Specifications Guide

Agilent Technologies PSA Series Spectrum Analyzers

This manual provides documentation for the following instruments:

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

Agilent Technologies

Manufacturing Part Numbers: E4440-90217

Supersedes: E4440-90062
Printed in USA
December 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 PSA Specifications

Definitions and Requirements

This chapter contains specifications and supplemental information for PSA Series 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. See the General chapter.
- 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

E4443A

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	10 MHz to 3.0 GHz (AC Coupled)	1–
1	2.85 to 6.6 GHz	1–
2	6.2 to 6.7 GHz	2–
Preamp On *(Option 1DS)*	100 kHz to 3.0 GHz[b]	1–

E4445A

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

c. 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).

d. 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.

E4440A

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	10 MHz to 3.0 GHz (AC Coupled)	1–
1	2.85 to 6.6 GHz	1–
2	6.2 to 13.2 GHz	2–
3	12.8 to 19.2 GHz	4–
4	18.7 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.

E4446A

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 to 6.6 GHz	1–
2	6.2 to 13.2 GHz	2–
3	12.8 to 19.2 GHz	4–
4	18.7 to 26.8 GHz	4–
5	26.4 to 31.15 GHz	4+
6	31.0 to 44.0 GHz	8–
Preamp On (*Option 1DS*)	100 kHz to 3.0 GHz[b]	1–

E4448A

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

c. 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).

d. 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 × aging rate) + temperature stability + calibration accuracy[a]]	
Temperature Stability		
20 to 30 °C	$\pm1 \times 10^{-8}$	
0 to 55 °C	$\pm5 \times 10^{-8}$	
Aging Rate	$\pm1 \times 10^{-7}$/year[b]	$\pm5 \times 10^{-10}$/day (nominal)
Settability	$\pm2 \times 10^{-9}$	
Warm-up and Retrace[c]		
Within 5 min. after turn on		$\pm1 \times 10^{-7}$ of final frequency (nominal)
Within 15 min. after turn on		$\pm5 \times 10^{-8}$ of final frequency (nominal)
Achievable Initial Calibration Accuracy[d]	$\pm7 \times 10^{-8}$	

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]

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

a. 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.

d. Instrument conditions: RBW = 1 kHz, gate time = auto (100 ms), S/N ≥ 50 dB, frequency = 1 GHz

e. If the signal being measured is locked to the same frequency reference as the analyzer, the specified count accuracy is ±0.100 Hz under the test conditions of footnote a. This error is a noisiness of the result. It will increase with noisy sources, wider RBWs, lower S/N ratios, and source frequencies >1 GHz.

Description	Specifications	Supplemental Information
Frequency Span		
Range Swept and FFT		
E4443A	0 Hz, 10 Hz to 6.7 GHz	
E4445A	0 Hz, 10 Hz to 13.2 GHz	
E4440A	0 Hz, 10 Hz to 26.5 GHz	
E4446A	0 Hz, 10 Hz to 44 GHz	
E4448A	0 Hz, 10 Hz to 50 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 × (Npts - 1) × 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 601 sweep points, that exception occurs only for spans > 450 MHz.

b. 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.

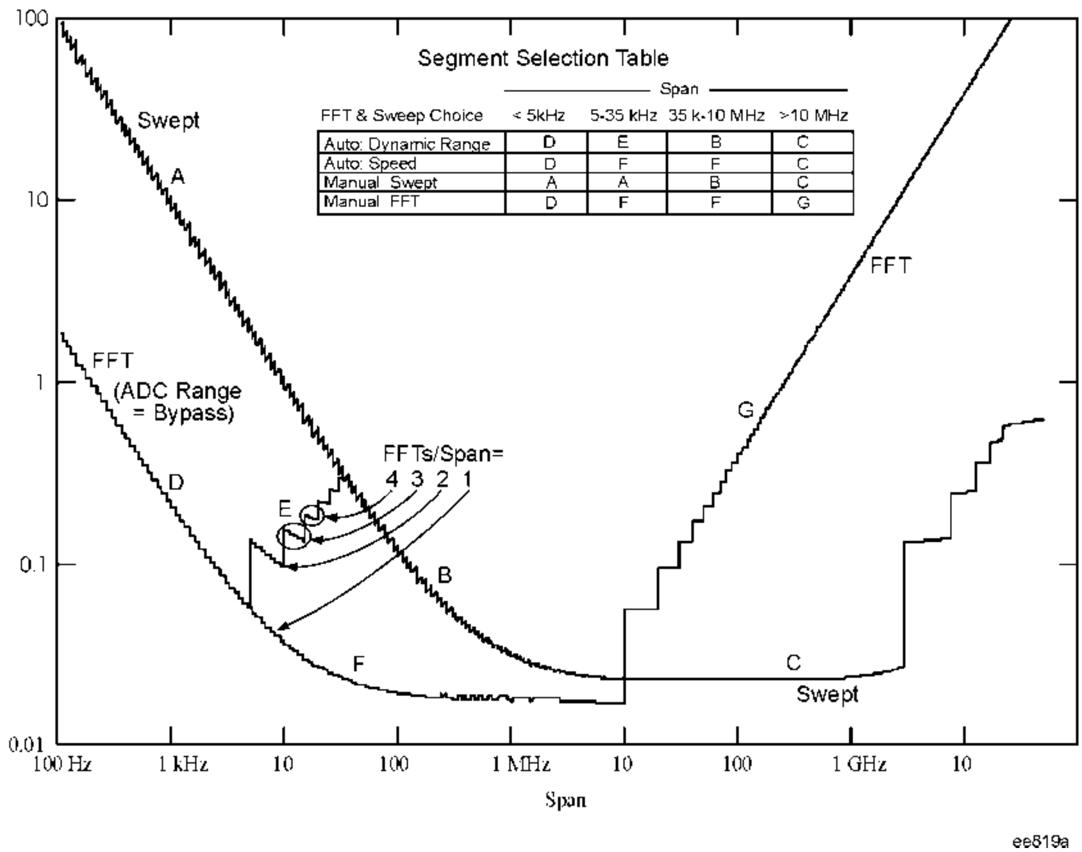
Description	Specifications	Supplemental Information
Sweep Time		
Range		
Span = 0 Hz	1 µs to 6000 s	
Span ≥ 10 Hz	1 ms to 2000 s	
Accuracy		
Span ≥ 10 Hz, swept		±0.01 % (nominal)
Span ≥ 10 Hz, FFT		±40 % (nominal)
Span = 0 Hz		±0.01 % (nominal)
Sweep Trigger	Free Run, Line, Video, External Front, External Rear, RF Burst	
Delayed Trigger[a]		
Range		
Span ≥ 10 Hz, swept	1 µs to 500 ms	
Span = 0 Hz or FFT	–150 ms to +500 ms	
Resolution	0.1 µs	

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 greater	
Gate Duration		1.83/RBW ± 2 % (nominal)

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 (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.	
Power bandwidth accuracy[a]			
RBW Range	CF Range		
1 Hz – 51 kHz	All	±0.5 %	Equivalent to ±0.022 dB
56 – 75 kHz	All	±1.0 %	Equivalent to ±0.044 dB
82 – 330 kHz	All	±0.5 %	Equivalent to ±0.022 dB
360 kHz – 1.2 MHz	< 3 GHz	±1.0 %	Equivalent to ±0.044 dB
1.3 – 2.0 MHz	< 3 GHz		±0.07 dB (nominal)
2.2 – 6 MHz	< 3 GHz		±0.2 dB (nominal)
Accuracy (–3.01 dB bandwidth)[b]			
1 Hz to 1.5 MHz RBW			±2 % (nominal)
1.6 MHz to 3 MHz RBW (CF ≤ 3 GHz) (CF > 3 GHz)			 ±7 % (nominal) ±8 % (nominal)
4 MHz to 8 MHz RBW (CF ≤ 3 GHz) (CF > 3 GHz)			 ±15 % (nominal) ±20 % (nominal)
Selectivity (–60 dB/–3 dB)			4.1:1 (nominal)

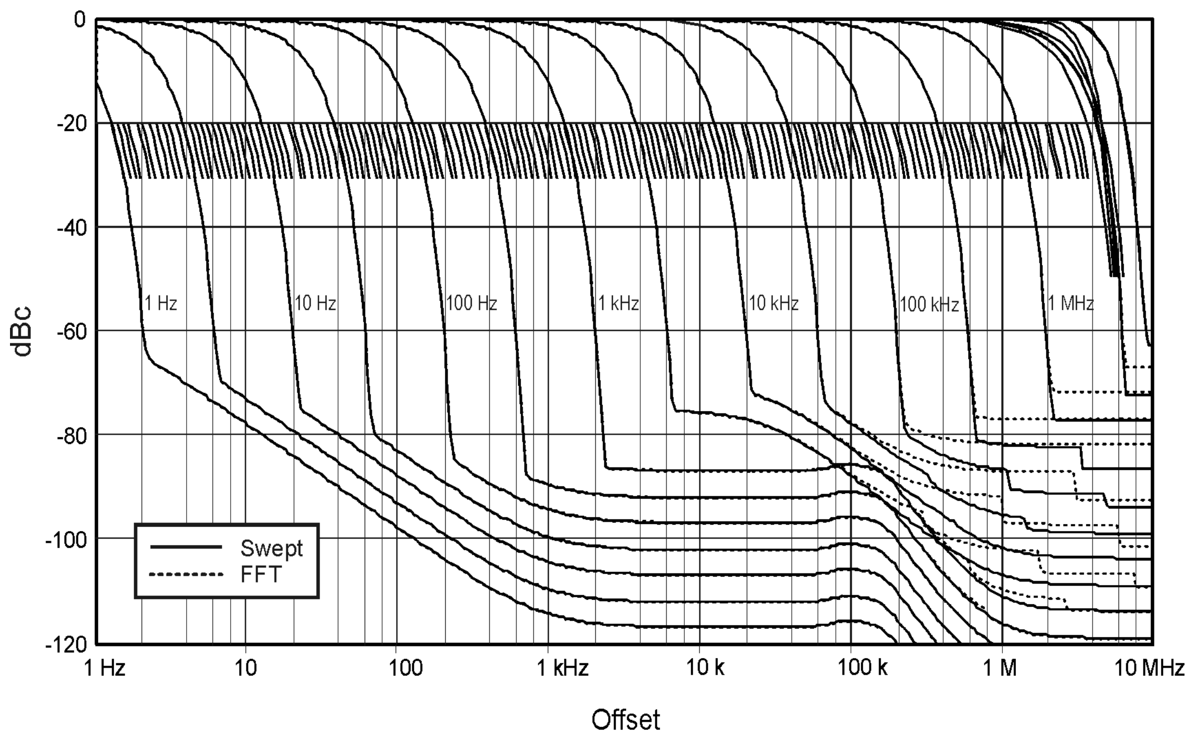
a. The noise marker, band power marker, channel power and ACP all compute their results using the power bandwidth of the RBW used for the measurement. Power bandwidth accuracy is the power uncertainty in the results of these measurements due only to bandwidth-related errors. (The analyzer knows this power bandwidth for each RBW with greater accuracy than the RBW width itself, and can therefore achieve lower errors.)

b. 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.

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
High band (2.85 to 26.5 GHz)		30 to 60 MHz[a]
mm band (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

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]

Description	Specifications		Supplemental Information	
Stability				
Noise Sidebands Center Frequency = 1 GHz[b] Best-case Optimization[c]	**20 to 30 °C**	**0 to 55 °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[d]	–148 dBc/Hz[d]
6 MHz	–151 dBc/Hz	–150 dBc/Hz	–152 dBc/Hz[d]	–156 dBc/Hz[d]
10 MHz	–151 dBc/Hz	–150 dBc/Hz	–152 dBc/Hz[d]	–157.5 dBc/Hz[d]
Residual FM	<(1 Hz × N[e]) p-p in 1 s			

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

b. 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 × 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 × log CF, where CF is the center frequency in GHz.

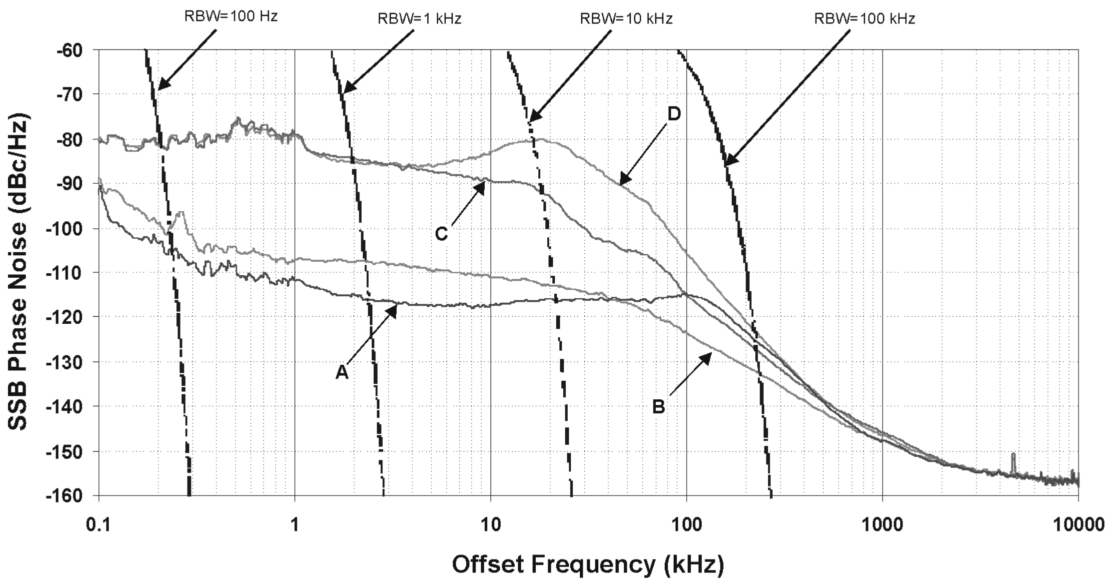
c. Noise sidebands for offsets of 30 kHz and below are shown for phase noise optimization set to optimize £(f) for f < 50 kHz; for offsets of 100 kHz and above, the optimization is set for f > 50 kHz.

