Technologies sales office, agent or distributor.

Rev. C

2 E4443A Specifications

Definitions and Requirements

This chapter contains specifications and supplemental information for PSA E444xA spectrum analyzers. 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, unless otherwise noted).
- 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.

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

Conditions Required to Meet Specifications

- The analyzer is within its calibration cycle.
- Under auto couple control, except that **Auto Sweep Time = Accy**.
- For center frequencies < 20 MHz, DC coupling applied.
- At least 2 hours of storage or operation at the operating temperature.
- Analyzer has been turned on at least 30 minutes with **Auto Align On** selected, or
- If **Auto Align Off** is selected, **Align All Now** must be run:
  - Within the last 24 hours, and
  - Any time the ambient temperature changes more than 3°C, and
  - After the analyzer has been at operating temperature at least 2 hours.

Certification

Agilent Technologies certifies that this product met its published specifications at the time of shipment from the factory. Agilent 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

Description	Specifications	Supplemental Information
Frequency Range		
DC Coupled	3 Hz to 6.7 GHz	
AC Coupled	10 MHz to 6.7 GHz	
Internal Mixing Bands		*Harmonic Mixing Mode (N[a])*
0	3 Hz to 3.0 GHz (DC Coupled)	1–
0	20 MHz to 3.0 GHz (AC Coupled)	1–
1	2.85 GHz to 6.6 GHz	1–
2	6.2 GHz to 6.7 GHz	2–
Preamp On *(Option 1DS)*	100 kHz to 3.0 GHz[b]	1–

a. N is the harmonic mixing mode. All mixing modes are negative (as indicated by the "–"), where the desired first LO harmonic is higher than the tuned frequency by the first IF (3.9214 GHz for the 3 Hz to 3.0 GHz band, 321.4 MHz for all other bands).

b. The low frequency range of the preamp extends to 100 kHz when the RF coupling is set to DC, and to 10 MHz when RF coupling is set to AC.

Description	Specifications	Supplemental Information
Frequency Reference		
Accuracy	± [(time since last adjustment x aging rate) + temperature stability + calibration accuracy[a]]	
Temperature Stability		
20 to 30°C	$\pm 1 \times 10^{-8}$	
0 to 55°C	$\pm 5 \times 10^{-8}$	
Aging Rate	$\pm 1 \times 10^{-7}$/year[b]	$\pm 5 \times 10^{-10}$/day (nominal)
Settability	$\pm 2 \times 10^{-9}$	
Warm-up and Retrace[c]		.
Within 5 min. after turn on		$\pm 1 \times 10^{-7}$ of final frequency (nominal)
Within 15 min. after turn on		$\pm 5 \times 10^{-8}$ of final frequency (nominal)
Achievable Initial Calibration Accuracy[d]	$\pm 7 \times 10^{-8}$	

a. Calibration accuracy depends on how accurately the frequency standard was adjusted to 10 MHz. If the calibration procedure is followed, the calibration accuracy is given by the specification “Achievable Initial Calibration Accuracy”.

b. For periods of one year or more.

c. Applies only when power is disconnected from instrument. Does not apply when instrument is in standby mode.

d. The achievable calibration accuracy at the beginning of the calibration cycle includes these effects:
1) The temperature difference between the calibration environment and the use environment.
2) The 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 unplugging the instrument.
4) Settability.

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])	see note[c]

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 1 MHz, 3% of RBW from 1.1 MHz 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% x RBW term contributes only 55 kHz to the total frequency readout accuracy, compared to 300 kHz for the 0.25% x 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 trace points. The points are spaced by span/(Npts - 1), where Npts is the number of sweep points. For example, with the factory preset value of 601 sweep points, the horizontal resolution is span/600. However, there is an exception: When both the detector mode is "normal" and the span > 0.25 x (Npts - 1) x RBW, peaks can occur only in even-numbered points, so the effective horizontal resolution becomes doubled, or span/300 for the factory preset case. When the RBW is autocoupled and there are 601 sweep points, that exception occurs only for spans > 450 MHz.

c. Swept (not FFT) spans < 2 MHz show a non-linearity in the frequency location at the right or left edge of the span of up to 1.4% of span per megahertz of span (unless using the “fast tuning” option for phase noise optimization). This non-linearity is corrected in the marker readout. Traces output to a remote computer will show the nonlinear relationship between frequency and trace point number. This non-linearity does not occur if the phase noise optimization is set to Fast Tuning.

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

Description	Specifications	Supplemental Information
Frequency Span		
Range		
Swept and FFT	0 Hz, 10 Hz to 6.7 GHz	
Resolution	2 Hz	
Span Accuracy		
Swept	± (0.2% x span + horizontal resolution[c])	see note [d]
FFT	± (0.2% x span + horizontal resolution[C])	

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 >1GHz.

c. Horizontal resolution is due to the marker reading out one of the trace points. The points are spaced by span/(Npts - 1), where Npts is the number of sweep points. For example, with the factory preset value of 601 sweep points, the horizontal resolution is span/600. However, there is an exception: When both the detector mode is "normal" and the span > 0.25 x (Npts - 1) x RBW, peaks can occur only in even-numbered points, so the effective horizontal resolution becomes doubled, or span/300 for the factory preset case. When the RBW is autocoupled and there are 601 sweep points, that exception occurs only for spans > 450 MHz.

d. Swept (not FFT) spans < 2 MHz show a non-linearity in the frequency location at the right or left edge of the span of up to 1.4% of span per megahertz of span (unless using the “fast tuning” option for phase noise optimization). This non-linearity is corrected in the marker readout. Traces output to a remote computer will show the nonlinear relationship between frequency and trace point number. This non-linearity does not occur if the phase noise optimization is set to Fast Tuning.

Description	Specifications	Supplemental Information
Sweep Time		
Range		
Span = 0 Hz	1 µs to 6000s	
Span ≥ 10 Hz	1 ms to 2000s	
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 Front, External Rear, RF Burst	
Delayed Trigger[a]	.	
Range		
Span ≥ 10 Hz, swept	1 µs to 500 ms	
Span = 0 Hz or FFT	–150 ms to +500ms	
Resolution	0.1 µs	

Gated Measurements

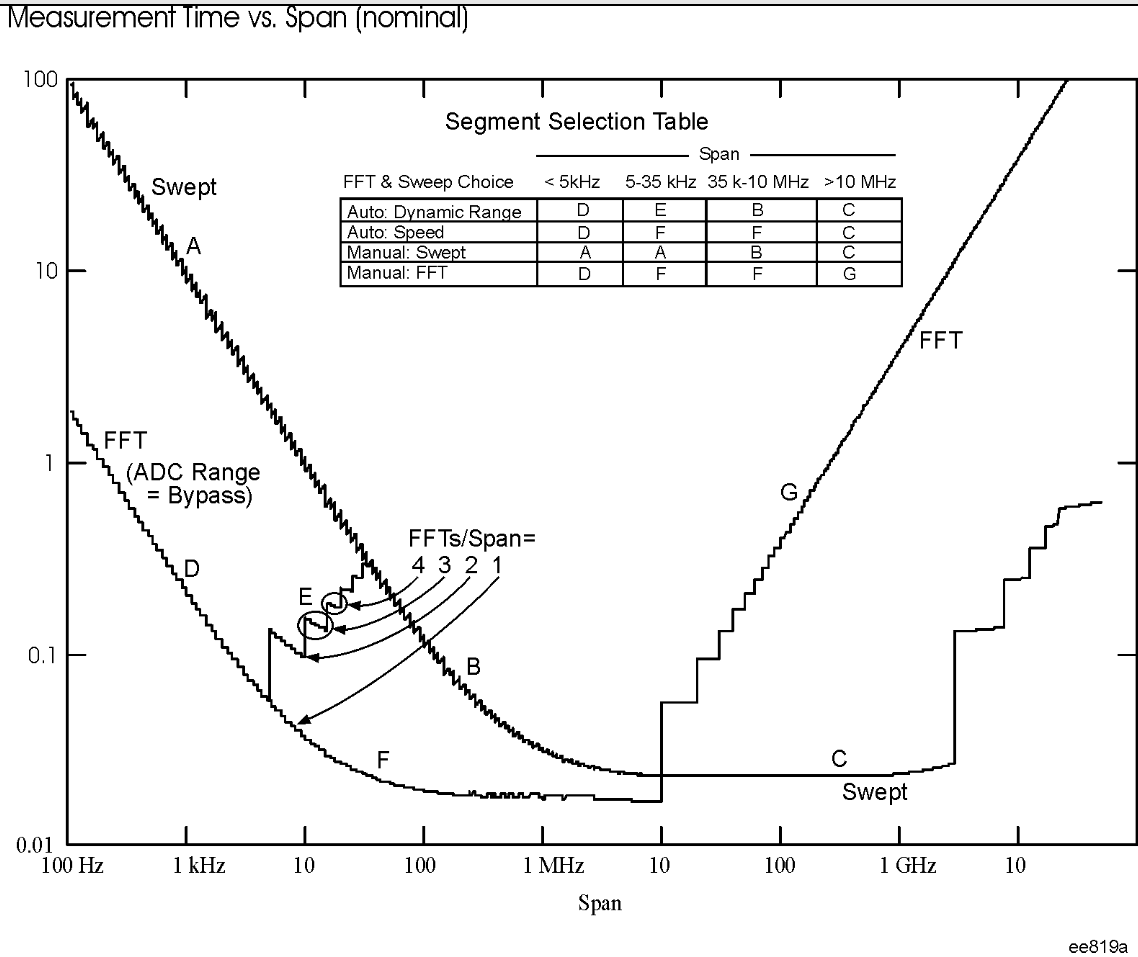
Description	Specifications	Supplemental information
Gated FFT[b]		
Maximum Span	10 MHz	
Delay Range	-150 to +500 ms	
Delay Resolution	100 ns or 4 digits, whichever is more	
Gate Duration		1.83/RBW ± 2%

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

b. Gated measurements (measuring a signal only during a specific time interval) are possible with triggered FFT measurements. The FFT allows analysis during a time interval set by the RBW (within nominally 2% of 1.83/RBW) for spans up to 10 MHz. This time interval is shorter than that of swept gating circuits, allowing higher resolution of the spectrum.

Measurement Time vs. Span

Measurement Time vs. Span (nominal)



Description	Specifications	Supplemental Information
Number of Frequency Display Trace Points (buckets)		
Factory preset	601	
Range:		
Span ≥ 10 Hz	101 to 8192	
Span = 0 Hz	2 to 8192	

Description	Specifications	Supplemental Information
Resolution Bandwidth (RBW)		
Range (–3.01 dB bandwidth)	1 Hz to 8 MHz. Bandwidths > 3 MHz = 4, 5, 6, and 8 MHz. Bandwidths 1 Hz to 3 MHz are spaced at 10% spacing, 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, and repeat, times ten to an integer.	
Accuracy (–3.01 dB bandwidth)[a]		
1 Hz to 1.5 MHz RBW		± 2% (nominal)
1.6 MHz to 3 MHz RBW		
(CF ≤ 3 GHz)		± 7% (nominal)
(CF > 3 GHz)		± 8% (nominal)
4 MHz to 8 MHz RBW		
(CF ≤ 3 GHz)		± 15% (nominal)
(CF > 3 GHz)		± 20% (nominal)
Power bandwidth accuracy[b]		
RBW Range / CF Range		
1 Hz – 51 kHz / all	± 0.5%	Equivalent to ± 0.022 dB
82 kHz – 330 kHz / all	± 0.5%	Equivalent to ± 0.022 dB
56 kHz – 75 kHz / all	± 1.0%	Equivalent to ± 0.044 dB
360 kHz – 1.2 MHz / < 3 GHz	± 1.0%	Equivalent to ± 0.044 dB
1.3 MHz – 2.0 MHz / < 3 GHz		± 0.07 dB, nominal
2.2 MHz – 6 MHz / < 3 GHz		± 0.2 dB, nominal
Selectivity (–60 dB/–3 dB)		4.1:1 (nominal)

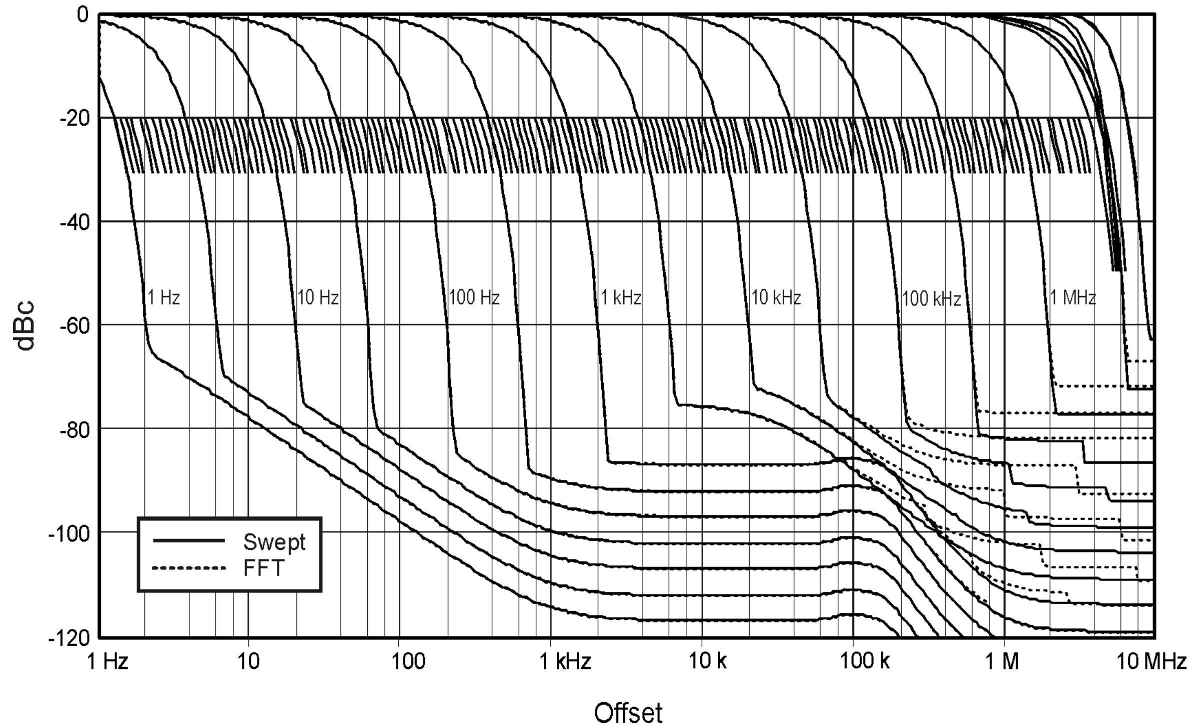
a. Resolution Bandwidth Accuracy can be observed at slower sweep times than autocoupled conditions. Normal sweep rates cause the shape of the RBW filter displayed on the analyzer screen to widen by nominally 6%. This widening declines to 0.6% nominal when the **Auto Swp Time** key is set to **Accy** instead of **Norm**. The true bandwidth, which determines the response to impulsive signals and noise-like signals, is not affected by the sweep rate.

b. 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.)

Description	Specification	Supplemental information
Information Bandwidth		
Maximum FFT width	10 MHz	
(Option B7J) I/Q Waveform digital bandwidths	10 MHz	
321.4 MHz rear panel output bandwidth		Nominal
At – 1 dB BW		
Low band (0 to 3 GHz)		30 MHz
High band (2.85 to 26.5 GHz)		20 to 30 MHz[a]
mm band (26.4 to 50 GHz)		30 MHz
At – 3 dB BW		
Low band (0 to 3 GHz)		40 MHz
Highband (2.85 to 26.5 GHz)		30 to 60 MHz
mm bnad (26.5 to 50 GHz)		40 MHz
(Option H70) bandwidth		Same as 321.4 MHz bandwidth

a. The bandwidth in the microwave preselected bands increases monotonically between the lowest and highest tuned frequencies in most, but not all, analyzers.

Typical Dynamic Range vs. Offset Frequency vs. RBW



CF = 1 GHz
Mixer Level = -10 dBm
Only 2/decade of the
24/decade RBW are shown fully
RBWs ≤ 1 kHz shown with
phase noise optimized for fm < 50 kHz
RBWs ≥ 3 kHz shown with
phase noise optimized for fm > 50 kHz

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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=0.1xRBW, four FFTs are averaged to generate one result.

Description	Specifications		Supplemental Information	
Stability				
Noise Sidebands Center Frequency = 1 GHz[a] Best-case Optimization[b]	**20 to 30°C**	**0 to 55°C**	**20 to 30°C**	**20 to 30°C**
Offset			(Typical)	(Nominal)
100 Hz	–91 dBc/Hz	–90 dBc/Hz	–97 dBc/Hz	
1 kHz	–103 dBc/Hz	–100 dBc/Hz	–107 dBc/Hz	
10 kHz	–114 dBc/Hz	–113 dBc/Hz	–117 dBc/Hz	
30 kHz	–114 dBc/Hz	–113 dBc/Hz	–117 dBc/Hz	
100 kHz	–120 dBc/Hz	–119 dBc/Hz	–123 dBc/Hz	
1 MHz	–144 dBc/Hz	–142 dBc/Hz	–146 dBc/Hz[c]	–148 dBc/Hz[c]
6 MHz	–151 dBc/Hz	–150 dBc/Hz	–152 dBc/Hz[c]	–156 dBc/Hz[c]
10 MHz	–151 dBc/Hz	–150 dBc/Hz	–152 dBc/Hz[c]	–157.5 dBc/Hz[c]
Residual FM	<(1 Hz x N[d]) p-p in 1 s			

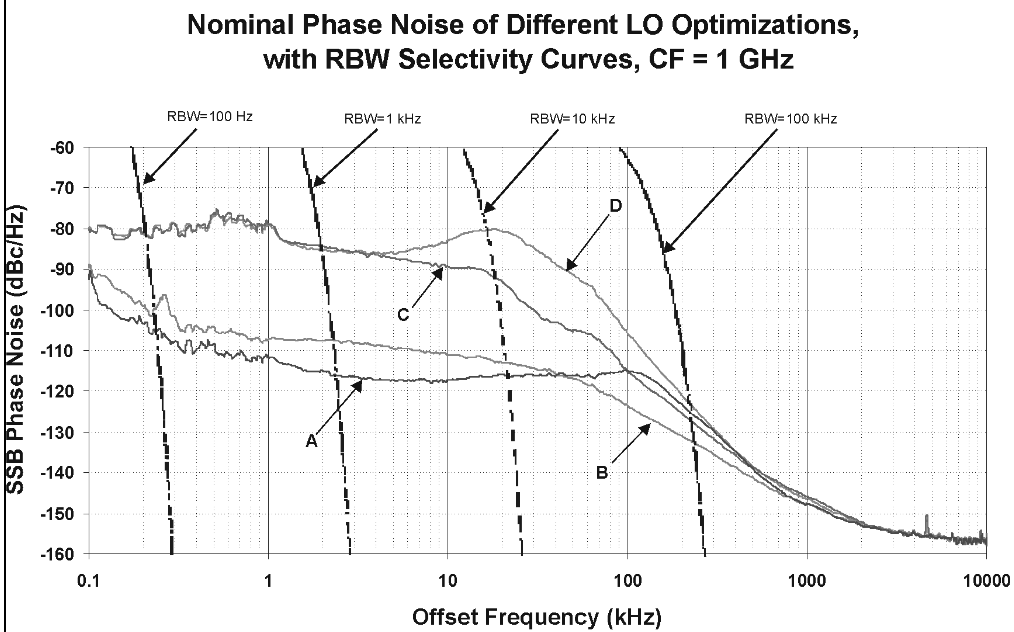
a. Nominal changes of phase noise sidebands with other center frequencies are shown by some examples in the graphs that follow. To predict the phase noise for other center frequencies, note that phase noise at offsets above approximately 1 kHz increases nominally as 20 X log N, where N is the harmonic mixer mode. For offsets below 1 kHz, and center frequencies above 1 GHz, the phase noise increases nominally as 20 X log CF, where CF is the center frequency in GHz.

b. Noise sidebands for offsets of 30 kHz and below are shown for phase noise optimization set to optimize $\mathscr{L}(f)$ for f<50 kHz; for offsets of 100 kHz and above, the optimization is set for f > 50 kHz.

c. “Typical” results include the effect of the signal generator used in verifying performance; nominal results show performance observed during development with specialized signal sources.

d. N is the harmonic mixing mode.

Nominal Phase Noise of Different LO Optimizations



<table>
<tr><th>Sweep Type</th><th>Span</th><th>Optimize L(f) for f < 50 kHz</th><th>Optimize L(f) for f > 50 kHz</th><th>Optimize LO for fast tuning</th></tr>
<tr><td>FFT</td><td>All</td><td rowspan="2">A (Dual Loop Wideband)</td><td rowspan="2">B (Dual Loop Narrowband)</td><td rowspan="2">D (Single Loop Wideband)</td></tr>
<tr><td rowspan="3">Swept</td><td>< 2 MHz</td></tr>
<tr><td>2 to 50 MHz</td><td colspan="2">C (Single Loop Narrowband)</td><td rowspan="2"></td></tr>
<tr><td>> 50 MHz</td><td colspan="2"></td></tr>
</table>

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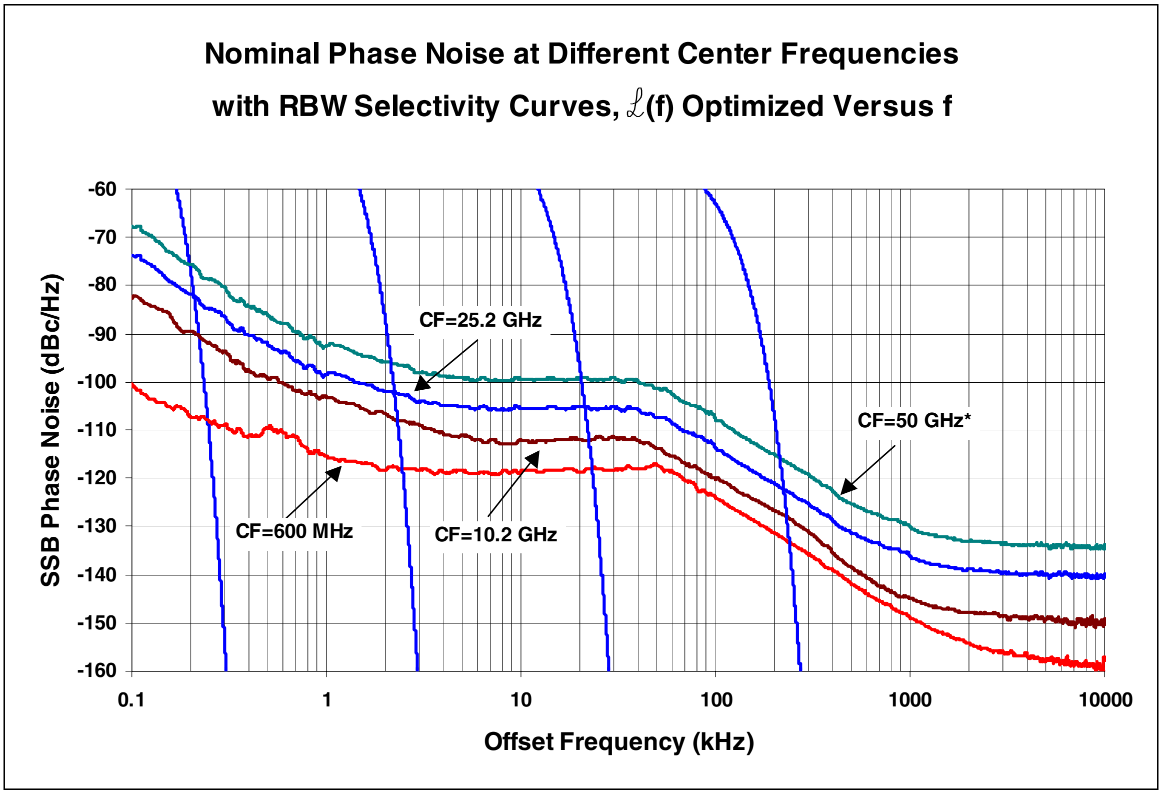
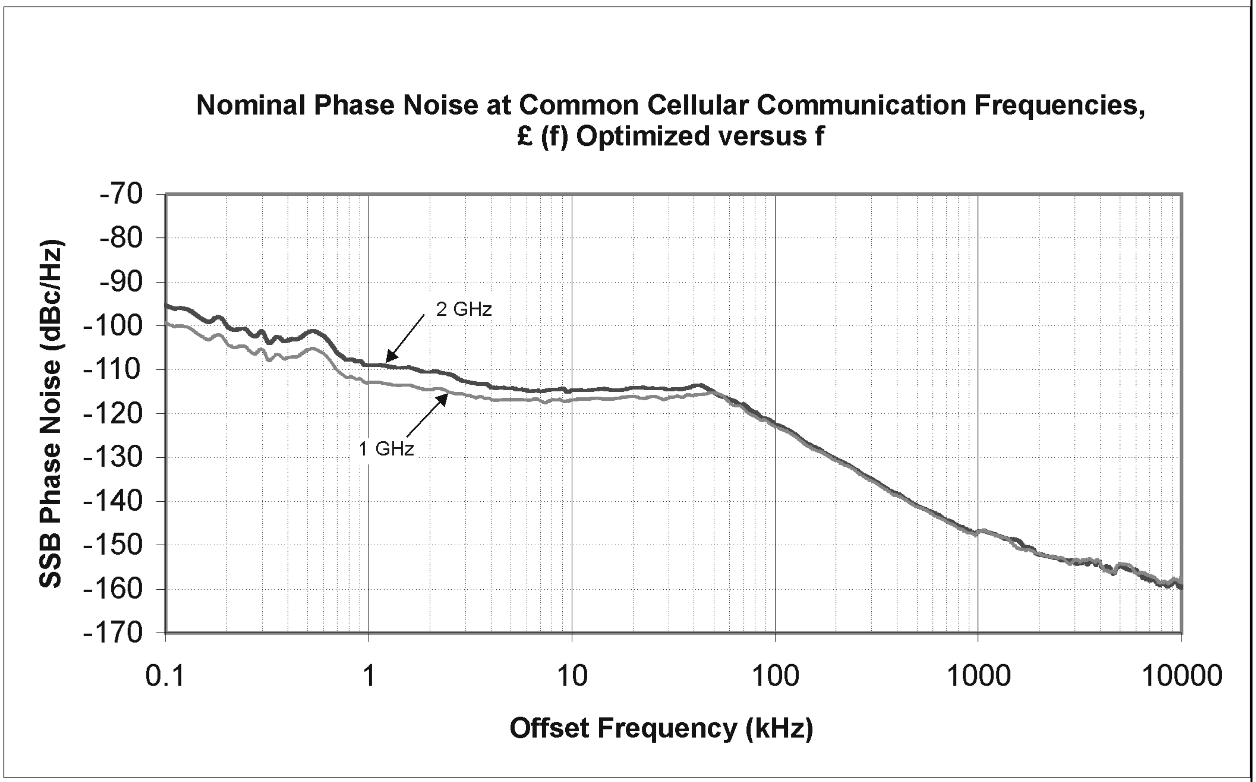
Nominal Phase Noise at Different Center Frequencies



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

PSA Phase Noise



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Amplitude

Description	Specifications	Supplemental Information
Measurement Range	Displayed Average Noise Level to +30 dBm	
Preamp *(Option 1DS)*	Displayed Average Noise Level to +25 dBm	
Input Attenuator Range	0 to 70 dB, in 2 dB steps	

Description	Specifications	Supplemental Information
Maximum Safe Input Level		Applies with or without preamp *(Option 1DS)*
Average Total Power	+30 dBm (1W)	
Peak Pulse Power <10 μs pulse width; <1% duty cycle; and input attenuation ≥ 30 dB	+50 dBm (100W)	
DC volts		
DC Coupled	± 0.2 Vdc	
AC Coupled (E4443A, E4445A, E4440A)	± 100 Vdc	

Description	Specifications	Supplemental Information	
1 dB Gain Compression Point (Two-tone)[abc]	Maximum power at mixer[d]	Nominal[e]	
20 MHz to 200 MHz	0 dBm	+ 3 dBm	
200 MHz to 3.0 GHz	+3 dBm	+7 dBm	
3.0 GHz to 6.6 GHz	+3 dBm	+4 dBm	
6.6 GHz to 6.7 GHz	–2 dBm	0 dBm	
Typical Gain Compression (Two-tone)		Mixer Level	Typical[e] Compression
20 MHz to 200 MHz		0 dBm	< 0.5 dB
200 MHz to 6.6 GHz		+3 dBm	< 0.5 dB
6.6 GHz to 6.7 GHz		–2 dBm	< 0.4 dB
Preamp On *(Option 1DS)* Total power at the preamp[f]			
10 MHz to 200 MHz		–30 dBm (nominal)	
200 MHz to 3 GHz		–25 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. Tone spacing > 15 times RBW, with a minimum of 30 kHz of separation

c. See Reference Level footnote (b) on page 41.

d. Mixer power level (dBm) = input power (dBm) – input attenuation (dB).

e. The compression of a small on-screen signal by a large interfering signal can be represented as a curve of compression versus the level of the interfering signal. The specified performance is a level/compression pair. The specification could be verified by finding the level for which the compression is 1 dB, or by finding the compression for the specified level. The latter technique is used. Therefore, the amount of compression is known in production, and the typical compression is known statistically, thus allowing a "typical" listing. The level required to reach 1 dB compression is not monitored in production, thus "nominal" performance is shown for this view of the performance.

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

Description	Specifications			Supplemental Information
Displayed Average Noise Level (DANL)[a]				
Input terminated Sample or Average detector Averaging type = Log Normalized to 0 dB input attenuation				**Nominal**
3 Hz to 1 kHz				–110 dBm
1 kHz to 10 kHz				–130 dBm
	Zerospan & swept Normalized[a] to 1 Hz 20 to 30°C	**Zerospan & swept Normalized[a] to 1 Hz 0 to 55°C**	**FFT Only Actual[b] 1 Hz 20 to 30°C**	**Zerospan & swept Normalized[a] to 1 Hz (typical)**
10 kHz to 100 kHz	–135 dBm	–135 dBm	–135 dBm	–142 dBm
100 kHz to 1 MHz	–145 dBm	–145 dBm	—-145 dBm	–149 dBm
1 MHz to 10 MHz	–150 dBm	–150 dBm	–150 dBm	–153 dBm
10 MHz to 1.2 GHz	–155 dBm	–154 dBm	–154 dBm	–156 dBm
1.2 GHz to 2.5 GHz	–154 dBm	–153 dBm	–153 dBm	–155 dBm
2.5 GHz to 3 GHz	–153 dBm	–152 dBm	–152 dBm	–154 dBm
3 GHz to 6.6 GHz	–152 dBm	–151 dBm	–151 dBm	–153 dBm
6.6 GHz to 6.7 GHz	–150 dBm	–149 dBm	–149 dBm	–152 dBm
Preamp On *(Option 1DS)*			Nominal FFT	
100 kHz to 10 MHz	–166 dBm	–163 dBm	–168 dBm	–168 dBm
10 MHz to 1.1 GHz	–169 dBm	–168 dBm	–170 dBm	–170 dBm
1.1 GHz to 2.5 GHz	–168 dBm	–167 dBm	–169 dBm	–169 dBm
2.5 GHZ to 3.0 GHz	–166 dBm	–166 dBm	–167 dBm	–167 dBm

a. DANL for zero span and swept is normalized in two ways and for two reasons. DANL is measured in a 1 kHz RBW and normalized to the narrowest available RBW, because the narrowest RBWs (1.0 to 1.8 are not usable for signals below –110 dBm but DANL can be a useful figure of merit for the other RBWs. (RBWs this small are usually best used in FFT mode, because sweep rates are very slow in these bandwidths. RBW autocoupling never selects these RBWs in swept mode because of potential errors at low signal levels.) The second normalization is that DANL is measured with 10 dB input attenuation and normalized to the 0 dB input attenuation case, because that makes DANL and third order intermodulation test conditions congruent, allowing accurate dynamic range estimation for the analyzer. Because of these normalizations, this measure of DANL is useful for estimating instrument performance such as TOI to noise range and compression to noise range, but not ultimate sensitivity.

b. DANL for FFT measurements are useful for estimating the ultimate sensitivity of the analyzer for low-level signals. This specification is verified with 0 dB input attenuation and 1 Hz RBW. A limitation of this DANL specification is that some instruments have a center-screen-only spurious signal of nominally –150 dBm, which can be avoided by tuning the analyzer a few hertz away from the frequency of interest.

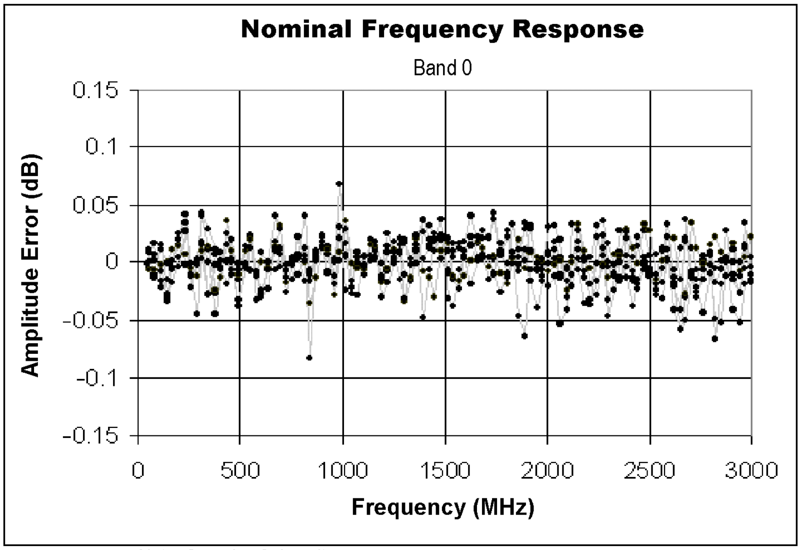
Description	Specifications	Supplemental Information
Display Range		
Log Scale	Ten divisions displayed; 0.1 to 1.0 dB/division in 0.1 dB steps, and 1 to 20 dB/division in 1 dB steps	
Linear Scale	Ten divisions	
Marker Readout[a]		
Log units resolution		
Average off, on-screen	0.01 dB	
Average on or remote	0.001 dB	
Linear units resolution		≤ 1% of signal level

a. See Reference Level footnote (b) on page 41.

Description	Specifications		Supplemental Information	
Frequency Response				
(10 dB input attenuation)				
Maximum error relative to reference condition (50 MHz)[a]	**20 to 30°C**	**0 to 55°C**	**Typical** (at worst observed frequency)	
3 Hz to 3.0 GHz	±0.38 dB	±0.58 dB	±0.10 dB	
3.0 GHz to 6.6 GHz[b]	±1.50 dB	±2.00 dB	±0.5 dB	
6.6 GHz to 6.7 GHz[b]	±2.00 dB	±2.50 dB	±1.0 dB	
Additional frequency response error, FFT mode[cd]	± [0.15 dB + (0.1 dB/MHz x FFT width[e])] to a max. of ± 0.40 dB			
100 kHz to 3.0 GHz Preamp On (*Option 1DS*)	±0.70 dB	±0.80 dB	< ± 0.2 dB	
Frequency Response at Attenuation ≠ 10 dB			At 0, 2, 4, 6, 20, 30 dB input attenuation steps. **Nominal**	
			20 to 30°C	**0 to 55°C**
10 MHz to 3 GHz			±0.8 dB	±1.0 dB

a. Specifications for frequencies > 3 GHz apply for sweep rates <100 MHz/ms.
b. Preselector centering applied.
c. FFT frequency response errors are specified relative to swept measurements.
d. This error need not be included in Absolute Amplitude Accuracy error budgets when the difference between the analyzer center frequency and the signal frequency is within ± 1.5% of the span.
e. An FFT width is given by the span divided by the FFTs/Span parameter.