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

e. N is the harmonic mixing mode.

Nominal Phase Noise of Different LO Optimizations

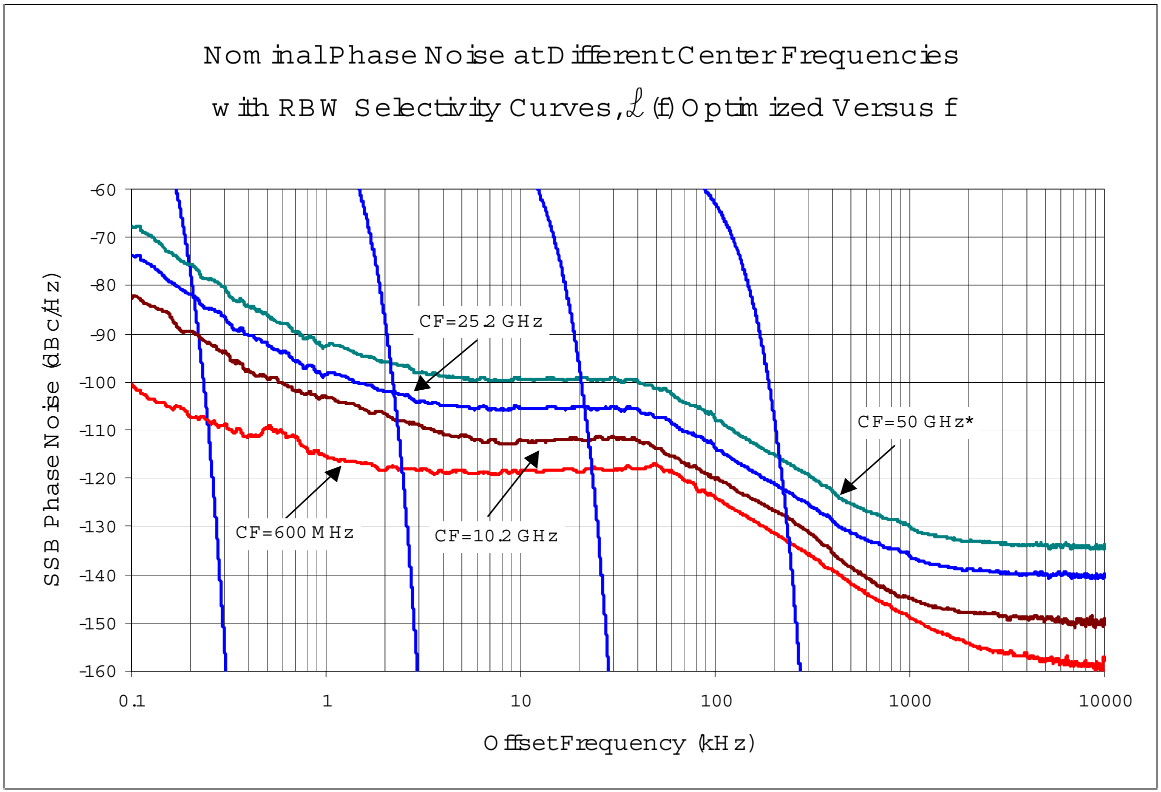
Nominal Phase Noise of Different LO Optimizations, with RBW Selectivity Curves, CF = 1 GHz



Sweep Type	Span	Optimize £ (f) for f < 50 kHz	Optimize £ (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			

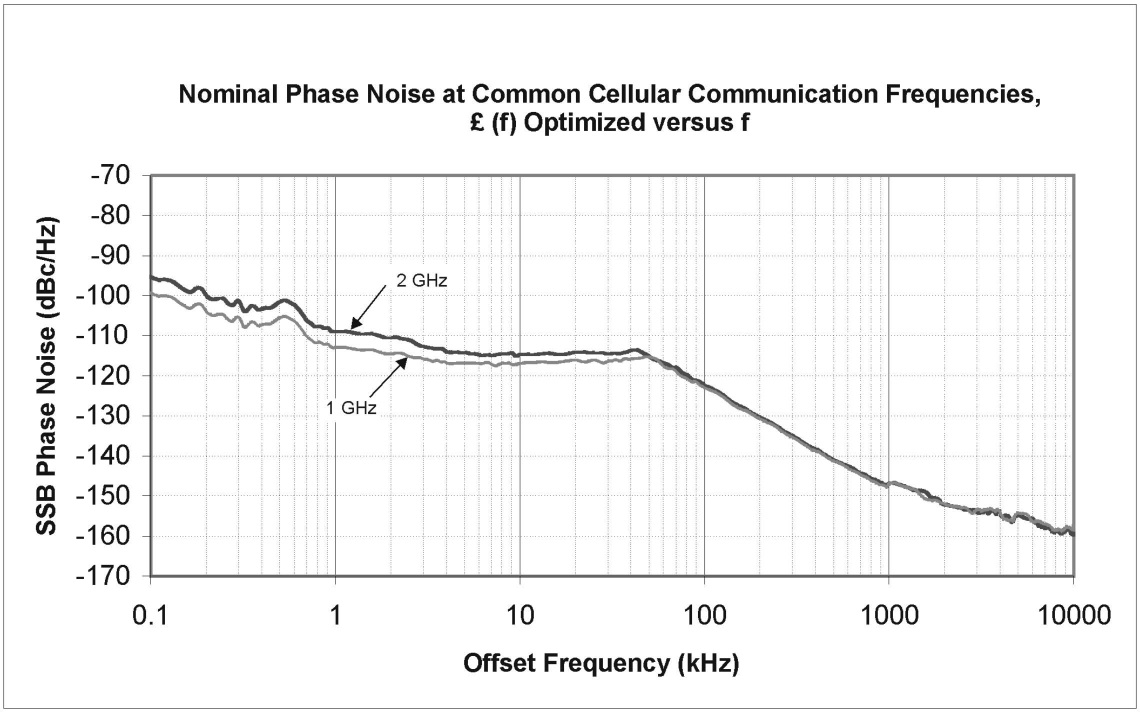
Ee815b

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.

Nominal Phase Noise at Common Cellular Communication Frequencies



Amplitude

Description	Specifications	Supplemental Information
Measurement Range	Displayed Average Noise Level to +30 dBm	
Preamp On (*Option 1DS*)	Displayed Average Noise Level to +25 dBm	
Input Attenuation 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 (1 W)	
Peak Pulse Power <10 μs pulse width, <1 % duty cycle, and input attenuation ≥ 30 dB	+50 dBm (100 W)	
DC volts DC Coupled AC Coupled (E4443A, E4445A, E4440A)	 ±0.2 Vdc ±100 Vdc	

Gain Compression

E4443A, E4445A, E4440A

Description	Specifications	Supplemental Information	
1 dB Gain Compression Point (Two-tone)[abc]	Maximum power at mixer[d]	Nominal[e]	
20 to 200 MHz	0 dBm	+3 dBm	
200 MHz to 3.0 GHz	+3 dBm	+7 dBm	
3.0 to 6.6 GHz	+3 dBm	+4 dBm	
6.6 to 26.5 GHz	–2 dBm	0 dBm	
Typical Gain Compression (Two-tone)		Mixer Level	Typical[e] Compression
20 to 200 MHz		0 dBm	< 0.5 dB
200 MHz to 6.6 GHz		+3 dBm	< 0.5 dB
6.6 to 26.5 GHz		–2 dBm	< 0.4 dB
Preamp On (*Option 1DS*) Maximum power at the preamp[f] for 1 dB gain compression			
10 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. 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 attenuation setting: When the input attenuation is set to auto, the rules for the determination of the input attenuation include dependence on the reference level. Because the input attenuation setting controls the tradeoff between large signal behaviors (third-order intermodulation, compression, and display scale fidelity) and small signal effects (noise), the measurement results can change with RL changes when the input attenuation is set to auto.

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

e. The 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).

E4446A, E4448A

Description	Specifications	Supplemental Information	
1 dB Gain Compression Point (Two-tone)[a,b,c]	Maximum power at mixer[d]	Nominal[e]	
20 to 200 MHz	+2 dBm	+3 dBm	
200 MHz to 3.0 GHz	+3 dBm	+7 dBm	
3.0 to 6.6 GHz	+3 dBm	+4 dBm	
6.6 to 26.8 GHz	–2 dBm	0 dBm	
26.8 to 50.0 GHz		0 dBm	
Typical Gain Compression (Two-tone)		Mixer Level	Typical[e] Compression
20 to 200 MHz		0 dBm	< 0.5 dB
200 MHz to 6.6 GHz		+3 dBm	< 0.5 dB
6.6 to 26.8 GHz		–2 dBm	< 0.4 dB
Preamp On *(Option 1DS)* Maximum power at the preamp[f] for 1 dB gain compression			
10 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. 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 attenuation setting: When the input attenuation is set to auto, the rules for the determination of the input attenuation include dependence on the reference level. Because the input attenuation setting controls the tradeoff between large signal behaviors (third-order intermodulation, compression, and display scale fidelity) and small signal effects (noise), the measurement results can change with RL changes when the input attenuation is set to auto.

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

e. The 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).

Displayed Average Noise Level (DANL)

E4443A, E4445A, E4440A

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 to 10 kHz				–130 dBm
	Zero span & swept Normalized[a] **to 1 Hz**		**FFT Only Actual**[b] **1 Hz**	**Zero span & swept**[a]
	20 to 30 °C	**0 to 55 °C**	**20 to 30 °C**	**(typical)**
10 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 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 to 2.5 GHz	–154 dBm	–153 dBm	–153 dBm	–155 dBm
2.5 to 3 GHz	–153 dBm	–152 dBm	–152 dBm	–154 dBm
3 to 6.6 GHz	–152 dBm	–151 dBm	–151 dBm	–153 dBm
6.6 to 13.2 GHz	–150 dBm	–149 dBm	–149 dBm	–152 dBm
13.2 to 20 GHz	–147 dBm	–146 dBm	–146 dBm	–149 dBm
20 to 26.5 GHz	–143 dBm	–142 dBm	–143 dBm	–145 dBm
Preamp On (*Option 1DS*)				
100 to 200 kHz	–161 dBm	–159 dBm	–160 dBm	–164 dBm
200 to 500 kHz	–164 dBm	–162 dBm	–163 dBm	–167 dBm
500 kHz to 10 MHz	–166 dBm	–163 dBm	–165 dBm	–168 dBm
10 MHz to 1.1 GHz	–169 dBm	–168 dBm	–168 dBm	–170 dBm
1.1 to 2.5 GHz	–168 dBm	–167 dBm	–167 dBm	–169 dBm
2.5 to 3.0 GHz	–166 dBm	–166 dBm	–165 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 Hz) 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.

E4446A, E4448A

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 to 10 kHz					–130 dBm
	Zero span & swept Normalized[a] **to 1 Hz**		**FFT Only Actual**[b] **1 Hz**		**Zero span & swept**
	20 to 30 °C	**0 to 55 °C**	**20 to 30 °C**	**0 to 55 °C**	**(typical)**
10 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 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 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
44 to 49 GHz	–128 dBm	–127 dBm	–127 dBm	–126 dBm	–131 dBm
49 to 50 GHz	–127 dBm	–126 dBm	–126 dBm	–125 dBm	–130 dBm
Preamp On (*Option 1DS*)					
100 to 200 kHz	–160 dBm	–159 dBm	–159 dBm	–157 dBm	–164 dBm
200 to 500 kHz	–163 dBm	–162 dBm	–162 dBm	–160 dBm	–167 dBm
500 kHz to 1 MHz	–164 dBm	–163 dBm	–163 dBm	–161 dBm	–168 dBm
1 to 10 MHz	–167 dBm	–166 dBm	–166 dBm	–166 dBm	–169 dBm
0.01 to 1.2 GHz	–167 dBm	–166 dBm	–167 dBm	–167 dBm	–169 dBm
1.2 to 2.2 GHz	–166 dBm	–165 dBm	–166 dBm	–166 dBm	–168 dBm
2.2 to 3.0 GHz	–164 dBm	–163 dBm	–164 dBm	–163 dBm	–166 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. 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 attenuation setting: When the input attenuation is set to auto, the rules for the determination of the input attenuation include dependence on the reference level. Because the input attenuation setting controls the tradeoff between large signal behaviors (third-order intermodulation, compression, and display scale fidelity) and small signal effects (noise), the measurement results can change with RL changes when the input attenuation is set to auto.