Nominal Frequency Response



Note: Sample of six units.

Description	Specifications	Supplemental Information
Input Attenuation Switching Uncertainty[a][b]		
Attenuator Setting ≥ 2 dB		
Frequency Range		
50 MHz	± 0.2 dB	
3 Hz to 3.0 GHz		± 0.3 dB (nominal)
3.0 to 6.7 GHz		± 0.5 dB (nominal)
Attenuator Setting = 0 dB		
50 MHz	± 0.3 dB	

Description	Specifications	Supplemental Information
Preamp (*Option* 1DS)[c]		
Gain		+28 dB (nominal)
Noise figure		
10 MHz to 1.5 GHz		6 dB (nominal)
1.5 GHz to 3.0 GHz		7 dB (nominal)

a. Referenced to 10 dB attenuation
b. Specifications also apply to Option 1DS.
c. The preamp is between the input attenuator and the input mixer.

Description	Specifications	Supplemental Information
Absolute Amplitude Accuracy		
At 50 MHz		
20 to 30°C[a]	± 0.24 dB	± 0.06 dB (typical)
0 to 55°C[b]	± 0.28 dB	
Amplitude Reference Accuracy		± 0.05 dB (nominal)
At all frequencies		
20 to 30°C[b]	± (0.24 dB + frequency response)	± (0.06 dB + frequency response) (typical)
0 to 55°C[b]	± (0.28dB + frequency response)	
Freq < 3 GHz 95% Confidence[b]		± 0.24 dB
Preamp On[c] (*Option* 1DS)	± (0.36 dB + frequency response)	± (0.09 dB + frequency response) (typical)

a. Absolute amplitude accuracy is the total of all amplitude measurement errors, and applies over the following subset of settings and conditions: 10 Hz ≤ RBW ≤1 MHz; Input signal –10 to –50 dBm; Input attenuation 10 dB; span <5 MHz (nominal additional error for span ≥ 5 MHz is 0.02 dB); all settings autocoupled except Auto Swp Time = Accy; combinations of low signal level and wide RBW use VBW ≤30 kHz to reduce noise. This absolute amplitude accuracy specification includes the sum of the following individual specifications under the conditions listed above: Scale Fidelity, Reference Level Accuracy, Display Scale Switching Uncertainty, Resolution Bandwidth Switching Uncertainty, 50 MHz Amplitude Reference Accuracy, and the accuracy with which the instrument aligns its internal gains to the 50 MHz Amplitude Reference.

b. Absolute Amplitude Accuracy for frequencies below 3 GHz with 95% confidence applies at all the conditions of footnote b, with an input frequency below 3 GHz, for temperatures of 20 to 30°C. The value given is the result of testing the most recent 113 analyzers as of this writing. It is computed by root-sum-squaring (r.s.s.) the 95th percentiles of these terms: the absolute amplitude accuracy observed at 50 MHz under 44 quasi-random combinations of settings, the frequency response relative to 50 MHz at 102 quasi-random test frequencies, and the measurement uncertainties of all these observations. To that root-sum-squaring result is added the environmental effects of 20 to 30°C variation. The 95th percentiles are determined with a 95% confidence level.

c. Same settings as footnote b, 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). For frequencies from 100 kHz to 3 GHz.

Description	Specifications	Supplemental Information
RF Input VSWR		Nominal
(at tuned frequency)		
10 dB attenuation, 50 MHz		1.07:1
≥ 8 dB *input attenuation*		
50 MHz to 3 GHz		< 1.2:1
3 GHz to 18 GHz		< 1.6:1
18 GHz to 26.5 GHz		< 1.9:1
2 to 6 dB *input attenuation*		
50 MHz to 3 GHz		< 1.6:1
3 GHz to 26.5 GHz		< 1.9:1
0 dB *input attenuation*		
50 MHz to 3 GHz		< 1.9:1
3 GHz to 26.5 GHz		< 1.9:1
Preamp On (*Option 1DS*)		
50 MHz to 3 GHz		
≥ 10 dB input attenuation		< 1.2:1
< 10 dB input attenuation		< 1.5:1
Internal 50 MHz calibrator is on		Open input
Alignments running		Open input

Description	Specifications	Supplemental Information
Resolution Bandwidth Switching Uncertainty[a]		
(relative to reference BW of 30 kHz)		
1.0 Hz to 1.0 MHz RBW	± 0.03 dB	
1.1 MHz to 3 MHz RBW	± 0.05 dB	
Manually selected wide RBWs: 4, 5, 6, 8 MHz	± 1.0 dB	

Description	Specifications	Supplemental Information
Reference Level[b]		
Range		
Log Units	–170 to +30 dBm, in 0.01 dB steps	
Linear Units	707 pV to 7.07V in 0.1% steps	
Accuracy	0 dB[c]	

a. RBW switching is specified and tested in the reference condition: –25 dBm signal input and 10 dB input attenuation. At higher input levels, changing RBW may cause a larger change in result than that specified, because the display scale fidelity can be slightly different for different RBWs. These RBW differences in scale fidelity are nominally within ±0.01 dB in all RBWs even for signals as large as –10 dBm at the input mixer.

b. Reference level and off-screen performance: The reference level (RL) behavior differs from previous analyzers in a way that makes PSA more flexible. In previous analyzers, the RL controlled how the measurement was performed as well as how it was displayed. Because the logarithmic amplifier in previous analyzers had both range and resolution limitations, this behavior was necessary for optimum measurement accuracy. The logarithmic amplifier in PSA, however, is implemented digitally such that the range and resolution greatly exceed other instrument limitations. Because of this, a PSA 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 attenuator setting: When the input attenuator 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.

c. 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[c]	

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[abcd]				
Log-Linear Fidelity (relative to the reference condition of −25 dBm input through the 10 dB attenuator, or −35 dBm at the input mixer.)				
Input mixer level[e]	Linearity			
≤ −20 dBm	± 0.07 dB			
≤ −10 dBm	± 0.13 dB			
Relative Fidelity[f]				
Equation for error ± A ± (B1 + B2) × ΔP) to a maximum of (C1 + C2))				
Level of larger signal		**A**	**B1**	**C1**
−20 dBm < ML < −12 dBm		0.011 dB	0.007	0.08 dB
−29 dBm < ML < −20 dBm		0.011 dB	0.0015	0.04 dB
Noise < ML < −29 dBm		0.001 dB	0.001	0.04 dB
RBW		**B2**	**C2**	
≥ 10 kHz		0.000	0.000 dB	
≤ 2 kHz		0.0035	0.038 dB	
others (RBW in Hz)		7/RBW	76 dB/RBW	

a. Supplemental information: The amplitude detection linearity specification applies at all levels below −10dBm 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 3sigma level can be reduced proportional to the square root of the number of averages taken.

b. Display scale fidelity and resolution bandwidth switching uncertainty interact slightly. See the footnote for RBW switching. RBW switching applies at only one level on the scale fidelity curve, but scale fidelity applies for all RBWs.

c. Scale fidelity is warranted with ADC dither turned on. Turning on ADC dither nominally increases DANL. The nominal increase is highest with the preamp off in the lowest-DANL frequency range, under 1.2 GHz, where the nominal increase is 2.5dB. Other ranges and the preamp-on case will show lower increases in DANL. Turning off ADC dither nominally degrades low-level (signal levels below −60 dBm at the input mixer level) scale fidelity by 0.2 dB.

d. See Reference Level footnote (b) on page 41.

e. Mixer level = Input Level - Input Attenuator

f. 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 −5dBm, using attenuator=10dB and RBW = 3 kHz.
Because the larger signal is −5 dBm with 10 dB attenuation, the mixer level, ML, defined to be input power minus input attenuation, is −15 dBm. The line for this mixer level shows A=0.011 dB, B1=0.007 and C1=0.08 dB. Because the RBW is neither 10 kHz and over, nor2 kHz and under, parameters B2 and C2 are determined by formulas. B2 is 7/3000, or 0.00233. C2 is 76dB/3000, or 0.025 dB. With these values for the parameters, the equation becomes: $\pm 0.011\ dB \pm (0.0093 \times \Delta P \text{ to a maximum of } 0.105\ dB)$ ΔP is (−5 − (−60)) or 55 dB. Therefore, the maximum error in the power ratio is 0.116 dB.

Description	Specifications			Supplemental Information	
General Spurious Responses	**Mixer Level**[a]	**Distortion**			
f < 10 MHz from carrier	–40 dBm	< (–73 + 20 log N) dBc[b]			
f ≥ 10 MHz from carrier	–40 dBm	< (–80 + 20 log N) dBc		< (–90 + 20 log N) dBc (typical)	
Second Harmonic Distortion	**Mixer Level**[a]	**Distortion**	**SHI**[c]	**Distortion** (nominal)	**SHI** (nominal)
Source Frequency					
10 MHz to 400 MHz	–40 dBm	< –82 dBc	+42 dBm		
400 MHz to 1.25 GHz	–40 dBm	< –92 dBc	+52 dBm		
1.25 GHz to 1.5 GHz	–40 dBm	< –82 dBc	+42 dBm		
1.5 GHz to 2.0 GHz	–10 dBm	< –90 dBc	+80 dBm		
2.0 GHz to 3.35 GHz	–10 dBm	< –100 dBc	+90 dBm		
Preamp On *(Option 1DS)* Input preamp level = –45 dBm					
10 MHz to 1.5 GHz				< –60 dBc	+15 dBm

a. Mixer level = Input Level – Input Attenuator

b. N = LO mixing harmonic

c. 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. The measurement is made with a –11 dBm tone at the input mixer.

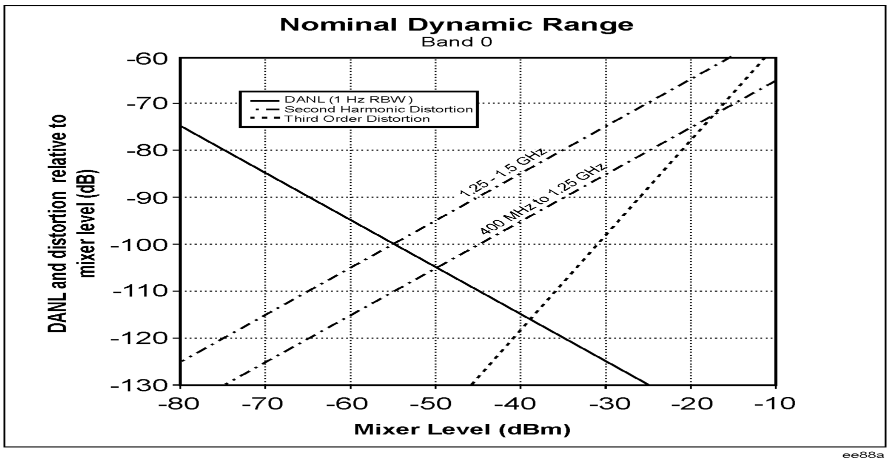
Description	Specifications		Supplemental Information
Third Order Intermodulation Distortion With two –30 dBm tones at input mixer Tone separation >15 kHz	**Distortion**[a]	**TOI**[b]	**TOI**[b] (typical)
20 to 30°C			
10 MHz to 100 MHz	< –88 dBc	+14 dBm	+17 dBm
100 MHz to 400 MHz	< –90 dBc	+15 dBm	+18 dBm
400 MHz to 1.7 GHz	< –92 dBc	+16 dBm	+19 dBm
1.7 GHz to 2.7 GHz	< –94 dBc	+17 dBm	+19 dBm
2.7 GHz to 3 GHz	< –94 dBc	+17 dBm	+20 dBm
3 GHz to 6 GHz	< –90 dBc	+15 dBm	+18 dBm
6 GHz to 6.7 GHz	< –76 dBc	+8 dBm	+11 dBm
0° to 55°C			
10 MHz to 100 MHz	< –86 dBc	+13 dBm	+17 dBm
100 MHz to 400 MHz	< –86 dBc	+13 dBm	+17 dBm
400 MHz to 2.7 GHz	< –90 dBc	+15 dBm	+18 dBm
2.7 GHz to 3 GHz	< –90 dBc	+15 dBm	+18 dBm
3 GHz to 6 GHz	< –90 dBc	+15 dBm	+18 dBm
6 GHz to 6.7 GHz	< –74 dBc	+7 dBm	+10 dBm
Preamp On *(Option 1DS)* Input preamp level = –45 dBm			**TOI** (nominal)
10 MHz to 500 MHz			–15 dBm
500 MHz to 3 GHz			–13 dBm
Other Input Related Spurious	**Mixer Level**[a]	**Distortion**	
Image Responses			
10 MHz to 6.7 GHz	–10 dBm	< –80 dBc	
Multiples and Out-of-band Responses			
10 MHz to 6.7 GHz	–10 dBm	< –80 dBc	
Residual Responses[c]			
200 kHz to 6.6 GHz	< –100 dBm		
6.6 GHz to 6.7 GHz			< –100 dBm (nominal)

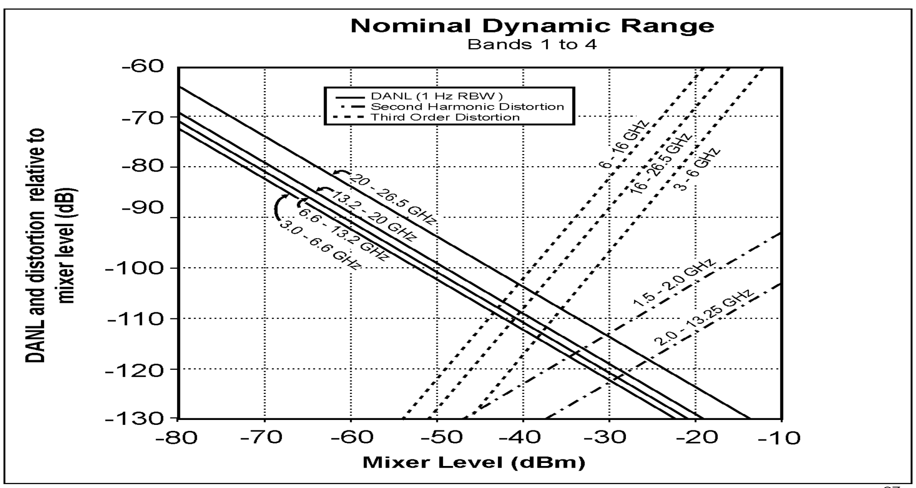
a. Computed from measured TOI.

b. 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. The measurement is made with two –18 dBm tones at the input mixer.

c. Input terminated, 0 dB input attenuation

Nominal Dynamic Range





Measurement	Specifications	Supplemental Information
Channel Power		
Amplitude Accuracy		Absolute Amplitude Accuracy[a] + Power Bandwidth Accuracy[bc]
Radio Std = 3GPPW-CDMA, or IS-95		
Absolute Power Accuracy 20 to 30°C Mixer level[d] < –20 dBm	±0.68 dB	±0.21 dB (typical)
Occupied Bandwidth		
Frequency Accuracy		± (Span/600) (nominal)

a. See Amplitude section.
b. See Frequency section
c. Expressed in dB
d. Mixer level is the input power minus the input attenuation.

Description	Specifications	Supplemental Information
Adjacent Channel Power (ACP)		
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	
Radio Std = 3GPP W-CDMA (ACPR; ACLR)[f]		
Minimum power at RF Input		–36 dBm (nominal)
ACPR Accuracy[g] Radio Offset Freq		RRC weighted, 3.84 MHz noise bandwidth.
MS (UE) 5 MHz	±0.12 dB	At ACPR range of –30 to –36 dBc with optimum mixer level[h]
MS (UE) 10 MHz	±0.17 dB	At ACPR range of –40 to –46 dBc with optimum mixer level[i]
BTS 5 MHz	±0.22 dB	At ACPR range of –42 to –48 dBc with optimum mixer level[j]
BTS 10 MHz	±0.22 dB	At ACPR range of –47 to –53 dBc with optimum mixer level[i]
BTS 5 MHz	±0.17 dB	At –48 dBc non-coherent ACPR[k]
Dynamic Range Noise Correction Offset Freq		RRC weighted, 3.84 MHz noise bandwidth
off 5 MHz		–74.5 dB (typical)[lm]
off 10 MHz		–82 dB (typical)[lm]
on 5 MHz		–81 dB (typical)[ln]
on 10 MHz		–88 dB (typical)[lm]
RRC Weighting Accuracy[o]		
White noise in Adjacent Channel TOI-induced spectrum r.m.s. CW error		0.00 dB nominal 0.004 dB nominal 0.023 dB nominal
Radio Std = IS-95 or J-STD-008		
Method		RBW method[p]
ACPR Relative Accuracy		
Offsets < 1300 kHz[q]	±0.10 dB	
Offsets > 1.85 MHz[rs]	±0.10 dB	

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 section

c. See Frequency section

d. Expressed in decibels

e. The passband of response for the adjacent channels is given by the convolution of two functions: a rectangle of width given by the programmed Ref BW parameter, and the power response of the RBW filter used. Therefore, the 3 dB bandwidth of the passband function will be equal to the Ref BW. 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 $x - 0.572 \times \text{RBW}$.

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 –26dBm, so the input attenuation must be set as close as possible to the average input power - (–26 dBm). For example, if the average input power is –6 dBm, set the attenuation to 20 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 Bbase Transmission Station (BTS) within 3 dB of the required –45 dBc ACPR. 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 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.

l. Agilent measures 100% of PSAs 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, Agilent only gives a typical result. More than 80% of prototype PSAs 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 Agilent 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. The optimum mixer drive level will be approximately –12 dBm.

n. The optimum mixer drive level will be approximately –15 dBm.

o. 3GPP requires the use of a root-raised-cosine filter in evaluating the ACLR of a device. The accuracy of the passband shape of the filter is not specified in standards, nor is any method of evaluating that accuracy. This footnote discusses the performance of the filter in this instrument. The effect of the RRC filter and the effect of the RBW used in the measurement interact. The analyzer compensates the shape of the RRC filter to accommodate the RBW filter. The effectiveness of this compensation is summarized in three ways:
– White noise in Adj Ch: The compensated RRC filter nominally has no errors if the adjacent channel has a spectrum that is flat across its width.
– TOI-induced spectrum: If the spectrum is due to third-order intermodulation, it has a distinctive shape. The computed errors of the compensated filter are –0.004 dB for the 470 kHz RBW used for UE testing, and 0.000 dB for the 30 kHz RBW filter used for BTS testing. The worst error for RBWs between these extremes is 0.05 dB for a 330 kHz RBW filter. r.m.s.
– 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 r.m.s. error of the compensated filter is 0.023 dB for the 470 kHz RBW used for UE

testing, and 0.000 dB for the 30 kHz RBW filter used for BTS testing. The worst error for RBWs between these extremes is 0.057 dB for a 430 kHz RBW filter.

p. The RBW method measures the power in the adjacent channels within the defined resolution bandwidth. The noise bandwidth of the RBW filter is nominally 1.055 times the 3.01 dB bandwidth. Therefore, the RBW method will nominally read 0.23 dB higher adjacent channel power than would a measurement using the integration bandwidth method, because the noise bandwidth of the integration bandwidth measurement is equal to that integration bandwidth. For cmdaOne ACPR measurements using the RBW method, the main channel is measured in a 3 MHz RBW, which does not respond to all the power in the carrier. Therefore, the carrier power is compensated by the expected under-response of the filter to a full width signal, of 0.15 dB. But the adjacent channel power is not compensated for the noise bandwidth effect.

   The reason the adjacent channel is not compensated is subtle. The RBW method of measuring ACPR is very similar to the preferred method of making measurements for compliance with FCC requirements, the source of the specifications for the cdmaOne Spur Close specifications. ACPR is a spot measurement of Spur Close, and thus is best done with the RBW method, even though the results will disagree by 0.23 dB from the measurement made with a rectangular passband.

q. The specified ACPR accuracy applies if the measured ACPR substantially exceeds the analyzer dynamic range at the specified offset. When this condition is not met, there are additional errors due to the addition of analyzer spectral components to UUT spectral components. In the worst case at these offsets, the analyzer spectral components are all coherent with the UUT components; in a more typical case, one third of the analyzer spectral power will be coherent with the distortion components in the UUT. Coherent means that the phases of the UUT distortion components and the analyzer distortion components are in a fixed relationship, and could be perfectly in-phase. This coherence is not intuitive to many users, because the signals themselves are usually pseudo-random; nonetheless, they can be coherent.

   When the analyzer components are 100% coherent with the UUT components, the errors add in a voltage sense. That error is a function of the signal (UUT ACPR) to noise (analyzer ACPR dynamic range limitation) ratio, SN, in decibels.

   The function is error = $20 \times \log(1 + 10^{(-SN/20)})$

   For example, if the UUT ACPR is –62 dB and the measurement floor is –82 dB, the SN is 20 dB and the error due to adding the analyzer's distortion to that of the UUT is 0.83 dB.

r. As in the previous footnote, the specified ACPR accuracy applies if the ACPR measured substantially exceeds the analyzer dynamic range at the specified offset. When this condition is not met, there are additional errors due to the addition of analyzer spectral components to UUT spectral components. Unlike the situation in footnote p, though, the spectral components from the analyzer will be noncoherent with the components from the UUT. Therefore, the errors add in a power sense. The error is a function of the signal (UUT ACPR) to noise (analyzer ACPR dynamic range limitation) ratio, SN, in decibels.

   The function is error = $10 \times \log(1 + 10^{(-SN/10)})$.

   For example, if the UUT ACPR is –75 dB and the measurement floor is –85 dB, the SN ratio is 10 dB and the error due to adding the analyzer's noise to that of the UUT is 0.41 dB.

Measurement	Specifications	Supplemental Information
Multi-Carrier Power		
Radio Std = 3GPP W-CDMA		
ACPR Dynamic Range (two carriers) 5 MHz offset 10 MHz offset		RRC weighted, 3.84 MHz noise bandwidth –70 dB (nominal) –75 dB (nominal)
ACPR Accuracy (two carriers) 5 MHz offset, –48 dBc ACPR		±0.38 dB (nominal)
Power Statistics CCDF		
Histogram Resolution[a]	0.1 dB	
Intermod (TOI)		Measure the third-order intercept from a signal with two dominant tones.
Harmonic Distortion		
Maximum harmonic number	10th	
Results	Fundamental power (dBm) Relative harmonics power (dBc)	
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	

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.

Measurement	Specifications	Supplemental Information
Spurious Emissions		Table-driven spurious signals; search across regions
Radio Std = cdma2000 or 3GPP W-CDMA		
Dynamic Range, relative 1980 MHz region[a]	–80.6 dB	–82.4 dB (typical)
Sensitivity, absolute 1980 MHz region[b]	–89.7 dBm	–91.7 dBm (typical)
Spectrum Emission Mask		Table-driven spurious signals; measurement near carriers
Radio Std = cdma2000		
Dynamic Range, relative 750 kHz offset[cd]	–85.3 dB	–88.3 dB (typical)
Sensitivity, absolute 750 kHz offset[e]	–105.7 dBm	–107 dBm (typical)
Accuracy, relative 750 kHz offset[f]	±0.09 dB	
Radio Std = 3GPP W-CDMA		
Dynamic Range, relative 2.515 MHz Offset[cg]	–87.3 dB	–89.5 dB (typical)
Sensitivity, absolute 2.515 MHz Offset[e]	–105.7 dBm	–107.7 dBm (typical)
Accuracy, relative 2.515 MHz Offset[f]	±0.10 dBm	

a. The dynamic range specification is the ratio of the channel power to the power in the region specified. The dynamic range depends on the many measurement settings. These specifications are based on the detector being set to average, the default RBW (1200 kHz), and depend on the mixer level. Mixer level is defined to be the input power minus the input attenuation. This dynamic range specification applies for a mixer level of –8 dBm. Higher mixer levels can give up to 5 dB better dynamic range, but at the expense of compression in the input mixer, which reduces accuracy. The compression behavior of the input mixer is specified in the amplitude section of these specifications.

b. The sensitivity for this region is specified in the default 1200 kHz bandwidth, at a center frequency of 1 GHz.

c. 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.

d. This dynamic range specification applies for the optimum mixer level, which is about –18 dBm. Mixer level is defined to be the input power minus the input attenuation.

e. 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.

f. 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.

g. This dynamic range specification applies for the optimum mixer level, which is about –16 dBm. Mixer level is defined to be the average input power minus the input attenuation.

Options

The following options affect instrument specifications.[a]

Option BJ7:	Digital demod hardware
Option 1DS:	Preamplifier
Option 202:	GSM with EDGE Personality
Option B78:	cdma2000 Personality
Option BAC:	cdmaOne Personality
Option BAE:	NADC, PDC Personalities
Option BAF:	W-CDMA Personality

a. For instrument personality specifications, refer to the User's Guide for that personality.

General

Description	Specifications	Supplemental Information
Temperature Range		
Operating	0 to 55°C	Floppy disk 10 to 40°C Maximum temperature: 40°C Maximum humidity: 80% relative (non-condensing)
Storage	–40 to 75°C	Temperature: -40 to +71°C Maximum humidity: 90% relative (non-condensing)
Altitude	2,000 meters	Approximately 6,562 feet

Description	Specifications	Supplemental Information
Display		
Resolution	640 x 480	
Scale		
Log Scale	0.1, 0.2, 0.3...1.0, 2.0, 3.0...20 dB per division	
Linear Scale	10% of reference level per division	
Acoustic Emissions (ISO 7779)		LNPE < 5.0 Bels at 25°C
Military Specification	Has been type tested to the environmental specifications of MIL-PRF-28800F class 3.	
EMI Compatibility	Conducted emission is in compliance with CISPR Pub. 11/1990 Group 1 Class A. Radiated emission is in compliance with CISPR Pub. 11/1990 Group 1 Class B.	

Description	Specifications	Supplemental Information
Immunity Testing		
Radiated Immunity		Testing was done at 3 V/m according to IEC 61000-4-3/1995. When the analyzer tuned frequency is identical to the immunity test signal frequency, there may be signals of up to –60 dBm displayed on the screen.
Electrostatic Discharge		Air discharges of up to 8 kV were applied according to IEC 61000-4-2/1995. Discharges to center pins of any of the connectors may cause damage to the associated circuitry.

Description	Specifications	Supplemental Information
Power Requirements		
Voltage, Frequency	100 to 132 Vrms, 47 to 66 Hz/360 to 440 Hz	
	195 to 250 Vrms, 47 to 66 Hz	
Power Consumption, On	Base: <260W; Fully Loaded: <450W	
Power Consumption, Standby	<20W	
Measurement Speed		
Local Measurement and Display Update rate[a]		
Sweep points = 601		≥ 50/s (nominal)
Remote Measurement and GPIB Transfer Rate		
Sweep points = 601		≥ 22/s (nominal)

a. Factory preset, fixed center frequency, RBW = 1 MHz, and span >10 MHz and ≤ 600 MHz, and stop frequency ≤ 3 GHz.

Description	Specifications	Supplemental Information
Data Storage		
Internal		2 MB
Floppy Drive (10 to 40°C)		3.5" 1.44 MB, MS-DOS® compatible
Weight		
(without options)		
Net E4440A, E4443A, E4445A		23 kg (nominal) 50 lbs (nominal)
Net E4446A, E4448A		24 kg (nominal) 53 lbs (nominal)
Shipping		33 kg (nominal) 73 lb (nominal)
Cabinet Dimensions		Cabinet dimensions exclude front and rear protrusions.
Height	177 mm (7.0 in)	
Width	426 mm (16.8 in)	
Length	483 mm (19 in)	

Inputs and Outputs

Front Panel

Description	Specifications	Supplemental Information	
RF INPUT		Nominal	
Connector	Type-N female		
Impedance		50Ω	
First LO Emission Level[a]		Band 0	Bands ≥ 1
		< –120 dBm	< –100 dBm

Description	Specifications	Supplemental Information
PROBE POWER		
Voltage/Current		+15 Vdc, ±7% at 150 mA max (nominal) –12.6 Vdc, ±10% at 150 mA max (nominal) GND
EXT TRIGGER INPUT		
Connector	BNC female	
Impedance		10 kΩ (nominal)
Trigger Level		5V TTL

a. With 10 dB attenuation

Rear Panel

Description	Specifications	Supplemental Information
10 MHz OUT (Switched)		Switchable On/Off
Connector	BNC female	
Impedance		50Ω (nominal)
Output Amplitude		≥ 0 dBm (nominal)
Frequency Accuracy	10 MHz ± (10 MHz x frequency reference accuracy)	
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.
Impedance		50Ω (nominal)
Input Amplitude Range		–5 to +10 dBm (nominal)
Frequency		1 to 30 MHz (nominal) (settable to 1 Hz resolution)
Frequency lock range	$\pm 5 \times 10^{-6}$ of specified external reference input frequency	
Trigger In		
Connector	BNC female	
External Trigger Input		Configurable Front or Rear
Impedance		>10 kΩ (nominal)
Trigger Level		5V TTL (nominal)
Keyboard		
Connector	6-pin mini-DIN (PS2)	
Trigger 1 and Trigger 2 Outputs		
Connector	BNC female	
Trigger 1 Output		HSWP (High = sweeping)
Impedance		50Ω (nominal)
Level		5V TTL
Trigger 2 Output		Reserved for future applications

Description	Specifications	Supplemental Information
Monitor Output		
Connector	VGA compatible, 15-pin mini D-SUB	
Format		VGA (31.5 kHz horizontal, 60Hz vertical sync rates, non-interlaced) Analog RGB
Resolution	640 x 480	
PRE-SEL TUNE OUT		
Connector	BNC female	
Load Impedance (dc Coupled)		110Ω (nominal)
Range		0 to 10V (nominal)
Sensitivity External Mixer		1.5 V/GHz of tuned L.O. frequency (nominal)
Remote Programming[a]		
GPIB Interface		
Connector	IEEE-488 bus connector	
GPIB Codes		SH1, AH1, T6, SR1, RL1, PP0, DC1, C1, C2, C3 and C28, DT1, L4, C0
Serial Interface		
Connector	9-pin D-SUB male	Factory use only
Parallel Interface		
Connector	25-pin D-SUB female	Printer port only
LAN TCP/IP Interface	RJ45 Ethertwist	
321.4 MHz IF Output		
Connector	SMA female	
Impedance		50Ω (nominal)
Frequency		321.4 MHz (nominal)
Conversion Gain[b]		+2 to +4 dB (nominal)
SCSI Interface		
Connector	Mini D 50, female	Factory use only

a. Control languages - SCPI version 1992.0

b. Conversion gain is measured from RF input to 321.4 MHz IF output, with 0 dB input attenuation. The 321.4 MHz IF output is located in the RF chain at a point where all of the frequency response corrections are *not* applied. Conversion gain varies nominally ± 3dB as a function of tune frequency.

Regulatory Information

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

This product has been designed and tested in accordance with IEC Publication 61010, Safety Requirements for Electronic Measuring Apparatus, 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.

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).
CSA	The CSA mark is the Canadian Standards Association safety mark.
ISM 1-A	This is a symbol of an Industrial Scientific and Medical Group 1 Class A product. (CISPR 11, Clause 4)

Declaration of Conformity

DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014

Manufacturer's Name: Agilent Technologies, Inc.

Manufacturer's Address: 1400 Fountaingrove Parkway
Santa Rosa, CA 95403-1799
USA

Declares that the product

Product Name: PSA Performance Spectrum Analyzer

Model Number: E4440A, E4443A, E4445A, E4446A, E4448A

Product Options: This declaration covers all options of the above product.

Conforms to the following product specifications:

EMC: IEC 61326-1:1997+A1:1998 / EN 61326-1:1997+A1:1998

Standard	Limit
CISPR 11:1990 / EN 55011-1991	Group 1, Class A
IEC 61000-4-2:1995+A1998 / EN 61000-4-2:1995	4 kV CD, 8 kV AD
IEC 61000-4-3:1995 / EN 61000-4-3:1995	3 V/m, 80 - 1000 MHz
IEC 61000-4-4:1995 / EN 61000-4-4:1995	0.5 kV sig., 1 kV power
IEC 61000-4-5:1995 / EN 61000-4-5:1996	0.5 kV L-L, 1 kV L-G
IEC 61000-4-6:1996 / EN 61000-4-6:1998	3 V, 0.15 – 80 MHz
IEC 61000-4-11:1994 / EN 61000-4-11:1998	1 cycle, 100%

Safety: IEC 61010-1:1990 + A1:1992 + A2:1995 / EN 61010-1:1993 +A2:1995
CAN/CSA-C22.2 No. 1010.1-92

Supplementary Information:
The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the CE-marking accordingly.

Santa Rosa, CA, USA 6 May, 2002

Greg Pfeiffer/Quality Engineering Manager

For further information, please contact your local Agilent Technologies sales office, agent or distributor.

Rev. C

3 E4445A Specifications

Definitions and Requirements

This chapter contains specifications and supplemental information for PSA E444xA spectrum analyzers. 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, unless otherwise noted).
- 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.

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

Conditions Required to Meet Specifications

- The analyzer is within its calibration cycle.
- Under auto couple control, except that **Auto Sweep Time = Accy**.
- For center frequencies < 20 MHz, DC coupling applied.
- At least 2 hours of storage or operation at the operating temperature.
- Analyzer has been turned on at least 30 minutes with **Auto Align On** selected, or
- If **Auto Align Off** is selected, **Align All Now** must be run:
  - Within the last 24 hours, and
  - Any time the ambient temperature changes more than 3°C, and
  - After the analyzer has been at operating temperature at least 2 hours.

Certification

Agilent Technologies certifies that this product met its published specifications at the time of shipment from the factory. Agilent 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

Description	Specifications	Supplemental Information
Frequency Range		
DC Coupled	3 Hz to 13.2 GHz	
AC Coupled	20 MHz to 13.2 GHz	
Internal Mixing Bands		*Harmonic Mixing Mode (N[a])*
0	3 Hz to 3.0 GHz (DC Coupled)	1–
0	10 MHz to 3.0 GHz (AC Coupled)	1–
1	2.85 GHz to 6.6 GHz	1–
2	6.2 GHz to 13.2 GHz	2–
Preamp On *(Option 1DS)*	100 kHz to 3.0 GHz[b]	1–

a. N is the harmonic mixing mode. All mixing modes are negative (as indicated by the "–"), where the desired first LO harmonic is higher than the tuned frequency by the first IF (3.9214 GHz for the 3 Hz to 3.0 GHz band, 321.4 MHz for all other bands).

b. The low frequency range of the preamp extends to 100 kHz when the RF coupling is set to DC, and to 10 MHz when RF coupling is set to AC.

Description	Specifications	Supplemental Information
Frequency Reference		
Accuracy	± [(time since last adjustment x aging rate) + temperature stability + calibration accuracy[a]]	
Temperature Stability		
20 to 30°C	$\pm 1 \times 10^{-8}$	
0 to 55°C	$\pm 5 \times 10^{-8}$	
Aging Rate	$\pm 1 \times 10^{-7}$/year[b]	$\pm 5 \times 10^{-10}$/day (nominal)
Settability	$\pm 2 \times 10^{-9}$	
Warm-up and Retrace[c]		.
Within 5 min. after turn on		$\pm 1 \times 10^{-7}$ of final frequency (nominal)
Within 15 min. after turn on		$\pm 5 \times 10^{-8}$ of final frequency (nominal)
Achievable Initial Calibration Accuracy[d]	$\pm 7 \times 10^{-8}$	

a. Calibration accuracy depends on how accurately the frequency standard was adjusted to 10 MHz. If the calibration procedure is followed, the calibration accuracy is given by the specification “Achievable Initial Calibration Accuracy” .

b. For periods of one year or more.

c. Applies only when power is disconnected from instrument. Does not apply when instrument is in standby mode.

d. The achievable calibration accuracy at the beginning of the calibration cycle includes these effects:
1) The temperature difference between the calibration environment and the use environment.
2) The 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 unplugging the instrument.
4) Settability.