Frequency Response

E4443A, E4445A, E4440A

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	±0.11 dB
3.0 to 6.6 GHz[b]	±1.50 dB	±2.00 dB	±0.6 dB
6.6 to 13.2GHz[b]	±2.00 dB	±2.50 dB	±1.0 dB
13.2 to 22.0 GHz[b]	±2.00 dB	±2.50 dB	±0.9 dB
22.0 to 26.5 GHz[b]	±2.50 dB	±3.50 dB	±1.3 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	±0.19 dB
Frequency Response at Attenuation ≠ 10 dB			
Atten = 20, 30 or 40 dB	**20 to 30 °C**	**0 to 55 °C**	
10 MHz to 2.2 GHz	±0.53 dB	±0.68 dB	
2.2 to 3 GHz	±0.69 dB	±0.84 dB	
Other atten settings			Nominally, same performance as the 20, 30 and 40 dB settings

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.

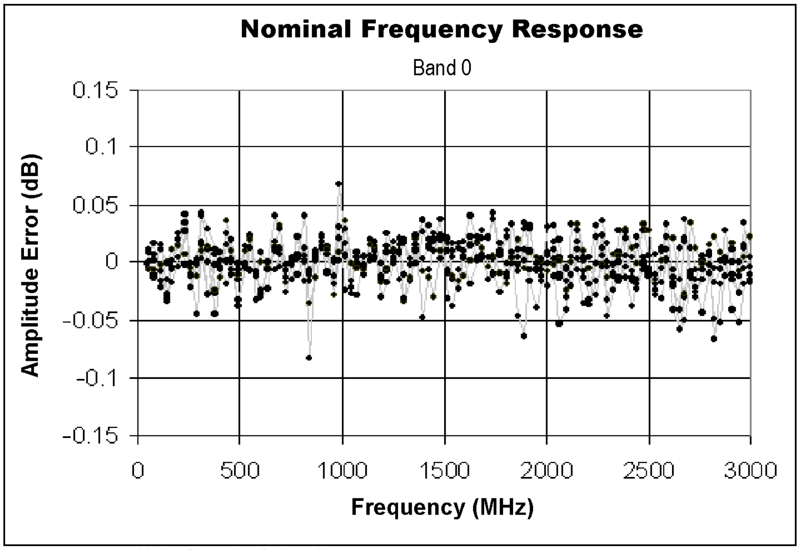
e. An FFT width is given by the span divided by the FFTs/Span parameter.

E4446A, E4448A

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	±0.70 dB	±0.15 dB
3.0 to 6.6 GHz[b]	±1.50 dB	±2.00 dB	±0.6 dB
6.6 to 13.2 GHz[b]	±2.00 dB	±3.00 dB	±1.0 dB
13.2 to 22.0 GHz[b]	±2.00 dB	±2.50 dB	±1.2 dB
22.0 to 26.8 GHz[b]	±2.50 dB	±3.50 dB	±1.3 dB
26.4 to 31.15 GHz[b]	±1.75 dB	±2.75 dB	±0.6 dB
31.15 to 50.0 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		
Preamp On (*Option 1DS*)			
100 kHz to 3.0 GHz	±0.70 dB	±0.80 dB	±0.30 dB
Frequency Response at Attenuation ≠ 10 dB			
Atten = 20, 30 or 40 dB	**20 to 30 °C**	**0 to 55 °C**	
10 MHz to 2.2 GHz	±0.53 dB	±0.68 dB	
2.2 to 3 GHz	±0.69 dB	±0.84 dB	
Other atten settings			Nominally, same performance as the 20, 30 and 40 dB settings

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		
Relative to 10 dB (reference setting)		
Specifications also apply to *Option 1DS*		
Frequency Range		
50 MHz (reference frequency)		
Atten = 12 to 40 dB	±0.14 dB	±0.037 dB (typical)
Other settings ≥ 2 dB	±0.18 dB	±0.053 dB (typical)
Atten = 0 dB	±0.20 dB	±0.083 dB (typical)
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)

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

a. The preamp is between the input attenuator and the input mixer.

Description	Specifications	Supplemental Information
Absolute Amplitude Accuracy		
At 50 MHz[a] 20 to 30 °C 0 to 55 °C	 ±0.24 dB ±0.28 dB	 ±0.06 dB (typical)
At all frequencies[a] 20 to 30 °C 0 to 55 °C	 ±(0.24 dB + frequency response) ±(0.28 dB + frequency response)	 ±(0.06 dB + frequency response) (typical)
95 % Confidence Absolute Amplitude Accuracy[b] Wide range of signal levels, RBWs,RL, etc.		
0 to 3 GHz, Atten = 10 dB		±0.24 dB
0 to 2.2 GHz, Atten = 10, 20, 30 or 40 dB		±0.26 dB
Amplitude Reference Accuracy		±0.05 dB (nominal)
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 a wide range of signal and measurement settings, with 95 % confidence, for the attenuation settings and frequency ranges shown. The wide range of settings of RBW, signal level, VBW, reference level and display scale are discussed in footnote a. The value given is computed from the observations of a statistically significant number of instruments. The computation includes the root-sum-squaring of these terms: the absolute amplitude accuracy observed at 50 MHz at 44 quasi-random combinations of settings and signal levels, the frequency response relative to 50 MHz at 102 quasi=random test frequencies, the attenuation switching uncertainty relative to 10 dB at 50 MHz, and the measurement uncertainties of 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 95 % confidence.

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.

RF Input VSWR

E4443A, E4445A, E4440A

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 to 18 GHz		< 1.6:1
18 to 26.5 GHz		< 1.9:1
2 to 6 dB input attenuation		
50 MHz to 3 GHz		< 1.6:1
3 to 26.5 GHz		< 1.9:1
0 dB input attenuation		
50 MHz to 3 GHz		< 1.9:1
3 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

E4446A, E4448A

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 to 18 GHz		< 1.27:1
18 to 26.5 GHz		< 1.37:1
26.5 to 50.0 GHz		< 1.57:1
2 to 6 dB input attenuation		
50 MHz to 3 GHz		< 1.29:1
3 to 18 GHz		< 1.75:1
18 to 26.5 GHz		< 1.68:1
26.5 to 50.0 GHz		< 1.94:1
0 dB input attenuation		
50 MHz to 3 GHz		< 1.48:1
3 to 18 GHz		< 2.55:1
18 to 26.5 GHz		< 2.90:1
26.5 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 7.07 V, 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 attenuation setting: When the input attenuation is set to auto, the rules for the determination of the input attenuation include dependence on the reference level. Because the input attenuation setting controls the tradeoff between large signal behaviors (third-order intermodulation, compression, and display scale fidelity) and small signal effects (noise), the measurement results can change with RL changes when the input attenuation is set to auto.

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[a]	

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

Description	Specifications	Supplemental Information		
Display Scale Fidelity[abcd]				
Log-Linear Fidelity (relative to the reference condition of –25 dBm input through the 10 dB attenuation, or –35 dBm at the input mixer)				
Input mixer level[e]	Linearity			
≤ –20 dBm ≤ –10 dBm	±0.07 dB ±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.

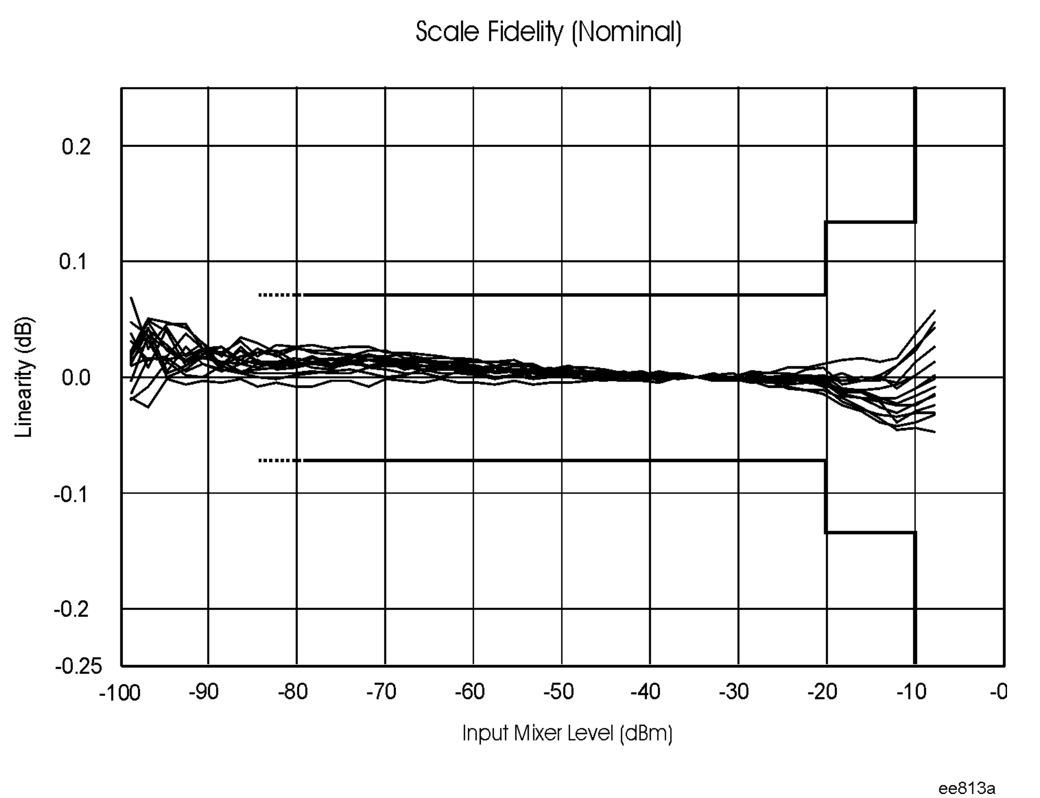
d. Reference level and off-screen performance: The reference level (RL) behavior differs from previous analyzers in a way that makes PSA more flexible. In previous analyzers, the RL controlled how the measurement was performed as well as how it was displayed. Because the logarithmic amplifier in previous 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.

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 –5 dBm, using attenuator = 10 dB 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, nor 2 kHz and under, parameters B2 and C2 are determined by formulas. B2 is 7/3000, or 0.00233. C2 is 76 dB/3000, or 0.025 dB. With these values for the parameters, the equation becomes: ± 0.011 dB $\pm$ ($0.0093 \times \Delta P$ 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.

Display Scale Fidelity



Description	Specifications	Supplemental Information
General Spurious Responses		
Mixer Level[a] = –40 dBm		
f < 10 MHz from carrier	(–73 + 20 log N) dBc[b]	
f ≥ 10 MHz from carrier	(–80 + 20 log N) dBc[b]	(–90 + 20 log N) dBc[b] (typical)

a. Mixer level = Input Level – Input Attenuation
b. N = LO mixing harmonic

Description	Specifications			Supplemental Information	
Second Harmonic Distortion	**Mixer Level**[a]	**Distortion**	**SHI**[b]	**Distortion** (nominal)	**SHI** (nominal)
Source Frequency					
10 to 400 MHz	–40 dBm	–82 dBc	+42 dBm		
400 to 1.25 GHz	–40 dBm	–92 dBc	+52 dBm		
1.25 to 1.5 GHz	–40 dBm	–82 dBc	+42 dBm		
1.5 to 2.0 GHz	–10 dBm	–90 dBc	+80 dBm		
2.0 to 13.25 GHz	–10 dBm	–100 dBc	+90 dBm		
13.25 to 25.0 GHz					
E4443A, E4445A, E4440A	N/A				
E4446A, E4448A	–10 dBm			–100 dBc	+90 dBm
Preamp On *(Option 1DS)*	**Preamp Level**[c]				
10 MHz to 1.5 GHz	–45 dBm			–60 dBc	+15 dBm

a. Mixer level = Input Level – Input Attenuation

b. SHI = second harmonic intercept. The SHI is given by the mixer power in dBm minus the second harmonic distortion level relative to the mixer tone in dBc. The measurement is made with a –11 dBm tone at the input mixer.

c. Preamp level = Input Level – Input Attenuation.

Third Order Intermodulation Distortion

E4443A, E4445A, E4440A

Description	Specifications		Supplemental Information
Third Order Intermodulation Distortion Tone separation >15 kHz Sweep type *not* set to FFT			Verification conditions[a]
	Distortion[b]	**TOI**[c]	**TOI** (typical)
20 to 30 °C	Two –30 dBm tones		
10 to 100 MHz	–88 dBc	+14 dBm	+17 dBm
100 to 400 MHz	–90 dBc	+15 dBm	+18 dBm
400 MHz to 1.7 GHz	–92 dBc	+16 dBm	+19 dBm
1.7 to 2.7 GHz	–94 dBc	+17 dBm	+19 dBm
2.7 to 3 GHz	–94 dBc	+17 dBm	+20 dBm
3 to 6 GHz	–90 dBc	+15 dBm	+18 dBm
6 to 16 GHz	–76 dBc	+8 dBm	+11 dBm
16 to 26.5 GHz	–84 dBc	+12 dBm	+14 dBm
0 to 55 °C			
10 to 100 MHz	–86 dBc	+13 dBm	+17 dBm
100 to 400 MHz	–86 dBc	+13 dBm	+17 dBm
400 MHz to 2.7 GHz	–90 dBc	+15 dBm	+18 dBm
2.7 to 3 GHz	–90 dBc	+15 dBm	+18 dBm
3 to 6 GHz	–90 dBc	+15 dBm	+18 dBm
6 to 16 GHz	–74 dBc	+7 dBm	+10 dBm
16 to 26.5 GHz	–82 dBc	+11 dBm	+13 dBm
Preamp On (*Option 1DS*)			Verification conditions[d]
			TOI (nominal)
10 to 500 MHz			–15 dBm
500 MHz to 3 GHz			–13 dBm

a. TOI is verified with two tones, each at –18 dBm at the mixer, spaced by 100 kHz.

b. Distortion for two tones that are each at –30 dBm is computed from TOI.

c. 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.

d. TOI is verified with two tones each at –45 dBm at the preamp, spaced by 100 kHz.

E4446A, E4448A

Description	Specifications		Supplemental Information
Third Order Intermodulation Distortion Tone separation >15 kHz Sweep type *not* set to FFT			Verification conditions[a]
	Distortion[b]	**TOI**[c]	**TOI** (typical)
20 to 30 °C	Two –30 dBm tones		
10 to 100 MHz	–90 dBc	+15 dBm	+20 dBm
100 to 400 MHz	–92 dBc	+16 dBm	+21 dBm
400 MHz to 1.7 GHz	–94 dBc	+17 dBm	+20 dBm
1.7 to 2.7 GHz	–96 dBc	+18 dBm	+21 dBm
2.7 to 3 GHz	–96 dBc	+18 dBm	+21 dBm
3 to 6 GHz	–92 dBc	+16 dBm	+21 dBm
6 to 16 GHz	–84 dBc	+12 dBm	+15 dBm
16 to 26.5 GHz	–84 dBc	+12 dBm	+16 dBm
26.5 to 50.0 GHz			+12.5 dBm (nominal)
0 to 55 °C			
10 to 100 MHz	–88 dBc	+14 dBm	+19 dBm
100 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 to 2.7 GHz	–94 dBc	+17 dBm	+20 dBm
2.7 to 3 GHz	–93 dBc	+16.5 dBm	+20.5 dBm
3 to 6 GHz	–92 dBc	+16 dBm	+21 dBm
6 to 16 GHz	–84 dBc	+12 dBm	+14 dBm
16 to 26.5 GHz	–84 dBc	+12 dBm	+15 dBm
26.5 to 50.0 GHz			+12.5 dBm (nominal)
Preamp On (*Option 1DS*)			Verification conditions[d]
			TOI (nominal)
10 to 500 MHz			–15 dBm
500 MHz to 3 GHz			–13 dBm

a. TOI is verified with two tones, each at –18 dBm at the mixer, spaced by 100 kHz.

b. Distortion for two tones that are each at –30 dBm is computed from TOI.

c. 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.

d. TOI is verified with two tones each at –45 dBm at the preamp, spaced by 100 kHz.

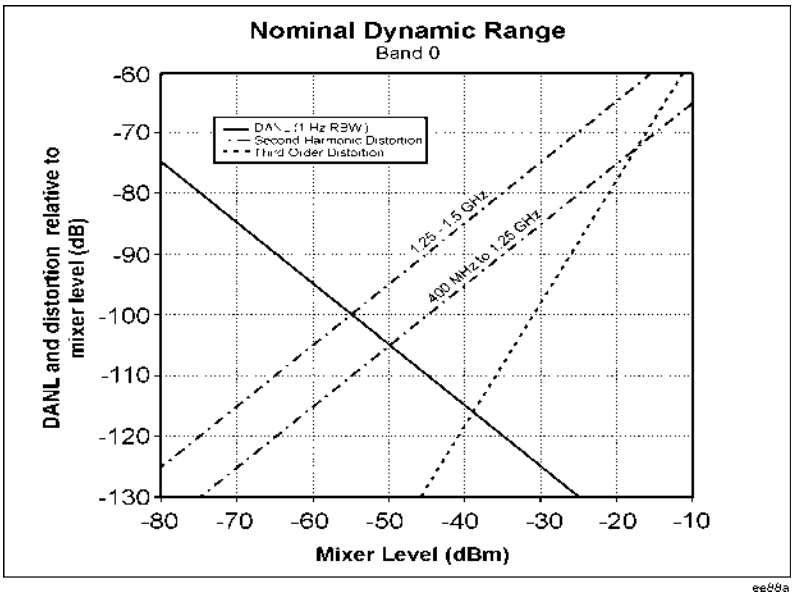
Description	Specifications		Supplemental Information
Other Input Related Spurious	**Mixer Level**[a]	**Distortion**	
Image Responses			
10 MHz to 26.8 GHz	–10 dBm	–80 dBc	
26.8 to 50 GHz	–30 dBm	–60 dBc	
Multiples and Out-of-band Responses			
10 MHz to 26.8 GHz	–10 dBm	–80 dBc	
26.8 to 50 GHz	–30 dBm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

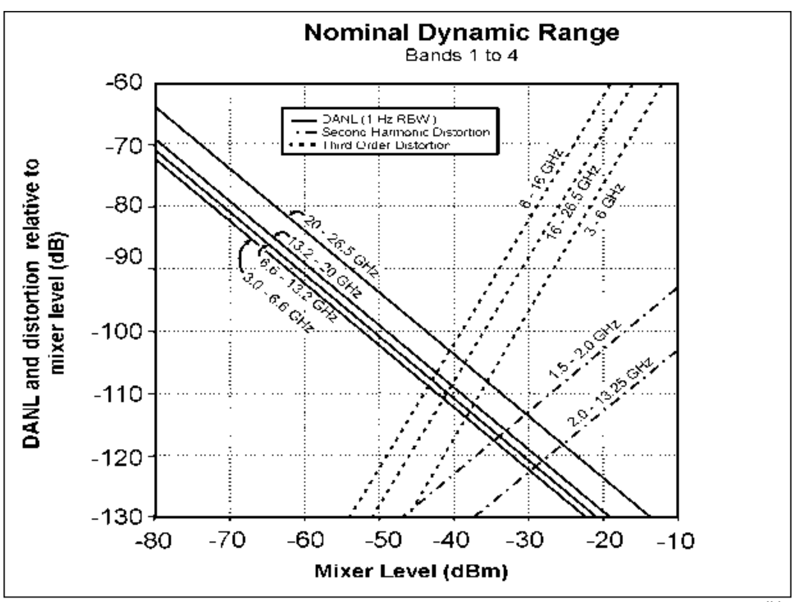
a. Mixer Level = Input Level – Input Attenuation.
b. Input terminated, 0 dB input attenuation.

Dynamic Range

E4443A, E4445A, E4440A

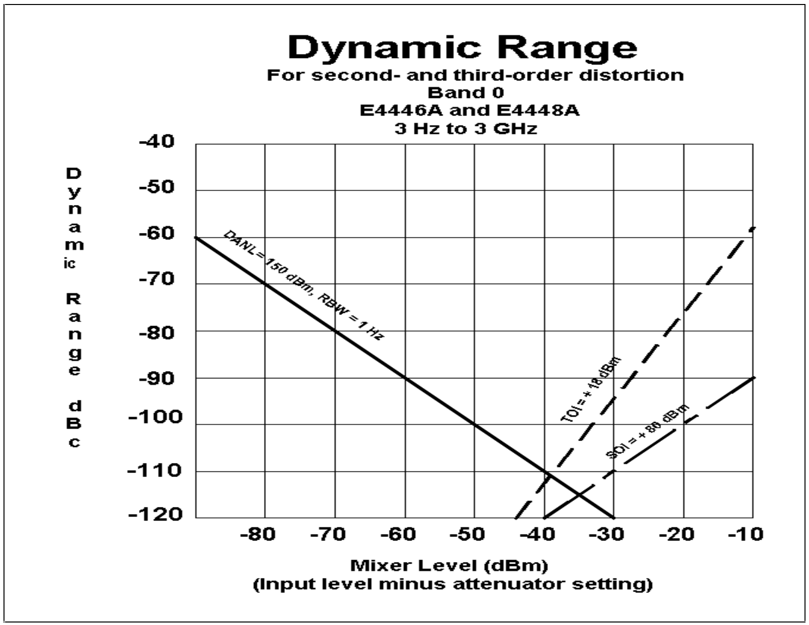
Nominal Dynamic Range

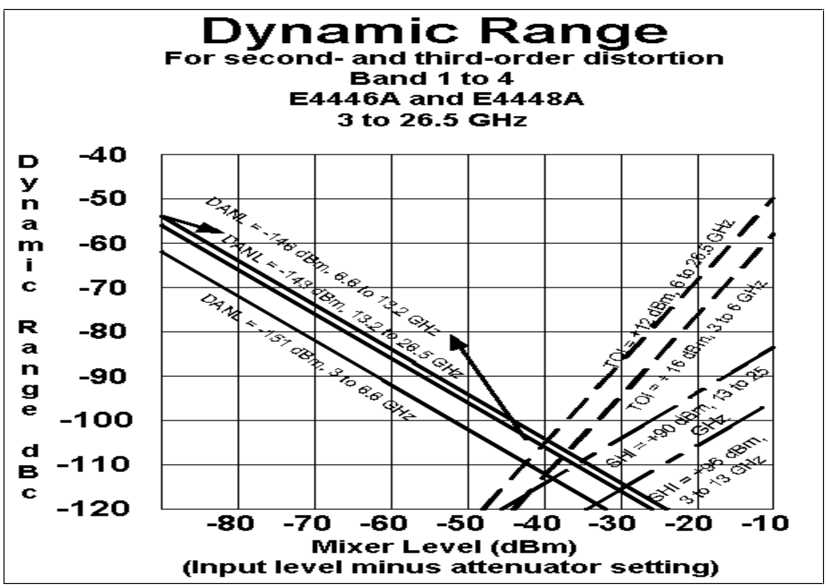




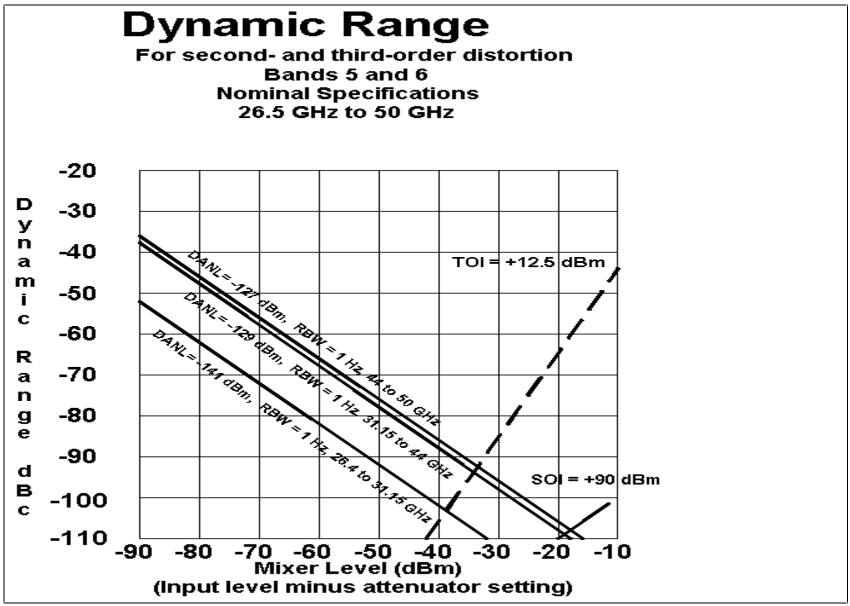
E4446A, E4448A: Bands 0–4

Dynamic Range





E4446A, E4448A: Bands 5–6

Dynamic Range


Power Suite Measurements

Description	Specifications	Supplemental Information
Channel Power		
Amplitude Accuracy		Absolute Amplitude Accuracy[a] + Power Bandwidth Accuracy[bc]
Radio Std = 3GPP W-CDMA, or IS-95		
Absolute Power Accuracy 20 to 30 °C Mixer level[d] < –20 dBm	±0.68 dB	±0.18 dB (typical)

Description	Specifications	Supplemental Information
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 rms 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[r]	±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. An ACP measurement measures the power in adjacent channels. The shape of the response versus frequency of those adjacent channels is occasionally critical. One parameter of the shape is its 3 dB bandwidth. When the bandwidth (called the Ref BW) of the adjacent channel is set, it is the 3 dB bandwidth that is set. The passband response is given by the convolution of two functions: a rectangle of width equal to Ref BW and the power response versus frequency of the RBW filter used. Measurements and specifications of analog radio ACPs are often based on defined bandwidths of measuring receivers, and these are defined by their –6 dB widths, not their –3 dB widths. To achieve a passband whose –6 dB width is x, set the Ref BW to be $x - 0.572 \times \mathrm{RBW}$.

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 Base 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.
– rms CW error: This error is a measure of the error in measuring a CW-like spurious component. It is evaluated by computing the root of the mean of the square of the power error across all frequencies within the adjacent channel. The computed rms error of the compensated filter is 0.023 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 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.