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])	see note[c]

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 1 MHz, 3% of RBW from 1.1 MHz 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% x RBW term contributes only 55 kHz to the total frequency readout accuracy, compared to 300 kHz for the 0.25% x 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 trace points. The points are spaced by span/(Npts - 1), where Npts is the number of sweep points. For example, with the factory preset value of 601 sweep points, the horizontal resolution is span/600. However, there is an exception: When both the detector mode is "normal" and the span > 0.25 x (Npts - 1) x RBW, peaks can occur only in even-numbered points, so the effective horizontal resolution becomes doubled, or span/300 for the factory preset case. When the RBW is autocoupled and there are 601 sweep points, that exception occurs only for spans > 450 MHz.

c. Swept (not FFT) spans < 2 MHz show a non-linearity in the frequency location at the right or left edge of the span of up to 1.4% of span per megahertz of span (unless using the “fast tuning” option for phase noise optimization). This non-linearity is corrected in the marker readout. Traces output to a remote computer will show the nonlinear relationship between frequency and trace point number. This non-linearity does not occur if the phase noise optimization is set to Fast Tuning.

Description	Specifications	Supplemental Information
Frequency Counter[a]		
Count Accuracy	± (marker freq. × freq. ref. accy. + 0.100 Hz)	See note[b]
Delta Count Accuracy	± (delta freq. × freq. ref. accy. + 0.141 Hz)	
Resoluti on	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 >1GHz.

Description	Specifications	Supplemental Information
Frequency Span		
Range		
Swept and FFT	0 Hz, 10 Hz to 13.2 GHz	
Resolution	2 Hz	
Span Accuracy		
Swept	± (0.2% x span + horizontal resolution[a])	see note [b]
FFT	± (0.2% x span + horizontal resolution[a])	

a. Horizontal resolution is due to the marker reading out one of the trace points. The points are spaced by span/(Npts - 1), where Npts is the number of sweep points. For example, with the factory preset value of 601 sweep points, the horizontal resolution is span/600. However, there is an exception: When both the detector mode is "normal" and the span > 0.25 x (Npts - 1) x RBW, peaks can occur only in even-numbered points, so the effective horizontal resolution becomes doubled, or span/300 for the factory preset case. When the RBW is autocoupled and there are 601 sweep points, that exception occurs only for spans > 450 MHz.

b. Swept spans < 2 MHz show a nonlinearity in the frequency location at the right or left edge of the span of up to 1.4% of span per megahertz of span (unless using the “fast tuning” option for phase noise optimization). This nonlinearity is corrected in the marker readout. Traces output to a remote computer will show the nonlinear relationship between frequency and trace point number.

Description	Specifications	Supplemental Information
Sweep Time		
Range		
Span = 0 Hz	1 µs to 6000s	
Span ≥ 10 Hz	1 ms to 2000s	
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 Front, External Rear, RF Burst	
Delayed Trigger[a]	.	
Range		
Span ≥ 10 Hz, swept	1 µs to 500 ms	
Span = 0 Hz or FFT	–150 ms to +500ms	
Resolution	0.1 µs	

Gated Measurements

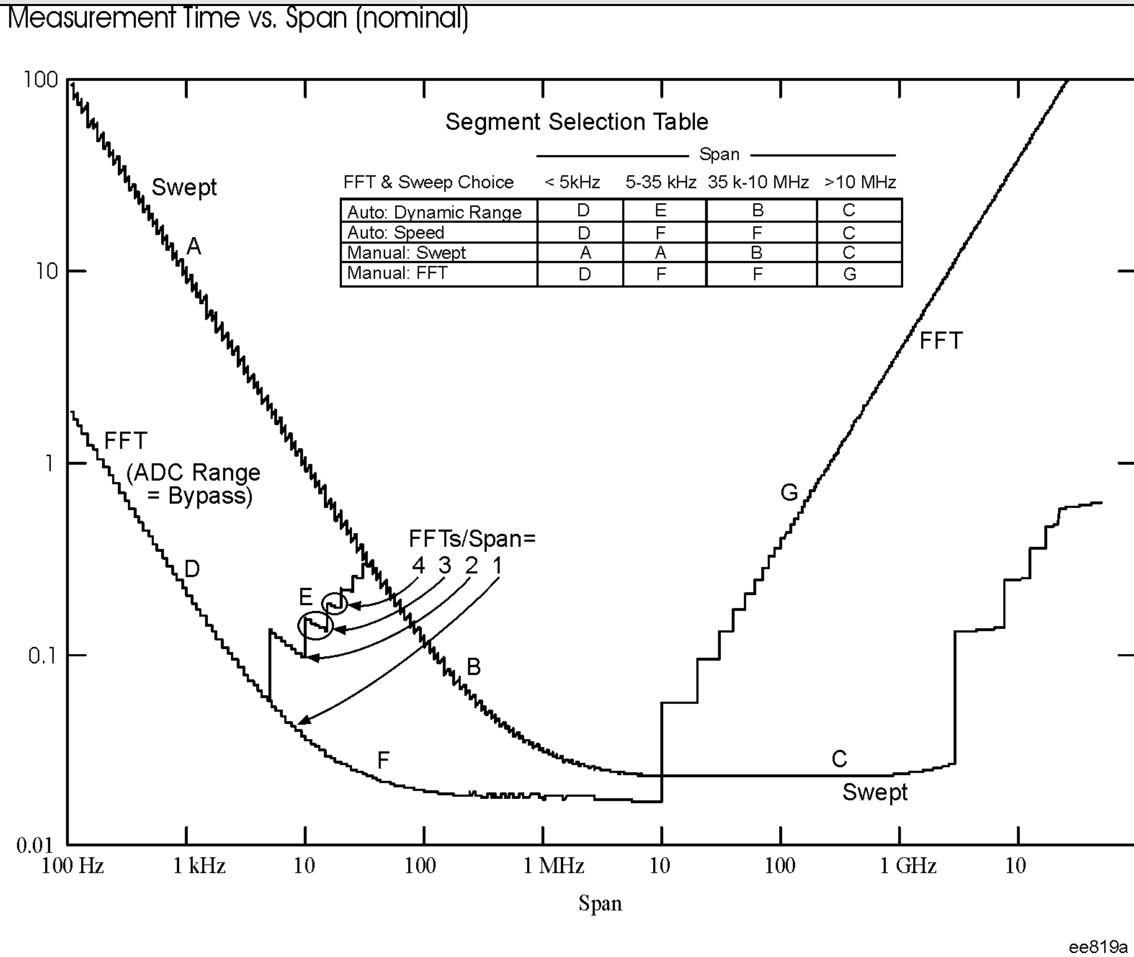
Description	Specifications	Supplemental information
Gated FFT[b]		
Maximum Span	10 MHz	
Delay Range	-150 to +500 ms	
Delay Resolution	100 ns or 4 digits, whichever is more	
Gate Duration		1.83/RBW ± 2%

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

b. Gated measurements (measuring a signal only during a specific time interval) are possible with triggered FFT measurements. The FFT allows analysis during a time interval set by the RBW (within nominally 2% of 1.83/RBW) for spans up to 10 MHz. This time interval is shorter than that of swept gating circuits, allowing higher resolution of the spectrum.

Measurement Time vs. Span

Measurement Time vs. Span (nominal)



Description	Specifications	Supplemental Information
Number of Frequency Display Trace Points (buckets)		
Factory preset	601	
Range:		
Span ≥ 10 Hz	101 to 8192	
Span = 0 Hz	2 to 8192	

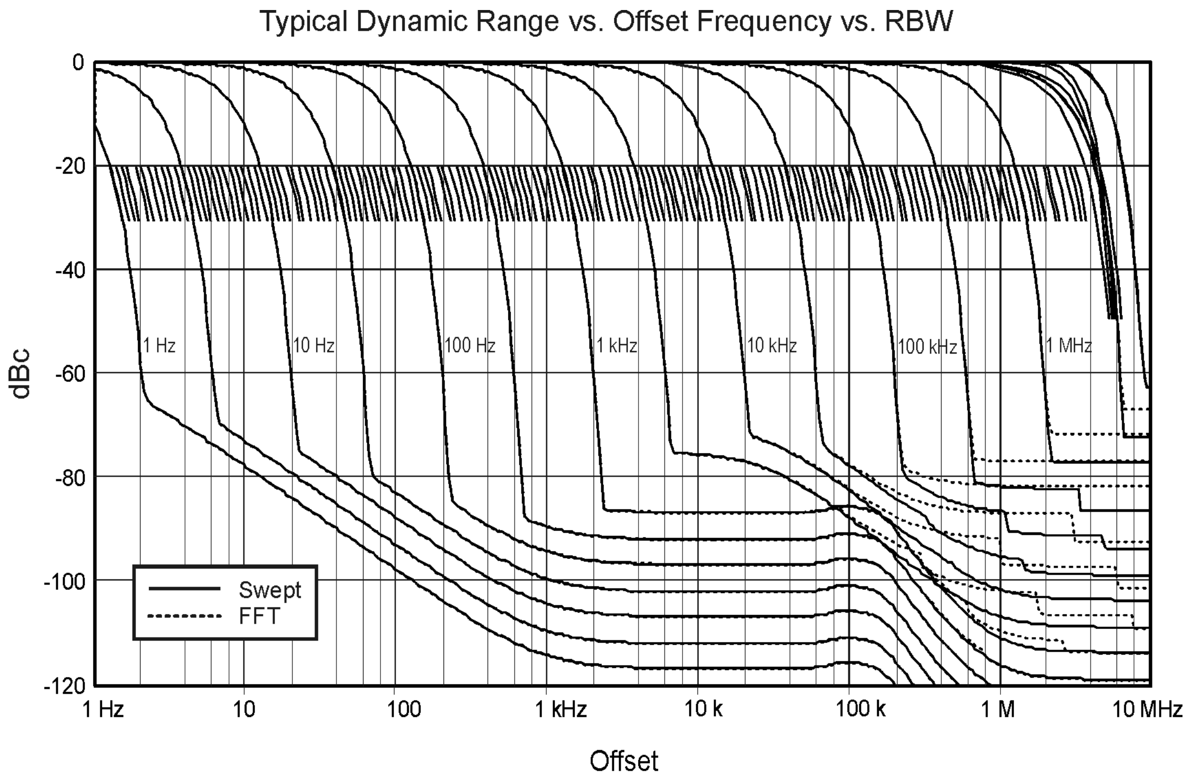
Description	Specifications	Supplemental Information
Resolution Bandwidth (RBW)		
Range (–3.01 dB bandwidth)	1 Hz to 8 MHz. Bandwidths > 3 MHz = 4, 5, 6, and 8 MHz. Bandwidths 1 Hz to 3 MHz are spaced at 10% spacing, 24 per decade: 1.0, 1.1, 1.2, 1.3, 1.5, 1.6, 1.8, 2.0, 2.2, 2.4, 2.7, 3.0, 3.3, 3.6, 3.9, 4.3, 4.7, 5.1, 5.6, 6.2, 6.8, 7.5, 8.2, 9.1, and repeat, times ten to an integer.	
Accuracy (–3.01 dB bandwidth)[a]		
1 Hz to 1.5 MHz RBW		± 2% (nominal)
1.6 MHz to 3 MHz RBW		
(CF ≤ 3 GHz)		± 7% (nominal)
(CF > 3 GHz)		± 8% (nominal)
4 MHz to 8 MHz RBW		
(CF ≤ 3 GHz)		± 15% (nominal)
(CF > 3 GHz)		± 20% (nominal)
Power bandwidth accuracy[b]		
RBW Range CF Range		
1 Hz – 51 kHz all	± 0.5%	Equivalent to ± 0.022 dB
82 kHz – 330 kHz all	± 0.5%	Equivalent to ± 0.022 dB
56 kHz – 75 kHz all	± 1.0%	Equivalent to ± 0.044 dB
360 kHz – 1.2 MHz < 3 GHz	± 1.0%	Equivalent to ± 0.044 dB
1.3 MHz – 2.0 MHz < 3 GHz		± 0.07 dB, nominal
2.2 MHz – 6 MHz < 3 GHz		± 0.2 dB, nominal
Selectivity (–60 dB/–3 dB)		4.1:1 (nominal)

a. Resolution Bandwidth Accuracy can be observed at slower sweep times than autocoupled 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 **Auto Swp Time** key is set to **Accy** instead of **Norm**. The true bandwidth, which determines the response to impulsive signals and noise-like signals, is not affected by the sweep rate.

b. 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.)

Description	Specification	Supplemental information
Information Bandwidth		
Maximum FFT width	10 MHz	
(Option B7J) I/Q Waveform digital bandwidths	10 MHz	
321.4 MHz rear panel output bandwidth		Nominal
At – 1 dB BW		
Low band (0 to 3 GHz)		30 MHz
High band (2.85 to 26.5 GHz)		20 to 30 MHz[a]
mm band (26.4 to 50 GHz)		30 MHz
At – 3 dB BW		
Low band (0 to 3 GHz)		40 MHz
Highband (2.85 to 26.5 GHz)		30 to 60 MHz
mm bnad (26.5 to 50 GHz)		40 MHz
(Option H70) bandwidth		Same as 321.4 MHz bandwidth

a. The bandwidth in the microwave preselected bands increases monotonically between the lowest and highest tuned frequencies in most, but not all, analyzers.



CF = 1 GHz
Mixer Level = -10 dBm
Only 2/decade of the
24/decade RBW are shown fully
RBWs ≤ 1 kHz shown with
phase noise optimized for fm < 50 kHz
RBWs ≥ 3 kHz shown with
phase noise optimized for fm > 50 kHz

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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=0.1xRBW, four FFTs are averaged to generate one result.

Description	Specifications		Supplemental Information	
Stability Noise Sidebands Center Frequency = 1 GHz[a] Best-case Optimization[b]	**20 to 30°C**	**0 to 55°C**	**20 to 30°C**	**20 to 30°C**
Offset			(Typical)	(Nominal)
100 Hz	–91 dBc/Hz	–90 dBc/Hz	–97 dBc/Hz	
1 kHz	–103 dBc/Hz	–100 dBc/Hz	–107 dBc/Hz	
10 kHz	–114 dBc/Hz	–113 dBc/Hz	–117 dBc/Hz	
30 kHz	–114 dBc/Hz	–113 dBc/Hz	–117 dBc/Hz	
100 kHz	–120 dBc/Hz	–119 dBc/Hz	–123 dBc/Hz	
1 MHz	–144 dBc/Hz	–142 dBc/Hz	–146 dBc/Hz[c]	–148 dBc/Hz[c]
6 MHz	–151 dBc/Hz	–150 dBc/Hz	–152 dBc/Hz[c]	–156 dBc/Hz[c]
10 MHz	–151 dBc/Hz	–150 dBc/Hz	–152 dBc/Hz[c]	–157.5 dBc/Hz[c]
Residual FM	<(1 Hz x N[d]) p-p in 1 s			

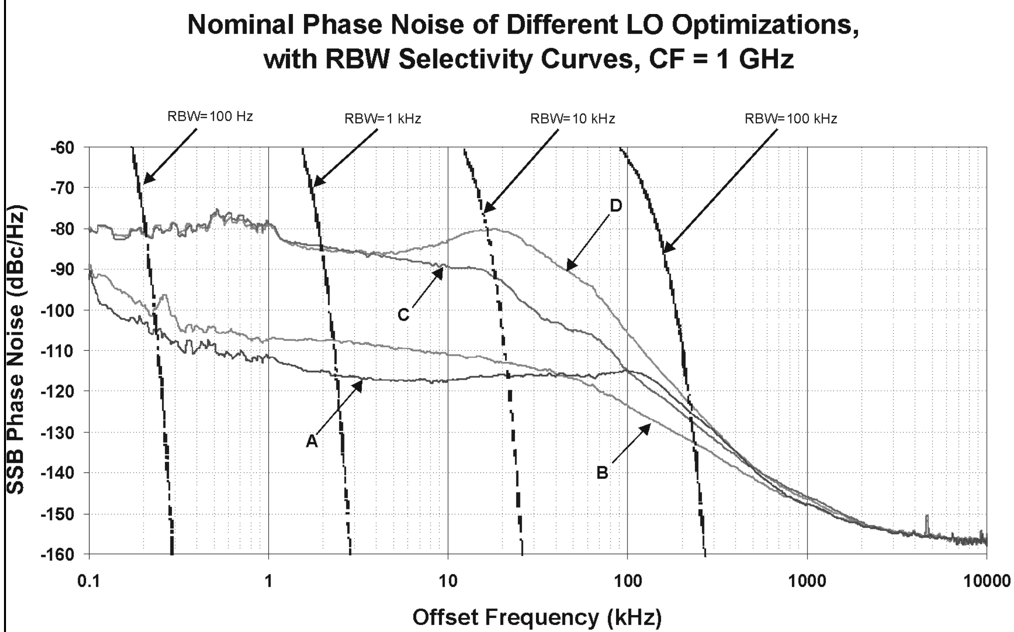
a. Nominal changes of phase noise sidebands with other center frequencies are shown by some examples in the graphs that follow. To predict the phase noise for other center frequencies, note that phase noise at offsets above approximately 1 kHz increases nominally as 20 X log N, where N is the harmonic mixer mode. For offsets below 1 kHz, and center frequencies above 1 GHz, the phase noise increases nominally as 20 X log CF, where CF is the center frequency in GHz.

b. Noise sidebands for offsets of 30 kHz and below are shown for phase noise optimization set to optimize $\mathscr{L}(f)$ for f<50 kHz; for offsets of 100 kHz and above, the optimization is set for f > 50 kHz.

c. "Typical" results include the effect of the signal generator used in verifying performance; nominal results show performance observed during development with specialized signal sources.

d. N is the harmonic mixing mode.

Nominal Phase Noise of Different LO Optimizations



Sweep Type	Span	Optimize L(f) for f < 50 kHz	Optimize L(f) for f > 50 kHz	Optimize LO for fast tuning
FFT	All	A (Dual Loop Wideband)	B (Dual Loop Narrowband)	D (Single Loop Wideband)
Swept	< 2 MHz			
	2 to 50 MHz	C (Single Loop Narrowband)		
	> 50 MHz			

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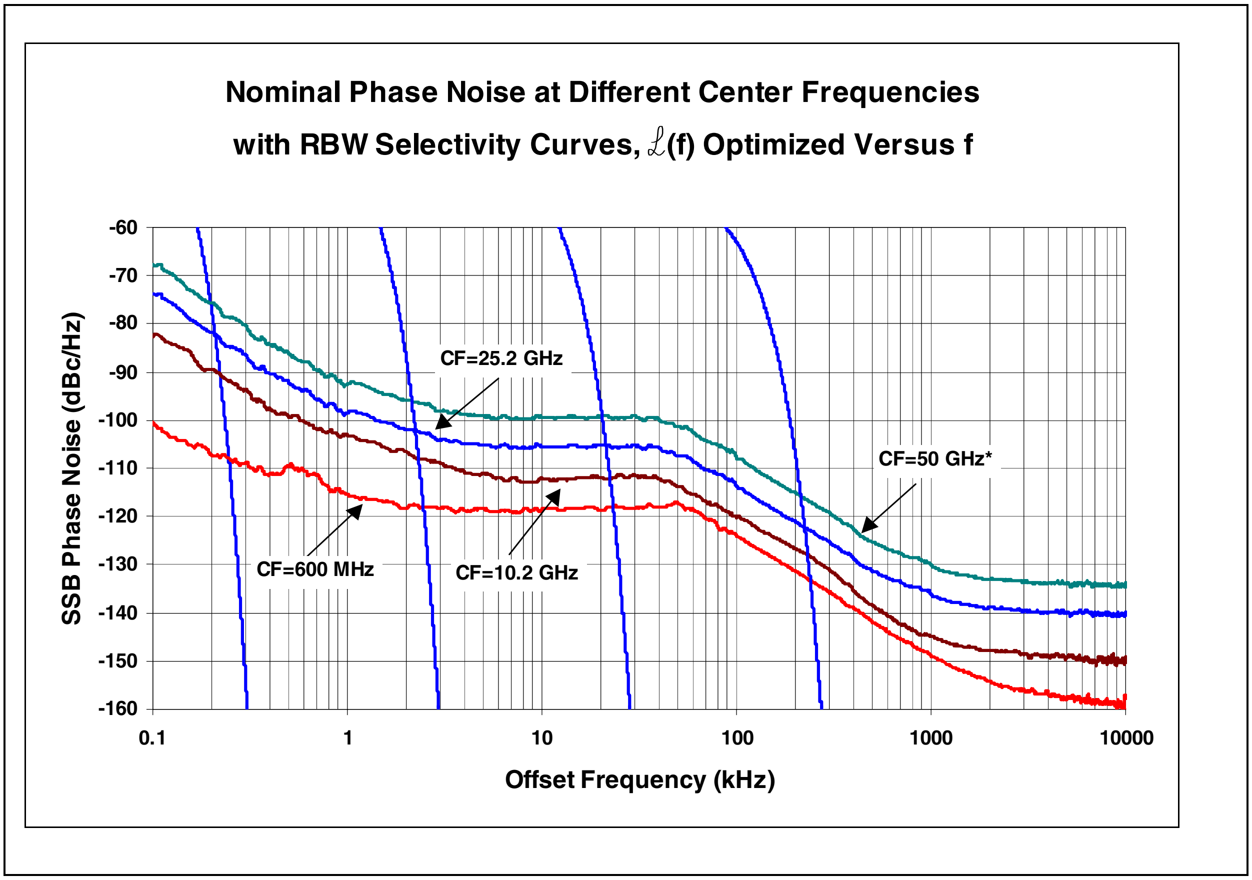
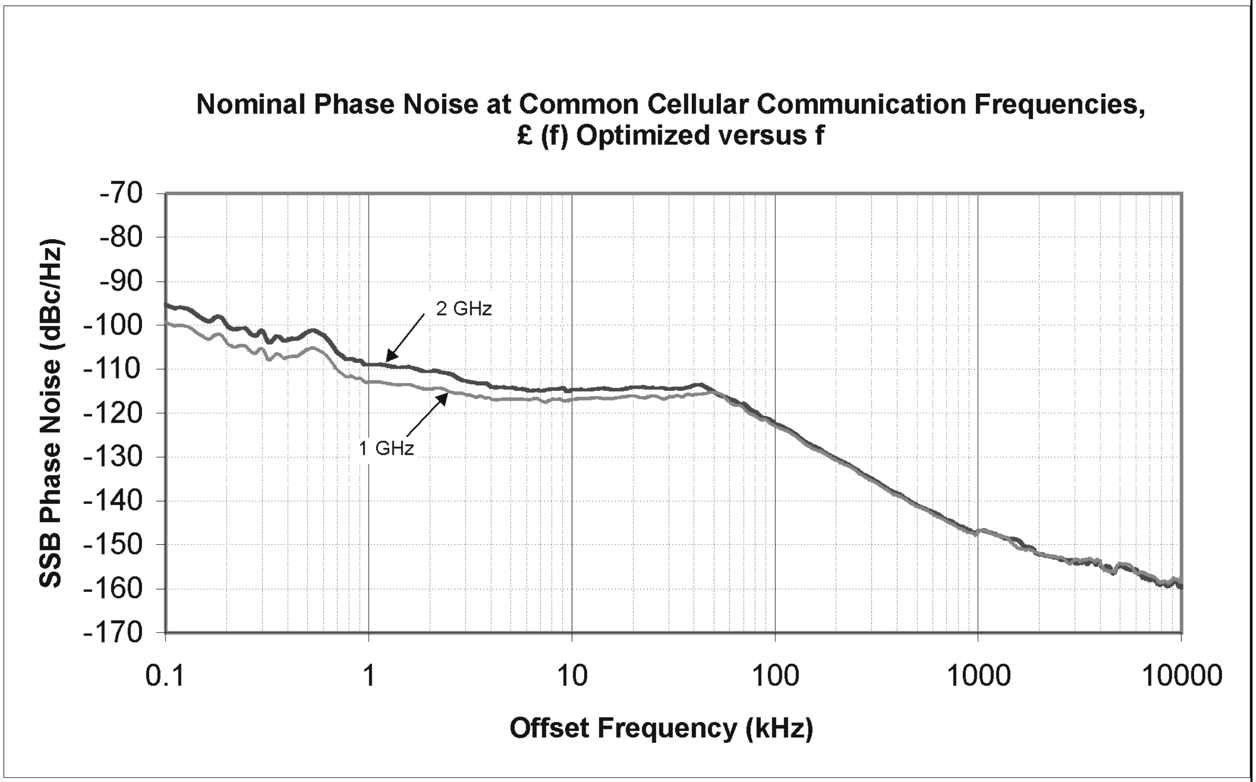
Nominal Phase Noise at Different Center Frequencies



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

PSA Phase Noise



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Amplitude

Description	Specifications	Supplemental Information
Measurement Range	Displayed Average Noise Level to +30 dBm	
Preamp *(Option 1DS)*	Displayed Average Noise Level to +25 dBm	
Input Attenuator Range	0 to 70 dB, in 2 dB steps	

Description	Specifications	Supplemental Information
Maximum Safe Input Level		Applies with or without preamp *(Option 1DS)*
Average Total Power	+30 dBm (1W)	
Peak Pulse Power <10 μs pulse width; <1% duty cycle; and input attenuation ≥ 30 dB	+50 dBm (100W)	
DC volts		
DC Coupled	± 0.2 Vdc	
AC Coupled (E4443A, E4445A, E4440A)	± 100 Vdc	

Description	Specifications	Supplemental Information	
1 dB Gain Compression Point **(Two-tone)**[abc]	Maximum power at mixer[d]	Nominal[e]	
20 MHz to 200 MHz	0 dBm	+3 dBm	
200 MHz to 3.0 GHz	+3 dBm	+7 dBm	
3.0 GHz to 6.6 GHz	+3 dBm	+4 dBm	
6.6 GHz to 13.2 GHz	–2 dBm	0 dBm	
Typical Gain Compression (Two-tone)		Mixer Level	Typical[e] Compression
20 MHz to 200 MHz		0 dBm	< 0.5 dB
200 MHz to 6.6 GHz		+3 dBm	< 0.5 dB
6.6 GHz to 13.2 GHz		–2 dBm	< 0.4 dB
Preamp On *(Option 1DS)* Total power at the preamp[f]			
10 MHz to 200 MHz		–30 dBm (nominal)	
200 MHz to 3 GHz		–25 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. Tone spacing > 15 times RBW, with a minimum of 30 kHz of separation

c. See Reference Level footnote (b) on page 41.

d. Mixer power level (dBm) = input power (dBm) – input attenuation (dB).

e. The compression of a small on-screen signal by a large interfering signal can be represented as a curve of compression versus the level of the interfering signal. The specified performance is a level/compression pair. The specification could be verified by finding the level for which the compression is 1 dB, or by finding the compression for the specified level. The latter technique is used. Therefore, the amount of compression is known in production, and the typical compression is known statistically, thus allowing a "typical" listing. The level required to reach 1 dB compression is not monitored in production, thus "nominal" performance is shown for this view of the performance.

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

Description	Specifications			Supplemental Information
Displayed Average Noise Level (DANL)[a]				
Input terminated Sample or Average detector Averaging type = Log Normalized to 0 dB input attenuation				**Nominal**
3 Hz to 1 kHz				–110 dBm
1 kHz to 10 kHz				–130 dBm
	Zerospan & swept Normalized[a] **to 1 Hz 20 to 30°C**	**Zerospan & swept Normalized**[a] **to 1 Hz 0 to 55°C**	**FFT Only Actual**[b] **1 Hz 20 to 30°C**	**Zerospan & swept Normalized**[a] **to 1 Hz (typical)**
10 kHz to 100 kHz	–135 dBm	–135 dBm	–135 dBm	–142 dBm
100 kHz to 1 MHz	–145 dBm	–145 dBm	–145 dBm	–149 dBm
1 MHz to 10 MHz	–150 dBm	–150 dBm	–150 dBm	–153 dBm
10 MHz to 1.2 GHz	–155 dBm	–154 dBm	–154 dBm	–156 dBm
1.2 GHz to 2.5 GHz	–154 dBm	–153 dBm	–153 dBm	–155 dBm
2.5 GHz to 3 GHz	–153 dBm	–152 dBm	–152 dBm	–154 dBm
3 GHz to 6.6 GHz	–152 dBm	–151 dBm	–151 dBm	–153 dBm
6.6 GHz to 13.2 GHz	–150 dBm	–149 dBm	–149 dBm	–152 dBm
Preamp On *(Option 1DS)*			Nominal FFT	
100 kHz to 10 MHz	–166 dBm	–163 dBm	–168 dBm	–168 dBm
10 MHz to 1.1 GHz	–169 dBm	–168 dBm	–170 dBm	–170 dBm
1.1 GHz to 2.5 GHz	–168 dBm	–167 dBm	–169 dBm	–169 dBm
2.5 GHz to 3.0 GHz	–166 dBm	–166 dBm	–167 dBm	–167 dBm

a. DANL for zero span and swept is normalized in two ways and for two reasons. DANL is measured in a 1 kHz RBW and normalized to the narrowest available RBW, because the narrowest RBWs (1.0 to 1.8 are not usable for signals below –110 dBm but DANL can be a useful figure of merit for the other RBWs. (RBWs this small are usually best used in FFT mode, because sweep rates are very slow in these bandwidths. RBW autocoupling never selects these RBWs in swept mode because of potential errors at low signal levels.) The second normalization is that DANL is measured with 10 dB input attenuation and normalized to the 0 dB input attenuation case, because that makes DANL and third order intermodulation test conditions congruent, allowing accurate dynamic range estimation for the analyzer. Because of these normalizations, this measure of DANL is useful for estimating instrument performance such as TOI to noise range and compression to noise range, but not ultimate sensitivity.

b. DANL for FFT measurements are useful for estimating the ultimate sensitivity of the analyzer for low-level signals. This specification is verified with 0 dB input attenuation and 1 Hz RBW. A limitation of this DANL specification is that some instruments have a center-screen-only spurious signal of nominally –150 dBm, which can be avoided by tuning the analyzer a few hertz away from the frequency of interest.

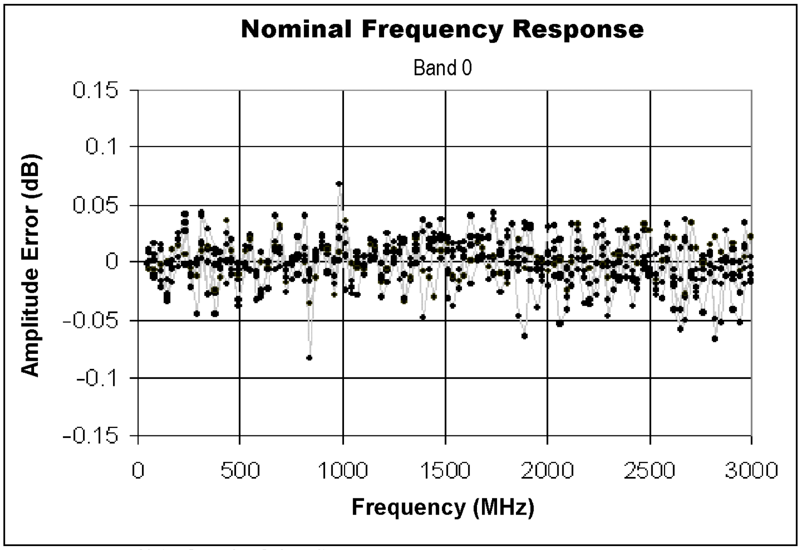
Description	Specifications	Supplemental Information
Display Range		
Log Scale	Ten divisions displayed; 0.1 to 1.0 dB/division in 0.1 dB steps, and 1 to 20 dB/division in 1 dB steps	
Linear Scale	Ten divisions	
Marker Readout[a]		
Log units resolution		
Average off, on-screen	0.01 dB	
Average on or remote	0.001 dB	
Linear units resolution		≤ 1% of signal level

a. See Reference Level footnote (b) on page 41.

Description	Specifications		Supplemental Information	
Frequency Response				
(10 dB input attenuation)				
Maximum error relative to reference condition (50 MHz)[a]	**20 to 30°C**	**0 to 55°C**	**Typical 20 to 30°C** (at worst observed frequency)	
3 Hz to 3.0 GHz	± 0.38 dB	± 0.58 dB	± 0.10 dB	
3.0 GHz to 6.6 GHz[b]	± 1.50 dB	± 2.00 dB	± 0.5 dB	
6.6 GHz to 13.2GHz[b]	± 2.00 dB	± 2.50 dB	± 1.0 dB	
Additional frequency response error, FFT mode[cd]	± [0.15 dB + (0.1 dB/MHz x FFT width[e])] to a max. of ± 0.40 dB			
100 kHz to 3.0 GHz Preamp On (*Option 1DS*)	± 0.70 dB	± 0.80 dB	< ± 0.2 dB	
Frequency Response at Attenuation ≠ 10 dB			At 0, 2, 4, 6, 20, 30 dB input attenuation steps. Nominal	
10 MHz to 3 GHz			20 to 30°C	0 to 55°C
			± 0.8 dB	± 1.0 dB

a. Specifications for frequencies > 3 GHz apply for sweep rates <100 MHz/ms.
b. Preselector centering applied.
c. FFT frequency response errors are specified relative to swept measurements.
d. This error need not be included in Absolute Amplitude Accuracy error budgets when the difference between the analyzer center frequency and the signal frequency is within ± 1.5% of the span.
e. An FFT width is given by the span divided by the FFTs/Span parameter.

Nominal Frequency Response



Note: Sample of six units.

Description	Specifications	Supplemental Information
Input Attenuation Switching Uncertainty[a][b]		
Attenuator Setting ≥ 2 dB		
Frequency Range		
50 MHz	± 0.2 dB	
3 Hz to 3.0 GHz		± 0.3 dB (nominal)
3.0 to 13.2 GHz		± 0.5 dB (nominal)
Attenuator Setting = 0 dB		
50 MHz	± 0.3 dB	

Description	Specifications	Supplemental Information
Preamp (*Option* 1DS)[c]		
Gain		+28 dB (nominal)
Noise figure		
10 MHz to 1.5 GHz		6 dB (nominal)
1.5 GHz to 3.0 GHz		7 dB (nominal)

a. Referenced to 10 dB attenuation
b. Specifications also apply to Option 1DS.
c. The preamp is between the input attenuator and the input mixer.

Description	Specifications	Supplemental Information
Absolute Amplitude Accuracy		
At 50 MHz		
20 to 30°C[a]	± 0.24 dB	± 0.06 dB (typical)
0 to 55°C[b]	± 0.28 dB	
Amplitude Reference Accuracy		± 0.05 dB (nominal)
At all frequencies		
20 to 30°C[b]	± (0.24 dB + frequency response)	± (0.06 dB + frequency response) (typical)
0 to 55°C[b]	± (0.28dB + frequency response)	
Freq < 3 GHz 95% Confidence[b]		± 0.24 dB
Preamp On[c] (*Option* 1DS)	± (0.36 dB + frequency response)	± (0.09 dB + frequency response) (typical)

a. Absolute amplitude accuracy is the total of all amplitude measurement errors, and applies over the following subset of settings and conditions: 10 Hz ≤ RBW ≤1 MHz; Input signal –10 to –50 dBm; Input attenuation 10 dB; span <5 MHz (nominal additional error for span ≥ 5 MHz is 0.02 dB); all settings autocoupled except Auto Swp Time = Accy; combinations of low signal level and wide RBW use VBW ≤30 kHz to reduce noise. This absolute amplitude accuracy specification includes the sum of the following individual specifications under the conditions listed above: Scale Fidelity, Reference Level Accuracy, Display Scale Switching Uncertainty, Resolution Bandwidth Switching Uncertainty, 50 MHz Amplitude Reference Accuracy, and the accuracy with which the instrument aligns its internal gains to the 50 MHz Amplitude Reference.

b. Absolute Amplitude Accuracy for frequencies below 3 GHz with 95% confidence applies at all the conditions of footnote b, with an input frequency below 3 GHz, for temperatures of 20 to 30°C. The value given is the result of testing the most recent 113 analyzers as of this writing. It is computed by root-sum-squaring (r.s.s.) the 95th percentiles of these terms: the absolute amplitude accuracy observed at 50 MHz under 44 quasi-random combinations of settings, the frequency response relative to 50 MHz at 102 quasi-random test frequencies, and the measurement uncertainties of all these observations. To that root-sum-squaring result is added the environmental effects of 20 to 30°C variation. The 95th percentiles are determined with a 95% confidence level.

c. Same settings as footnote b, 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). For frequencies from 100 kHz to 3 GHz.