Description	Specifications	Supplemental Information
Multi-Carrier Power		
Radio Std = 3GPP W-CDMA		
ACPR Dynamic Range 5 MHz offset Two carriers Four carriers		RRC weighted, 3.84 MHz noise bandwidth –70 dB (nominal) –68 dB (nominal)
ACPR Accuracy (two carriers) 5 MHz offset, –48 dBc ACPR		±0.38 dB (nominal)

Description	Specifications	Supplemental Information
Power Statistics CCDF		
Histogram Resolution[a]	0.1 dB	

Description	Specifications	Supplemental Information
Intermod (TOI)		Measures the third-order intercept from a signal with two dominant tones

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

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

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

Description	Specifications	Supplemental Information
Spurious Emissions W-CDMA signals		Table-driven spurious signals; search across regions
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)

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.

Description	Specifications	Supplemental Information
Spectrum Emission Mask		Table-driven spurious signals; measurement near carriers
Radio Std = cdma2000		
Dynamic Range, relative 750 kHz offset[a][b]	85.3 dB	88.3 dB (typical)
Sensitivity, absolute 750 kHz offset[c]	–105.7 dBm	–107 dBm (typical)
Accuracy, relative 750 kHz offset[d]	±0.09 dB	
Radio Std = 3GPP W-CDMA		
Dynamic Range, relative 2.515 MHz offset[a][e]	87.3 dB	89.5 dB (typical)
Sensitivity, absolute 2.515 MHz offset[c]	–105.7 dBm	–107.7 dBm (typical)
Accuracy, relative 2.515 MHz offset[d]	±0.10 dBm	

a. The dynamic range specification is the ratio of the channel power to the power in the offset specified. The dynamic range depends on the measurement settings, such as peak power or integrated power. Dynamic range specifications are based on default measurement settings, with detector set to average, and depend on the mixer level. Default measurement settings include 30 kHz RBW.

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

c. The sensitivity is specified with 0 dB input attenuation. It represents the noise limitations of the analyzer. It is tested without an input signal. The sensitivity at this offset is specified in the default 30 kHz RBW, at a center frequency of 2 GHz.

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

e. 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.

Option 1DS:	Preamplifier
Option 202:	GSM with EDGE Measurement Personality
Option 204:	IxEV-DO Measurement Personality
Option 219:	Noise Figure Measurement Personality
Option 226:	Phase Noise Measurement Personality
Option 266:	HP 8566B/68B Code Compatibility Measurement Personality
Option B78:	cdma2000 Measurement Personality
Option B7J:	Digital Demod Hardware
Option BAC:	cdmaOne Measurement Personality
Option BAE:	NADC, PDC Measurement Personalities
Option BAF:	W-CDMA Measurement Personality

General

Description	Specifications	Supplemental Information
Calibration Cycle	1 year	

Description	Specifications	Supplemental Information
Temperature Range		
Operating	0 to 55 °C	Floppy disk 10 to 40 °C
Storage	–40 to 75 °C	
Altitude	4600 meters (approx. 15,000 feet)	

Description	Specifications	Supplemental Information
Acoustic Emissions (ISO 7779)		LNPE < 5.0 Bels at 25 °C

Description	Specifications	Supplemental Information
Military Specification	Has been type tested to the environmental specifications of MIL-PRF-28800F class 3.	

Description	Specifications	Supplemental Information
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 or 360 to 440 Hz		
	195 to 250 Vrms, 47 to 66 Hz		
Power Consumption, On	No Options < 260 W	All Options < 450 W	
Power Consumption, Standby	< 20 W		

Description	Specifications	Supplemental Information
Measurement Speed		nominal
Local measurement and display update rate[a]		
Sweep points = 101 Sweep points = 401 Sweep points = 601		≥ 50/s ≥ 50/s ≥ 50/s
Remote measurement and GPIB transfer rate[ab]		
Sweep points = 101 Sweep points = 401 Sweep points = 601		≥ 45/s ≥ 30/s ≥ 25/s

Description	Specifications	Supplemental Information
Display[c]		
Resolution	640 x 480	
Size		213 mm (8.4 in) diagonal (nominal)
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	

Description	Specifications	Supplemental Information
Volume Control *and* **Headphone Jack**		Reserved for future applications

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

b. LO = Fast Tuning, Display Off, 32 bit integer format, markers Off, single sweep, measured with 1BM compatible PC with 1.1 GHz Pentium Pro running Windows NT4.0, one meter GPIB cable, National Instruments PCI-GPIC Card and NI-488.2 DLL.

c. The LCD display is manufactured using high precision technology. However, there may be up to five bright points (white, blue, red or green in color) that constantly appear on the LCD screen. These points are normal in the manufacturing process and do not affect the measurement integrity of the product in any way.

Description	Specifications	Supplemental Information
Data Storage		
Internal		2 MB (nominal)
Floppy Drive (10 to 40 °C)		3.5" 1.44 MB, MS-DOS® compatible

Description	Specifications	Supplemental Information
Weight without options		
Net E4440A, E4443A, E4445A		23 kg (50 lb) (nominal)
Net E4446A, E4448A		24 kg (53 lb) (nominal)
Shipping		33 kg (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/Outputs (Front Panel)

RF Input

E4443A, E4445A, E4440A

Description	Specifications	Supplemental Information	
RF Input		Nominal	
Connector			
E4440A			
Standard	Type-N female		
Option BAB	APC 3.5 male		
E4443A, E4445A	Type-N female		
Impedance		50 Ω (see RF Input VSWR)	
First LO Emission Level[a]		Band 0	Bands ≥ 1
		< –120 dBm	< –100 dBm

E4446A, E4448A

Description	Specifications	Supplemental Information	
RF Input		Nominal	
Connector	2.4 mm male		
Impedance		50 Ω (see RF Input VSWR)	
First LO Emission Level[b]		Band 0	Bands ≥ 1
		< –120 dBm	< –100 dBm

a. With 10 dB attenuation.
b. With 10 dB attenuation.

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		Trigger source may be selected from front or rear.
Connector	BNC female	
Impedance		10 kΩ (nominal)
Trigger Level		5 V TTL

Rear Panel

Description	Specifications	Supplemental Information
10 MHz Out (Switched)		Switchable On/Off
Connector	BNC female	
Impedance		50 Ω (nominal)
Output Amplitude		≥ 0 dBm (nominal)
Frequency Accuracy	10 MHz ± (10 MHz × frequency reference accuracy)	

Description	Specifications	Supplemental Information
Ext Ref In		
Connector	BNC female	*Note*: Analyzer noise sidebands and spurious response performance may be affected by the quality of the external reference used.
Impedance		50 Ω (nominal)
Input Amplitude Range		–5 to +10 dBm (nominal)
Input Frequency		1 to 30 MHz (nominal) (selectable to 1 Hz resolution)
Lock range	$\pm 5 \times 10^{-6}$ of selected external reference input frequency	

Description	Specifications	Supplemental Information
Trigger In		Trigger source may be selected from front or rear.
Connector	BNC female	
External Trigger Input Impedance Trigger Level		 10 kΩ (nominal) 5 V TTL (nominal)

Description	Specifications	Supplemental Information
Keyboard		
Connector	6-pin mini-DIN (PS2)	Factory use only

Description	Specifications	Supplemental Information
Trigger 1 and Trigger 2 Outputs		
Connector	BNC female	
Trigger 1 Output Impedance Level		HSWP (High = sweeping) 50 Ω (nominal) 5 V 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, 60 Hz vertical sync rates, non-interlaced)
Resolution	640 x 480	Analog RGB

Description	Specifications	Supplemental Information
Pre-Sel Tune Out		Reserved for future applications.
Connector	BNC female	
Load Impedance (dc Coupled)		110 Ω (nominal)
Range		0 to 10 V (nominal)

Description	Specifications	Supplemental Information
Noise Source Drive Output		Used by *Option 219*
Connector	BNC female	
Output Voltage		
On	28.0 ± 0.1 V	60 mA maximum
Off	< 1 V	

Description	Specifications	Supplemental Information
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	

a. Control languages - SCPI version 1992.0

Description	Specifications	Supplemental Information
321.4 MHz IF Output		
Connector	SMA female	
Impedance		50 Ω (nominal)
Frequency		321.4 MHz (nominal)
Conversion Gain[a]		+2 to +4 dB (nominal)

Description	Specifications	Supplemental Information
SCSI Interface		
Connector	Mini D 50, female	Factory use only

a. 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 ±3 dB 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 Digital Communications Basic Measurement Personality

This chapter contains specifications for the PSA Series, *Option B7J*, basic measurement personality for vector signal analysis. These specifications also apply to the other digital communications measurement personalities (W-CDMA, GSM with EDGE, cdma2000, 1xEV-DO, cdmaOne, NADC, PDC).

Additional Definitions and Requirements

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

The specifications for this chapter apply to the E4440A, E4443A and E4445A spectrum analyzers. For the E4446A and E4448A, the performance is nominal only and not subject to any warranted specifications.

The measurement performance is only slightly different in the E4446A and E4448A when compared to the performance of the E4440A, E4443A and E4445A analyzers. Because the hardware performance of the analyzers is very similar but not identical, you can estimate the nominal performance of the measurements from the specifications in this chapter.

Frequency Description	Specifications	Supplemental Information
Frequency Range	7 MHz to 3 GHz	

Description	Specifications		Supplemental Information
Frequency Response			
At all input attenuations Maximum error relative to reference condition (50 MHz)	+20 to +30°C	0 to +55°C	Typical
Attenuation = 0 to 2 dB			
7 to 810 MHz	±0.79 dB	±0.95 dB	±0.60 dB
810 to 960 MHz	±0.50 dB	±0.66 dB	±0.22 dB
960 to 1428 MHz	±0.59 dB	±0.75 dB	±0.22 dB
1428 to 1503 MHz	±0.41 dB	±0.57 dB	±0.15 dB
1503 to 1710 MHz	±0.59 dB	±0.75 dB	±0.22 dB
1710 to 2205 MHz	±0.41 dB	±0.57 dB	±0.15 dB
2205 to 3000 MHz	±1.17 dB	±1.33 dB	±0.66 dB
Attenuation ≥ 3 dB			
7 to 810 MHz	±0.69 dB	±0.85 dB	±0.28 dB
810 to 960 MHz	±0.41 dB	±0.57 dB	±0.15 dB
960 to 1428 MHz	±0.59 dB	±0.75 dB	±0.22 dB
1428 to 1503 MHz	±0.41 dB	±0.57 dB	±0.15 dB
1503 to 1710 MHz	±0.59 dB	±0.75 dB	±0.22 dB
1710 to 2205 MHz	±0.41 dB	±0.57 dB	±0.15 dB
2205 to 3000 MHz	±0.98 dB	±1.14 dB	±0.50 dB
Electronic Input Attenuator			The standard mechanical input attenuator is locked to 6 dB when using the electronic input attenuator.
Range	0 to +40 dB		
Step size	1 dB steps		
Accuracy at 50 MHz +20°C to +30°C	±0.15 dB relative to 10 dB electronic attenuation		±0.05 dB (typical)

Description	Specifications	Supplemental Information
Absolute Amplitude Accuracy		
Excluding: mismatch, scalloping,and IF flatness[a] Including: linearity, RBW switching, attenuator,[b] Freq. tuned to the input CW freq.		
At 50 MHz, +20 °C to +30 °C	±0.25 dB	±0.06 dB (typical)
At 50 MHz, all temperatures	±0.33 dB	
At all frequencies (Absolute amplitude accuracy at 50MHz + Frequency Response)		
+20 °C to +30 °C	±(0.25 dB + frequency response)	±(0.06 dB + frequency response) (typical)
0 °C to +55 °C	±(0.33 dB + frequency response)	
50 MHz Amplitude Ref. Accuracy		±0.05 dB (nominal)

a. Absolute amplitude error does not include input mismatch errors. It is tested only when the analyzer center frequency is tuned to the input CW frequency. In this test condition, the effects of FFT scalloping error and IF Flatness do not apply. FFT scalloping error, the possible variation in peak level as the signal frequency is varied between FFT bins, is a mathematical parameter of the FFT window; it is under 0.01 dB for the flattop window. IF flatness, the variation in measured amplitude with signal frequency variations across the span of an FFT result, is not specified separately for the digital communications personalities, but the errors caused by IF flatness are included in all individual personality specifications.

b. Absolute amplitude error is tested at a combination of signal levels, spans, bandwidths and input attenuator settings. As a result, it is a measure of the sum of many errors normally specified separately for a spectrum analyzer: detection linearity (also known as scale or log fidelity), RBW switching uncertainty, attenuator switching uncertainty, IF gain accuracy, Amplitude Calibrator accuracy, and the accuracy with which the analyzer aligns itself to its internal calibrator.

Description	Specifications	Supplemental Information
LO emissions < 3 GHz		< −125 dBm (nominal)
Third-order Intermodulation Distortion		When using the electronic input attenuator, the standard mechanical input attenuator is locked to 6 dB. TOI performance will nominally be *better* than shown in the Amplitude chapter by 7 dB + (CF × 1 dB/GHz).
Displayed Average Noise Level		When using the electronic input attenuator, the standard mechanical input attenuator is locked to 6 dB. DANL performance will nominally be *worse* than shown in the Amplitude chapter by 7 dB + (CF × 1 dB/GHz).

Description	Specifications	Supplemental Information
Measurement Range	Displayed Average Noise Level to +30 dBm	

Measurements

Spectrum

These specifications apply to the measurements available in Basic Mode.

Description	Specifications	Supplemental Information
Spectrum		
Span range	10 Hz to 10 MHz	1, 1.5, 2, 3, 5, 7.5, 10 sequence or arbitrary user-definable
Capture time		66 ns to 40 s 2 points to 200 kpoints Coupled to span and RBW
Resolution BW range		
Overall	100 mHz to 1 MHz	1, 1.5, 2, 3, 5, 7.5, 10 sequence or arbitrary user-definable
Span = 10 MHz	3 kHz to 1 MHz	
Span = 100 kHz	30 Hz to 500 kHz	
Span = 1 kHz	400 mHz to 7.5 kHz	
Span = 100 Hz	100 mHz to 2 kHz	
Pre-FFT filter		
Type	Gaussian, Flat	
BW	Auto, Manual 1 Hz to 10 MHz	
FFT window	Flat Top (high amplitude accuracy); Uniform; Hanning; Hamming; Gaussian; Blackman; Blackman-Harris; Kaiser-Bessel 70; K-B 90; K-B 110	
Displays	Spectrum, I/Q waveform, Simultaneous Spectrum & I/Q waveform	

Waveform

Description	Specifications	Supplemental Information
Waveform		
Sweep time range[a]		
RBW ≤ 7.5 MHz	10 μs to 200 ms	
RBW ≤ 1 MHz	10 μs to 400 ms	
RBW ≤ 100 kHz	10 μs to 2 s	
RBW ≤ 10 kHz	10 μs to 20 s	
Time record length		2 to >900 kpoints (nominal)
Resolution bandwidth filter		1, 1.5, 2, 3, 5, 7.5, 10 sequence or arbitrary user-definable
Gaussian	10 Hz to 8 MHz	
Flat Top	10 Hz to 10 MHz	
Frequency response for 10 MHz setting		±0.25 dB over 8 MHz (nominal) –3 dB rolloff bandwidth is 10 MHz (nominal)
Displays	RF envelope, I/Q waveform	
X-axis display		
Range	10 divisions x scale/div	Allows expanded views of portions of the trace data.
Controls	Scale/Div, Ref Value, and Ref Position	

a. The maximum available sweep time range is proportional to the setting of the decimation (**Meas Setup** > **Advanced** > **Decimation**).
The limits shown are for decimation = 4, the maximum allowed. The default for decimation is 1.

Description	Specifications	Supplemental Information
Both Spectrum and Waveform		
Trigger		
Source	Free Run (immediate), Video (IF envelope), RF Burst (wideband), Ext Front, Ext Rear, Frame, Line	
Trigger delay Range Repeatability Resolution	 –100 ms to +500 ms ±33 ns 33 ns	For Video, RF Burst, Ext Front, Ext Rear
Trigger slope	Positive, Negative	
Trigger holdoff Range Resolution	 0 to 500 ms 1 μs	
Auto trigger Time interval range	On, Off	 0 to 10 s (nominal) Does an immediate trigger if no trigger occurs before the set time interval.
RF burst trigger Peak carrier power range at RF Input	 +27 dBm to –40 dBm	Wideband IF for repetitive burst signals.
Trigger level range	0 to –25 dB	Relative to signal peak
Bandwidth		>15 MHz (nominal)
Video (IF envelope) trigger Range	 +30 dBm to noise floor	
Measurement Control	Single, Continuous, Restart, Pause, Resume	
Averaging		
Avg number	1 to 10,000	
Avg mode	Exponential, Repeat	
Avg type	Power Avg (RMS), Log-Power Avg (Video), Voltage Avg, Maximum, Minimum	
Y-axis display controls	Scale/Div, Ref Value, and Ref Position	Allows expanded views of portions of the trace data
Markers	Normal, Delta, Band Power, Noise	

Inputs and Outputs

Front Panel

Description	Specifications	Supplemental Information
RF Input		
VSWR with electronic attenuator 7 MHz to 3 GHz		
0 or 1 dB input attenuation ≥ 2 dB input attenuation		< 1.3:1 (nominal) < 1.2:1 (nominal)

3 GSM/EDGE Specifications

This chapter contains specifications for the PSA Series, *Option 202*, GSM with EDGE measurement personality.

Additional Definitions and Requirements

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

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

The specifications for this chapter apply to the E4440A, E4443A and E4445A spectrum analyzers. For the E4446A and E4448A, the performance is nominal only and not subject to any warranted specifications.

The measurement performance is only slightly different in the E4446A and E4448A when compared to the performance of the E4440A, E4443A and E4445A analyzers. Because the hardware performance of the analyzers is very similar but not identical, you can estimate the nominal performance of the measurements from the specifications in this chapter.

Description	Specifications	Supplemental Information
EDGE Error Vector Magnitude (EVM)		3π/8 shifted 8PSK modulation
		Specifications based on 200 bursts
Carrier Power Range at RF Input		+24 to –45 dBm (nominal)
EVM		
Operating range[a]		0 to 25 % (nominal)
Floor (RMS)	0.5 %	0.3 % (typical)
Accuracy[b] (RMS) EVM range 1 % to 10 %	±0.5 %	+24 to –12 dBm power range at RF input
Frequency Error		
Accuracy	±1 Hz + (transmitter frequency × frequency reference accuracy)	
IQ Origin Offset Range	–20 to –45 dBc	

a. The operating range applies when the Burst Sync is set to Training Sequence.

b. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows: floorerror = sqrt($EVMUUT^2$ + $EVMsa^2$) – EVMUUT, where EVMUUT is the EVM of the UUT in percent, and EVMsa is the EVM floor of the analyzer in percent. For example, if the EVM of the UUT is 3 %, and the floor is 0.5 %, the error due to the floor is 0.04 %. The total error can cause a reading as high as EVMUUT + floorerror + accyerror, or as low as EVMUUT – accyerror, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.

Description	Specifications	Supplemental Information
Power vs. Time *and* **EDGE Power vs. Time**		GMSK modulation (GSM) 3π/8 shifted 8PSK modulation (EDGE) Measures mean transmitted RF carrier power during the useful part of the burst (GSM method) and the power vs. time ramping. 510 kHz RBW
Minimum carrier power at RF Input for GSM and EDGE		–40 dBm (nominal)
Absolute power accuracy for in-bandsignal (excluding mismatch error)[a]		
20 to 30 °C; attenuation > 2 dB[b]	–0.11 ±0.66 dB	–0.11 ±0.18 dB (typical)
20 to 30 °C; attenuation ≤ 2 dB[b]	–0.11 ±0.75 dB	–0.11 ±0.24 dB (typical)
0 to 55 °C; attenuation > 2 dB[b]	–0.11 ±0.90 dB	
Power ramp relative accuracy		Referenced to mean transmitted power
RF Input Range = Auto[c] +6 dB to noise[cd]	 ±0.13 dB	
Mixer Level ≤ –12 dBm[c] 0 to +6 dB 0 to noise[cd]	 ±0.13 dB ±0.08 dB	
Mixer Level ≤ –18 dBm[c] +6 dB to noise[d]	 ±0.08 dB	
Measurement floor		–88 dBm + Input Attenuation (nominal)
Time resolution	200 ns	
Burst to mask uncertainty	±0.2 bit (approx ±0.7 μs)	

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

b. The absolute power accuracy depends on the setting of the electronic input attenuator as well as the signal-to-noise ratio. For high input levels, the Auto setting of RF Input Range will result in high signal-to-noise ratios and Input Atten > 2 dB, for which the Absolute power accuracy is best. At moderate levels, manually setting the Input Atten can give better accuracy than the automatic setting. At very low levels, automatic or manual setting of the Input Atten to 0 dB optimizes the accuracy by maximizing the signal-to-noise ratio.
For GSM and EDGE respectively, "high levels" would nominally be levels above –2.3 dBm and–5.5 dBm respectively, and "very low levels" would nominally be below –68 dBm.

The error due to very low signals levels is a function of the signal (mean transmit power) to noise (measurement floor) ratio, SN, in decibels.
The function is error = 10 × log(1 + 10^(–SN/10)).
For example, if the mixer level (input power minus attenuation) is 26.4 dB above the measurement floor, the error due to adding the analyzer's noise to the UUT is only 0.01 dB.

c. Using auto setting of RF Input range optimizes the dynamic range of analysis, but the scale fidelity is poorer at the relatively high mixer levels chosen. Because of this, manually setting the input attenuator so that the mixer level (RF Input power minus Input Attenuation) is lower can improve the relative accuracy of power ramp measurements as shown.

d. The relative error specification does not change as the levels approach the noise floor, except for the effect of the noise power itself. If the mixer level is not high enough to make the contribution of the measurement floor negligible, the noise of the analyzer will add power to the signal being measured, resulting in an error. That error is a function of the signal (carrier power) to noise (measurement floor) ratio (SN), in decibels.
The function is error = $10 \times \log(1 + 10^{(-SN/10)})$. For example, if the mixer level is 26.4 dB above the measurement floor, the error due to adding the noise of the analyzer to the UUT is only 0.01 dB.

Description	Specifications	Supplemental Information
Phase and Frequency Error		GMSK modulation (GSM) Specifications based on 3GPP essential conformance requirements, and 200 bursts
Carrier power range at RF Input		+27 to –45 dBm (nominal)
Phase error Floor (RMS) Accuracy (RMS) Phase error range 1 ° to 15 °	 0.5 ° ±0.5 °	
Peak phase error Accuracy Phase error range 3 ° to 25 °	 ±2.0 °	
Frequency error		
Initial frequency error range		±75 kHz (nominal)
Accuracy	±5 Hz + (transmitter frequency × frequency reference accuracy)	
I/Q Origin Offset Range		 –15 to –50 dBc (nominal)
Burst sync time uncertainty	±0.1 bit (approx ±0.4 μs)	

Description	Specifications		Supplemental Information	
Output RF Spectrum *and* **EDGE Output RF Spectrum**			GMSK modulation (GSM) 3π/8 shifted 8PSK modulation (EDGE)	
Minimum carrier power at RF Input			–20 dBm (nominal)	
ORFS Relative RF Power Uncertainty[a]				
Due to modulation				
Offsets ≤ 1.2 MHz	±0.15 dB			
Offsets ≥ 1.8 MHz	±0.25 dB			
Due to switching			±0.15 dB (nominal)[b]	
ORFS Absolute RF Power Accuracy[c]				
20 to 30 °C, attenuation > 2 dB[d]	±0.72 dB		±0.18 dB (typical)	
20 to 30 °C, attenuation ≤ 2 dB[d]	±0.81 dB		±0.24 dB (typical)	
Dynamic Range, Spectrum due to modulation[e] 20 to 30 °C			5-pole sync-tuned filters[f] Methods: Direct Time[g] and FFT[h]	
Offset Frequency	**GSM**	**EDGE**	**GSM (typical)**	**EDGE (typical)**
100 kHz[i]	67.3 dB			
200 kHz[i]	74.5 dB			
250 kHz[i]	76.9 dB			
400 kHz	81.5 dB	81.3 dB		
600 kHz	85.6 dB	85.1 dB	87.7 dB	87.0 dB
1.2 MHz	91.0 dB	89.4 dB	92.8 dB	91.0 dB
			GSM (nominal)	**EDGE (nominal)**
1.8 MHz[j]	90.3 dB	90.2 dB	93.1 dB	92.0 dB
6.0 MHz[j]	94.0 dB	93.7 dB	96.8 dB	94.5 dB
Dynamic Range, Spectrum due to switching[e]			5-pole sync-tuned filters[k]	
Offset Frequency				
400 kHz[i]	72.1 dB			
600 kHz	75.9 dB			

Description	Specifications	Supplemental Information
1.2 MHz	80.2 dB	
1.8 MHz	84.6 dB	
Spectrum (Frequency Domain)	See Spectrum on page 78.	
Waveform (Time Domain)	See Waveform on page 79.	

a. The uncertainty in the RF power ratio reported by ORFS has many components. This specification does not include the effects of added power in the measurements due to dynamic range limitations, but does include the following errors: detection linearity, RF and IF flatness, uncertainty in the bandwidth of the RBW filter, and compression due to high drive levels in the front end.

b. The worst-case modeled and computed errors in ORFS due to switching are shown, but there are two further considerations in evaluating the accuracy of the measurement: First, Agilent has been unable to create a signal of known ORFS due to switching, so we have been unable to verify the accuracy of our models. This performance value is therefore shown as nominal instead of guaranteed. Second, the standards for ORFS allow the use of any RBW of at least 300 kHz for the reference measurement against which the ORFS due to switching is ratioed. Changing the RBW can make the measured ratio change by up to about 0.24 dB, making the standards ambiguous to this level. The user may choose the RBW for the reference; the default 300 kHz RBW has good dynamic range and speed, and agrees with past practices. Using wider RBWs would allow for results that depend less on the RBW, and give larger ratios of the reference to the ORFS due to switching by up to about 0.24 dB.