Description	Specifications	Supplemental Information
RF Input VSWR		Nominal
(at tuned frequency)		
10 dB attenuation, 50 MHz		1.07:1
≥ 8 dB *input attenuation*		
50 MHz to 3 GHz		< 1.2:1
3 GHz to 18 GHz		< 1.6:1
18 GHz to 26.5 GHz		< 1.9:1
2 to 6 dB *input attenuation*		
50 MHz to 3 GHz		< 1.6:1
3 GHz to 26.5 GHz		< 1.9:1
0 dB *input attenuation*		
50 MHz to 3 GHz		< 1.9:1
3 GHz to 26.5 GHz		< 1.9:1
Preamp On (*Option 1DS*)		
50 MHz to 3 GHz		
≥ 10 dB input attenuation		< 1.2:1
< 10 dB input attenuation		< 1.5:1
Internal 50 MHz calibrator is on		Open input
Alignments running		Open input

Description	Specifications	Supplemental Information
Resolution Bandwidth Switching Uncertainty[a]		
(relative to reference BW of 30 kHz)		
1.0 Hz to 1.0 MHz RBW	± 0.03 dB	
1.1 MHz to 3 MHz RBW	± 0.05 dB	
Manually selected wide RBWs: 4, 5, 6, 8 MHz	± 1.0 dB	

a. RBW switching is specified and tested in the reference condition: –25 dBm signal input and 10 dB input attenuation. At higher input levels, changing RBW may cause a larger change in result than that specified, because the display scale fidelity can be slightly different for different RBWs. These RBW differences in scale fidelity are nominally within ±0.01 dB in all RBWs even for signals as large as –10 dBm at the input mixer.

Description	Specifications	Supplemental Information
Reference Level[a]		
Range		
Log Units	–170 to +30 dBm, in 0.01 dB steps	
Linear Units	707 pV to 7.07V in 0.1% steps	
Accuracy	0 dB[b]	

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

a. Reference level and off-screen performance: The reference level (RL) behavior differs from previous analyzers in a way that makes PSA more flexible. In previous analyzers, the RL controlled how the measurement was performed as well as how it was displayed. Because the logarithmic amplifier in previous analyzers had both range and resolution limitations, this behavior was necessary for optimum measurement accuracy. The logarithmic amplifier in PSA, however, is implemented digitally such that the range and resolution greatly exceed other instrument limitations. Because of this, a PSA 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 attenuator setting: When the input attenuator 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.

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

c. 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[abcd]				
Log-Linear Fidelity (relative to the reference condition of –25 dBm input through the 10 dB attenuator, or –35 dBm at the input mixer.)				
Input mixer level[e]	Linearity			
≤ –20 dBm	± 0.07 dB			
≤ –10 dBm	± 0.13 dB			
Relative Fidelity[f] Equation for error ± A ± (B1 + B2) × ΔP) to a maximum of (C1 + C2))				
Level of larger signal		**A**	**B1**	**C1**
–20 dBm < ML < –12 dBm		0.011 dB	0.007	0.08 dB
–29 dBm < ML < –20 dBm		0.011 dB	0.0015	0.04 dB
Noise < ML < –29 dBm		0.001 dB	0.001	0.04 dB
RBW		**B2**	**C2**	
≥ 10 kHz		0.000	0.000 dB	
≤ 2 kHz		0.0035	0.038 dB	
others (RBW in Hz)		7/RBW	76 dB/RBW	

a. Supplemental information: The amplitude detection linearity specification applies at all levels below –10dBm 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 3sigma level can be reduced proportional to the square root of the number of averages taken.

b. Display scale fidelity and resolution bandwidth switching uncertainty interact slightly. See the footnote for RBW switching. RBW switching applies at only one level on the scale fidelity curve, but scale fidelity applies for all RBWs.

c. Scale fidelity is warranted with ADC dither turned on. Turning on ADC dither nominally increases DANL. The nominal increase is highest with the preamp off in the lowest-DANL frequency range, under 1.2 GHz, where the nominal increase is 2.5dB. Other ranges and the preamp-on case will show lower increases in DANL. Turning off ADC dither nominally degrades low-level (signal levels below –60 dBm at the input mixer level) scale fidelity by 0.2 dB.

d. See Reference Level footnote (b) on page 41.

e. Mixer level = Input Level - Input Attenuator

f. 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 –5dBm, using attenuator=10dB and RBW = 3 kHz.
Because the larger signal is –5 dBm with 10 dB attenuation, the mixer level, ML, defined to be input power minus input attenuation, is –15 dBm. The line for this mixer level shows A=0.011 dB, B1=0.007 and C1=0.08 dB. Because the RBW is neither 10 kHz and over, nor2 kHz and under, parameters B2 and C2 are determined by formulas. B2 is 7/3000, or 0.00233. C2 is 76dB/3000, or 0.025 dB. With these values for the parameters, the equation becomes: $\pm 0.011\ dB\ \pm(0.0093 \times \Delta P\ \text{to a maximum of}\ 0.105\ dB)$ ΔP is (–5 – (–60)) or 55 dB. Therefore, the maximum error in the power ratio is 0.116 dB.

Description	Specifications			Supplemental Information	
General Spurious Responses	**Mixer Level**[a]	**Distortion**			
f < 10 MHz from carrier	−40 dBm	*< (−73 + 20 log N) dBc*[b]			
f ≥ 10 MHz from carrier	−40 dBm	< (−80 + 20 log N) dBc		< (−90 + 20 log N) dBc (typical)	
Second Harmonic Distortion Source Frequency	**Mixer Level**[a]	**Distortion**	**SHI**[c]	**Distortion** (nominal)	**SHI** (nominal)
10 MHz to 400 MHz	−40 dBm	< −82 dBc	+42dBm		
400 MHz to 1.25 GHz	−40 dBm	< −92 dBc	+52dBm		
1.25 GHz to 1.5 GHz	−40 dBm	< −82 dBc	+42dBm		
1.5 GHz to 2.0 GHz	−10 dBm	< −90 dBc	+80dBm		
2.0 GHz to 6.6 GHz	−10 dBm	< −100 dBc	+90dBm		
Preamp On (Option 1DS) Input preamp level = −45 dBm					
10 MHz to 1.5 GHz				< −60 dBc	+ 15dBm

a. Mixer level = Input Level – Input Attenuator

b. N = LO mixing harmonic

c. 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. The measurement is made with a –11 dBm tone at the input mixer.

Description	Specifications		Supplemental Information
Third Order Intermodulation Distortion	**Distortion**[a]	**TOI**[b]	**TOI**[b] (typical)
With two –30 dBm tones at input mixer Tone separation >15 kHz			
20 to 30 °C			
10 MHz to 100 MHz	< –88 dBc	+14 dBm	+17 dBm
100 MHz to 400 MHz	< –90 dBc	+15 dBm	+18 dBm
400 MHz to 1.7 GHz	< –92 dBc	+16 dBm	+19 dBm
1.7 GHz to 2.7 GHz	< –94 dBc	+17 dBm	+19 dBm
2.7 GHz to 3 GHz	< –94 dBc	+17 dBm	+20 dBm
3 GHz to 6 GHz	< –90 dBc	+15 dBm	+18 dBm
6 GHz to 13.2 GHz	< –76 dBc	+8 dBm	+11 dBm
0 to 55 °C			
10 MHz to 100 MHz	< –86 dBc	+13 dBm	+17 dBm
100 MHz to 400 MHz	< –86 dBc	+13 dBm	+17 dBm
400 MHz to 2.7 GHz	< –90 dBc	+15 dBm	+18 dBm
2.7 GHz to 3 GHz	< –90 dBc	+15 dBm	+18 dBm
3 GHz to 6 GHz	< –90 dBc	+15 dBm	+18 dBm
6 GHz to 13.2 GHz	< –74 dBc	+7 dBm	+10 dBm
Preamp On *(Option 1DS)* Input preamp level = –45 dBm			**TOI** (nominal)
10 MHz to 500 MHz			–15 dBm
500 MHz to 3 GHz			–13 dBm
Other Input Related Spurious	**Mixer Level**[c]	**Distortion**	
Image Responses 10 MHz to 13.2 GHz	–10 dBm	< –80 dBc[d]	
Multiples and Out-of-band Responses 10 MHz to 13.2 GHz	–10 dBm	< –80 dBc	
Residual Responses[e]			
200 kHz to 6.6 GHz		< –100 dBm	
6.6 GHz to 13.2 GHz			< –100 dBm (nominal)

a. Computed from measured TOI.

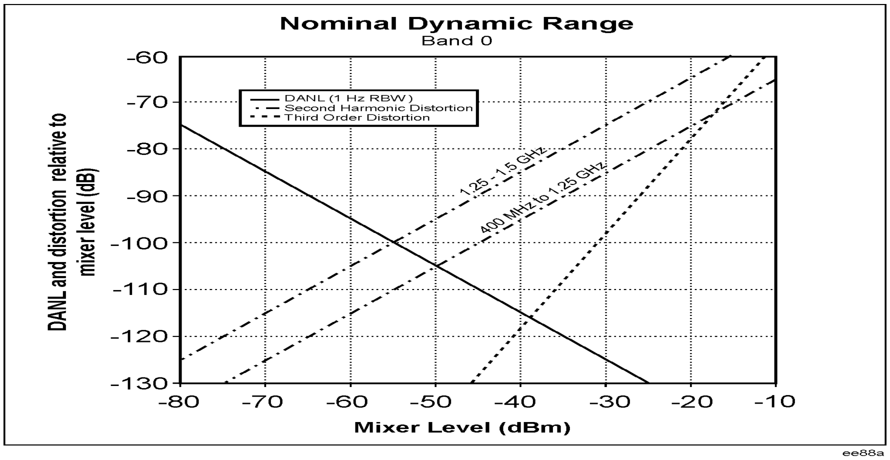
b. TOI = third order intercept. The TOI is given by the mixer tone level (in dBm) minus (distortion/2) where distortion is the relative level of the distortion tones in dBc. The measurement is made with two –18 dBm tones at the input mixer.

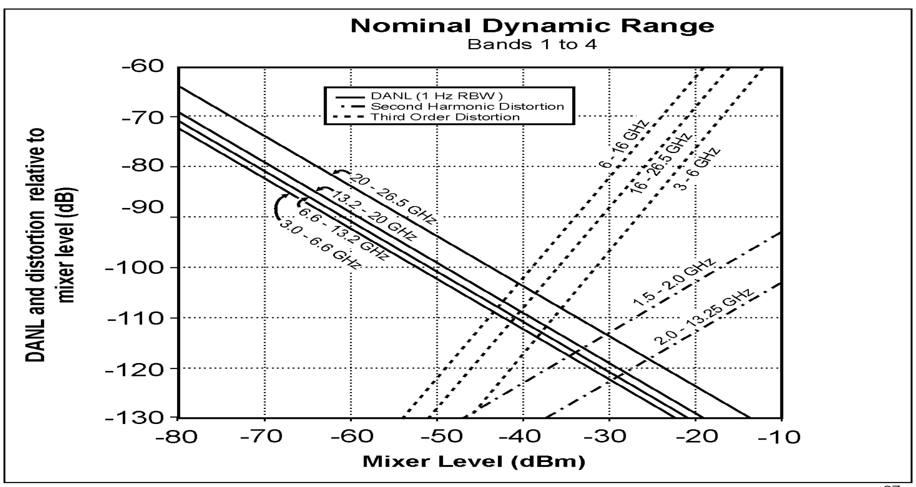
c. Mixer level = Input Level – Input Attenuator

d. For frequencies >19 GHz, an image 42.8 MHz below the input signal frequency may be seen, typically –78 dBc or lower.

e. Input terminated, 0 dB input attenuation

Nominal Dynamic Range





Measurement	Specifications	Supplemental Information
Channel Power		
Amplitude Accuracy		Absolute Amplitude Accuracy[a] + Power Bandwidth Accuracy[bc]
Radio Std = 3GPPW-CDMA, or IS-95		
Absolute Power Accuracy 20 to 30°C Mixer level[d] < –20 dBm	±0.68 dB	±0.21 dB (typical)
Occupied Bandwidth		
Frequency Accuracy		± (Span/600) (nominal)

a. See Amplitude section.
b. See Frequency section
c. Expressed in dB
d. Mixer level is the input power minus the input attenuation.

Description	Specifications	Supplemental Information
Adjacent Channel Power (ACP)		
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	
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.
Radio Offset Freq		
MS (UE) 5 MHz	±0.12 dB	At ACPR range of –30 to –36 dBc with optimum mixer level[h]
MS (UE) 10 MHz	±0.17 dB	At ACPR range of –40 to –46 dBc with optimum mixer level[i]
BTS 5 MHz	±0.22 dB	At ACPR range of –42 to –48 dBc with optimum mixer level[j]
BTS 10 MHz	±0.22 dB	At ACPR range of –47 to –53 dBc with optimum mixer level[i]
BTS 5 MHz	±0.17 dB	At –48 dBc non-coherent ACPR[k]
Dynamic Range		RRC weighted, 3.84 MHz noise bandwidth
Noise Correction Offset Freq		
off 5 MHz		–74.5 dB (typical)[lm]
off 10 MHz		–82 dB (typical)[lm]
on 5 MHz		–81 dB (typical)[ln]
on 10 MHz		–88 dB (typical)[lm]
RRC Weighting Accuracy[o]		
White noise in Adjacent Channel		0.00 dB nominal
TOI-induced spectrum		0.004 dB nominal
r.m.s. CW error		0.023 dB nominal
Radio Std = IS-95 or J-STD-008		
Method		RBW method[p]
ACPR Relative Accuracy		
Offsets < 1300 kHz[q]	±0.10 dB	
Offsets > 1.85 MHz[rs]	±0.10 dB	

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 section

c. See Frequency section

d. Expressed in decibels

e. The passband of response for the adjacent channels is given by the convolution of two functions: a rectangle of width given by the programmed Ref BW parameter, and the power response of the RBW filter used. Therefore, the 3 dB bandwidth of the passband function will be equal to the Ref BW. 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 $x - 0.572 \times \mathrm{RBW}$.

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 –26dBm, so the input attenuation must be set as close as possible to the average input power - (–26 dBm). For example, if the average input power is –6 dBm, set the attenuation to 20 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 Bbase Transmission Station (BTS) within 3 dB of the required –45 dBc ACPR. 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 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.

l. Agilent measures 100% of PSAs 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, Agilent only gives a typical result. More than 80% of prototype PSAs 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 Agilent 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. The optimum mixer drive level will be approximately –12 dBm.

n. The optimum mixer drive level will be approximately –15 dBm.

o. 3GPP requires the use of a root-raised-cosine filter in evaluating the ACLR of a device. The accuracy of the passband shape of the filter is not specified in standards, nor is any method of evaluating that accuracy. This footnote discusses the performance of the filter in this instrument. The effect of the RRC filter and the effect of the RBW used in the measurement interact. The analyzer compensates the shape of the RRC filter to accommodate the RBW filter. The effectiveness of this compensation is summarized in three ways:
– White noise in Adj Ch: The compensated RRC filter nominally has no errors if the adjacent channel has a spectrum that is flat across its width.
– TOI-induced spectrum: If the spectrum is due to third-order intermodulation, it has a distinctive shape. The computed errors of the compensated filter are –0.004 dB for the 470 kHz RBW used for UE testing, and 0.000 dB for the 30 kHz RBW filter used for BTS testing. The worst error for RBWs between these extremes is 0.05 dB for a 330 kHz RBW filter. r.m.s.
– 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 r.m.s. error of the compensated filter is 0.023 dB for the 470 kHz RBW used for UE

testing, and 0.000 dB for the 30 kHz RBW filter used for BTS testing. The worst error for RBWs between these extremes is 0.057 dB for a 430 kHz RBW filter.

p. The RBW method measures the power in the adjacent channels within the defined resolution bandwidth. The noise bandwidth of the RBW filter is nominally 1.055 times the 3.01 dB bandwidth. Therefore, the RBW method will nominally read 0.23 dB higher adjacent channel power than would a measurement using the integration bandwidth method, because the noise bandwidth of the integration bandwidth measurement is equal to that integration bandwidth. For cmdaOne ACPR measurements using the RBW method, the main channel is measured in a 3 MHz RBW, which does not respond to all the power in the carrier. Therefore, the carrier power is compensated by the expected under-response of the filter to a full width signal, of 0.15 dB. But the adjacent channel power is not compensated for the noise bandwidth effect.
The reason the adjacent channel is not compensated is subtle. The RBW method of measuring ACPR is very similar to the preferred method of making measurements for compliance with FCC requirements, the source of the specifications for the cdmaOne Spur Close specifications. ACPR is a spot measurement of Spur Close, and thus is best done with the RBW method, even though the results will disagree by 0.23 dB from the measurement made with a rectangular passband.

q. The specified ACPR accuracy applies if the measured ACPR substantially exceeds the analyzer dynamic range at the specified offset. When this condition is not met, there are additional errors due to the addition of analyzer spectral components to UUT spectral components. In the worst case at these offsets, the analyzer spectral components are all coherent with the UUT components; in a more typical case, one third of the analyzer spectral power will be coherent with the distortion components in the UUT. Coherent means that the phases of the UUT distortion components and the analyzer distortion components are in a fixed relationship, and could be perfectly in-phase. This coherence is not intuitive to many users, because the signals themselves are usually pseudo-random; nonetheless, they can be coherent.
When the analyzer components are 100% coherent with the UUT components, the errors add in a voltage sense. That error is a function of the signal (UUT ACPR) to noise (analyzer ACPR dynamic range limitation) ratio, SN, in decibels.
The function is error = 20 × log(1 + 10^(–SN/20))
For example, if the UUT ACPR is –62 dB and the measurement floor is –82 dB, the SN is 20 dB and the error due to adding the analyzer's distortion to that of the UUT is 0.83 dB.

r. As in the previous footnote, the specified ACPR accuracy applies if the ACPR measured substantially exceeds the analyzer dynamic range at the specified offset. When this condition is not met, there are additional errors due to the addition of analyzer spectral components to UUT spectral components. Unlike the situation in footnote p, though, the spectral components from the analyzer will be noncoherent with the components from the UUT. Therefore, the errors add in a power sense. The error is a function of the signal (UUT ACPR) to noise (analyzer ACPR dynamic range limitation) ratio, SN, in decibels.
The function is error = 10 × log(1 + 10^(–SN/10)).
For example, if the UUT ACPR is –75 dB and the measurement floor is –85 dB, the SN ratio is 10 dB and the error due to adding the analyzer's noise to that of the UUT is 0.41 dB.

Measurement	Specifications	Supplemental Information
Multi-Carrier Power		
Radio Std = 3GPP W-CDMA		
ACPR Dynamic Range (two carriers)		RRC weighted, 3.84 MHz noise bandwidth
5 MHz offset		–70 dB (nominal)
10 MHz offset		–75 dB (nominal)
ACPR Accuracy (two carriers)		
5 MHz offset, –48 dBc ACPR		±0.38 dB (nominal)
Power Statistics CCDF		
Histogram Resolution[a]	0.1 dB	
Intermod (TOI)		Measure the third-order intercept from a signal with two dominant tones.
Harmonic Distortion		
Maximum harmonic number	10^{th}	
Results	Fundamental power (dBm) Relative harmonics power (dBc)	
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	

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.

Measurement	Specifications	Supplemental Information
Spurious Emissions		Table-driven spurious signals; search across regions
Radio Std = cdma2000 or 3GPP W-CDMA		
Dynamic Range, relative 1980 MHz region[a]	–80.6 dB	–82.4 dB (typical)
Sensitivity, absolute 1980 MHz region[b]	–89.7 dBm	–91.7 dBm (typical)
Spectrum Emission Mask		Table-driven spurious signals; measurement near carriers
Radio Std = cdma2000		
Dynamic Range, relative 750 kHz offset[cd]	–85.3 dB	–88.3 dB (typical)
Sensitivity, absolute 750 kHz offset[e]	–105.7 dBm	–107 dBm (typical)
Accuracy, relative 750 kHz offset[f]	±0.09 dB	
Radio Std = 3GPP W-CDMA		
Dynamic Range, relative 2.515 MHz Offset[cg]	–87.3 dB	–89.5 dB (typical)
Sensitivity, absolute 2.515 MHz Offset[e]	–105.7 dBm	–107.7 dBm (typical)
Accuracy, relative 2.515 MHz Offset[f]	±0.10 dBm	

a. The dynamic range specification is the ratio of the channel power to the power in the region specified. The dynamic range depends on the many measurement settings. These specifications are based on the detector being set to average, the default RBW (1200 kHz), and depend on the mixer level. Mixer level is defined to be the input power minus the input attenuation. This dynamic range specification applies for a mixer level of –8 dBm. Higher mixer levels can give up to 5 dB better dynamic range, but at the expense of compression in the input mixer, which reduces accuracy. The compression behavior of the input mixer is specified in the amplitude section of these specifications.

b. The sensitivity for this region is specified in the default 1200 kHz bandwidth, at a center frequency of 1 GHz.

c. 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.

d. This dynamic range specification applies for the optimum mixer level, which is about –18 dBm. Mixer level is defined to be the input power minus the input attenuation.

e. 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.

f. 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.

g. This dynamic range specification applies for the optimum mixer level, which is about –16 dBm. Mixer level is defined to be the average input power minus the input attenuation.

Options

The following options affect instrument specifications.[a]

Option BJ7:	Digital demod hardware
Option 1DS:	Preamplifier
Option 202:	GSM with EDGE Personality
Option B78:	cdma2000 Personality
Option BAC:	cdmaOne Personality
Option BAE:	NADC, PDC Personalities
Option BAF:	W-CDMA Personality

a. For instrument personality specifications, refer to the User's Guide for that personality.

General

Description	Specifications	Supplemental Information
Temperature Range		
Operating	0 to 55°C	Floppy disk 10 to 40°C Maximum temperature: 40°C Maximum humidity: 80% relative (non-condensing)
Storage	–40 to 75°C	Temperature: -40 to +71°C Maximum humidity: 90% relative (non-condensing)
Altitude	2,000 meters	Approximately 6,562 feet

Description	Specifications	Supplemental Information
Display		
Resolution	640 x 480	
Scale		
Log Scale	0.1, 0.2, 0.3...1.0, 2.0, 3.0...20 dB per division	
Linear Scale	10% of reference level per division	
Acoustic Emissions (ISO 7779)		LNPE < 5.0 Bels at 25°C
Military Specification	Has been type tested to the environmental specifications of MIL-PRF-28800F class 3.	
EMI Compatibility	Conducted emission is in compliance with CISPR Pub. 11/1990 Group 1 Class A. Radiated emission is in compliance with CISPR Pub. 11/1990 Group 1 Class B.	

Description	Specifications	Supplemental Information
Immunity Testing		
Radiated Immunity		Testing was done at 3 V/m according to IEC 61000-4-3/1995. When the analyzer tuned frequency is identical to the immunity test signal frequency, there may be signals of up to –60 dBm displayed on the screen.
Electrostatic Discharge		Air discharges of up to 8 kV were applied according to IEC 61000-4-2/1995. Discharges to center pins of any of the connectors may cause damage to the associated circuitry.

Description	Specifications	Supplemental Information
Power Requirements		
Voltage, Frequency	100 to 132 Vrms, 47 to 66 Hz/360 to 440 Hz	
	195 to 250 Vrms, 47 to 66 Hz	
Power Consumption, On	Base: <260W; Fully Loaded: <450W	
Power Consumption, Standby	<20W	
Measurement Speed		
Local Measurement and Display Update rate[a]		
Sweep points = 601		≥ 50/s (nominal)
Remote Measurement and GPIB Transfer Rate		
Sweep points = 601		≥ 22/s (nominal)

a. Factory preset, fixed center frequency, RBW = 1 MHz, and span >10 MHz and ≤ 600 MHz, and stop frequency ≤ 3 GHz.

Description	Specifications	Supplemental Information
Data Storage		
Internal		2 MB
Floppy Drive (10 to 40°C)		3.5" 1.44 MB, MS-DOS® compatible
Weight		
(without options)		
Net E4440A, E4443A, E4445A		23 kg (nominal) 50 lbs (nominal)
Net E4446A, E4448A		24 kg (nominal) 53 lbs (nominal)
Shipping		33 kg (nominal) 73 lb (nominal)
Cabinet Dimensions		Cabinet dimensions exclude front and rear protrusions.
Height	177 mm (7.0 in)	
Width	426 mm (16.8 in)	
Length	483 mm (19 in)	

Inputs and Outputs

Front Panel

Description	Specifications	Supplemental Information	
RF INPUT		Nominal	
Connector	Type-N female		
Impedance		50Ω	
First LO Emission Level[a]		Band 0	Bands ≥ 1
		< –120 dBm	< –100 dBm

Description	Specifications	Supplemental Information
PROBE POWER		
Voltage/Current		+15 Vdc, ±7% at 150 mA max (nominal) –12.6 Vdc, ±10% at 150 mA max (nominal) GND
EXT TRIGGER INPUT		
Connector	BNC female	
Impedance		10 kΩ (nominal)
Trigger Level		5V TTL

a. With 10 dB attenuation

Rear Panel

Description	Specifications	Supplemental Information
10 MHz OUT (Switched)		Switchable On/Off
Connector	BNC female	
Impedance		50Ω (nominal)
Output Amplitude		≥ 0 dBm (nominal)
Frequency Accuracy	10 MHz ± (10 MHz x frequency reference accuracy)	
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.
Impedance		50Ω (nominal)
Input Amplitude Range		–5 to +10 dBm (nominal)
Frequency		1 to 30 MHz (nominal) (settable to 1 Hz resolution)
Frequency lock range	$\pm 5 \times 10^{-6}$ of specified external reference input frequency	
Trigger In		
Connector	BNC female	
External Trigger Input		Configurable Front or Rear
Impedance		>10 kΩ (nominal)
Trigger Level		5V TTL (nominal)
Keyboard		
Connector	6-pin mini-DIN (PS2)	
Trigger 1 and Trigger 2 Outputs		
Connector	BNC female	
Trigger 1 Output		HSWP (High = sweeping)
Impedance		50Ω (nominal)
Level		5V TTL
Trigger 2 Output		Reserved for future applications

Description	Specifications	Supplemental Information
Monitor Output		
Connector	VGA compatible, 15-pin mini D-SUB	
Format		VGA (31.5 kHz horizontal, 60Hz vertical sync rates, non-interlaced) Analog RGB
Resolution	640 x 480	
PRE-SEL TUNE OUT		
Connector	BNC female	
Load Impedance (dc Coupled)		110Ω (nominal)
Range		0 to 10V (nominal)
Sensitivity		
External Mixer		1.5 V/GHz of tuned L.O. frequency (nominal)
Remote Programming[a]		
GPIB Interface		
Connector	IEEE-488 bus connector	
GPIB Codes		SH1, AH1, T6, SR1, RL1, PP0, DC1, C1, C2, C3 and C28, DT1, L4, C0
Serial Interface		
Connector	9-pin D-SUB male	Factory use only
Parallel Interface		
Connector	25-pin D-SUB female	Printer port only
LAN TCP/IP Interface	RJ45 Ethertwist	
321.4 MHz IF Output		
Connector	SMA female	
Impedance		50Ω (nominal)
Frequency		321.4 MHz (nominal)
Conversion Gain[b]		+2 to +4 dB (nominal)
SCSI Interface		
Connector	Mini D 50, female	Factory use only

a. Control languages - SCPI version 1992.0

b. Conversion gain is measured from RF input to 321.4 MHz IF output, with 0 dB input attenuation. The 321.4 MHz IF output is located in the RF chain at a point where all of the frequency response corrections are *not* applied. Conversion gain varies nominally ± 3dB as a function of tune frequency.

Regulatory Information

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

This product has been designed and tested in accordance with IEC Publication 61010, Safety Requirements for Electronic Measuring Apparatus, 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.

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).
CSA	The CSA mark is the Canadian Standards Association safety mark.
ISM 1-A	This is a symbol of an Industrial Scientific and Medical Group 1 Class A product. (CISPR 11, Clause 4)

Declaration of Conformity

DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014

Manufacturer's Name: Agilent Technologies, Inc.

Manufacturer's Address: 1400 Fountaingrove Parkway
Santa Rosa, CA 95403-1799
USA

Declares that the product

Product Name: PSA Performance Spectrum Analyzer

Model Number: E4440A, E4443A, E4445A, E4446A, E4448A

Product Options: This declaration covers all options of the above product.

Conforms to the following product specifications:

EMC: IEC 61326-1:1997+A1:1998 / EN 61326-1:1997+A1:1998

Standard	Limit
CISPR 11:1990 / EN 55011-1991	Group 1, Class A
IEC 61000-4-2:1995+A1998 / EN 61000-4-2:1995	4 kV CD, 8 kV AD
IEC 61000-4-3:1995 / EN 61000-4-3:1995	3 V/m, 80 - 1000 MHz
IEC 61000-4-4:1995 / EN 61000-4-4:1995	0.5 kV sig., 1 kV power
IEC 61000-4-5:1995 / EN 61000-4-5:1996	0.5 kV L-L, 1 kV L-G
IEC 61000-4-6:1996 / EN 61000-4-6:1998	3 V, 0.15 – 80 MHz
IEC 61000-4-11:1994 / EN 61000-4-11:1998	1 cycle, 100%

Safety: IEC 61010-1:1990 + A1:1992 + A2:1995 / EN 61010-1:1993 +A2:1995
CAN/CSA-C22.2 No. 1010.1-92

Supplementary Information:
The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the CE-marking accordingly.

Santa Rosa, CA, USA 6 May, 2002

Greg Pfeiffer/Quality Engineering Manager

For further information, please contact your local Agilent Technologies sales office, agent or distributor.

Rev. C

4 E4446A Specifications

Definitions and Requirements

This chapter contains specifications and supplemental information for PSA E444xA spectrum analyzers. 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, unless otherwise noted).
- 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.

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

Conditions Required to Meet Specifications

- The analyzer is within its calibration cycle.
- Under auto couple control, except that **Auto Sweep Time = Accy**.
- For center frequencies < 20 MHz, DC coupling applied.
- At least 2 hours of storage or operation at the operating temperature.
- Analyzer has been turned on at least 30 minutes with **Auto Align On** selected, or
- If **Auto Align Off** is selected, **Align All Now** must be run:
  - Within the last 24 hours, and
  - Any time the ambient temperature changes more than 3°C, and
  - After the analyzer has been at operating temperature at least 2 hours.

Certification

Agilent Technologies certifies that this product met its published specifications at the time of shipment from the factory. Agilent 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

Description	Specifications	Supplemental Information
Frequency Range		
DC Coupled	3 Hz to 44.0 GHz	
Internal Mixing Bands		*Harmonic Mixing Mode (N[a])*
0	3 Hz to 3.0 GHz	1–
1	2.85 GHz to 6.6 GHz	1–
2	6.2 GHz to 13.2 GHz	2–
3	12.8 GHz to 19.2 GHz	4–
4	18.7 GHz to 26.8 GHz	4–
5	26.4 GHz to 31.15 GHz	4+
6	31.0 GHz to 44.0 GHz	8–
Preamp On *(Option 1DS)*	100 kHz to 3.0 GHz[b]	1–

a. N is the harmonic mixing mode. Most mixing modes are negative (as indicated by the "–"), where the desired first LO harmonic is higher than the tuned frequency by the first IF (3.9214 GHz for Bands 0, 5 and 6, 321.4 MHz for all other bands). A positive mixing mode (indicated by "+") is one in which the tuned frequency is higher than the desired first LO harmonic by the first IF (3.9214 GHz for band 5).

b. The low frequency range of the preamp extends to 100 kHz when the RF coupling is set to DC, and to 10 MHz when RF coupling is set to AC.

Description	Specifications	Supplemental Information
Frequency Reference		
Accuracy	± [(time since last adjustment x aging rate) + temperature stability + calibration accuracy[a]]	
Temperature Stability		
20 to 30°C	$\pm 1 \times 10^{-8}$	
0 to 55°C	$\pm 5 \times 10^{-8}$	
Aging Rate	$\pm 1 \times 10^{-7}$/year[b]	$\pm 5 \times 10^{-10}$/day (nominal)
Settability	$\pm 2 \times 10^{-9}$	
Warm-up and Retrace[c]		
Within 5 min. after turn on		$\pm 1 \times 10^{-7}$ of final frequency (nominal)
Within 15 min. after turn on		$\pm 5 \times 10^{-8}$ of final frequency (nominal)
Achievable Initial Calibration Accuracy[d]	$\pm 7 \times 10^{-8}$	

a. Calibration accuracy depends on how accurately the frequency standard was adjusted to 10 MHz. If the calibration procedure is followed, the calibration accuracy is given by the specification “Achievable Initial Calibration Accuracy” .

b. For periods of one year or more.

c. Applies only when power is disconnected from instrument. Does not apply when instrument is in standby mode.

d. The achievable calibration accuracy at the beginning of the calibration cycle includes these effects:
1) The temperature difference between the calibration environment and the use environment.
2) The 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 unplugging the instrument.
4) Settability.

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])	see note[c]

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 1 MHz, 3% of RBW from 1.1 MHz 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% x RBW term contributes only 55 kHz to the total frequency readout accuracy, compared to 300 kHz for the 0.25% x 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 trace points. The points are spaced by span/(Npts - 1), where Npts is the number of sweep points. For example, with the factory preset value of 601 sweep points, the horizontal resolution is span/600. However, there is an exception: When both the detector mode is "normal" and the span > 0.25 x (Npts - 1) x RBW, peaks can occur only in even-numbered points, so the effective horizontal resolution becomes doubled, or span/300 for the factory preset case. When the RBW is autocoupled and there are 601 sweep points, that exception occurs only for spans > 450 MHz.

c. Swept (not FFT) spans < 2 MHz show a non-linearity in the frequency location at the right or left edge of the span of up to 1.4% of span per megahertz of span (unless using the “fast tuning” option for phase noise optimization). This non-linearity is corrected in the marker readout. Traces output to a remote computer will show the nonlinear relationship between frequency and trace point number. This non-linearity does not occur if the phase noise optimization is set to Fast Tuning.

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

Description	Specifications	Supplemental Information
Frequency Span		
Range		
Swept and FFT	0 Hz, 10 Hz to 44.0 GHz	
Resolution	2 Hz	
Span Accuracy		
Swept	± (0.2% × span + horizontal resolution[c])	see note [d]
FFT	± (0.2% × span + horizontal resolution[c])	

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 >1GHz.

c. Horizontal resolution is due to the marker reading out one of the trace points. The points are spaced by span/(Npts - 1), where Npts is the number of sweep points. For example, with the factory preset value of 601 sweep points, the horizontal resolution is span/600. However, there is an exception: When both the detector mode is "normal" and the span > 0.25 x (Npts - 1) x RBW, peaks can occur only in even-numbered points, so the effective horizontal resolution becomes doubled, or span/300 for the factory preset case. When the RBW is autocoupled and there are 601 sweep points, that exception occurs only for spans > 450 MHz.

d. Swept spans < 2 MHz show a nonlinearity in the frequency location at the right or left edge of the span of up to 1.4% of span per megahertz of span (unless using the “fast tuning” option for phase noise optimization). This nonlinearity is corrected in the marker readout. Traces output to a remote computer will show the nonlinear relationship between frequency and trace point number.

Description	Specifications	Supplemental Information
Sweep Time		
Range		
Span = 0 Hz	1 μs to 6000s	
Span ≥ 10 Hz	1 ms to 2000s	
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 Front, External Rear, RF Burst	
Delayed Trigger[a]	.	
Range		
Span ≥ 10 Hz, swept	1 μs to 500 ms	
Span = 0 Hz or FFT	–150 ms to +500ms	
Resolution	0.1 μs	

Gated Measurements

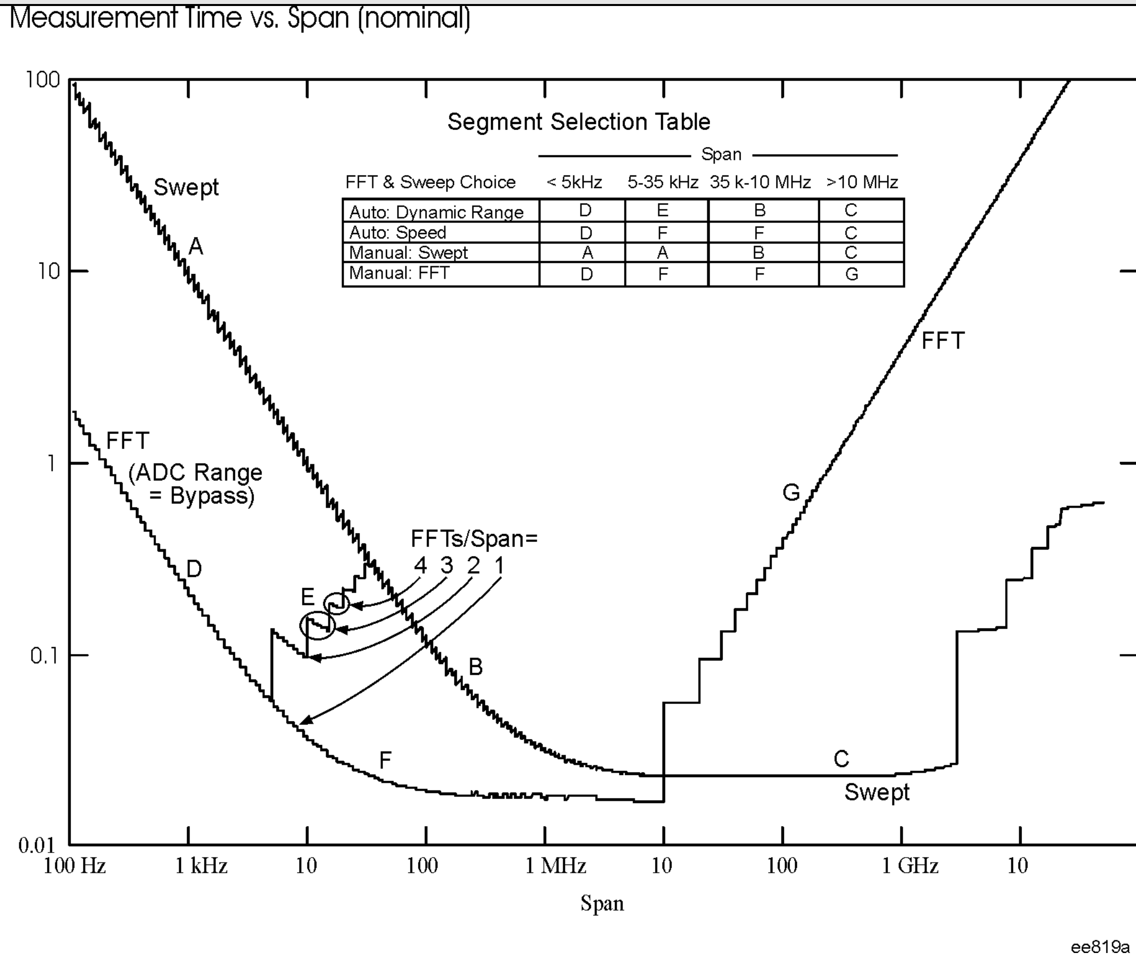
Description	Specifications	Supplemental information
Gated FFT[b]		
Maximum Span	10 MHz	
Delay Range	-150 to +500 ms	
Delay Resolution	100 ns or 4 digits, whichever is more	
Gate Duration		1.83/RBW ± 2%

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

b. Gated measurements (measuring a signal only during a specific time interval) are possible with triggered FFT measurements. The FFT allows analysis during a time interval set by the RBW (within nominally 2% of 1.83/RBW) for spans up to 10 MHz. This time interval is shorter than that of swept gating circuits, allowing higher resolution of the spectrum.

Measurement Time vs. Span

Measurement Time vs. Span (nominal)



Description	Specifications	Supplemental Information
Number of Frequency Display Trace Points (buckets)		
Factory preset	601	
Range:		
Span ≥ 10 Hz	101 to 8192	
Span = 0 Hz	2 to 8192	

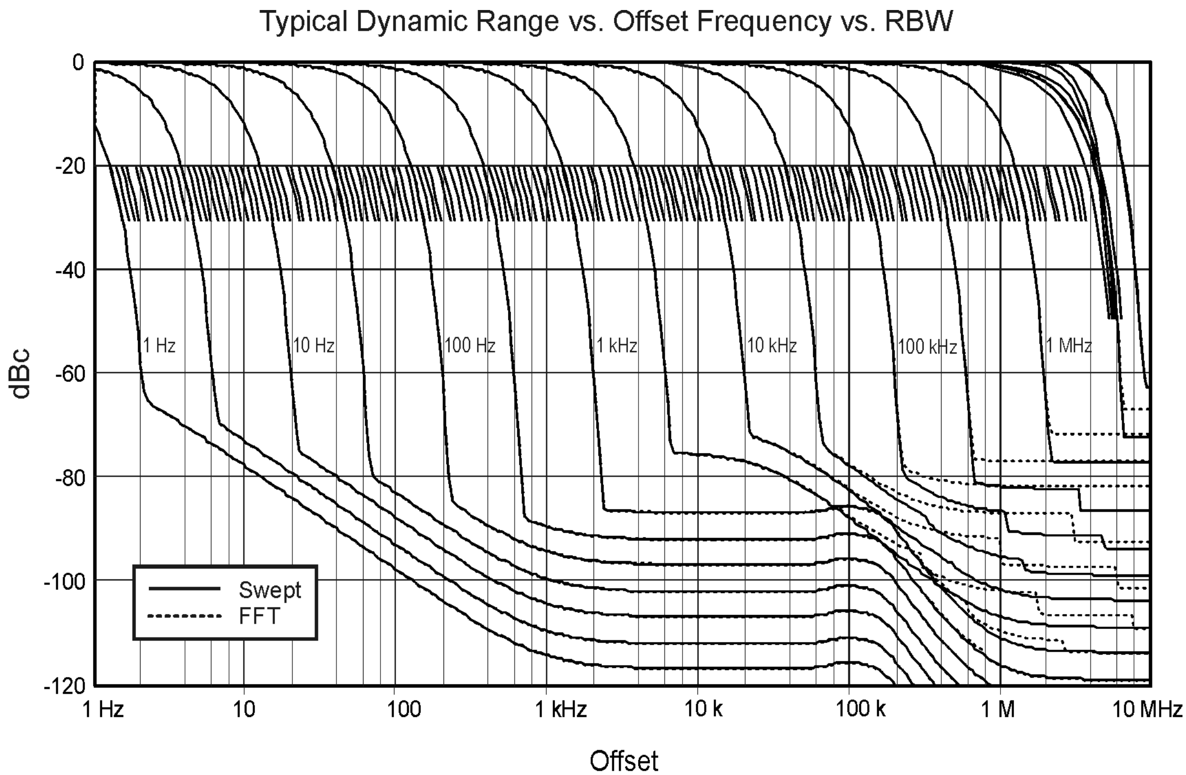
Description	Specifications	Supplemental Information
Resolution Bandwidth (RBW)		
Range (–3.01 dB bandwidth)	1 Hz to 8 MHz. Bandwidths > 3 MHz = 4, 5, 6, and 8 MHz. Bandwidths 1 Hz to 3 MHz are spaced at 10% spacing, 24 per decade: 1.0, 1.1, 1.2, 1.3, 1.5, 1.6, 1.8, 2.0, 2.2, 2.4, 2.7, 3.0, 3.3, 3.6, 3.9, 4.3, 4.7, 5.1, 5.6, 6.2, 6.8, 7.5, 8.2, 9.1, and repeat, times ten to an integer.	
Accuracy (–3.01 dB bandwidth)[a]		
1 Hz to 1.5 MHz RBW		± 2% (nominal)
1.6 MHz to 3 MHz RBW		
(CF ≤ 3 GHz)		± 7% (nominal)
(CF > 3 GHz)		± 8% (nominal)
4 MHz to 8 MHz RBW		
(CF ≤ 3 GHz)		± 15% (nominal)
(CF > 3 GHz)		± 20% (nominal)
Power bandwidth accuracy[b]		
RBW Range / CF Range		
1 Hz – 51 kHz / all	± 0.5%	Equivalent to ± 0.022 dB
82 kHz – 330 kHz / all	± 0.5%	Equivalent to ± 0.022 dB
56 kHz – 75 kHz / all	± 1.0%	Equivalent to ± 0.044 dB
360 kHz – 1.2 MHz / < 3 GHz	± 1.0%	Equivalent to ± 0.044 dB
1.3 MHz – 2.0 MHz / < 3 GHz		± 0.07 dB, nominal
2.2 MHz – 6 MHz / < 3 GHz		± 0.2 dB, nominal
Selectivity (–60 dB/–3 dB)		4.1:1 (nominal)

a. Resolution Bandwidth Accuracy can be observed at slower sweep times than autocoupled 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 **Auto Swp Time** key is set to **Accy** instead of **Norm**. The true bandwidth, which determines the response to impulsive signals and noise-like signals, is not affected by the sweep rate.

b. 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.)

Description	Specification	Supplemental information
Information Bandwidth		
Maximum FFT width	10 MHz	
(Option B7J) I/Q Waveform digital bandwidths	10 MHz	
321.4 MHz rear panel output bandwidth		Nominal
At – 1 dB BW		
Low band (0 to 3 GHz)		30 MHz
High band (2.85 to 26.5 GHz)		20 to 30 MHz[a]
mm band (26.4 to 50 GHz)		30 MHz
At – 3 dB BW		
Low band (0 to 3 GHz)		40 MHz
Highband (2.85 to 26.5 GHz)		30 to 60 MHz
mm bnad (26.5 to 50 GHz)		40 MHz
(Option H70) bandwidth		Same as 321.4 MHz bandwidth

a. The bandwidth in the microwave preselected bands increases monotonically between the lowest and highest tuned frequencies in most, but not all, analyzers.



CF = 1 GHz
Mixer Level = -10 dBm
Only 2/decade of the
24/decade RBW are shown fully
RBWs ≤ 1 kHz shown with
phase noise optimized for fm < 50 kHz
RBWs ≥ 3 kHz shown with
phase noise optimized for fm > 50 kHz

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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=0.1xRBW, four FFTs are averaged to generate one result.

Description	Specifications		Supplemental Information	
Stability Noise Sidebands Center Frequency = 1 GHz[a] Best-case Optimization[b]	**20 to 30°C**	**0 to 55°C**	**20 to 30°C**	**20 to 30°C**
Offset			(Typical)	(Nominal)
100 Hz	–91 dBc/Hz	–90 dBc/Hz	–97 dBc/Hz	
1 kHz	–103 dBc/Hz	–100 dBc/Hz	–107 dBc/Hz	
10 kHz	–114 dBc/Hz	–113 dBc/Hz	–117 dBc/Hz	
30 kHz	–114 dBc/Hz	–113 dBc/Hz	–117 dBc/Hz	
100 kHz	–120 dBc/Hz	–119 dBc/Hz	–123 dBc/Hz	
1 MHz	–144 dBc/Hz	–142 dBc/Hz	–146 dBc/Hz[c]	–148 dBc/Hz[c]
6 MHz	–151 dBc/Hz	–150 dBc/Hz	–152 dBc/Hz[c]	–156 dBc/Hz[c]
10 MHz	–151 dBc/Hz	–150 dBc/Hz	–152 dBc/Hz[c]	–157.5 dBc/Hz[c]
Residual FM	<(1 Hz x N[d]) p-p in 1 s			

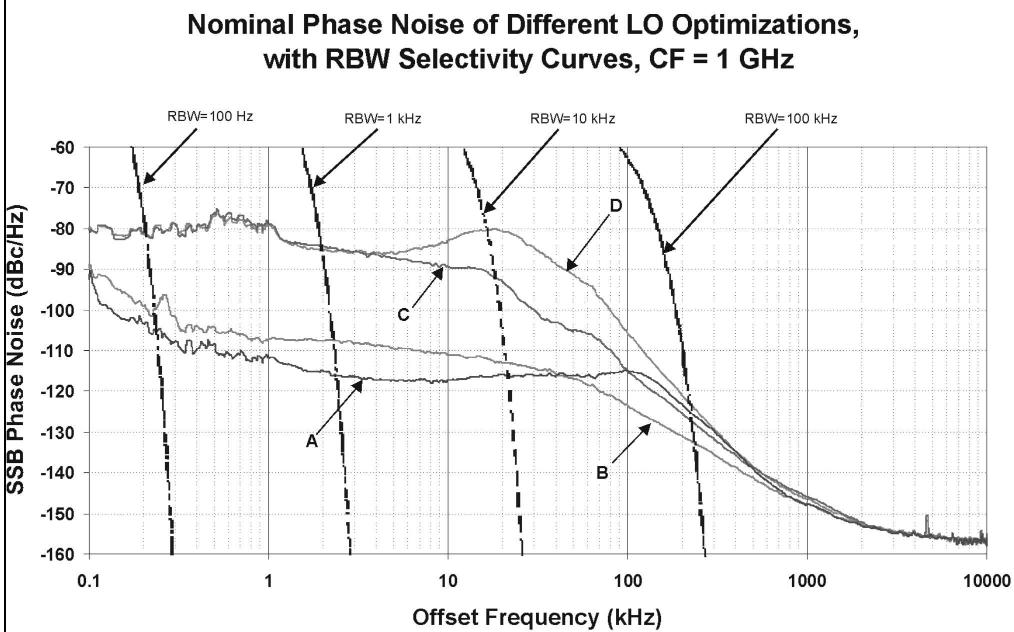
a. Nominal changes of phase noise sidebands with other center frequencies are shown by some examples in the graphs that follow. To predict the phase noise for other center frequencies, note that phase noise at offsets above approximately 1 kHz increases nominally as 20 X log N, where N is the harmonic mixer mode. For offsets below 1 kHz, and center frequencies above 1 GHz, the phase noise increases nominally as 20 X log CF, where CF is the center frequency in GHz.

b. Noise sidebands for offsets of 30 kHz and below are shown for phase noise optimization set to optimize $\mathscr{L}(f)$ for $f<50$ kHz; for offsets of 100 kHz and above, the optimization is set for $f > 50$ kHz.

c. “Typical” results include the effect of the signal generator used in verifying performance; nominal results show performance observed during development with specialized signal sources.

d. N is the harmonic mixing mode.

Nominal Phase Noise of Different LO Optimizations



Sweep Type	Span	Optimize L(f) for f < 50 kHz	Optimize L(f) for f > 50 kHz	Optimize LO for fast tuning
FFT	All	A (Dual Loop Wideband)	B (Dual Loop Narrowband)	D (Single Loop Wideband)
Swept	< 2 MHz			
	2 to 50 MHz	C (Single Loop Narrowband)		
	> 50 MHz			

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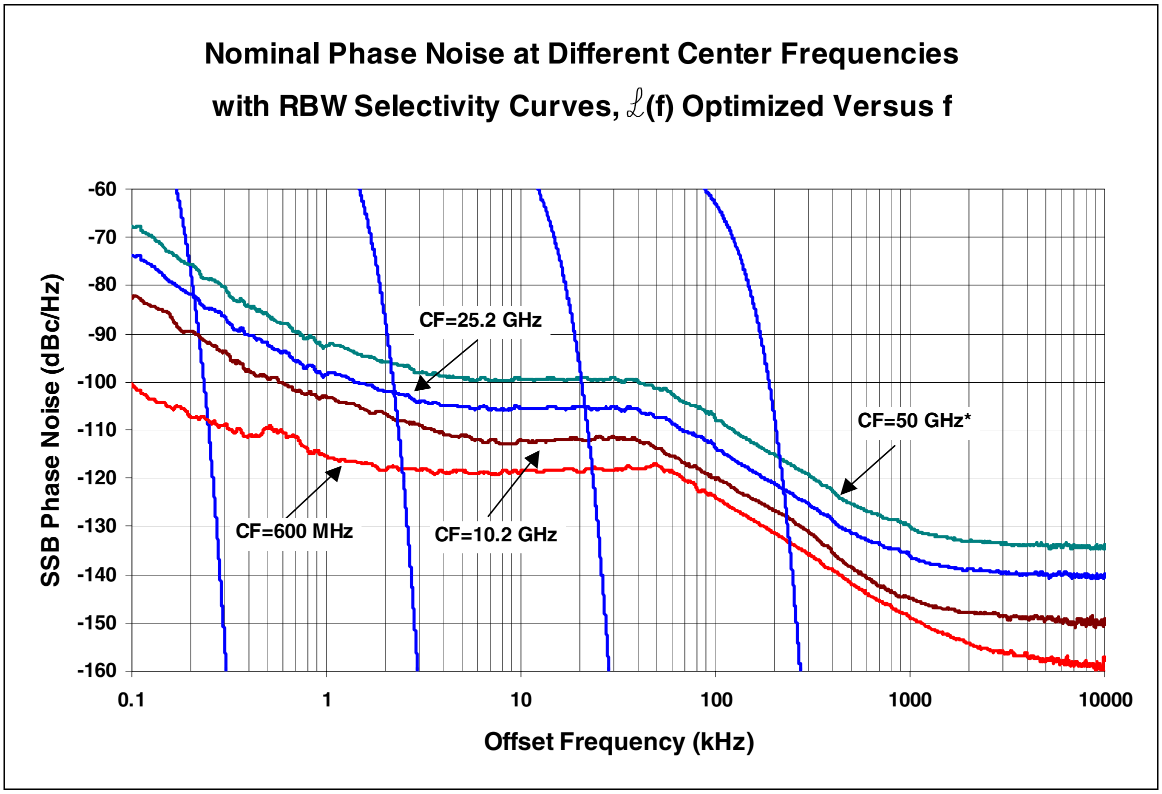
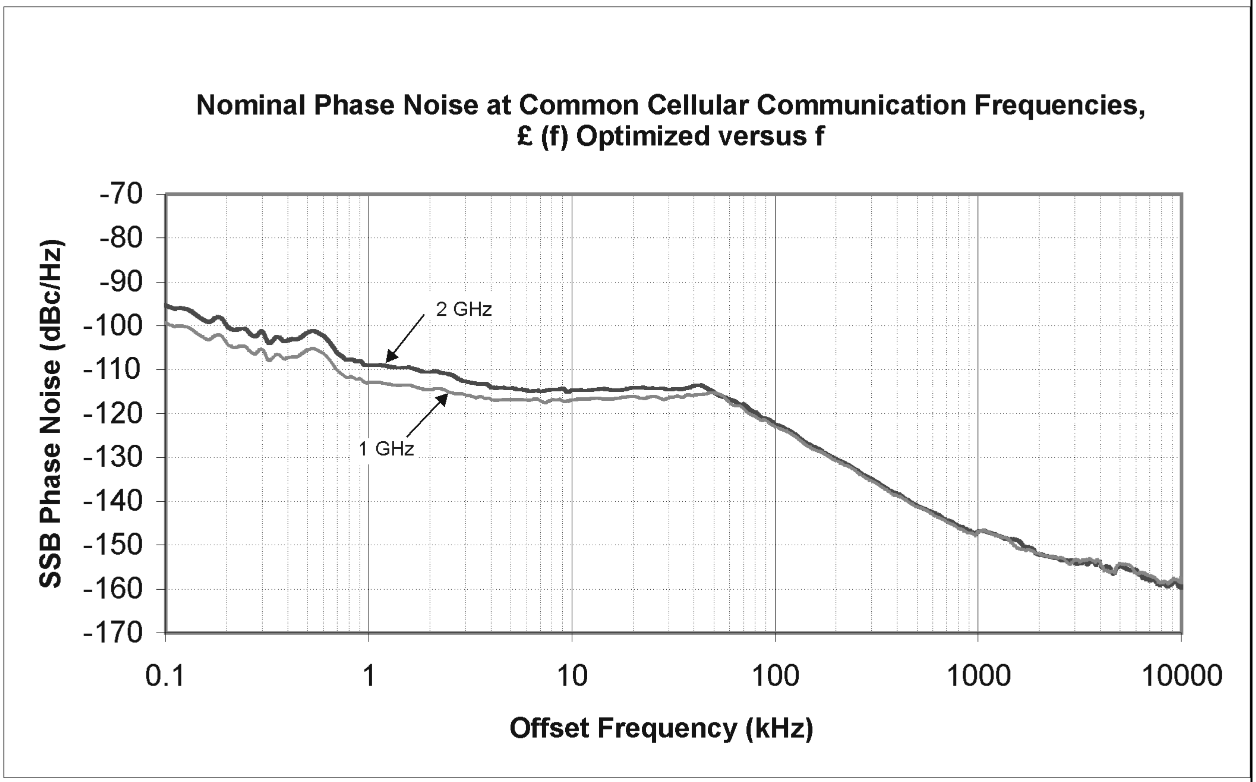
Nominal Phase Noise at Different Center Frequencies



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

PSA Phase Noise



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Amplitude

Description	Specifications	Supplemental Information
Measurement Range	Displayed Average Noise Level to +30 dBm	
Preamp *(Option 1DS)*	Displayed Average Noise Level to +25 dBm	
Input Attenuator Range	0 to 70 dB, in 2 dB steps	

Description	Specifications	Supplemental Information
Maximum Safe Input Level		Applies with or without preamp *(Option 1DS)*
Average Total Power	+30 dBm (1W)	
Peak Pulse Power <10 μs pulse width; <1% duty cycle; and input attenuation ≥ 30 dB	+50 dBm (100W)	
DC volts		
DC Coupled	± 0.2 Vdc	
AC Coupled (E4443A, E4445A, E4440A)	± 100 Vdc	

Description	Specifications	Supplemental Information	
1 dB Gain Compression Point (Two-tone)[abc]	Maximum power at mixer[d]	Nominal[e]	
20 MHz to 200 MHz	2 dBm	+3 dBm	
200 MHz to 3.0 GHz	+3 dBm	+7 dBm	
3.0 GHz to 6.6 GHz	+3 dBm	+4 dBm	
6.6 GHz to 26.8 GHz	−2dBm	0 dBm	
26.8 GHz to 44.0 GHz		0 dBm	
Typical Gain Compression (Two-tone)		Mixer Level	Typical Compression
20 MHz to 200 MHz		0 dBm	< 0.5 dB
200 MHz to 6.6 GHz		+3 dBm	< 0.5 dB
6.6 GHz to 26.8 GHz		−2 dBm	< 0.4 dB
Preamp On *(Option 1DS)* Total power at the preamp[f]			
10 MHz to 200 MHz		−30 dBm (nominal)	
200 MHz to 3 GHz		−25 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. Tone spacing > 15 times RBW, with a minimum of 30 kHz of separation

c. See Reference Level footnote (b) on page 41.

d. Mixer power level (dBm) = input power (dBm) – input attenuation (dB).

e. The compression of a small on-screen signal by a large interfering signal can be represented as a curve of compression versus the level of the interfering signal. The specified performance is a level/compression pair. The specification could be verified by finding the level for which the compression is 1 dB, or by finding the compression for the specified level. The latter technique is used. Therefore, the amount of compression is known in production, and the typical compression is known statistically, thus allowing a "typical" listing. The level required to reach 1 dB compression is not monitored in production, thus "nominal" performance is shown for this view of the performance.

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

Description	Specifications				Supplemental Information
Displayed Average Noise Level (DANL)[a]					
Input terminated Sample or Average detector Averaging type = Log Normalized to 0 dB input attenuation					**Nominal**
3 Hz to 1 kHz					–110 dBm
1 kHz to 10 kHz					–130 dBm
	Zerospan & swept Normalized to 1 Hz 20 to 30° C	**Zerospan & swept Normalized to 1 Hz 0 to 55°C**	**FFT Only Actual 1 Hz 20 to 30°C**[b]	**FFT Only Actual 1 Hz 0 to 55°Cb**	**Zerospan & swept Normalized to 1 Hz (typical)**
10 kHz to 100 kHz	–140 dBm	–140 dBm	–140 dBm	–140 dBm	–143 dBm
100 kHz to 1 MHz	–145 dBm	–145 dBm	–145 dBm	–145 dBm	–150 dBm
1 MHz to 10 MHz	–150 dBm	–150 dBm	–150 dBm	–150 dBm	–155 dBm
10 MHz to 1.2 GHz	–154 dBm	–153 dBm	–153 dBm	–152 dBm	–155 dBm
1.2 GHz to 2.2 GHz	–153 dBm	–152 dBm	–152 dBm	–151 dBm	–154 dBm
2.2 to 3 GHz	–152 dBm	–150 dBm	–151 dBm	–149 dBm	–153 dBm
3 to 6.6 GHz	–151 dBm	–149 dBm	–150 dBm	–149 dBm	–152 dBm
6.6 to 13.2 GHz	–146 dBm	–145 dBm	–146 dBm	–145 dBm	–149 dBm
13.2 to 20 GHz	–145 dBm	–143 dBm	–144 dBm	–142 dBm	–147 dBm
20 to 22.5 GHz	–143 dBm	–141 dBm	–143 dBm	–141 dBm	–146 dBm
22.5 to 26.8 GHz	–140 dBm	–138 dBm	–140 dBm	–138 dBm	–144 dBm
26.8 to 31.15 GHz	–142 dBm	–140 dBm	–141 dBm	–139 dBm	–145 dBm
31.15 to 36 GHz	–134 dBm	–132 dBm	–133 dBm	–131 dBm	–136 dBm
36 to 38 GHz	–129 dBm	–127 dBm	–129 dBm	–127 dBm	–132 dBm
38 to 44 GHz	–131 dBm	–129 dBm	–131 dBm	–128 dBm	–134 dBm
Preamp On *(Option 1DS)*					
100 kHz to 1 MHz	–164 dBm	–163 dBm			–168 dBm

a. DANL for zero span and swept is normalized in two ways and for two reasons. DANL is measured in a 1 kHz RBW and normalized to the narrowest available RBW, because the narrowest RBWs (1.0 to 1.8 are not usable for signals below –110 dBm but DANL can be a useful figure of merit for the other RBWs. (RBWs this small are usually best used in FFT mode, because sweep rates are very slow in these bandwidths. RBW autocoupling never selects these RBWs in swept mode because of potential errors at low signal levels.) The second normalization is that DANL is measured with 10 dB input attenuation and normalized to the 0 dB input attenuation case, because that makes DANL and third order intermodulation test conditions congruent, allowing accurate dynamic range estimation for the analyzer. Because of these normalizations, this measure of DANL is useful for estimating instrument performance such as TOI to noise range and compression to noise range, but not ultimate sensitivity.

b. DANL for FFT measurements are useful for estimating the ultimate sensitivity of the analyzer for low-level signals. This specification is verified with 0 dB input attenuation and 1 Hz RBW. A limitation of this DANL specification is that some instruments have a center-screen-only spurious signal of nominally –150 dBm, which can be avoided by tuning the analyzer a few hertz away from the frequency of interest.

Description	Specifications				Supplemental Information
1 MHz to 10 MHz	–167 dBm	–166 dBm			–169 dBm
10 MHz to 1.2 GHz	–167 dBm	–166 dBm	Note[a]	Note[a]	–169 dBm
1.2 GHz to 2.2 GHz	–166 dBm	–165 dBm	Note [a]	Note[a]	–168 dBm
2.2 GHz to 3.0 GHz	–164 dBm	–163 dBm	Note[a]	Note[a]	–166 dBm

a. DANL for FFT measurements with the preamp on is not warranted performance. Observations and computations show that it should be nominally only 0.04 dB worse that swept performance.

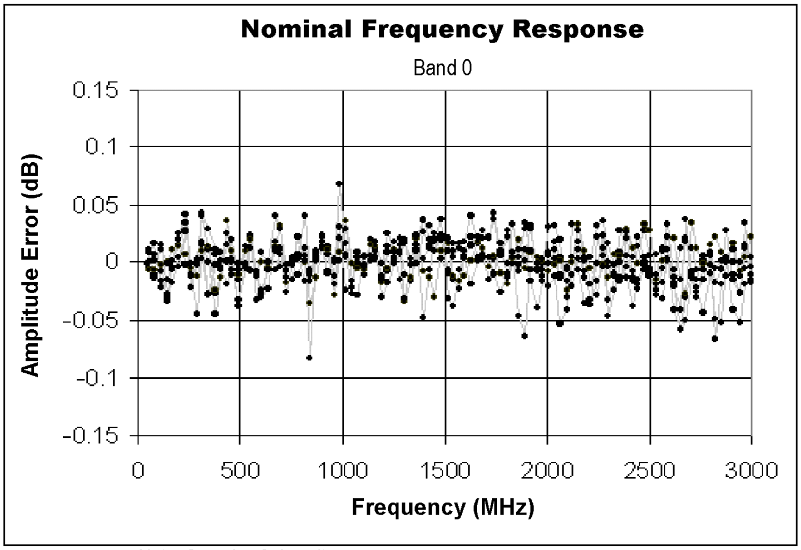
Description	Specifications	Supplemental Information
Display Range		
Log Scale	Ten divisions displayed; 0.1 to 1.0 dB/division in 0.1 dB steps, and 1 to 20 dB/division in 1 dB steps	
Linear Scale	Ten divisions	
Marker Readout[a]		
Log units resolution		
Average off, on-screen	0.01 dB	
Average on or remote	0.001 dB	
Linear units resolution		≤ 1% of signal level

a. See Reference Level footnote (b) on page 41.

Description	Specifications		Supplemental Information
Frequency Response			
(10 dB input attenuation)			
Maximum error relative to reference condition (50 MHz)[a]	**20 to 30°C**	**0 to 55°C**	**Typical 20 to 30°C** (at worst observed frequency)
3 Hz to 3.0 GHz	± 0.38 dB	± 0.70 dB	± 0.10 dB
3.0 GHz to 6.6 GHz[b]	± 1.50 dB	± 2.00 dB	± 0.7 dB
6.6 GHz to 13.2GHz[b]	± 2.00 dB	± 3.00 dB	± 1.0 dB
13.2 GHz to 22.0 GHz[b]	± 2.00 dB	± 2.50 dB	± 1.0 dB
22.0 GHz to 26.8 GHz[b]	± 2.50 dB	± 3.50 dB	± 1.0 dB
26.4 GHz to 31.15 GHz[b]	± 1.75 dB	± 2.75 dB	± 1.0 dB
31.15 GHz to 44.0 GHz[b]	± 3.00 dB	± 4.00 dB	± 2.0 dB
Additional frequency response error, FFT mode[cd]	± [0.15 dB + (0.1 dB/MHz x FFT width[e])] to a max. of ± 0.40 dB		
100 kHz to 3.0 GHz Preamp On (*Option 1DS*)	± 0.70 dB	± 0.80 dB	< ± 0.2 dB
Frequency Response at Attenuation ≠ 10 dB			At 0, 2, 4, 6, 20, 30 dB input attenuation steps. Nominal
			20 to 30°C 0 to 55°C
10 MHz to 3 GHz			± 0.8 dB ± 1.0 dB

a. Specifications for frequencies > 3 GHz apply for sweep rates <100 MHz/ms.
b. Preselector centering applied.
c. FFT frequency response errors are specified relative to swept measurements.
d. This error need not be included in Absolute Amplitude Accuracy error budgets when the difference between the analyzer center frequency and the signal frequency is within ± 1.5% of the span.
e. An FFT width is given by the span divided by the FFTs/Span parameter.

Nominal Frequency Response



Note: Sample of six units.

Description	Specifications	Supplemental Information
Input Attenuation Switching Uncertainty[a,b]		
Attenuator Setting ≥ 2 dB		
Frequency Range		
50 MHz	± 0.2 dB	
3 Hz to 3.0 GHz		± 0.3 dB (nominal)
3.0 to 13.2 GHz		± 0.5 dB (nominal)
13.2 to 26.8 GHz		± 0.7 dB (nominal)
26.8 to 44.0 GHz		± 1.0 dB (nominal)
Attenuator Setting = 0 dB		
50 MHz	± 0.3 dB	

Description	Specifications	Supplemental Information
Preamp (*Option* 1DS)[c]		
Gain		+28 dB (nominal)
Noise figure		
10 MHz to 1.5 GHz		6 dB (nominal)
1.5 GHz to 3.0 GHz		7 dB (nominal)

a. Referenced to 10 dB attenuation
b. Specifications also apply to Option 1DS.
c. The preamp is between the input attenuator and the input mixer.

Description	Specifications	Supplemental Information
Absolute Amplitude Accuracy		
At 50 MHz		
20 to 30°C[a]	± 0.24 dB	± 0.06 dB (typical)
0 to 55°C[b]	± 0.28 dB	
Amplitude Reference Accuracy		± 0.05 dB (nominal)
At all frequencies		
20 to 30°C[b]	± (0.24 dB + frequency response)	± (0.06 dB + frequency response) (typical)
0 to 55°C[b]	± (0.28dB + frequency response)	
Freq < 3 GHz 95% Confidence[b]		± 0.24 dB
Preamp On[c] (*Option* 1DS)	± (0.36 dB + frequency response)	± (0.09 dB + frequency response) (typical)

a. Absolute amplitude accuracy is the total of all amplitude measurement errors, and applies over the following subset of settings and conditions: 10 Hz ≤ RBW ≤1 MHz; Input signal –10 to –50 dBm; Input attenuation 10 dB; span <5 MHz (nominal additional error for span ≥ 5 MHz is 0.02 dB); all settings autocoupled except Auto Swp Time = Accy; combinations of low signal level and wide RBW use VBW ≤30 kHz to reduce noise.
This absolute amplitude accuracy specification includes the sum of the following individual specifications under the conditions listed above: Scale Fidelity, Reference Level Accuracy, Display Scale Switching Uncertainty, Resolution Bandwidth Switching Uncertainty, 50 MHz Amplitude Reference Accuracy, and the accuracy with which the instrument aligns its internal gains to the 50 MHz Amplitude Reference.

b. Absolute Amplitude Accuracy for frequencies below 3 GHz with 95% confidence applies at all the conditions of footnote b, with an input frequency below 3 GHz, for temperatures of 20 to 30°C. The value given is the result of testing the most recent 113 analyzers as of this writing. It is computed by root-sum-squaring (r.s.s.) the 95th percentiles of these terms: the absolute amplitude accuracy observed at 50 MHz under 44 quasi-random combinations of settings, the frequency response relative to 50 MHz at 102 quasi-random test frequencies, and the measurement uncertainties of all these observations. To that root-sum-squaring result is added the environmental effects of 20 to 30°C variation. The 95th percentiles are determined with a 95% confidence level.

c. Same settings as footnote b, 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). For frequencies from 100 kHz to 3 GHz.