c. The absolute power accuracy depends on the setting of the electronic input attenuator as well as the signal-to-noise ratio. For high input levels, the Auto setting of RF Input Range will result in high signal-to-noise ratios and Input Atten > 2 dB, for which the Absolute power accuracy is best. At moderate levels, manually setting the Input Atten can give better accuracy than the automatic setting. For GSM and EDGE respectively, “high levels” would nominally be levels above –2.3 dBm and –3.7 dBm respectively.

d. Using the RF Input Range auto setting nominally results in better accuracy for power levels above –2.3 dBm for GSM and –3.69 dBm for EDGE, because these power levels set the input attenuator to 3 dB or more where RF frequency response errors are smaller.

e. Maximum dynamic range requires RF input power above –2 dBm for offsets of 1.2 MHz and below. For offsets of 1.8 MHz and above, the required RF input power for maximum dynamic range is +6 dBm for GSM signals and +5 dBm for EDGE signals

f. ORFS standards call for the use of a 5-pole, sync-tuned filter; this and the following footnotes review the instrument's conformance to that standard. Offset frequencies can be measured by using either the FFT method or the direct time method. By default, the FFT method is used for offsets of 400 kHz and below, and the direct time method is used for offsets above 400 kHz. The FFT method is slower and has lower dynamic range than the direct time method.

g. The FFT method uses an exact 5-pole sync-tuned RBW filter, implemented in software.

h. The direct time method uses digital Gaussian RBW filters whose noise bandwidth (the measure of importance to “spectrum due to modulation”) is within ±0.5 % of the noise bandwidth of an ideal 5-pole sync-tuned filter. However, the Gaussian filters do not match the 5-pole standard behavior at offsets of 400 kHz and less, because they have *lower* leakage of the carrier into the filter. The lower leakage of the Gaussian filters provides a superior measurement because the leakage of the carrier masks the ORFS due to the UUT, so that less masking lets the test be more sensitive to variations in the UUT spectral splatter. But this superior measurement gives a result that does not conform with ORFS standards. Therefore, the default method for offsets of 400 kHz and below is the FFT method.

i. The dynamic range for offsets at and below 400 kHz is not directly observable because the signal spectrum obscures the result. These dynamic range specifications are computed from phase noise observations.

j. Offsets of 1.8 MHz and higher use 100 kHz analysis bandwidths.

k. The impulse bandwidth (the measure of importance to “spectrum due to switching transients”) of the filter used in the direct time method is 0.8 % less than the impulse bandwidth of an ideal 5-pole sync-tuned filter, with a tolerance of ±0.5 %. Unlike the case with spectrum due to modulation, the shape of the filter response (Gaussian vs sync-tuned) does not affect the results due to carrier leakage, so the only parameter of the filter that matters to the results is the impulse bandwidth. There is a mean error of –0.07 dB due to the impulse bandwidth of the filter, which is compensated in the measurement of ORFS due to switching. By comparison, an analog RBW filter with a ±10 % width tolerance would cause a maximum amplitude uncertainty of 0.9 dB.

Description	GSM Specifications	EDGE Specifications	Supplemental Information
In-Band Frequency Ranges[a]			
GSM 900, P-GSM	890 to 915 MHz 935 to 960 MHz	890 to 915 MHz 935 to 960 MHz	
GSM 900, E-GSM	880 to 915 MHz 925 to 960 MHz	880 to 915 MHz 925 to 960 MHz	
DCS1800	1710 to 1785 MHz 1805 to 1880 MHz	1710 to 1785 MHz 1805 to 1880 MHz	
PCS1900	1850 to 1910 MHz 1930 to 1990 MHz		
GSM850	824 to 849 MHz 869 to 894 MHz		

Description	GSM Specifications	EDGE Specifications	Supplemental Information
Alternative Frequency Ranges[b]			
Down Band GSM	400 to 500 MHz	400 to 500 MHz	
GSM450	450.4 to 457.6 MHz 460.4 to 467.6 MHz		
GSM480	478.8 to 486 MHz 488.8 to 496 MHz		
GSM700	447.2 to 761.8 MHz		

a. Frequency ranges over which all specifications apply.

b. Frequency ranges with tuning plans but degraded specifications for absolute power accuracy. The degradation should be nominally ±0.30 dB.

Description	Specifications	Supplemental Information
Trigger		
Trigger source		RF burst (wideband), Video (IF envelope), Ext Front, Ext Rear, Frame Timer. Actual available choices dependent on measurement.
Trigger delay, level, and slope		Each trigger source has a separate set of these parameters.
Trigger delay Range Repeatability Resolution	 –100 to +500 ms ±33 ns 33 ns	
External trigger inputs Level Impedance		 5V TTL (nominal) 10 kΩ (nominal)
Burst Sync		
Source		Training sequence, RF amplitude, None. Actual available choices dependent on measurement.
Training sequence code		GSM defined 0 to 7 Auto (search) or Manual
Burst type		Normal (TCH & CCH) Sync (SCH) Access (RACH)
Range Control		RF Input Autorange[a] Manually set **Max Total Pwr** Manually set **Input Atten**

a. Autorange is *not* continuous with each measurement acquisition; it will run only once immediately following a measurement restart, initiated either by pressing the **Restart** hardkey, or by sending the GPIB command `INIT:IMM`. This behavior was chosen to maintain best measurement speed, but it requires caution when input power levels change. If the input signal power changes, the analyzer will not readjust the input attenuators for optimal dynamic range unless a measurement restart is initiated. For example, if a sequence of power measurements is made, beginning with a maximum power level that is large enough to require non-zero input attenuation, it is advisable to do a measurement restart to automatically set a lower input attenuator value to maintain optimal dynamic range for approximately every 3 dB the input signal power level is reduced, or smaller, depending upon how precisely dynamic range needs to be optimized. Conversely, if the input signal power increases to a high enough level, input overloading will occur if the input attenuators are not readjusted by doing a measurement restart.

4 W-CDMA Specifications

This chapter contains specifications for the PSA Series, *Option BAF*, W-CDMA Measurement Personality.

Additional Definitions and Requirements

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

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

The specifications for this chapter apply to the E4440A, E4443A and E4445A spectrum analyzers. For the E4446A and E4448A, the performance is nominal only and not subject to any warranted specifications.

The measurement performance is only slightly different in the E4446A and E4448A when compared to the performance of the E4440A, E4443A and E4445A analyzers. Because the hardware performance of the analyzers is very similar but not identical, you can estimate the nominal performance of the measurements from the specifications in this chapter.

Conformance With 3GPP TS 25.141 Base Station Requirements for a Manufacturing Environment

Sub-clause	Name	3GPP Required Test Instrument Tolerance (as of 2002-06)	Instrument Tolerance Interval[abc]	Supplemental Information
Conditions 25 to 35 °C[d] Derived tolerances[e] 95th percentile[d] 100 % limit tested[b] Calibration uncertainties included[d]				
6.2.1	**Maximum Output Power**	±0.7 dB (95 %)	±0.28 dB (95 %)	±0.71 dB (100 %)
6.2.2	**CPICH Power Accuracy**	±0.8 dB (95 %)	±0.29 dB (95 %)	–10 dB CDP[f]
6.3.4	**Frequency Error**	±12 Hz (95 %)	±10 Hz (100 %)	Freq Ref locked[g]
6.4.2	**Power Control Steps**[h]			
	1 dB step	±0.1 dB (95 %)	±0.03 dB (95 %)	Test Model 2
	0.5 dB step	±0.1 dB (95 %)	±0.03 dB (95 %)	Test Model 2
	Ten 1 dB steps	±0.1 dB (95 %)	±0.03 dB (95 %)	Test Model 2
	Ten 0.5 dB steps	±0.1 dB (95 %)	±0.03 dB (95 %)	Test Model 2
6.4.3	**Power Dynamic Range**	±1.1 dB (95 %)	±0.50 dB (95 %)	
6.4.4	**Total Power Dynamic Range**[h]	±0.3 dB (95 %)	±0.015 dB (95 %)	Ref –35 dBm at mixer[i]
6.5.1	**Occupied Bandwidth**	±100 kHz (95 %)	±38 kHz (95 %)	10 averages[j]
6.5.2.1	**Spectrum Emission Mask**	±1.5 dB (95 %)	±0.59 dB (95 %)	Absolute peak[k]
6.5.2.2	**ACLR**			
	5 MHz offset	±0.8 dB (95 %)	±0.22 dB (100 %)	
	10 MHz offset	±0.8 dB (95 %)	±0.22 dB (100 %)	
6.5.3	**Spurious Emissions**			
	f < 3 GHz	±1.5 to 2.0 dB (95 %)	±0.65 dB (100 %)	
	3 GHz < f < 4 GHz	±2.0 dB (95 %)	±1.77 dB (100 %)	
	4 GHz < f < 12.6 GHz	±4.0 dB (95 %)	±2.27 dB (100 %)	
6.7.1	**EVM**	±2.5 % (95 %)	±1.0 % (95 %)	Range 15 to 20 %[l]
6.7.2	**Peak Code Domain Error**	±1.0 dB (95 %)	±1.0 dB (nominal)	

a. Those tolerances marked as 95 % are derived from 95th percentile observations with 95 % confidence.

b. Those tolerances marked as 100 % are derived from 100 % limit tested observations. Only the 100 % limit tested observations are covered by the product warranty.
c. The computation of the instrument tolerance intervals shown includes the uncertainty of the tracing of calibration references to national standards. It is added, in a root-sum-square fashion, to the observed performance of the instrument.
d. This table is intended for users in the manufacturing environment, and as such, the tolerance limits have been computed for temperatures of the ambient air near the analyzer of 25 to 35 °C.
e. Most of the tolerance limits in this table are derived from measurements made of standard instrument specifications, rather than direct observations.
f. Tolerance limits are computed for a CPICH code domain power of –10 dB relative to total signal power.
g. The frequency references of the DUT and the test equipment must be locked together to meet this tolerance interval.
h. These measurements are obtained by utilizing the code domain power function or general instrument capability. The tolerance limits given represent instrument capabilities.
i. The tolerance interval is based on the largest signal power being –35 dBm at the mixer.
j. The OBW measurement errors are dominated by the noise-like nature of the signal. The errors decline in proportion to the square root of the number of averages. The tolerance interval shown is for ten averages.
k. The tolerance interval shown is for the peak absolute power of a CW-like spurious signal. The standards for SEM measurements are ambiguous as of this writing; the tolerance interval shown is based on Agilent's interpretation of the current standards and is subject to change.
l. EVM tolerances apply with signals having EVMs within ±2.5 % of the required 17.5 % EVM limit.

Description	Specifications	Supplemental Information
Channel Power		
Minimum power at RF Input		–70 dBm (nominal)
Absolute power accuracy[a]		
20 to 30 °C, Attenuation > 2 dB[b] 20 to 30 °C, Attenuation ≤ 2 dB[b]	±0.71 dB ±0.80 dB	±0.19 dB (typical) ±0.25 dB (typical)
Measurement floor[c]		–78 dBm (nominal)

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

b. The absolute power accuracy depends on the setting of the electronic input attenuator as well as the signal-to-noise ratio. For high input levels, the Auto setting of RF Input Range will result in high signal-to-noise ratios and Input Atten > 2 dB, for which the Absolute power accuracy is best. At moderate levels, manually setting the Input Atten can give better accuracy than the automatic setting. At very low levels, automatic or manual setting of the Input Atten to 0 dB optimizes the accuracy by maximizing the signal-to-noise ratio. For W-CDMA, “high levels” would nominally be levels above –14.4 dBm, and “very low levels” would nominally be below –58 dBm.
The error due to very low signals levels is a function of the signal (channel power) to noise (measurement floor) ratio, SN, in decibels. The function is error = $10 \times \log(1 + 10^{(-SN/10)})$. For example, if the mixer level (input power minus attenuation) is 26.4 dB above the measurement floor, the error due to adding the analyzer's noise to the UUT is only 0.01 dB.

c. Measurement floor is the channel power measured due only to the noise of the analyzer. The measurement floor nominally changes by +1 dB/GHz for signal frequencies different from the 2 GHz frequency for which this nominal floor was determined.

Description		Specifications	Supplemental Information
Adjacent Channel Power Ratio (ACPR; ACLR)[a]			
Minimum power at RF Input			–27 dBm (nominal)
ACPR Accuracy[b] 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[c]
MS (UE)	10 MHz	±0.17 dB	At ACPR range of –40 to –46 dBc with optimum mixer level[d]
BTS	5 MHz	±0.22 dB	At ACPR range of –42 to –48 dBc with optimum mixer level[e]
BTS	10 MHz	±0.22 dB	At ACPR range of –47 to –53 dBc with optimum mixer level[d]
BTS	5 MHz	±0.17 dB	At –48 dBc non-coherent ACPR[f]
Dynamic Range			RRC weighted, 3.84 MHz noise bandwidth
Offset Frequency			
5 MHz			–74.5 dB (typical)[g]
10 MHz			–82 dB (typical)[g]

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

b. The accuracy of the Adjacent Channel Power Ratio will depend on the mixer drive level and whether the distortion products from the analyzer are coherent with those in the UUT. Except for the “noncoherent case” described in footnote f, the 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 –29 dBm - (ACPR/3), where the ACPR is given in (negative) decibels.

c. In order 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 –18 dBm, so the input attenuation must be set as close as possible to the average input power - (–18 dBm). For example, if the average input power is –6 dBm, set the attenuation to 12 dB. This specification applies for the normal 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.

d. ACPR accuracy at 10 MHz offset is warranted when the input attenuator is set to give an average mixer level of –6 dBm.

e. To meet this specified accuracy, the mixer level must be optimized for accuracy when measuring node B of the Base Transmission Station (BTS) within 3 dB of the required –45 dBc ACPR. This optimum mixer level is –14 dBm, so the input attenuation must be set as close as possible to the average input power - (–14 dBm). For example, if the average input power is –6 dBm, set the attenuation to 8 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.

f. 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.

g. The optimum mixer drive level is approximately –7 dBm.