Description	Specifications	Supplemental Information
RF Input VSWR		Nominal
(at tuned frequency)		
10 dB attenuation, 50 MHz		< 1.03:1
≥ 8 dB *input attenuation*		
50 MHz to 3 GHz		< 1.13:1
3 GHz to 18 GHz		< 1.27:1
18 GHz to 26.5 GHz		< 1.37:1
26.5 GHz to 50.0 GHz		< 1.57:1
2 to 6 dB *input attenuation*		
50 MHz to 3 GHz		< 1.29:1
3 GHz to 18 GHz		< 1.75:1
18 GHz to 26.5 GHz		<1.68:1
26.5 GHz to 50.0 GHz		< 1.94:1
0 dB *input attenuation*		
50 MHz to 3 GHz		< 1.48:1
3 GHz to 18 GHz		< 2.55:1
18 GHz to 26.5 GHz		<2.90:1
26.5 GHz to 50.0 GHz		< 2.12:1
Preamp On (*Option 1DS*)		
50 MHz to 3 GHz		
≥ 10 dB input attenuation		< 1.13:1
< 10 dB input attenuation		< 1.30:1
Internal 50 MHz calibrator is on		Open input
Alignments running		Open input

Description	Specifications	Supplemental Information
Resolution Bandwidth Switching Uncertainty[a]		
(relative to reference BW of 30 kHz)		
1.0 Hz to 1.0 MHz RBW	± 0.03 dB	
1.1 MHz to 3 MHz RBW	± 0.05 dB	
Manually selected wide RBWs: 4, 5, 6, 8 MHz	± 1.0 dB	

Description	Specifications	Supplemental Information
Reference Level[b]		
Range		
Log Units	–170 to +30 dBm, in 0.01 dB steps	
Linear Units	707 pV to 7.07V in 0.1% steps	
Accuracy	0 dB[c]	

a. RBW switching is specified and tested in the reference condition: –25 dBm signal input and 10 dB input attenuation. At higher input levels, changing RBW may cause a larger change in result than that specified, because the display scale fidelity can be slightly different for different RBWs. These RBW differences in scale fidelity are nominally within ±0.01 dB in all RBWs even for signals as large as –10 dBm at the input mixer.

b. Reference level and off-screen performance: The reference level (RL) behavior differs from previous analyzers in a way that makes PSA more flexible. In previous analyzers, the RL controlled how the measurement was performed as well as how it was displayed. Because the logarithmic amplifier in previous analyzers had both range and resolution limitations, this behavior was necessary for optimum measurement accuracy. The logarithmic amplifier in PSA, however, is implemented digitally such that the range and resolution greatly exceed other instrument limitations. Because of this, a PSA 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 attenuator setting: When the input attenuator 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.

c. 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[c]	

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[abcd]				
Log-Linear Fidelity (relative to the reference condition of –25 dBm input through the 10 dB attenuator, or –35 dBm at the input mixer.)				
Input mixer level[e]	Linearity			
≤ –20 dBm	± 0.07 dB			
≤ –10 dBm	± 0.13 dB			
Relative Fidelity[f] Equation for error ± A ± (B1 + B2) × ΔP) to a maximum of (C1 + C2))				
Level of larger signal		**A**	**B1**	**C1**
–20 dBm < ML < –12 dBm		0.011 dB	0.007	0.08 dB
–29 dBm < ML < –20 dBm		0.011 dB	0.0015	0.04 dB
Noise < ML < –29 dBm		0.001 dB	0.001	0.04 dB
RBW		**B2**	**C2**	
≥ 10 kHz		0.000	0.000 dB	
≤ 2 kHz		0.0035	0.038 dB	
others (RBW in Hz)		7/RBW	76 dB/RBW	

a. Supplemental information: The amplitude detection linearity specification applies at all levels below –10dBm 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 3sigma level can be reduced proportional to the square root of the number of averages taken.

b. Display scale fidelity and resolution bandwidth switching uncertainty interact slightly. See the footnote for RBW switching. RBW switching applies at only one level on the scale fidelity curve, but scale fidelity applies for all RBWs.

c. Scale fidelity is warranted with ADC dither turned on. Turning on ADC dither nominally increases DANL. The nominal increase is highest with the preamp off in the lowest-DANL frequency range, under 1.2 GHz, where the nominal increase is 2.5dB. Other ranges and the preamp-on case will show lower increases in DANL. Turning off ADC dither nominally degrades low-level (signal levels below –60 dBm at the input mixer level) scale fidelity by 0.2 dB.

d. See Reference Level footnote (b) on page 41.

e. Mixer level = Input Level - Input Attenuator

f. 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 –5dBm, using attenuator=10dB and RBW = 3 kHz.
Because the larger signal is –5 dBm with 10 dB attenuation, the mixer level, ML, defined to be input power minus input attenuation, is –15 dBm. The line for this mixer level shows A=0.011 dB, B1=0.007 and C1=0.08 dB. Because the RBW is neither 10 kHz and over, nor2 kHz and under, parameters B2 and C2 are determined by formulas. B2 is 7/3000, or 0.00233. C2 is 76dB/3000, or 0.025 dB. With these values for the parameters, the equation becomes: $\pm 0.011\ \text{dB} \pm (0.0093 \times \Delta P \text{ to a maximum of } 0.105\ \text{dB})$ ΔP is (–5 – (–60)) or 55 dB. Therefore, the maximum error in the power ratio is 0.116 dB.

Description	Specifications			Supplemental Information	
General Spurious Responses	**Mixer Level**[a]	**Distortion**			
f < 10 MHz from carrier	−40 dBm	*< (−73 + 20 log N) dBc*[b]			
f ≥ 10 MHz from carrier	−40 dBm	< (−80 + 20 log N) dBc		< (−90 + 20 log N) dBc (typical)	
Second Harmonic Distortion Source Frequency	**Mixer Level**[a]	**Distortion**	**SHI**[c]	**Distortion** (nominal)	**SHI** (nominal)
10 MHz to 400 MHz	−40 dBm	< −82 dBc	+42dBm		
400 MHz to 1.25 GHz	−40 dBm	< −91 dBc	+51dBm		
1.25 GHz to 1.5 GHz	−40 dBm	< −81 dBc	+41dBm		
1.5 GHz to 2.0 GHz	−10 dBm	< −90 dBc	+80dBm		
2.0 GHz to 3.25 GHz	−10 dBm	< −94 dBc	+84dBm		
3.25 GHz to 13.25 GHz	−10 dBm	< −96 dBc	+86dBm		
13.25 GHz to 22.0 GHz	−10 dBm			< −100 dBc	+90dBm
Preamp On (Option 1DS) Input preamp level = −45 dBm					
10 MHz to 1.5 GHz				< −60 dBc	+ 15dBm

a. Mixer level = Input Level – Input Attenuator
b. N = LO mixing harmonic
c. 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. The measurement is made with a −11 dBm tone at the input mixer.

Description	Specifications		Supplemental Information?
Third Order Intermodulation Distortion	**Distortion**[a]	**TOI**[b] Sweep type *not* set to FFT	**TOI**[b] (typical)
With two −30 dBm tones at input mixer Tone separation >15 kHz			
20 to 30 °C			
10 MHz to 100 MHz	< −90 dBc	+15 dBm	+20 dBm
100 MHz to 400 MHz	< −92 dBc	+16 dBm	+21 dBm
400 MHz to 1.7 GHz	< −94 dBc	+17 dBm	+20 dBm
1.7 GHz to 2.7 GHz	< −96 dBc	+18 dBm	+21 dBm
2.7 GHz to 3 GHz	< −96 dBc	+18 dBm	+21 dBm
3 GHz to 6 GHz	< −92 dBc	+16 dBm	+21 dBm
6 GHz to 16 GHz	< −84 dBc	+12 dBm	+15 dBm
16 GHz to 26.5 GHz	< −84 dBc	+12 dBm	+16 dBm
26.5 GHz to 44.0 GHz			+12.5 dBm (nominal)
0 to 55 °C			
10 MHz to 100 MHz	< −88 dBc	+14 dBm	+19 dBm
100 MHz to 400 MHz	< −91 dBc	+15.5 dBm	+20 dBm
400 MHz to 1.7 GHz	< −92 dBc	+16 dBm	+19.5 dBm
1.7 GHz to 2.7 GHz	< −94 dBc	+17 dBm	+20 dBm
2.7 GHz to 3 GHz	< −93 dBc	+16.5 dBm	+20.5 dBm
3 GHz to 6 GHz	< −92 dBc	+16 dBm	+21 dBm
6 GHz to 16 GHz	< −84 dBc	+12 dBm	+14 dBm
16 GHz to 26.5 GHz	< −84 dBc	+12 dBm	+15 dBm
26.5 GHz to 44.0 GHz			+12.5 dBm (nominal)
Preamp On *(Option 1DS)* Input preamp level = −45 dBm			**TOI** (nominal)
10 MHz to 500 MHz			−15 dBm
500 MHz to 3 GHz			−13 dBm

a. Computed from measured TOI.

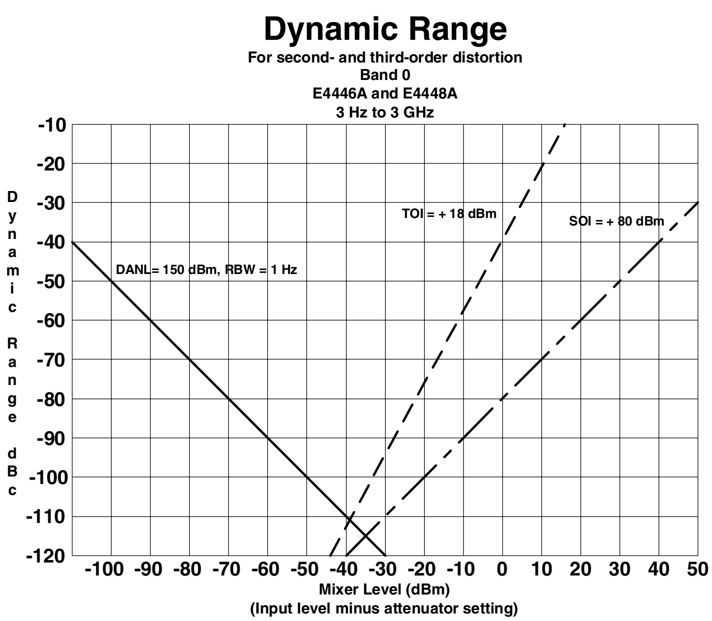
b. TOI = third order intercept. The TOI is given by the mixer tone level (in dBm) minus (distortion/2) where distortion is the relative level of the distortion tones in dBc. The measurement is made with two −18 dBm tones at the input mixer.

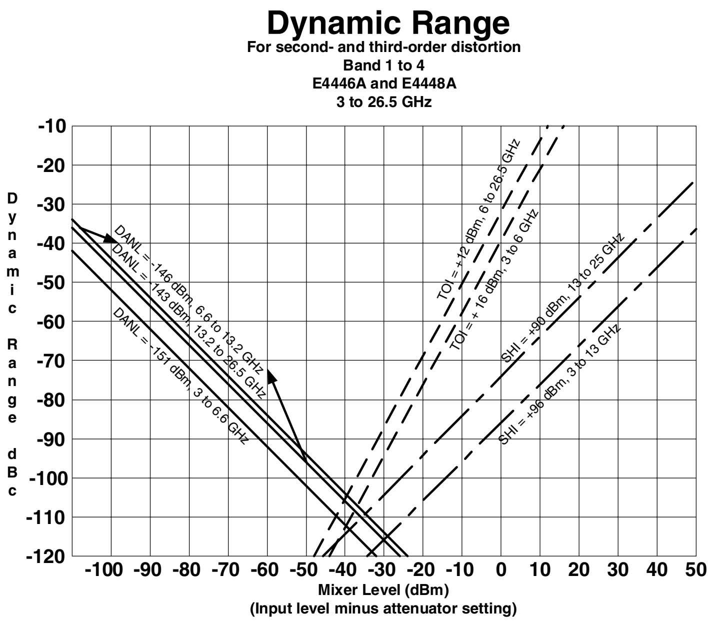
Other Input Related Spurious	**Mixer Level**[a]	**Distortion**	
Image Responses			
10 MHz to 26.8 GHz	–10 dBm	< –80 dBc[b]	
26.8 GHz to 44 GHz	–30 dBm	< –60 dBc	
Multiples and Out-of-band Responses			
10 MHz to 26.8 GHz	–10 dBm	< –80 dBc	
26.8 GHz to 44 GHz	–30 dBm	< –55 dBc	
Residual Responses[c]			
200 kHz to 6.6 GHz		< –100 dBm	
6.6 GHz to 26.8 GHz			< –100 dBm (nominal)
26.8 GHz to 44 GHz			< – 90 dBm (nominal)

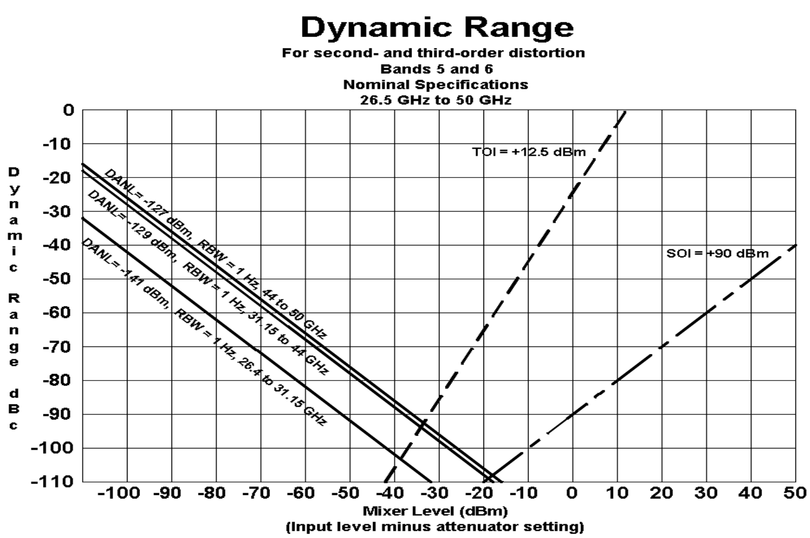
a. Computed from measured TOI.

b. For frequencies >19 GHz, an image 42.8 MHz below the input signal frequency may be seen, typically –78 dBc or lower.

c. Input terminated, 0 dB input attenuation




Dynamic Range
For second- and third-order distortion
Band 1 to 4
E4446A and E4448A
3 to 26.5 GHz
DANL = -146 dBm, 6.6 to 13.2 GHz
DANL = -143 dBm, 13.2 to 26.5 GHz
DANL = -151 dBm, 3 to 6.6 GHz
TOI = +12 dBm, 6 to 26.5 GHz
TOI = + 16 dBm, 3 to 6 GHz
SHI = +90 dBm, 13 to 25 GHz
SHI = +96 dBm, 3 to 13 GHz
Dynamic Range dBc
-10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120
-100 -90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50
Mixer Level (dBm)
(Input level minus attenuator setting)


Dynamic Range
For second- and third-order distortion
Bands 5 and 6
Nominal Specifications
26.5 GHz to 50 GHz
TOI = +12.5 dBm
SOI = +90 dBm
DANL= -127 dBm, RBW = 1 Hz, 44 to 50 GHz
DANL= -129 dBm, RBW = 1 Hz, 31.15 to 44 GHz
DANL= -141 dBm, RBW = 1 Hz, 26.4 to 31.15 GHz
Dynamic Range dBc
0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110
-100 -90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50
Mixer Level (dBm)
(Input level minus attenuator setting)

Measurement	Specifications	Supplemental Information
Channel Power		
Amplitude Accuracy		Absolute Amplitude Accuracy[a] + Power Bandwidth Accuracy[bc]
Radio Std = 3GPPW-CDMA, or IS-95		
Absolute Power Accuracy 20 to 30°C Mixer level[d] < –20 dBm	±0.68 dB	±0.21 dB (typical)
Occupied Bandwidth		
Frequency Accuracy		± (Span/600) (nominal)

a. See Amplitude section.
b. See Frequency section
c. Expressed in dB
d. Mixer level is the input power minus the input attenuation.

Description	Specifications	Supplemental Information
Adjacent Channel Power (ACP)		
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	
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.
Radio Offset Freq		
MS (UE) 5 MHz	±0.12 dB	At ACPR range of –30 to –36 dBc with optimum mixer level[h]
MS (UE) 10 MHz	±0.17 dB	At ACPR range of –40 to –46 dBc with optimum mixer level[i]
BTS 5 MHz	±0.22 dB	At ACPR range of –42 to –48 dBc with optimum mixer level[j]
BTS 10 MHz	±0.22 dB	At ACPR range of –47 to –53 dBc with optimum mixer level[i]
BTS 5 MHz	±0.17 dB	At –48 dBc non-coherent ACPR[k]
Dynamic Range		RRC weighted, 3.84 MHz noise bandwidth
Noise Correction Offset Freq		
off 5 MHz		–74.5 dB (typical)[lm]
off 10 MHz		–82 dB (typical)[lm]
on 5 MHz		–81 dB (typical)[ln]
on 10 MHz		–88 dB (typical)[lm]
RRC Weighting Accuracy[o]		
White noise in Adjacent Channel		0.00 dB nominal
TOI-induced spectrum		0.004 dB nominal
r.m.s. CW error		0.023 dB nominal
Radio Std = IS-95 or J-STD-008		
Method		RBW method[p]
ACPR Relative Accuracy		
Offsets < 1300 kHz[q]	±0.10 dB	
Offsets > 1.85 MHz[rs]	±0.10 dB	

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 section

c. See Frequency section

d. Expressed in decibels

e. The passband of response for the adjacent channels is given by the convolution of two functions: a rectangle of width given by the programmed Ref BW parameter, and the power response of the RBW filter used. Therefore, the 3 dB bandwidth of the passband function will be equal to the Ref BW. 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 $x - 0.572 \times \text{RBW}$.

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 –26dBm, so the input attenuation must be set as close as possible to the average input power - (–26 dBm). For example, if the average input power is –6 dBm, set the attenuation to 20 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 Bbase Transmission Station (BTS) within 3 dB of the required –45 dBc ACPR. 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 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.

l. Agilent measures 100% of PSAs 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, Agilent only gives a typical result. More than 80% of prototype PSAs 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 Agilent 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. The optimum mixer drive level will be approximately –12 dBm.

n. The optimum mixer drive level will be approximately –15 dBm.

o. 3GPP requires the use of a root-raised-cosine filter in evaluating the ACLR of a device. The accuracy of the passband shape of the filter is not specified in standards, nor is any method of evaluating that accuracy. This footnote discusses the performance of the filter in this instrument. The effect of the RRC filter and the effect of the RBW used in the measurement interact. The analyzer compensates the shape of the RRC filter to accommodate the RBW filter. The effectiveness of this compensation is summarized in three ways:
– White noise in Adj Ch: The compensated RRC filter nominally has no errors if the adjacent channel has a spectrum that is flat across its width.
– TOI-induced spectrum: If the spectrum is due to third-order intermodulation, it has a distinctive shape. The computed errors of the compensated filter are –0.004 dB for the 470 kHz RBW used for UE testing, and 0.000 dB for the 30 kHz RBW filter used for BTS testing. The worst error for RBWs between these extremes is 0.05 dB for a 330 kHz RBW filter. r.m.s.
– 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 r.m.s. error of the compensated filter is 0.023 dB for the 470 kHz RBW used for UE

testing, and 0.000 dB for the 30 kHz RBW filter used for BTS testing. The worst error for RBWs between these extremes is 0.057 dB for a 430 kHz RBW filter.

p. The RBW method measures the power in the adjacent channels within the defined resolution bandwidth. The noise bandwidth of the RBW filter is nominally 1.055 times the 3.01 dB bandwidth. Therefore, the RBW method will nominally read 0.23 dB higher adjacent channel power than would a measurement using the integration bandwidth method, because the noise bandwidth of the integration bandwidth measurement is equal to that integration bandwidth. For cmdaOne ACPR measurements using the RBW method, the main channel is measured in a 3 MHz RBW, which does not respond to all the power in the carrier. Therefore, the carrier power is compensated by the expected under-response of the filter to a full width signal, of 0.15 dB. But the adjacent channel power is not compensated for the noise bandwidth effect.

The reason the adjacent channel is not compensated is subtle. The RBW method of measuring ACPR is very similar to the preferred method of making measurements for compliance with FCC requirements, the source of the specifications for the cdmaOne Spur Close specifications. ACPR is a spot measurement of Spur Close, and thus is best done with the RBW method, even though the results will disagree by 0.23 dB from the measurement made with a rectangular passband.

q. The specified ACPR accuracy applies if the measured ACPR substantially exceeds the analyzer dynamic range at the specified offset. When this condition is not met, there are additional errors due to the addition of analyzer spectral components to UUT spectral components. In the worst case at these offsets, the analyzer spectral components are all coherent with the UUT components; in a more typical case, one third of the analyzer spectral power will be coherent with the distortion components in the UUT. Coherent means that the phases of the UUT distortion components and the analyzer distortion components are in a fixed relationship, and could be perfectly in-phase. This coherence is not intuitive to many users, because the signals themselves are usually pseudo-random; nonetheless, they can be coherent.

When the analyzer components are 100% coherent with the UUT components, the errors add in a voltage sense. That error is a function of the signal (UUT ACPR) to noise (analyzer ACPR dynamic range limitation) ratio, SN, in decibels.

The function is error = $20 \times \log(1 + 10^{(-SN/20)})$

For example, if the UUT ACPR is –62 dB and the measurement floor is –82 dB, the SN is 20 dB and the error due to adding the analyzer's distortion to that of the UUT is 0.83 dB.

r. As in the previous footnote, the specified ACPR accuracy applies if the ACPR measured substantially exceeds the analyzer dynamic range at the specified offset. When this condition is not met, there are additional errors due to the addition of analyzer spectral components to UUT spectral components. Unlike the situation in footnote p, though, the spectral components from the analyzer will be noncoherent with the components from the UUT. Therefore, the errors add in a power sense. The error is a function of the signal (UUT ACPR) to noise (analyzer ACPR dynamic range limitation) ratio, SN, in decibels.

The function is error = $10 \times \log(1 + 10^{(-SN/10)})$.

For example, if the UUT ACPR is –75 dB and the measurement floor is –85 dB, the SN ratio is 10 dB and the error due to adding the analyzer's noise to that of the UUT is 0.41 dB.

Measurement	Specifications	Supplemental Information
Multi-Carrier Power		
Radio Std = 3GPP W-CDMA		
ACPR Dynamic Range (two carriers) 5 MHz offset 10 MHz offset		RRC weighted, 3.84 MHz noise bandwidth –70 dB (nominal) –75 dB (nominal)
ACPR Accuracy (two carriers) 5 MHz offset, –48 dBc ACPR		±0.38 dB (nominal)
Power Statistics CCDF		
Histogram Resolution[a]	0.1 dB	
Intermod (TOI)		Measure the third-order intercept from a signal with two dominant tones.
Harmonic Distortion		
Maximum harmonic number	10th	
Results	Fundamental power (dBm) Relative harmonics power (dBc)	
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	

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.

Measurement	Specifications	Supplemental Information
Spurious Emissions		Table-driven spurious signals; search across regions
Radio Std = cdma2000 or 3GPP W-CDMA		
Dynamic Range, relative 1980 MHz region[a]	–80.6 dB	–82.4 dB (typical)
Sensitivity, absolute 1980 MHz region[b]	–89.7 dBm	–91.7 dBm (typical)
Spectrum Emission Mask		Table-driven spurious signals; measurement near carriers
Radio Std = cdma2000		
Dynamic Range, relative 750 kHz offset[cd]	–85.3 dB	–88.3 dB (typical)
Sensitivity, absolute 750 kHz offset[e]	–105.7 dBm	–107 dBm (typical)
Accuracy, relative 750 kHz offset[f]	±0.09 dB	
Radio Std = 3GPP W-CDMA		
Dynamic Range, relative 2.515 MHz Offset[cg]	–87.3 dB	–89.5 dB (typical)
Sensitivity, absolute 2.515 MHz Offset[e]	–105.7 dBm	–107.7 dBm (typical)
Accuracy, relative 2.515 MHz Offset[f]	±0.10 dBm	

a. The dynamic range specification is the ratio of the channel power to the power in the region specified. The dynamic range depends on the many measurement settings. These specifications are based on the detector being set to average, the default RBW (1200 kHz), and depend on the mixer level. Mixer level is defined to be the input power minus the input attenuation. This dynamic range specification applies for a mixer level of –8 dBm. Higher mixer levels can give up to 5 dB better dynamic range, but at the expense of compression in the input mixer, which reduces accuracy. The compression behavior of the input mixer is specified in the amplitude section of these specifications.

b. The sensitivity for this region is specified in the default 1200 kHz bandwidth, at a center frequency of 1 GHz.

c. 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.

d. This dynamic range specification applies for the optimum mixer level, which is about –18 dBm. Mixer level is defined to be the input power minus the input attenuation.

e. 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.

f. 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.

g. This dynamic range specification applies for the optimum mixer level, which is about –16 dBm. Mixer level is defined to be the average input power minus the input attenuation.

Options

The following options affect instrument specifications.[a]

Option 1DS:	Preamplifier

a. For instrument personality specifications, refer to the User's Guide for that personality.

General

Description	Specifications	Supplemental Information
Temperature Range		
Operating	0 to 55°C	Floppy disk 10 to 40°C Maximum temperature: 40°C Maximum humidity: 80% relative (non-condensing)
Storage	–40 to 75°C	Temperature: -40 to +71°C Maximum humidity: 90% relative (non-condensing)
Altitude	2,000 meters	Approximately 6,562 feet

Description	Specifications	Supplemental Information
Display		
Resolution	640 x 480	
Scale		
Log Scale	0.1, 0.2, 0.3...1.0, 2.0, 3.0...20 dB per division	
Linear Scale	10% of reference level per division	
Acoustic Emissions (ISO 7779)		LNPE < 5.0 Bels at 25°C
Military Specification	Has been type tested to the environmental specifications of MIL-PRF-28800F class 3.	
EMI Compatibility	Conducted emission is in compliance with CISPR Pub. 11/1990 Group 1 Class A. Radiated emission is in compliance with CISPR Pub. 11/1990 Group 1 Class B.	

Description	Specifications	Supplemental Information
Immunity Testing		
Radiated Immunity		Testing was done at 3 V/m according to IEC 61000-4-3/1995. When the analyzer tuned frequency is identical to the immunity test signal frequency, there may be signals of up to –60 dBm displayed on the screen.
Electrostatic Discharge		Air discharges of up to 8 kV were applied according to IEC 61000-4-2/1995. Discharges to center pins of any of the connectors may cause damage to the associated circuitry.

Description	Specifications	Supplemental Information
Power Requirements		
Voltage, Frequency	100 to 132 Vrms, 47 to 66 Hz/360 to 440 Hz 195 to 250 Vrms, 47 to 66 Hz	
Power Consumption, On	Base <260W; Fully Loaded <450W	
Power Consumption, Standby	<20W	
Measurement Speed		
Local Measurement and Display Update rate[a]		
Sweep points = 601		≥ 50/s (nominal)
Remote Measurement and GPIB Transfer Rate		
Sweep points = 601		≥ 22/s (nominal)

a. Factory preset, fixed center frequency, RBW = 1 MHz, and span >10 MHz and ≤ 600 MHz, and stop frequency ≤ 3 GHz.

Description	Specifications	Supplemental Information
Data Storage		
Internal		2 MB
Floppy Drive (10 to 40°C)		3.5" 1.44 MB, MS-DOS® compatible
Weight		
(without options)		
Net E4440A, E4443A, E4445A		23 kg (nominal) 50 lbs (nominal)
Net E4446A, E4448A		24 kg (nominal) 53 lbs (nominal)
Shipping		33 kg (nominal) 73 lb (nominal)
Cabinet Dimensions		Cabinet dimensions exclude front and rear protrusions.
Height	177 mm (7.0 in)	
Width	426 mm (16.8 in)	
Length	483 mm (19 in)	

Inputs and Outputs

Front Panel

Description	Specifications	Supplemental Information	
RF INPUT		Nominal	
Connector	2.4 mm male		
Impedance		50Ω	
First LO Emission Level[a]		Band 0	Band ≥ 1
		< −120 dBm	< −100 dBm

Description	Specifications	Supplemental Information
PROBE POWER		
Voltage/Current		+15 Vdc, ±7% at 150 mA max (nominal) −12.6 Vdc, ±10% at 150 mA max (nominal) GND
EXT TRIGGER INPUT		
Connector	BNC female	
Impedance		10 kΩ (nominal)
Trigger Level		5V TTL

a. With 10 dB attenuation

Rear Panel

Description	Specifications	Supplemental Information
10 MHz OUT (Switched)		Switchable On/Off
Connector	BNC female	
Impedance		50Ω (nominal)
Output Amplitude		≥ 0 dBm (nominal)
Frequency Accuracy	10 MHz ± (10 MHz x frequency reference accuracy)	
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.
Impedance		50Ω (nominal)
Input Amplitude Range		–5 to +10 dBm (nominal)
Frequency		1 to 30 MHz (nominal) (settable to 1 Hz resolution)
Frequency lock range	$\pm 5 \times 10^{-6}$ of specified external reference input frequency	
Trigger In		
Connector	BNC female	
External Trigger Input		Configurable Front or Rear
Impedance		>10 kΩ (nominal)
Trigger Level		5V TTL (nominal)
Keyboard		
Connector	6-pin mini-DIN (PS2)	
Trigger 1 and Trigger 2 Outputs		
Connector	BNC female	
Trigger 1 Output		HSWP (High = sweeping)
Impedance		50Ω (nominal)
Level		5V TTL
Trigger 2 Output		Reserved for future applications

Description	Specifications	Supplemental Information
Monitor Output		
Connector	VGA compatible, 15-pin mini D-SUB	
Format		VGA (31.5 kHz horizontal, 60Hz vertical sync rates, non-interlaced) Analog RGB
Resolution	640 x 480	
PRE-SEL TUNE OUT		
Connector	BNC female	
Load Impedance (dc Coupled)		110Ω (nominal)
Range		0 to 10V (nominal)
Sensitivity		
External Mixer		1.5 V/GHz of tuned L.O. frequency (nominal)
Remote Programming[a]		
GPIB Interface		
Connector	IEEE-488 bus connector	
GPIB Codes		SH1, AH1, T6, SR1, RL1, PP0, DC1, C1, C2, C3 and C28, DT1, L4, C0
Serial Interface		
Connector	9-pin D-SUB male	Factory use only
Parallel Interface		
Connector	25-pin D-SUB female	Printer port only
LAN TCP/IP Interface	RJ45 Ethertwist	
321.4 MHz IF Output		
Connector	SMA female	
Impedance		50Ω (nominal)
Frequency		321.4 MHz (nominal)
Conversion Gain[b]		+2 to +4 dB (nominal)
SCSI Interface		
Connector	Mini D 50, female	Factory use only

a. Control languages - SCPI version 1992.0

b. Conversion gain is measured from RF input to 321.4 MHz IF output, with 0 dB input attenuation. The 321.4 MHz IF output is located in the RF chain at a point where all of the frequency response corrections are *not* applied. Conversion gain varies nominally ± 3dB as a function of tune frequency.

Regulatory Information

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

This product has been designed and tested in accordance with IEC Publication 61010, Safety Requirements for Electronic Measuring Apparatus, 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.

	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).
	The CSA mark is the Canadian Standards Association safety mark.
ISM 1-A	This is a symbol of an Industrial Scientific and Medical Group 1 Class A product. (CISPR 11, Clause 4)

Declaration of Conformity

DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014

Manufacturer's Name: Agilent Technologies, Inc.

Manufacturer's Address: 1400 Fountaingrove Parkway
Santa Rosa, CA 95403-1799
USA

Declares that the product

Product Name: PSA Performance Spectrum Analyzer

Model Number: E4440A, E4443A, E4445A, E4446A, E4448A

Product Options: This declaration covers all options of the above product.

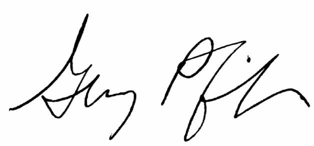
Conforms to the following product specifications:

EMC: IEC 61326-1:1997+A1:1998 / EN 61326-1:1997+A1:1998

Standard	Limit
CISPR 11:1990 / EN 55011-1991	Group 1, Class A
IEC 61000-4-2:1995+A1998 / EN 61000-4-2:1995	4 kV CD, 8 kV AD
IEC 61000-4-3:1995 / EN 61000-4-3:1995	3 V/m, 80 - 1000 MHz
IEC 61000-4-4:1995 / EN 61000-4-4:1995	0.5 kV sig., 1 kV power
IEC 61000-4-5:1995 / EN 61000-4-5:1996	0.5 kV L-L, 1 kV L-G
IEC 61000-4-6:1996 / EN 61000-4-6:1998	3 V, 0.15 – 80 MHz
IEC 61000-4-11:1994 / EN 61000-4-11:1998	1 cycle, 100%

Safety: IEC 61010-1:1990 + A1:1992 + A2:1995 / EN 61010-1:1993 +A2:1995
CAN/CSA-C22.2 No. 1010.1-92

Supplementary Information:
The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the CE-marking accordingly.



Santa Rosa, CA, USA 6 May, 2002

Greg Pfeiffer/Quality Engineering Manager

For further information, please contact your local Agilent Technologies sales office, agent or distributor.

Rev. C

5 E4448A Specifications

Definitions and Requirements

This chapter contains specifications and supplemental information for PSA E444xA spectrum analyzers. 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, unless otherwise noted).
- 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.

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

Conditions Required to Meet Specifications

- The analyzer is within its calibration cycle.
- Under auto couple control, except that **Auto Sweep Time = Accy**.
- For center frequencies < 20 MHz, DC coupling applied.
- At least 2 hours of storage or operation at the operating temperature.
- Analyzer has been turned on at least 30 minutes with **Auto Align On** selected, or
- If **Auto Align Off** is selected, **Align All Now** must be run:
  - Within the last 24 hours, and
  - Any time the ambient temperature changes more than 3°C, and
  - After the analyzer has been at operating temperature at least 2 hours.

Certification

Agilent Technologies certifies that this product met its published specifications at the time of shipment from the factory. Agilent 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

Description	Specifications	Supplemental Information
Frequency Range		
DC Coupled	3 Hz to 50.0 GHz	
Internal Mixing Bands		*Harmonic Mixing Mode (N[a])*
0	3 Hz to 3.0 GHz	1–
1	2.85 GHz to 6.6 GHz	1–
2	6.2 GHz to 13.2 GHz	2–
3	12.8 GHz to 19.2 GHz	4–
4	18.7 GHz to 26.8 GHz	4–
5	26.4 GHz to 31.15 GHz	4+
6	31.0 GHz to 50.0 GHz	8–
Preamp On *(Option 1DS)*	100 kHz to 3.0 GHz[b]	1–

a. N is the harmonic mixing mode. Most mixing modes are negative (as indicated by the "–"), where the desired first LO harmonic is higher than the tuned frequency by the first IF (3.9214 GHz for Bands 0, 5 and 6, 321.4 MHz for all other bands). A positive mixing mode (indicated by "+") is one in which the tuned frequency is higher than the desired first LO harmonic by the first IF (3.9214 GHz for band 5).

b. The low frequency range of the preamp extends to 100 kHz when the RF coupling is set to DC, and to 10 MHz when RF coupling is set to AC.

Description	Specifications	Supplemental Information
Frequency Reference		
Accuracy	± [(time since last adjustment x aging rate) + temperature stability + calibration accuracy[a]]	
Temperature Stability		
20 to 30°C	$\pm 1 \times 10^{-8}$	
0 to 55°C	$\pm 5 \times 10^{-8}$	
Aging Rate	$\pm 1 \times 10^{-7}$/year[b]	$\pm 5 \times 10^{-10}$/day (nominal)
Settability	$\pm 2 \times 10^{-9}$	
Warm-up and Retrace[c]		.
Within 5 min. after turn on		$\pm 1 \times 10^{-7}$ of final frequency (nominal)
Within 15 min. after turn on		$\pm 5 \times 10^{-8}$ of final frequency (nominal)
Achievable Initial Calibration Accuracy[d]	$\pm 7 \times 10^{-8}$	

a. Calibration accuracy depends on how accurately the frequency standard was adjusted to 10 MHz. If the calibration procedure is followed, the calibration accuracy is given by the specification "Achievable Initial Calibration Accuracy" .

b. For periods of one year or more.

c. Applies only when power is disconnected from instrument. Does not apply when instrument is in standby mode.

d. The achievable calibration accuracy at the beginning of the calibration cycle includes these effects:
1) The temperature difference between the calibration environment and the use environment.
2) The 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 unplugging the instrument.
4) Settability.

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])	see note[c]

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 1 MHz, 3% of RBW from 1.1 MHz 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% x RBW term contributes only 55 kHz to the total frequency readout accuracy, compared to 300 kHz for the 0.25% x 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 trace points. The points are spaced by span/(Npts - 1), where Npts is the number of sweep points. For example, with the factory preset value of 601 sweep points, the horizontal resolution is span/600. However, there is an exception: When both the detector mode is "normal" and the span > 0.25 x (Npts - 1) x RBW, peaks can occur only in even-numbered points, so the effective horizontal resolution becomes doubled, or span/300 for the factory preset case. When the RBW is autocoupled and there are 601 sweep points, that exception occurs only for spans > 450 MHz.

c. Swept (not FFT) spans < 2 MHz show a non-linearity in the frequency location at the right or left edge of the span of up to 1.4% of span per megahertz of span (unless using the “fast tuning” option for phase noise optimization). This non-linearity is corrected in the marker readout. Traces output to a remote computer will show the nonlinear relationship between frequency and trace point number. This non-linearity does not occur if the phase noise optimization is set to Fast Tuning.

Description	Specifications	Supplemental Information
Frequency Counter[a]		
Count Accuracy	± (marker freq. × freq. ref. accy. + 0.100 Hz)	See note[b]
Delta Count Accuracy	± (delta freq. × freq. ref. accy. + 0.141 Hz)	
Resoluti on	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 >1GHz.

Description	Specifications	Supplemental Information
Frequency Span		
Range		
Swept and FFT	0 Hz, 10 Hz to 50.0 GHz	
Resolution	2 Hz	
Span Accuracy		
Swept	± (0.2% × span + horizontal resolution[a])	see note [b]
FFT	± (0.2% × span + horizontal resolution[a])	

a. Horizontal resolution is due to the marker reading out one of the trace points. The points are spaced by span/(Npts - 1), where Npts is the number of sweep points. For example, with the factory preset value of 601 sweep points, the horizontal resolution is span/600. However, there is an exception: When both the detector mode is "normal" and the span > 0.25 x (Npts - 1) x RBW, peaks can occur only in even-numbered points, so the effective horizontal resolution becomes doubled, or span/300 for the factory preset case. When the RBW is auto-coupled and there are 601sweep points, that exception occurs only for spans > 450 MHz.

b. Swept spans < 2 MHz show a non-linearity in the frequency location at the right or left edge of the span of up to 1.4% of span per megahertz of span (unless using the “fast tuning” option for phase noise optimization). This non-linearity is corrected in the marker readout. Traces output to a remote computer will show the nonlinear relationship between frequency and trace point number.

Description	Specifications	Supplemental Information
Sweep Time		
Range		
Span = 0 Hz	1 μs to 6000s	
Span ≥ 10 Hz	1 ms to 2000s	
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 Front, External Rear, RF Burst	
Delayed Trigger[a]		
Range		
Span ≥ 10 Hz, swept	1 μs to 500 ms	
Span = 0 Hz or FFT	–150 ms to +500ms	
Resolution	0.1 μs	

Gated Measurements

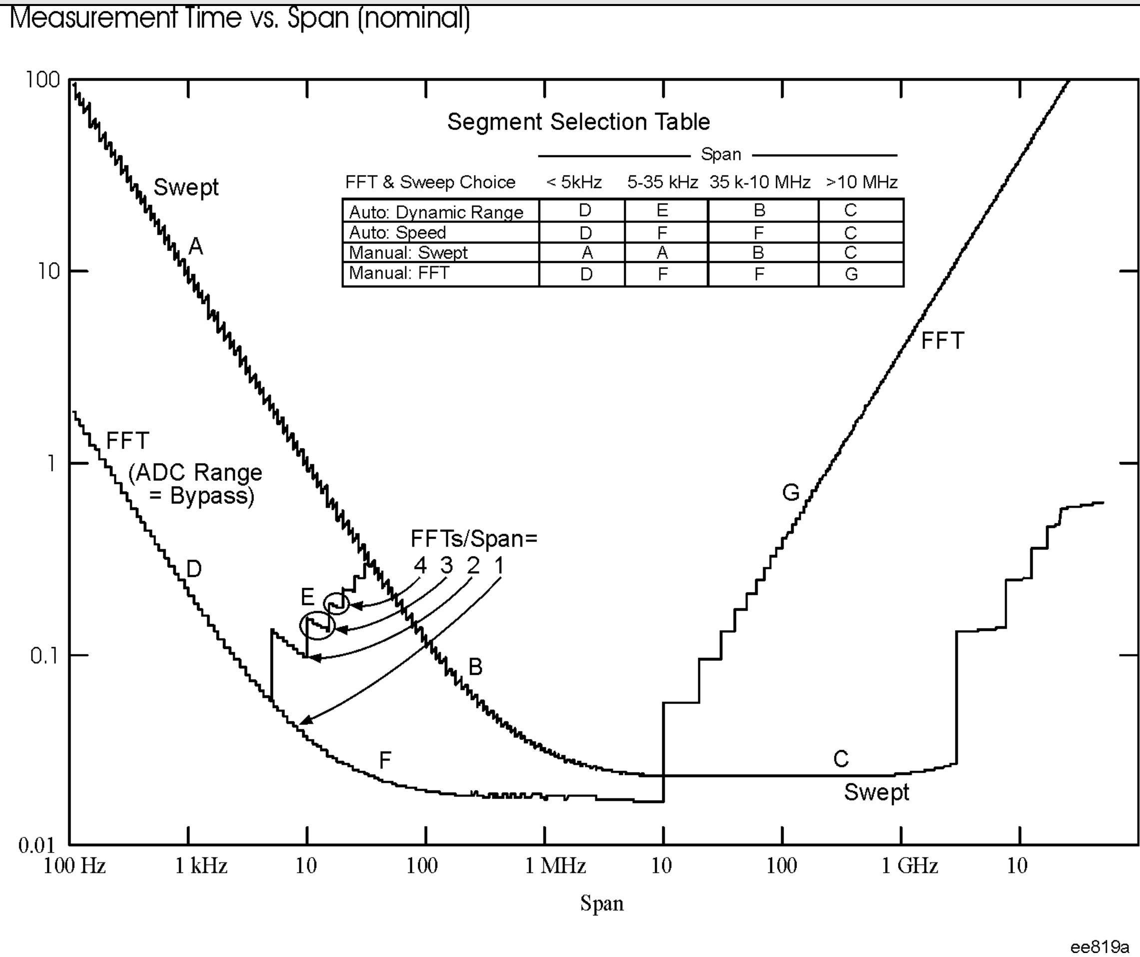
Description	Specifications	Supplemental information
Gated FFT[b]		
Maximum Span	10 MHz	
Delay Range	-150 to +500 ms	
Delay Resolution	100 ns or 4 digits, whichever is more	
Gate Duration		1.83/RBW ± 2%

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

b. Gated measurements (measuring a signal only during a specific time interval) are possible with triggered FFT measurements. The FFT allows analysis during a time interval set by the RBW (within nominally 2% of 1.83/RBW) for spans up to 10 MHz. This time interval is shorter than that of swept gating circuits, allowing higher resolution of the spectrum.

Measurement Time vs. Span

Measurement Time vs. Span (nominal)



Description	Specifications	Supplemental Information
Number of Frequency Display Trace Points (buckets)		
Factory preset	601	
Range:		
Span ≥ 10 Hz	101 to 8192	
Span = 0 Hz	2 to 8192	

Description	Specifications	Supplemental Information
Resolution Bandwidth (RBW)		
Range (–3.01 dB bandwidth)	1 Hz to 8 MHz. Bandwidths > 3 MHz = 4, 5, 6, and 8 MHz. Bandwidths 1 Hz to 3 MHz are spaced at 10% spacing, 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, and repeat, times ten to an integer.	
Accuracy (–3.01 dB bandwidth)[a]		
1 Hz to 1.5 MHz RBW		± 2% (nominal)
1.6 MHz to 3 MHz RBW		
(CF ≤ 3 GHz)		± 7% (nominal)
(CF > 3 GHz)		± 8% (nominal)
4 MHz to 8 MHz RBW		
(CF ≤ 3 GHz)		± 15% (nominal)
(CF > 3 GHz)		± 20% (nominal)
Power bandwidth accuracy[b]		
RBW Range — CF Range		
1 Hz – 51 kHz — all	± 0.5%	Equivalent to ± 0.022 dB
82 kHz – 330 kHz — all	± 0.5%	Equivalent to ± 0.022 dB
56 kHz – 75 kHz — all	± 1.0%	Equivalent to ± 0.044 dB
360 kHz – 1.2 MHz — < 3 GHz	± 1.0%	Equivalent to ± 0.044 dB
1.3 MHz – 2.0 MHz — < 3 GHz		± 0.07 dB, nominal
2.2 MHz – 6 MHz — < 3 GHz		± 0.2 dB, nominal
Selectivity (–60 dB/–3 dB)		4.1:1 (nominal)

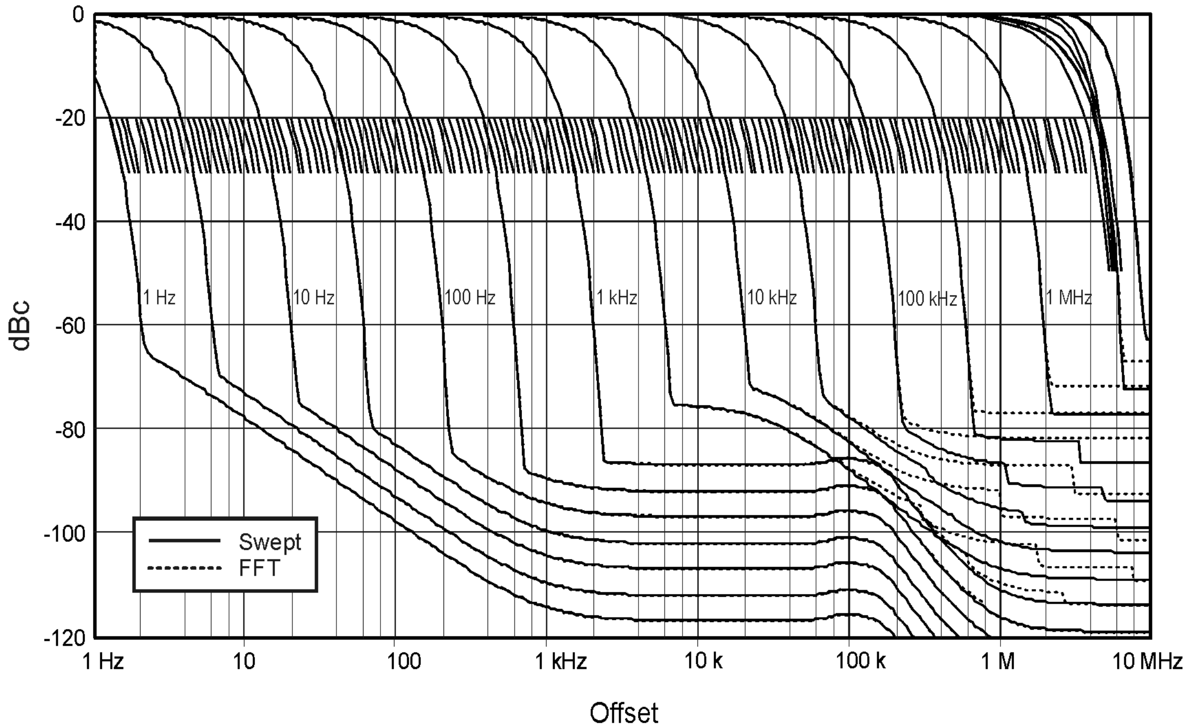
a. Resolution Bandwidth Accuracy can be observed at slower sweep times than autocoupled conditions. Normal sweep rates cause the shape of the RBW filter displayed on the analyzer screen to widen by nominally 6%. This widening declines to 0.6% nominal when the **Auto Swp Time** key is set to **Accy** instead of **Norm**. The true bandwidth, which determines the response to impulsive signals and noise-like signals, is not affected by the sweep rate.

b. 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.)

Description	Specification	Supplemental information
Information Bandwidth		
Maximum FFT width	10 MHz	
(Option B7J) I/Q Waveform digital bandwidths	10 MHz	
321.4 MHz rear panel output bandwidth		Nominal
At – 1 dB BW		
Low band (0 to 3 GHz)		30 MHz
High band (2.85 to 26.5 GHz)		20 to 30 MHz[a]
mm band (26.4 to 50 GHz)		30 MHz
At – 3 dB BW		
Low band (0 to 3 GHz)		40 MHz
Highband (2.85 to 26.5 GHz)		30 to 60 MHz
mm bnad (26.5 to 50 GHz)		40 MHz
(Option H70) bandwidth		Same as 321.4 MHz bandwidth

a. The bandwidth in the microwave preselected bands increases monotonically between the lowest and highest tuned frequencies in most, but not all, analyzers.

Typical Dynamic Range vs. Offset Frequency vs. RBW



CF = 1 GHz
Mixer Level = -10 dBm
Only 2/decade of the
24/decade RBW are shown fully
RBWs ≤ 1 kHz shown with
phase noise optimized for fm < 50 kHz
RBWs ≥ 3 kHz shown with
phase noise optimized for fm > 50 kHz

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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=0.1xRBW, four FFTs are averaged to generate one result.

Description	Specifications		Supplemental Information	
Stability Noise Sidebands Center Frequency = 1 GHz[a] Best-case Optimization[b]	**20 to 30°C**	**0 to 55°C**	**20 to 30°C**	**20 to 30°C**
Offset			(Typical)	(Nominal)
100 Hz	–91 dBc/Hz	–90 dBc/Hz	–97 dBc/Hz	
1 kHz	–103 dBc/Hz	–100 dBc/Hz	–107 dBc/Hz	
10 kHz	–114 dBc/Hz	–113 dBc/Hz	–117 dBc/Hz	
30 kHz	–114 dBc/Hz	–113 dBc/Hz	–117 dBc/Hz	
100 kHz	–120 dBc/Hz	–119 dBc/Hz	–123 dBc/Hz	
1 MHz	–144 dBc/Hz	–142 dBc/Hz	–146 dBc/Hz[c]	–148 dBc/Hz[c]
6 MHz	–151 dBc/Hz	–150 dBc/Hz	–152 dBc/Hz[c]	–156 dBc/Hz[c]
10 MHz	–151 dBc/Hz	–150 dBc/Hz	–152 dBc/Hz[c]	–157.5 dBc/Hz[c]
Residual FM	<(1 Hz x N[d]) p-p in 1 s			

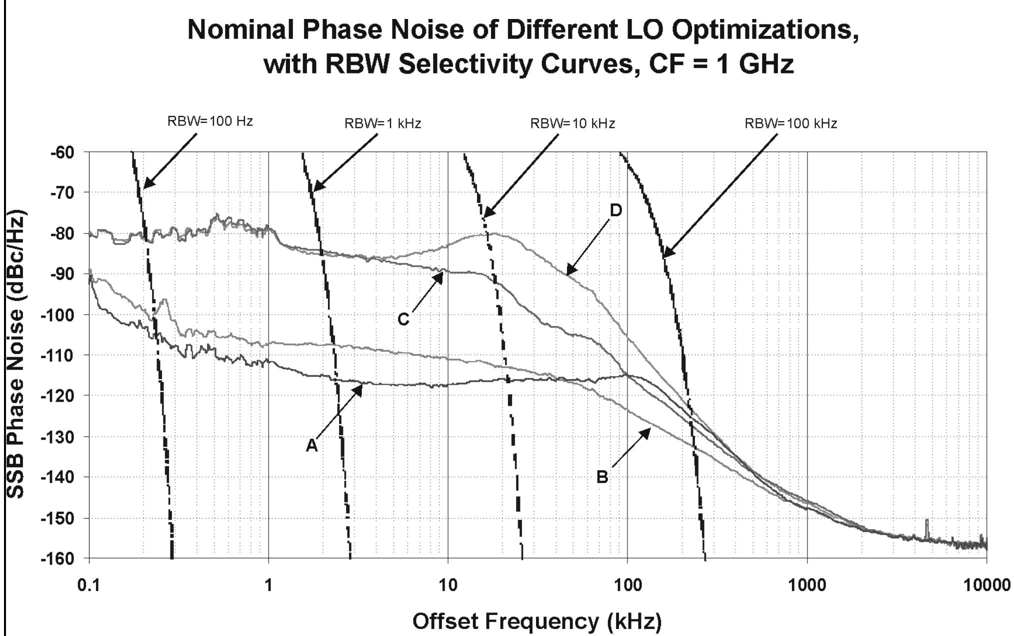
a. Nominal changes of phase noise sidebands with other center frequencies are shown by some examples in the graphs that follow. To predict the phase noise for other center frequencies, note that phase noise at offsets above approximately 1 kHz increases nominally as 20 X log N, where N is the harmonic mixer mode. For offsets below 1 kHz, and center frequencies above 1 GHz, the phase noise increases nominally as 20 X log CF, where CF is the center frequency in GHz.

b. Noise sidebands for offsets of 30 kHz and below are shown for phase noise optimization set to optimize $\mathscr{L}$(f) for f<50 kHz; for offsets of 100 kHz and above, the optimization is set for f > 50 kHz.

c. “Typical” results include the effect of the signal generator used in verifying performance; nominal results show performance observed during development with specialized signal sources.

d. N is the harmonic mixing mode.

Nominal Phase Noise of Different LO Optimizations



<table>
<tr><th>Sweep Type</th><th>Span</th><th>Optimize L(f) for f < 50 kHz</th><th>Optimize L(f) for f > 50 kHz</th><th>Optimize LO for fast tuning</th></tr>
<tr><td>FFT</td><td>All</td><td rowspan="2">A
(Dual Loop Wideband)</td><td rowspan="2">B
(Dual Loop Narrowband)</td><td rowspan="2">D
(Single Loop Wideband)</td></tr>
<tr><td rowspan="3">Swept</td><td>< 2 MHz</td></tr>
<tr><td>2 to 50 MHz</td><td colspan="2">C (Single Loop Narrowband)</td><td rowspan="2"></td></tr>
<tr><td>> 50 MHz</td><td colspan="2"></td></tr>
</table>

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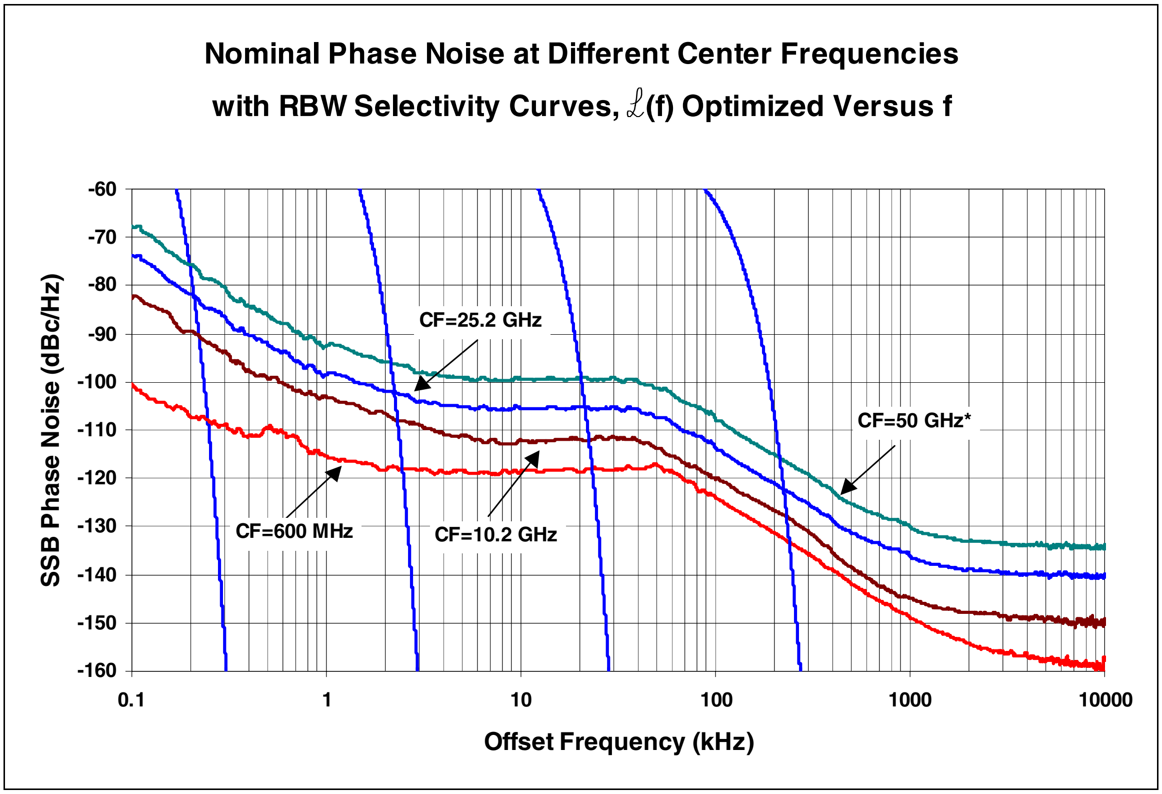
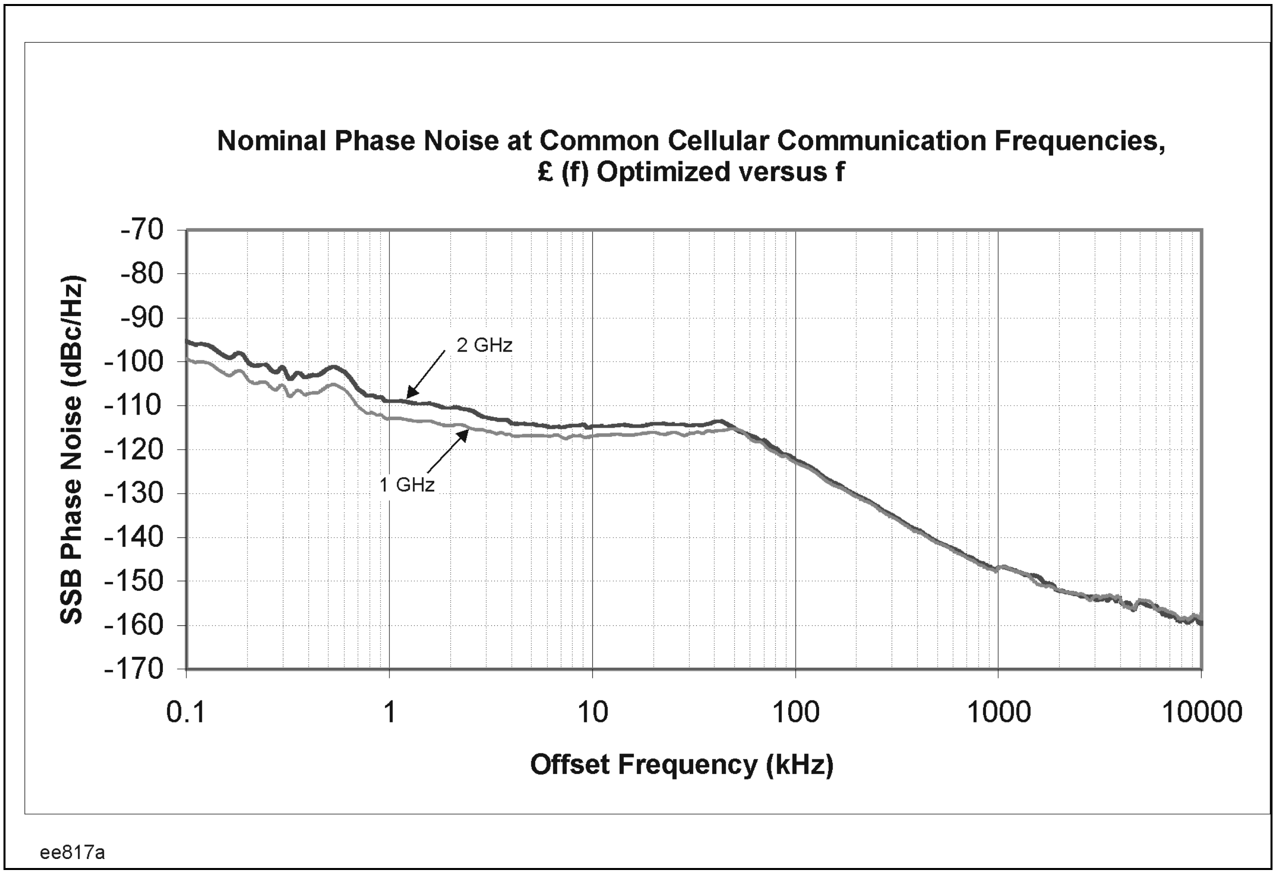
Nominal Phase Noise at Different Center Frequencies



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

PSA Phase Noise



Amplitude

Description	Specifications	Supplemental Information
Measurement Range	Displayed Average Noise Level to +30 dBm	
Preamp *(Option 1DS)*	Displayed Average Noise Level to +25 dBm	
Input Attenuator Range	0 to 70 dB, in 2 dB steps	

Description	Specifications	Supplemental Information
Maximum Safe Input Level		Applies with or without preamp *(Option 1DS)*
Average Total Power	+30 dBm (1W)	
Peak Pulse Power <10 µs pulse width; <1% duty cycle; and input attenuation ≥ 30 dB	+50 dBm (100W)	
DC volts		
DC Coupled	± 0.2 Vdc	
AC Coupled (E4443A, E4445A, E4440A)	± 100 Vdc	

Description	Specifications	Supplemental Information	
1 dB Gain Compression Point (Two-tone)[abc]	Maximum power at mixer[d]	Nominal[e]	
20 MHz to 200 MHz	+2 dBm	+3 dBm	
200 MHz to 3.0 GHz	+3 dBm	+7 dBm	
3.0 GHz to 6.6 GHz	+3 dBm	+4 dBm	
6.6 GHz to 26.8 GHz	–2 dBm	0 dBm	
26.8 GHz to 50.0 GHz		0 dBm	
Typical Gain Compression (Two-tone)		Mixer Level	Typical Compression
20 MHz to 200 MHz		0 dBm	< 0.5 dB
200 MHz to 6.6 GHz		+3 dBm	< 0.5 dB
6.6 GHz to 26.8 GHz		–2 dBm	< 0.4 dB
Preamp On *(Option 1DS)* Total power at the preamp[f]			
10 MHz to 200 MHz		–30 dBm (nominal)	
200 MHz to 3 GHz		–25 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. Tone spacing > 15 times RBW, with a minimum of 30 kHz of separation

c. See Reference Level footnote (b) on page 41.

d. Mixer power level (dBm) = input power (dBm) – input attenuation (dB).

e. The compression of a small on-screen signal by a large interfering signal can be represented as a curve of compression versus the level of the interfering signal. The specified performance is a level/compression pair. The specification could be verified by finding the level for which the compression is 1 dB, or by finding the compression for the specified level. The latter technique is used. Therefore, the amount of compression is known in production, and the typical compression is known statistically, thus allowing a "typical" listing. The level required to reach 1 dB compression is not monitored in production, thus "nominal" performance is shown for this view of the performance.

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

Description	Specifications				Supplemental Information
Displayed Average Noise Level (DANL)[a]					
Input terminated Sample or Average detector Averaging type = Log Normalized to 0 dB input attenuation					**Nominal**
3 Hz to 1 kHz					–110 dBm
1 kHz to 10 kHz					–130 dBm
	Zerospan & swept Normalized to 1 Hz 20 to 30°C	**Zerospan & swept Normalized to 1 Hz 0 to 55°C**	**FFT Only Actual 1 Hz 20 to 30°C**[b]	**FFT Only Actual 1 Hz 0 to 55°Cb**	**Zerospan & swept Normalized to 1 Hz (typical)**
10 kHz to 100 kHz	–140 dBm	–140 dBm	–140 dBm	–140 dBm	–143 dBm
100 kHz to 1 MHz	–145 dBm	–145 dBm	–145 dBm	–145 dBm	–150 dBm
1 MHz to 10 MHz	–150 dBm	–150 dBm	–150 dBm	–150 dBm	–155 dBm
10 MHz to 1.2 GHz	–154 dBm	–153 dBm	–153 dBm	–152 dBm	–155 dBm
1.2 GHz to 2.2 GHz	–153 dBm	–152 dBm	–152 dBm	–151 dBm	–154 dBm
2.2 to 3 GHz	–152 dBm	–150 dBm	–151 dBm	–149 dBm	–153 dBm
3 to 6.6 GHz	–151 dBm	–149 dBm	–150 dBm	–149 dBm	–152 dBm
6.6 to 13.2 GHz	–146 dBm	–145 dBm	–146 dBm	–145 dBm	–149 dBm
13.2 to 20 GHz	–145 dBm	–143 dBm	–144 dBm	–142 dBm	–147 dBm
20 to 22.5 GHz	–143 dBm	–141 dBm	–143 dBm	–141 dBm	–146 dBm
22.5 to 26.8 GHz	–140 dBm	–138 dBm	–140 dBm	–138 dBm	–144 dBm
26.8 to 31.15 GHz	–142 dBm	–140 dBm	–141 dBm	–139 dBm	–145 dBm
31.15 to 36 GHz	–134 dBm	–132 dBm	–133 dBm	–131 dBm	–136 dBm

a. DANL for zero span and swept is normalized in two ways and for two reasons. DANL is measured in a 1 kHz RBW and normalized to the narrowest available RBW, because the narrowest RBWs (1.0 to 1.8 are not usable for signals below –110 dBm but DANL can be a useful figure of merit for the other RBWs. (RBWs this small are usually best used in FFT mode, because sweep rates are very slow in these bandwidths. RBW autocoupling never selects these RBWs in swept mode because of potential errors at low signal levels.) The second normalization is that DANL is measured with 10 dB input attenuation and normalized to the 0 dB input attenuation case, because that makes DANL and third order intermodulation test conditions congruent, allowing accurate dynamic range estimation for the analyzer. Because of these normalizations, this measure of DANL is useful for estimating instrument performance such as TOI to noise range and compression to noise range, but not ultimate sensitivity.

b. DANL for FFT measurements are useful for estimating the ultimate sensitivity of the analyzer for low-level signals. This specification is verified with 0 dB input attenuation and 1 Hz RBW. A limitation of this DANL specification is that some instruments have a center-screen-only spurious signal of nominally –150 dBm, which can be avoided by tuning the analyzer a few hertz away from the frequency of interest.

Description	Specifications				Supplemental Information
36 to 38 GHz	–129 dBm	–127 dBm	–129 dBm	–127 dBm	–132 dBm
38 to 44 GHz	–131 dBm	–129 dBm	–131 dBm	–128 dBm	–134 dBm
44 GHz to 49 GHz	–128 dBm	–127 dBm	–127 dBm	–126 dBm	–131 dBm
49 GHz to 50 GHz	–127 dBm	–126 dBm	–126 dBm	–125 dBm	–130 dBm
Preamp On *(Option 1DS)*					
100 kHz to 1 MHz	–164 dBm	–163 dBm	Note[a]	Note	–168 dBm
1 MHz to 10 MHz	–167 dBm	–166 dBm	Note[a]	Note[a]	–169 dBm
10 MHz to 1.2 GHz	–167 dBm	–166 dBm	Note[a]	Note[a]	–169 dBm
1.2 GHz to 2.2 GHz	–166 dBm	–165 dBm	Note[a]	Note[a]	–168 dBm
2.2 GHz to 3.0 GHz	–164 dBm	–163 dBm	Note[a]	Note[a]	–166 dBm

a. DANL for FFT measurements with the preamp on is not warranted performance. Observations and computations show that it should be nominally only 0.04 dB worse that swept performance.

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	
Marker Readout[a]		
Log units resolution		
Average off, on-screen	0.01 dB	
Average on or remote	0.001 dB	
Linear units resolution		≤ 1% of signal level

a. See Reference Level footnote (b) on page 41.

Description	Specifications		Supplemental Information	
Frequency Response				
(10 dB input attenuation)				
Maximum error relative to reference condition (50 MHz)[a]	**20 to 30°**C	**0 to 55°**C	**Typical 20 to 30°C** (at worst observed frequency)	
3 Hz to 3.0 GHz	± 0.38 dB	± 0.70 dB	± 0.1 dB	
3.0 GHz to 6.6 GHz[b]	± 1.50 dB	± 2.00 dB	± 0.7 dB	
6.6 GHz to 13.2 GHz[b]	± 2.00 dB	± 3.00 dB	± 1.0 dB	
13.2 GHz to 22.0 GHz[b]	± 2.00 dB	± 2.50 dB	± 1.0 dB	
22.0 GHz to 26.8 GHz[b]	± 2.50 dB	± 3.50 dB	± 1.0 dB	
26.4 GHz to 31.15 GHz[b]	± 1.75 dB	± 2.75 dB	± 1.0 dB	
31.15 GHz to 50.0 GHz[b]	± 3.00 dB	± 4.00 dB	± 2.0 dB	
Additional frequency response error, FFT mode[cd]	± [0.15 dB + (0.1 dB/MHz x FFT width[e])] to a max. of ± 0.40 dB			
Preamp On (*Option 1DS*)				
100 kHz to 3.0 GHz	± 0.70 dB	± 0.80 dB	< ± 0.2 dB	
Frequency Response at Attenuation ≠ 10 dB			At 0, 2, 4, 6, 20, 30 dB input attenuation steps. Nominal	
10 MHz to 3 GHz			20 to 30°C	0 to 55°C
			± 0.8 dB	± 1.0 dB

a. Specifications for frequencies > 3 GHz apply for sweep rates <100 MHz/ms.

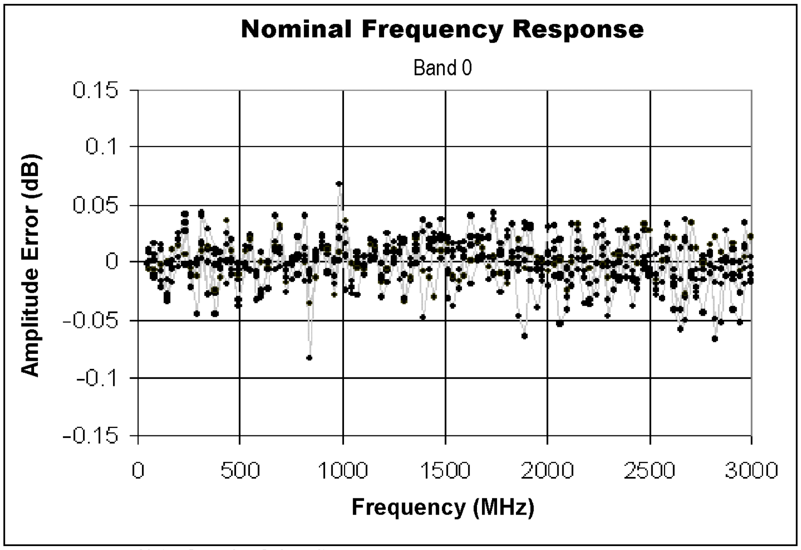
b. Preselector centering applied.

c. FFT frequency response errors are specified relative to swept measurements.

d. This error need not be included in Absolute Amplitude Accuracy error budgets when the difference between the analyzer center frequency and the signal frequency is within ± 1.5% of the span.

e. An FFT width is given by the span divided by the FFTs/Span parameter.

Nominal Frequency Response



Note: Sample of six units.

Description	Specifications	Supplemental Information
Input Attenuation Switching Uncertainty[a,b]		
Attenuator Setting ≥ 2 dB		
Frequency Range		
50 MHz	± 0.2 dB	
3 Hz to 3.0 GHz		± 0.3 dB (nominal)
3.0 to 13.2 GHz		± 0.5 dB (nominal)
13.2 to 26.8 GHz		± 0.7 dB (nominal)
26.8 to 50 GHz		± 1.0 dB (nominal)
Attenuator Setting = 0 dB		
50 MHz	± 0.3 dB	

Description	Specifications	Supplemental Information
Preamp (*Option* 1DS)[c]		
Gain		+28 dB (nominal)
Noise figure		
10 MHz to 1.5 GHz		6 dB (nominal)
1.5 GHz to 3.0 GHz		7 dB (nominal)

a. Referenced to 10 dB attenuation
b. Specifications also apply to Option 1DS.
c. The preamp is between the input attenuator and the input mixer.

Description	Specifications	Supplemental Information
Absolute Amplitude Accuracy		
At 50 MHz		
20 to 30°C[a]	± 0.24 dB	± 0.06 dB (typical)
0 to 55°C[b]	± 0.28 dB	
Amplitude Reference Accuracy		± 0.05 dB (nominal)
At all frequencies		
20 to 30°C[b]	± (0.24 dB + frequency response)	± (0.06 dB + frequency response) (typical)
0 to 55°C[b]	± (0.28dB + frequency response)	
Freq < 3 GHz 95% Confidence[b]		± 0.24 dB
Preamp On[c] (*Option* 1DS)	± (0.36 dB + frequency response)	± (0.09 dB + frequency response) (typical)

a. Absolute amplitude accuracy is the total of all amplitude measurement errors, and applies over the following subset of settings and conditions: 10 Hz ≤ RBW ≤1 MHz; Input signal −10 to −50 dBm; Input attenuation 10 dB; span <5 MHz (nominal additional error for span ≥ 5 MHz is 0.02 dB); all settings autocoupled except Auto Swp Time = Accy; combinations of low signal level and wide RBW use VBW ≤30 kHz to reduce noise.
This absolute amplitude accuracy specification includes the sum of the following individual specifications under the conditions listed above: Scale Fidelity, Reference Level Accuracy, Display Scale Switching Uncertainty, Resolution Bandwidth Switching Uncertainty, 50 MHz Amplitude Reference Accuracy, and the accuracy with which the instrument aligns its internal gains to the 50 MHz Amplitude Reference.

b. Absolute Amplitude Accuracy for frequencies below 3 GHz with 95% confidence applies at all the conditions of footnote b, with an input frequency below 3 GHz, for temperatures of 20 to 30°C. The value given is the result of testing the most recent 113 analyzers as of this writing. It is computed by root-sum-squaring (r.s.s.) the 95th percentiles of these terms: the absolute amplitude accuracy observed at 50 MHz under 44 quasi-random combinations of settings, the frequency response relative to 50 MHz at 102 quasi-random test frequencies, and the measurement uncertainties of all these observations. To that root-sum-squaring result is added the environmental effects of 20 to 30°C variation. The 95th percentiles are determined with a 95% confidence level.

c. Same settings as footnote b, 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). For frequencies from 100 kHz to 3 GHz.

Description	Specifications	Supplemental Information
RF Input VSWR		Nominal
(at tuned frequency)		
10 dB attenuation, 50 MHz		< 1.03:1
≥ 8 dB *input attenuation*		
50 MHz to 3 GHz		< 1.13:1
3 GHz to 18 GHz		< 1.27:1
18 GHz to 26.5 GHz		< 1.37:1
26.5 GHz to 50.0 GHz		< 1.57:1
2 to 6 dB *input attenuation*		
50 MHz to 3 GHz		< 1.29:1
3 GHz to 18 GHz		< 1.75:1
18 GHz to 26.5 GHz		<1.68:1
26.5 GHz to 50.0 GHz		< 1.94:1
0 dB *input attenuation*		
50 MHz to 3 GHz		< 1.48:1
3 GHz to 18 GHz		< 2.55:1
18 GHz to 26.5 GHz		<2.90:1
26.5 GHz to 50.0 GHz		< 2.12:1
Preamp On (*Option 1DS*)		
50 MHz to 3 GHz		
≥ 10 dB input attenuation		< 1.13:1
< 10 dB input attenuation		< 1.30:1
Internal 50 MHz calibrator is on		Open input
Alignments running		Open input

Description	Specifications	Supplemental Information
Resolution Bandwidth Switching Uncertainty[a]		
(relative to reference BW of 30 kHz)		
1.0 Hz to 1.0 MHz RBW	± 0.03 dB	
1.1 MHz to 3 MHz RBW	± 0.05 dB	
Manually selected wide RBWs: 4, 5, 6, 8 MHz	± 1.0 dB	

Description	Specifications	Supplemental Information
Reference Level[b]		
Range		
Log Units	–170 to +30 dBm, in 0.01 dB steps	
Linear Units	707 pV to 7.07V in 0.1% steps	
Accuracy	0 dB[c]	

a. RBW switching is specified and tested in the reference condition: –25 dBm signal input and 10 dB input attenuation. At higher input levels, changing RBW may cause a larger change in result than that specified, because the display scale fidelity can be slightly different for different RBWs. These RBW differences in scale fidelity are nominally within ±0.01 dB in all RBWs even for signals as large as –10 dBm at the input mixer.

b. Reference level and off-screen performance: The reference level (RL) behavior differs from previous analyzers in a way that makes PSA more flexible. In previous analyzers, the RL controlled how the measurement was performed as well as how it was displayed. Because the logarithmic amplifier in previous analyzers had both range and resolution limitations, this behavior was necessary for optimum measurement accuracy. The logarithmic amplifier in PSA, however, is implemented digitally such that the range and resolution greatly exceed other instrument limitations. Because of this, a PSA 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 attenuator setting: When the input attenuator 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.

c. 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[c]	

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[abcd]				
Log-Linear Fidelity (relative to the reference condition of –25 dBm input through the 10 dB attenuator, or –35 dBm at the input mixer.)				
Input mixer level[e]	Linearity			
≤ –20 dBm	± 0.07 dB			
≤ –10 dBm	± 0.13 dB			
Relative Fidelity[f]				
Equation for error ± A ± (B1 + B2) × ΔP) to a maximum of (C1 + C2))				
Level of larger signal		**A**	**B1**	**C1**
–20 dBm < ML < –12 dBm		0.011 dB	0.007	0.08 dB
–29 dBm < ML < –20 dBm		0.011 dB	0.0015	0.04 dB
Noise < ML < –29 dBm		0.001 dB	0.001	0.04 dB
RBW		**B2**	**C2**	
≥ 10 kHz		0.000	0.000 dB	
≤ 2 kHz		0.0035	0.038 dB	
others (RBW in Hz)		7/RBW	76 dB/RBW	

a. Supplemental information: The amplitude detection linearity specification applies at all levels below –10dBm 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 3sigma level can be reduced proportional to the square root of the number of averages taken.

b. Display scale fidelity and resolution bandwidth switching uncertainty interact slightly. See the footnote for RBW switching. RBW switching applies at only one level on the scale fidelity curve, but scale fidelity applies for all RBWs.

c. Scale fidelity is warranted with ADC dither turned on. Turning on ADC dither nominally increases DANL. The nominal increase is highest with the preamp off in the lowest-DANL frequency range, under 1.2 GHz, where the nominal increase is 2.5dB. Other ranges and the preamp-on case will show lower increases in DANL. Turning off ADC dither nominally degrades low-level (signal levels below –60 dBm at the input mixer level) scale fidelity by 0.2 dB.

d. See Reference Level footnote (b) on page 41.

e. Mixer level = Input Level - Input Attenuator

f. 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 –5dBm, using attenuator=10dB and RBW = 3 kHz.
Because the larger signal is –5 dBm with 10 dB attenuation, the mixer level, ML, defined to be input power minus input attenuation, is –15 dBm. The line for this mixer level shows A=0.011 dB, B1=0.007 and C1=0.08 dB. Because the RBW is neither 10 kHz and over, nor2 kHz and under, parameters B2 and C2 are determined by formulas. B2 is 7/3000, or 0.00233. C2 is 76dB/3000, or 0.025 dB. With these values for the parameters, the equation becomes: $\pm 0.011\ \text{dB}\ \pm (0.0093 \times \Delta P\ \text{to a maximum of}\ 0.105\ \text{dB})$ ΔP is (–5 – (–60)) or 55 dB. Therefore, the maximum error in the power ratio is 0.116 dB.

Description	Specifications			Supplemental Information	
General Spurious Responses	**Mixer Level**[a]	**Distortion**			
f < 10 MHz from carrier	–40 dBm	< *(–73 + 20 log N) dBc*[b]			
f ≥ 10 MHz from carrier	–40 dBm	< (–80 + 20 log N) dBc		< (–90 + 20 log N) dBc (typical)	
Second Harmonic Distortion Source Frequency	**Mixer Level**[a]	**Distortion**	**SHI**[c]	**Distortion** (nominal)	**SHI** (nominal)
10 MHz to 400 MHz	–40 dBm	< –82 dBc	+42dBm		
400 MHz to 1.25 GHz	–40 dBm	< –91 dBc	+51dBm		
1.25 GHz to 1.5 GHz	–40 dBm	< –81 dBc	+41dBm		
1.5 GHz to 2.0 GHz	–10 dBm	< –90 dBc	+80dBm		
2.0 GHz to 3.25 GHz	–10 dBm	< –94 dBc	+84dBm		
3.25 GHz to 13.25 GHz	–10 dBm	< –96 dBc	+86dBm		
13.25 GHz to 25.0 GHz	–10 dBm			< –100 dBc	+90dBm
Preamp On (Option 1DS) Input preamp level = –45dBm					
10 MHz to 1.5 GHz				< –60 dBc	+ 15dBm

a. Mixer level = Input Level – Input Attenuator

b. N = LO mixing harmonic

c. 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. The measurement is made with a –11 dBm tone at the input mixer.

Description	Specifications		Supplemental Information
Third Order Intermodulation Distortion With two −30 dBm tones at input mixer Tone separation >15 kHz	**Distortion**[a]	**TOI**[b] Sweep type *not* set to FFT	**TOI**[b] (typical)
20 to 30 °C			
10 MHz to 100 MHz	< −90 dBc	+15 dBm	+20 dBm
100 MHz to 400 MHz	< −92 dBc	+16 dBm	+21 dBm
400 MHz to 1.7 GHz	< −94 dBc	+17 dBm	+20 dBm
1.7 GHz to 2.7 GHz	< −96 dBc	+18 dBm	+21 dBm
2.7 GHz to 3 GHz	< −96 dBc	+18 dBm	+21dBm
3 GHz to 6 GHz	< −92 dBc	+16 dBm	+21 dBm
6 GHz to 16 GHz	< −84 dBc	+12 dBm	+15 dBm
16 GHz to 26.5 GHz	< −84 dBc	+12 dBm	+16 dBm
26.5 GHz to 50.0 GHz			+12.5 dBm (nominal)
0 to 55 °C			
10 MHz to 100 MHz	< −88 dBc	+14 dBm	+19 dBm
100 MHz to 400 MHz	< −91 dBc	+15.5 dBm	+20 dBm
400 MHz to 1.7 GHz	< −92 dBc	+16 dBm	+19.5 dBm
1.7 GHz to 2.7 GHz	< −94 dBc	+17 dBm	+20 dBm
2.7 GHz to 3 GHz	< −93 dBc	+16.5 dBm	+20.5 dBm
3 GHz to 6 GHz	< −92 dBc	+16 dBm	+21 dBm
6 GHz to 16 GHz	< −84 dBc	+12 dBm	+14 dBm
16 GHz to 26.5 GHz	< −84 dBc	+12 dBm	+15 dBm
26.5 GHz to 50.0 GHz			+12.5 dBm (nominal)
Preamp On *(Option 1DS)* Input preamp level = −45dBm			**TOI** (nominal)
10 MHz to 500 MHz			−15 dBm
500 MHz to 3 GHz			−13 dBm

a. Computed from measured TOI.

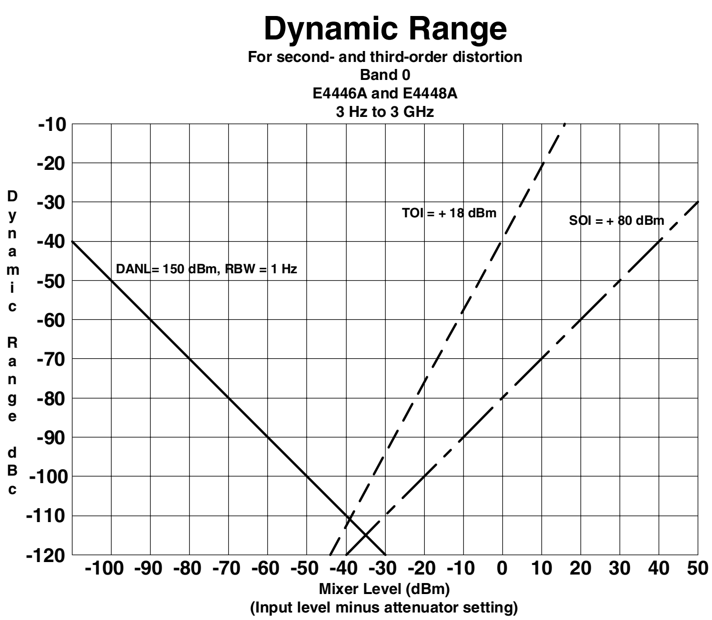
b. TOI = third order intercept. The TOI is given by the mixer tone level (in dBm) minus (distortion/2) where distortion is the relative level of the distortion tones in dBc. The measurement is made with two −20 dBm tones at the input mixer.

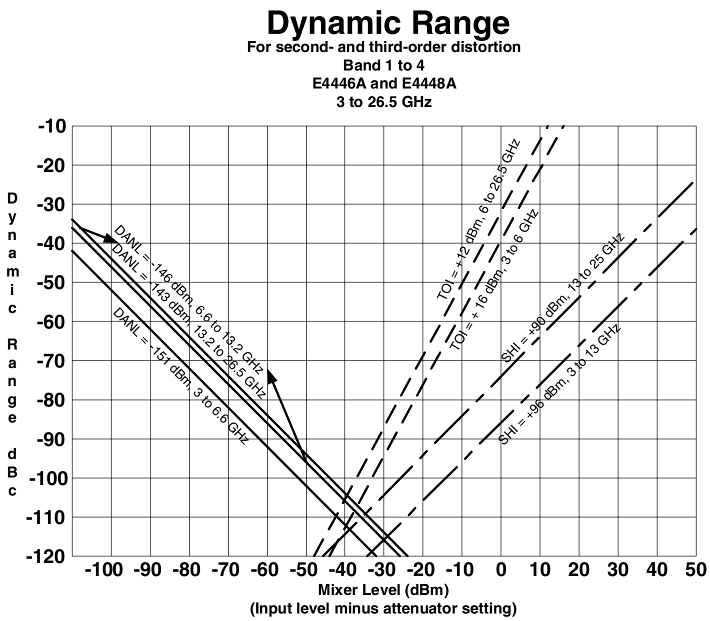
Other Input Related Spurious	Mixer Level[a]	Distortion	
Image Responses			
10 MHz to 26.8 GHz	–10 dBm	< –80 dBc[b]	
26.8 GHz to 50 GHz	–30 dBm	< –60 dBc	
Multiples and Out-of-band Responses			
10 MHz to 26.8 GHz	–10 dBm	< –80 dBc	
26.8 GHz to 50 GHz	–30 dBm	< –55 dBc	
Residual Responses[c]			
200 kHz to 6.6 GHz		< –100 dBm	
6.6 GHz to 26.8 GHz			< –100 dBm (nominal)
26.8 GHz to 50.0 GHz			< – 90 dBm (nominal)

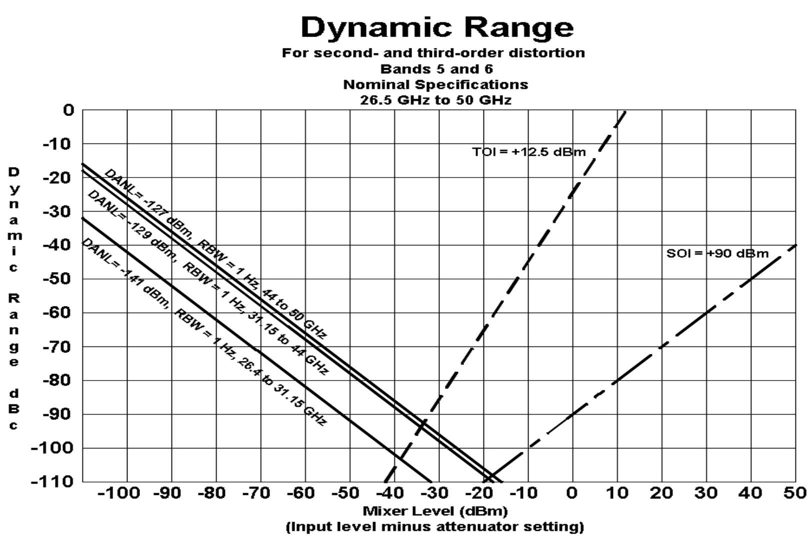
a. Computed from measured TOI.

b. For frequencies >19 GHz, an image 42.8 MHz below the input signal frequency may be seen, typically –78 dBc or lower.

c. Input terminated, 0 dB input attenuation.




Dynamic Range
For second- and third-order distortion
Band 1 to 4
E4446A and E4448A
3 to 26.5 GHz
Dynamic Range dBc
Mixer Level (dBm)
(Input level minus attenuator setting)
DANL = -146 dBm, 6.6 to 13.2 GHz
DANL = -143 dBm, 13.2 to 26.5 GHz
DANL = -151 dBm, 3 to 6.6 GHz
TOI = +12 dBm, 6 to 26.5 GHz
TOI = + 16 dBm, 3 to 6 GHz
SHI = +90 dBm, 13 to 25 GHz
SHI = +96 dBm, 3 to 13 GHz


Dynamic Range
For second- and third-order distortion
Bands 5 and 6
Nominal Specifications
26.5 GHz to 50 GHz
Dynamic Range dBc
Mixer Level (dBm)
(Input level minus attenuator setting)
DANL= -127 dBm, RBW = 1 Hz, 44 to 50 GHz
DANL= -129 dBm, RBW = 1 Hz, 31.15 to 44 GHz
DANL= -141 dBm, RBW = 1 Hz, 26.4 to 31.15 GHz
TOI = +12.5 dBm
SOI = +90 dBm

Measurement	Specifications	Supplemental Information
Channel Power		
Amplitude Accuracy		Absolute Amplitude Accuracy[a] + Power Bandwidth Accuracy[bc]
Radio Std = 3GPPW-CDMA, or IS-95		
Absolute Power Accuracy 20 to 30°C Mixer level[d] < −20 dBm	±0.68 dB	±0.21 dB (typical)
Occupied Bandwidth		
Frequency Accuracy		± (Span/600) (nominal)

a. See Amplitude section.
b. See Frequency section
c. Expressed in dB
d. Mixer level is the input power minus the input attenuation.

Description	Specifications	Supplemental Information
Adjacent Channel Power (ACP)		
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	
Radio Std = 3GPP W-CDMA (ACPR; ACLR)[f]		
Minimum power at RF Input		–36 dBm (nominal)
ACPR Accuracy[g] Radio Offset Freq		RRC weighted, 3.84 MHz noise bandwidth.
MS (UE) 5 MHz	±0.12 dB	At ACPR range of –30 to –36 dBc with optimum mixer level[h]
MS (UE) 10 MHz	±0.17 dB	At ACPR range of –40 to –46 dBc with optimum mixer level[i]
BTS 5 MHz	±0.22 dB	At ACPR range of –42 to –48 dBc with optimum mixer level[j]
BTS 10 MHz	±0.22 dB	At ACPR range of –47 to –53 dBc with optimum mixer level[i]
BTS 5 MHz	±0.17 dB	At –48 dBc non-coherent ACPR[k]
Dynamic Range Noise Correction Offset Freq		RRC weighted, 3.84 MHz noise bandwidth
off 5 MHz		–74.5 dB (typical)[lm]
off 10 MHz		–82 dB (typical)[lm]
on 5 MHz		–81 dB (typical)[ln]
on 10 MHz		–88 dB (typical)[lm]
RRC Weighting Accuracy[o]		
White noise in Adjacent Channel TOI-induced spectrum r.m.s. CW error		0.00 dB nominal 0.004 dB nominal 0.023 dB nominal
Radio Std = IS-95 or J-STD-008		
Method		RBW method[p]
ACPR Relative Accuracy		
Offsets < 1300 kHz[q]	±0.10 dB	
Offsets > 1.85 MHz[rs]	±0.10 dB	

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 section

c. See Frequency section

d. Expressed in decibels

e. The passband of response for the adjacent channels is given by the convolution of two functions: a rectangle of width given by the programmed Ref BW parameter, and the power response of the RBW filter used. Therefore, the 3 dB bandwidth of the passband function will be equal to the Ref BW. 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 $x - 0.572 \times \mathrm{RBW}$.

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 –26dBm, so the input attenuation must be set as close as possible to the average input power - (–26 dBm). For example, if the average input power is –6 dBm, set the attenuation to 20 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 Bbase Transmission Station (BTS) within 3 dB of the required –45 dBc ACPR. 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 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.

l. Agilent measures 100% of PSAs 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, Agilent only gives a typical result. More than 80% of prototype PSAs 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 Agilent 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. The optimum mixer drive level will be approximately –12 dBm.

n. The optimum mixer drive level will be approximately –15 dBm.

o. 3GPP requires the use of a root-raised-cosine filter in evaluating the ACLR of a device. The accuracy of the passband shape of the filter is not specified in standards, nor is any method of evaluating that accuracy. This footnote discusses the performance of the filter in this instrument. The effect of the RRC filter and the effect of the RBW used in the measurement interact. The analyzer compensates the shape of the RRC filter to accommodate the RBW filter. The effectiveness of this compensation is summarized in three ways:
– White noise in Adj Ch: The compensated RRC filter nominally has no errors if the adjacent channel has a spectrum that is flat across its width.
– TOI-induced spectrum: If the spectrum is due to third-order intermodulation, it has a distinctive shape. The computed errors of the compensated filter are –0.004 dB for the 470 kHz RBW used for UE testing, and 0.000 dB for the 30 kHz RBW filter used for BTS testing. The worst error for RBWs between these extremes is 0.05 dB for a 330 kHz RBW filter. r.m.s.
– 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 r.m.s. error of the compensated filter is 0.023 dB for the 470 kHz RBW used for UE

testing, and 0.000 dB for the 30 kHz RBW filter used for BTS testing. The worst error for RBWs between these extremes is 0.057 dB for a 430 kHz RBW filter.

p. The RBW method measures the power in the adjacent channels within the defined resolution bandwidth. The noise bandwidth of the RBW filter is nominally 1.055 times the 3.01 dB bandwidth. Therefore, the RBW method will nominally read 0.23 dB higher adjacent channel power than would a measurement using the integration bandwidth method, because the noise bandwidth of the integration bandwidth measurement is equal to that integration bandwidth. For cmdaOne ACPR measurements using the RBW method, the main channel is measured in a 3 MHz RBW, which does not respond to all the power in the carrier. Therefore, the carrier power is compensated by the expected under-response of the filter to a full width signal, of 0.15 dB. But the adjacent channel power is not compensated for the noise bandwidth effect.

   The reason the adjacent channel is not compensated is subtle. The RBW method of measuring ACPR is very similar to the preferred method of making measurements for compliance with FCC requirements, the source of the specifications for the cdmaOne Spur Close specifications. ACPR is a spot measurement of Spur Close, and thus is best done with the RBW method, even though the results will disagree by 0.23 dB from the measurement made with a rectangular passband.

q. The specified ACPR accuracy applies if the measured ACPR substantially exceeds the analyzer dynamic range at the specified offset. When this condition is not met, there are additional errors due to the addition of analyzer spectral components to UUT spectral components. In the worst case at these offsets, the analyzer spectral components are all coherent with the UUT components; in a more typical case, one third of the analyzer spectral power will be coherent with the distortion components in the UUT. Coherent means that the phases of the UUT distortion components and the analyzer distortion components are in a fixed relationship, and could be perfectly in-phase. This coherence is not intuitive to many users, because the signals themselves are usually pseudo-random; nonetheless, they can be coherent.

   When the analyzer components are 100% coherent with the UUT components, the errors add in a voltage sense. That error is a function of the signal (UUT ACPR) to noise (analyzer ACPR dynamic range limitation) ratio, SN, in decibels.

   The function is error = $20 \times \log(1 + 10^{(-SN/20)})$

   For example, if the UUT ACPR is –62 dB and the measurement floor is –82 dB, the SN is 20 dB and the error due to adding the analyzer's distortion to that of the UUT is 0.83 dB.

r. As in the previous footnote, the specified ACPR accuracy applies if the ACPR measured substantially exceeds the analyzer dynamic range at the specified offset. When this condition is not met, there are additional errors due to the addition of analyzer spectral components to UUT spectral components. Unlike the situation in footnote p, though, the spectral components from the analyzer will be noncoherent with the components from the UUT. Therefore, the errors add in a power sense. The error is a function of the signal (UUT ACPR) to noise (analyzer ACPR dynamic range limitation) ratio, SN, in decibels.

   The function is error = $10 \times \log(1 + 10^{(-SN/10)})$.

   For example, if the UUT ACPR is –75 dB and the measurement floor is –85 dB, the SN ratio is 10 dB and the error due to adding the analyzer's noise to that of the UUT is 0.41 dB.

Measurement	Specifications	Supplemental Information
Multi-Carrier Power Radio Std = 3GPP W-CDMA ACPR Dynamic Range (two carriers) 5 MHz offset 10 MHz offset ACPR Accuracy (two carriers) 5 MHz offset, –48 dBc ACPR		RRC weighted, 3.84 MHz noise bandwidth –70 dB (nominal) –75 dB (nominal) ±0.38 dB (nominal)
Power Statistics CCDF Histogram Resolution[a]	0.1 dB	
Intermod (TOI)		Measure the third-order intercept from a signal with two dominant tones.
Harmonic Distortion Maximum harmonic number Results	10th Fundamental power (dBm) Relative harmonics power (dBc)	
Burst Power Methods Results	Power above threshold Power within burst width Output power, average Output power, single burst Maximum power Minimum power within burst Burst width	

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.

Measurement	Specifications	Supplemental Information
Spurious Emissions		Table-driven spurious signals; search across regions
Radio Std = cdma2000 or 3GPP W-CDMA		
Dynamic Range, relative 1980 MHz region[a]	–80.6 dB	–82.4 dB (typical)
Sensitivity, absolute 1980 MHz region[b]	–89.7 dBm	–91.7 dBm (typical)
Spectrum Emission Mask		Table-driven spurious signals; measurement near carriers
Radio Std = cdma2000		
Dynamic Range, relative 750 kHz offset[cd]	–85.3 dB	–88.3 dB (typical)
Sensitivity, absolute 750 kHz offset[e]	–105.7 dBm	–107 dBm (typical)
Accuracy, relative 750 kHz offset[f]	±0.09 dB	
Radio Std = 3GPP W-CDMA		
Dynamic Range, relative 2.515 MHz Offset[cg]	–87.3 dB	–89.5 dB (typical)
Sensitivity, absolute 2.515 MHz Offset[e]	–105.7 dBm	–107.7 dBm (typical)
Accuracy, relative 2.515 MHz Offset[f]	±0.10 dBm	

a. The dynamic range specification is the ratio of the channel power to the power in the region specified. The dynamic range depends on the many measurement settings. These specifications are based on the detector being set to average, the default RBW (1200 kHz), and depend on the mixer level. Mixer level is defined to be the input power minus the input attenuation. This dynamic range specification applies for a mixer level of –8 dBm. Higher mixer levels can give up to 5 dB better dynamic range, but at the expense of compression in the input mixer, which reduces accuracy. The compression behavior of the input mixer is specified in the amplitude section of these specifications.

b. The sensitivity for this region is specified in the default 1200 kHz bandwidth, at a center frequency of 1 GHz.

c. 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.

d. This dynamic range specification applies for the optimum mixer level, which is about –18 dBm. Mixer level is defined to be the input power minus the input attenuation.

e. 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.

f. 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.

g. This dynamic range specification applies for the optimum mixer level, which is about –16 dBm. Mixer level is defined to be the average input power minus the input attenuation.

Options

The following options affect instrument specifications.[a]

Option 1DS:	Preamplifier

a. For instrument personality specifications, refer to the User's Guide for that personality.

General

Description	Specifications	Supplemental Information
Temperature Range		
Operating	0 to 55°C	Floppy disk 10 to 40°C Maximum temperature: 40°C Maximum humidity: 80% relative (non-condensing)
Storage	–40 to 75°C	Temperature: -40 to +71°C Maximum humidity: 90% relative (non-condensing)
Altitude	2,000 meters	Approximately 6,562 feet

Description	Specifications	Supplemental Information
Display		
Resolution	640 x 480	
Scale		
Log Scale	0.1, 0.2, 0.3...1.0, 2.0, 3.0...20 dB per division	
Linear Scale	10% of reference level per division	
Acoustic Emissions (ISO 7779)		LNPE < 5.0 Bels at 25°C
Military Specification	Has been type tested to the environmental specifications of MIL-PRF-28800F class 3.	
EMI Compatibility	Conducted emission is in compliance with CISPR Pub. 11/1990 Group 1 Class A. Radiated emission is in compliance with CISPR Pub. 11/1990 Group 1 Class B.	

Description	Specifications	Supplemental Information
Immunity Testing		
Radiated Immunity		Testing was done at 3 V/m according to IEC 61000-4-3/1995. When the analyzer tuned frequency is identical to the immunity test signal frequency, there may be signals of up to –60 dBm displayed on the screen.
Electrostatic Discharge		Air discharges of up to 8 kV were applied according to IEC 61000-4-2/1995. Discharges to center pins of any of the connectors may cause damage to the associated circuitry.

Description	Specifications	Supplemental Information
Power Requirements		
Voltage, Frequency	100 to 132 Vrms, 47 to 66 Hz/360 to 440 Hz 195 to 250 Vrms, 47 to 66 Hz	
Power Consumption, On	Base <260W; Fully Loaded <450W	
Power Consumption, Standby	<20W	
Measurement Speed		
Local Measurement and Display Update rate[a]		
Sweep points = 601		≥ 50/s (nominal)
Remote Measurement and GPIB Transfer Rate		
Sweep points = 601		≥ 22/s (nominal)

a. Factory preset, fixed center frequency, RBW = 1 MHz, and span >10 MHz and ≤ 600 MHz, and stop frequency ≤ 3 GHz.

Description	Specifications	Supplemental Information
Data Storage		
Internal		2 MB
Floppy Drive (10 to 40°C)		3.5" 1.44 MB, MS-DOS® compatible
Weight		
(without options)		
Net E4440A, E4443A, E4445A		23 kg (nominal) 50 lbs (nominal)
Net E4446A, E4448A		24 kg (nominal) 53 lbs (nominal)
Shipping		33 kg (nominal) 73 lb (nominal)
Cabinet Dimensions		Cabinet dimensions exclude front and rear protrusions.
Height	177 mm (7.0 in)	
Width	426 mm (16.8 in)	
Length	483 mm (19 in)	

Inputs and Outputs

Front Panel

Description	Specifications	Supplemental Information	
RF INPUT		Nominal	
Connector	2.4 mm male		
Impedance		50Ω	
First LO Emission Level[a]		Band 0	Band ≥ 1
		< −120 dBm	< −100 dBm

Description	Specifications	Supplemental Information
PROBE POWER		
Voltage/Current		+15 Vdc, ±7% at 150 mA max (nominal) −12.6 Vdc, ±10% at 150 mA max (nominal) GND
EXT TRIGGER INPUT		
Connector	BNC female	
Impedance		10 kΩ (nominal)
Trigger Level		5V TTL

a. With 10 dB attenuation

Rear Panel

Description	Specifications	Supplemental Information
10 MHz OUT (Switched)		Switchable On/Off
Connector	BNC female	
Impedance		50Ω (nominal)
Output Amplitude		≥ 0 dBm (nominal)
Frequency Accuracy	10 MHz ± (10 MHz x frequency reference accuracy)	
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.
Impedance		50Ω (nominal)
Input Amplitude Range		–5 to +10 dBm (nominal)
Frequency		1 to 30 MHz (nominal) (settable to 1 Hz resolution)
Frequency lock range	$\pm 5 \times 10^{-6}$ of specified external reference input frequency	
Trigger In		
Connector	BNC female	
External Trigger Input Impedance Trigger Level		Configurable Front or Rear >10 kΩ (nominal) 5V TTL (nominal)
Keyboard		
Connector	6-pin mini-DIN (PS2)	
Trigger 1 and Trigger 2 Outputs		
Connector	BNC female	
Trigger 1 Output Impedance Level		HSWP (High = sweeping) 50Ω (nominal) 5V TTL
Trigger 2 Output		Reserved for future applications

Description	Specifications	Supplemental Information
Monitor Output		
Connector	VGA compatible, 15-pin mini D-SUB	
Format		VGA (31.5 kHz horizontal, 60Hz vertical sync rates, non-interlaced) Analog RGB
Resolution	640 x 480	
PRE-SEL TUNE OUT		
Connector	BNC female	
Load Impedance (dc Coupled)		110Ω (nominal)
Range		0 to 10V (nominal)
Sensitivity		
External Mixer		1.5 V/GHz of tuned L.O. frequency (nominal)
Remote Programming[a]		
GPIB Interface		
Connector	IEEE-488 bus connector	
GPIB Codes		SH1, AH1, T6, SR1, RL1, PP0, DC1, C1, C2, C3 and C28, DT1, L4, C0
Serial Interface		
Connector	9-pin D-SUB male	Factory use only
Parallel Interface		
Connector	25-pin D-SUB female	Printer port only
LAN TCP/IP Interface	RJ45 Ethertwist	
321.4 MHz IF Output		
Connector	SMA female	
Impedance		50Ω (nominal)
Frequency		321.4 MHz (nominal)
Conversion Gain[b]		+2 to +4 dB (nominal)
SCSI Interface		
Connector	Mini D 50, female	Factory use only

a. Control languages - SCPI version 1992.0

b. Conversion gain is measured from RF input to 321.4 MHz IF output, with 0 dB input attenuation. The 321.4 MHz IF output is located in the RF chain at a point where all of the frequency response corrections are *not* applied. Conversion gain varies nominally ± 3dB as a function of tune frequency.

Regulatory Information

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

This product has been designed and tested in accordance with IEC Publication 61010, Safety Requirements for Electronic Measuring Apparatus, 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.

	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).
	The CSA mark is the Canadian Standards Association safety mark.
ISM 1-A	This is a symbol of an Industrial Scientific and Medical Group 1 Class A product. (CISPR 11, Clause 4)

Declaration of Conformity

DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014

Manufacturer's Name: Agilent Technologies, Inc.

Manufacturer's Address: 1400 Fountaingrove Parkway
Santa Rosa, CA 95403-1799
USA

Declares that the product

Product Name: PSA Performance Spectrum Analyzer

Model Number: E4440A, E4443A, E4445A, E4446A, E4448A

Product Options: This declaration covers all options of the above product.

Conforms to the following product specifications:

EMC: IEC 61326-1:1997+A1:1998 / EN 61326-1:1997+A1:1998

Standard	Limit
CISPR 11:1990 / EN 55011-1991	Group 1, Class A
IEC 61000-4-2:1995+A1998 / EN 61000-4-2:1995	4 kV CD, 8 kV AD
IEC 61000-4-3:1995 / EN 61000-4-3:1995	3 V/m, 80 - 1000 MHz
IEC 61000-4-4:1995 / EN 61000-4-4:1995	0.5 kV sig., 1 kV power
IEC 61000-4-5:1995 / EN 61000-4-5:1996	0.5 kV L-L, 1 kV L-G
IEC 61000-4-6:1996 / EN 61000-4-6:1998	3 V, 0.15 – 80 MHz
IEC 61000-4-11:1994 / EN 61000-4-11:1998	1 cycle, 100%

Safety: IEC 61010-1:1990 + A1:1992 + A2:1995 / EN 61010-1:1993 +A2:1995
CAN/CSA-C22.2 No. 1010.1-92

Supplementary Information:
The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the CE-marking accordingly.

Santa Rosa, CA, USA 6 May, 2002

Greg Pfeiffer/Quality Engineering Manager

For further information, please contact your local Agilent Technologies sales office, agent or distributor.

Rev. C