Description	Specifications	Supplemental Information
Multi-Carrier Power		
Minimum Carrier Power at RF Input		–12 dBm (nominal)
ACPR Dynamic Range, two carriers		RRC weighted, 3.84 MHz noise bandwidth
5 MHz offset 10 MHz offset		–70 dB (nominal) –75 dB (nominal)
ACPR Accuracy, two carriers 5 MHz offset, –48 dBc ACPR		±0.38 dB (nominal)

Description	Specifications	Supplemental Information
Power Statistics CCDF		
Minimum Power at RF Input		–40 dBm, average (nominal)
Histogram Resolution	0.01 dB[a]	

Description	Specifications	Supplemental Information
Intermodulation		
Minimum Carrier Power at RF Input		–30 dBm (nominal)
Third-order Intercept		
CF = 1 GHz		TOI + 7.2 dB[b]
CF = 2 GHz		TOI + 7.5 dB[b]

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

b. The third-order intercept (TOI) of the analyzer as configured for the W-CDMA personality is higher than the third-order intercept specified for the analyzer without the personality, due to the configuration of loss elements in front of the input mixer. The personality configures the mechanical attenuator to be in a fixed 6 dB attenuation position, and has additional loss in the electronic attenuator. The TOI increases by the nominal amount shown due to these losses when the electronic attenuator is set to 0 dB, and further increases proportional to the setting of the electronic attenuator.

Description	Specifications	Supplemental Information
Occupied Bandwidth		
Minimum carrier power at RF Input		–40 dBm (nominal)
Frequency Resolution	100 Hz	
Frequency Accuracy		$\frac{1.4\%}{\sqrt{N_{avg}}}$ (nominal)[a]
Spectrum Emission Mask		
Minimum power at RF Input		–20 dBm (nominal)
Dynamic Range, relative[b]		
2.515 MHz offset[c]	–86.7 dB	–88.9 dB (typical)
1980 MHz region[d]	–80.7 dB	–83.0 dB (typical)
Sensitivity, absolute[e]		
2.515 MHz offset[f]	–97.9 dBm	–99.9 dBm (typical)
1980 MHz region[g]	–81.9 dBm	–83.9 dBm (typical)
Accuracy, relative		
Display = Abs Peak Pwr	±0.14 dB	
Display = Rel Peak Pwr	±0.56 dB	

a. The errors in Occupied Bandwidth measurement are due mostly to the noisiness of any measurement of a noise-like signal, such as the W-CDMA signal. The observed standard deviation of the OBW measurement is 60 kHz, so with 1000 averages, the standard deviation should be about 2 kHz, or 0.05 %. The frequency errors due to the FFT processing are computed to be 0.028 % with the RBW (30 kHz) used.

b. The dynamic range specification is the ratio of the channel power to the power in the offset and region specified. The dynamic range depends on the measurement settings, such as peak power or integrated power. This specification is derived from other analyzer performance limitations such as third-order intermodulation, DANL and phase noise. Dynamic range specifications are based on default measurement settings, with detector set to average, and depend on the mixer level. Mixer level is defined to be the input power minus the input attenuation.

c. Default measurement settings include 30 kHz RBW. This dynamic range specification applies for the optimum mixer level, which is about –9 dBm.

d. Default measurement settings include 1200 kHz RBW. This dynamic range specification applies for a mixer level of 0 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 PSA Specifications Guide; the levels into the mixer are nominally 8 dB lower in this application when the center frequency is 2 GHz.

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.

f. The sensitivity at this offset is specified in the default 30 kHz RBW.

g. The sensitivity for this region is specified in the default 1200 kHz bandwidth.

Description	Specifications	Supplemental Information
Code Domain BTS Measurements –25 dBm ≤ ML[a] ≤ –15 dBm 25 to 35 °C[b], 95 %[c] Preamp *(Option 1DS)* Off, except as noted		
Code domain power		
Minimum power at RF input		
Preamp *(Option 1DS)* Off Preamp *(Option 1DS)* On		–75 dBm (nominal)[de] –102 dBm (nominal)[f]
Maximum power at RF input Preamp *(Option 1DS)* On		 –45 dBm (nominal)[g]
Relative accuracy[h]		
Test signal		
Test Model 2 Code domain power range		
0 to –10 dBc –10 to –30 dBc –30 to –40 dBc	±0.015 dB ±0.06 dB ±0.07 dB	
Test Model 1 with 32 DPCH Code domain power range		
0 to –10 dBc –10 to –30 dBc –30 to –40 dBc	±0.015 dB ±0.08 dB ±0.15 dB	
Symbol power vs. time[i]		
Minimum power at RF Input Relative accuracy Test signal Test Model 1 with 32 DPCH signal Code domain power range		–50 dBm (nominal)[de]
0 to –25 dBc –25 to –40 dBc	±0.10 dB ±0.50 dB	
Symbol error vector magnitude		
Minimum power at RF Input Accuracy Test signal Test Model 1 with 32 DPCH signal Code domain power range 0 to –25 dBc	 ±1.0 %	–50 dBm (nominal)[de]

a. ML (mixer level) is RF input power minus attenuation.
b. This table is intended for users in the manufacturing environment, and as such, the tolerance limits have been computed for temperatures of the ambient air near the analyzer of 25 to 35 °C.
c. All specifications given are derived from 95th percentile observations with 95 % confidence.
d. Nominal operating range. Accuracy specifications apply when mixer level (RF input power minus attenuation) is between –25 and –15 dBm.
e. Predefined test models under the Symbol Boundary menu are recommended for RF input power levels below –60 dBm. At low signal-to-noise ratios the auto channel ID algorithm may not correctly detect an active code channel as turned on. The predefined test model bypasses the auto channel ID algorithm.
f. CPICH synchronization requires a minimum RF input power of –102 dBm. CPICH synchronization can be achieved for RF input power down to –112 dBm, but lock will not be consistent.
g. CPICH synchronization can be obtained above –45 dBm, but TOI products will begin to raise the code domain noise floor. The power range that is free from TOI-induced noise floor problems can be extended up to 20 dB by increasing the input attenuation above the factory preset setting of 0 dB when using the preamplifier. There is no auto mode for setting input attenuation when the preamplifier is On.
h. A code channel power measurement made on a specific spreading code includes all power that projects onto that code. This power is primarily made up from the intended signal power that was spread using that code, but also includes that part of the SCH power (when present) that also projects onto the code being measured. The reason for this addition is that the SCH power is spread using a gold code, which is not orthogonal to the code being measured. The increase in decibels due to this SCH leakage effect is given by the following formula:
   SCH leakage effect = $10 \log (10^{S/10}/(10F) + 10^{C/10}) - C$
   Where:
   S = Relative SCH power in dB (during the first 10 % of each timeslot)
   F = Spreading factor of the code channel being measured
   C = Ideal relative code channel power in dB (excluding SCH energy)
   For example, consider a composite signal comprising the SCH set to –10 dB during the first 10 % of each slot, and a DPCH at spreading factor 128 set to –28 dB. Performing a code channel power measurement on the DPCH will return a nominal code channel power measurement of –27.79 dB. The SCH leakage effect of 0.21 dB should not be considered as a measurement error but rather the expected consequence of the non-orthogonal SCH projecting energy onto the code used by the DPCH.
   In order to calculate the ideal code channel power C from a code channel power measurement M that includes SCH energy, the following formula can be used:
   $C = 10 \log (10^{M/10} - 10^{S/10}/(10F))$
   Therefore a code channel power measurement M = –27.79 dB at spreading factor 128 of a signal including a relative SCH power of –10 dB indicates an ideal code channel power of –28 dB.
i. The SCH leakage effect due to its being spread by a gold code not orthogonal to the symbol power being measured will add additional power to the measured result during the portion of the slot where SCH power is present. When SCH power is present, the accuracy specification excludes the noise-like contribution of the SCH power.

Description	Specifications	Supplemental Information
QPSK EVM Preamp (*Option 1DS*) Off, except as noted.		
Minimum power at RF Input		–20 dBm (nominal)
QPSK Downlink		
EVM Operating range		0 to 25 % (nominal)
Floor		
Preamp (*Option 1DS*) Off Preamp (*Option 1DS*) On	 1.5 %	1.5 % (nominal) RF input power = –50 dBm, Attenuator = 0 dB
Accuracy[a]		±1.0 % (nominal) at EVM of 10 %
I/Q origin offset Range		–10 to –50 dBc (nominal)
Frequency error Range		±300 kHz (nominal)
Accuracy		±10 Hz (nominal) + (transmitter frequency × frequency reference accuracy)
12.2 k RMC Uplink		
EVM Operating range Floor Accuracy[a]		 0 to 20 % (nominal) 1.5 % (nominal) ±1.0 % (nominal) at EVM of 10 %
I/Q origin offset Range		–10 to –50 dBc (nominal)
Frequency error Range Accuracy		 ±20 kHz (nominal) ±10 Hz (nominal) + (transmitter frequency × frequency reference accuracy)

a. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows: error = $\mathrm{sqrt}(EVMUUT^2 + EVMsa^2) - EVMUUT$, where EVMUUT is the EVM of the UUT in percent, and EVMsa is the EVM floor of the analyzer in percent. For example, if the EVM of the UUT is 7 %, and the floor is 2.5 %, the error due to the floor is 0.43 %. The total error can cause a reading as high as EVMUUT + floorerror + accyerror, or as low as EVMUUT – accyerror, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.

Description	Specifications	Supplemental Information
Modulation Accuracy (Composite EVM) BTS Measurements –25 dBm ≤ ML[a] ≤ –15 dBm Preamp (Option 1DS) Off, except as noted		
Composite EVM		
Minimum power at RF input Preamp (*Option 1DS*) Off Preamp (*Option 1DS*) On	 	 –75 dBm (nominal)[bc] –102 dBm (nominal)[d]
Maximum power at RF input Preamp (*Option 1DS*) On		 –45 dBm (nominal)[e]
Test Model 4 Range Floor Accuracy[f]	 0 to 25 % 1.5 % ±1.0 %	
Test Model 1 with 32 DPCH Range Floor Accuracy[f]	 0 to 25 % 1.5 % ±1.0 %	
Peak Code Domain Error Using Test Model 3 with 16 DPCH signal spreading code 256 Accuracy		 ±1.0 dB (nominal)
I/Q Origin Offset Range		 –10 to –50 dBc (nominal)
Frequency Error Specified for CPICH power ≥ –15 dBc Range Accuracy	 ±500 Hz ±2 Hz + (transmitter frequency × frequency reference accuracy)	
Time offset Frame offset accuracy Relative offset accuracy[g]	 ±150 ns ±1.25 ns	
Spectrum (Frequency Domain)	See Spectrum on page 78.	
Waveform (Time Domain)	See Waveform on page 79.	

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

b. Predefined test models under the Symbol Boundary menu are recommended for RF input power levels below –60 dBm. At low signal-to-noise ratios the auto channel ID algorithm may not correctly detect an active code channel as turned on. The predefined test model bypasses the auto channel ID algorithm.

c. Nominal operating range. Accuracy specification applies when mixer level (Rf input power minus attenuation) is between –25 and –15 dBm.

d. CPICH synchronization requires a minimum RF input power of –102 dBm. CPICH synchronization can be achieved for RF input power down to –112 dBm, but lock will not be consistent.

e. CPICH synchronization can be obtained above –45 dBm, but TOI products will begin to raise the EVM floor. The power range that is free from TOI-induced noise floor problems can be extended up to 20 dB by increasing the input attenuation above the factory preset setting of 0 dB when using the preamplifier. There is no auto mode for setting input attenuation when the preamplifier is On.

f. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows: error = sqrt($EVMUUT^2$ + $EVMsa^2$) – EVMUUT, where EVMUUT is the EVM of the UUT in percent, and EVMsa is the EVM floor of the analyzer in percent. For example, if the EVM of the UUT is 7 %, and the floor is 2.5 %, the error due to the floor is 0.43 %. The total error can cause a reading as high as EVMUUT + floorerror + accyerror, or as low as EVMUUT – accyerror, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.

g. The accuracy specification applies when the measured signal is the combination of CPICH (antenna-1) and CPICH (antenna-2), and where the power level of each CPICH is –3 dB relative to the total power of the combined signal. Further, the range of the measurement for the accuracy specification to apply is ±0.5 chips.

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

Frequency

Description	Specifications	Supplemental Information
In-Band Frequency Range	2110 to 2170 MHz 1920 to 1980 MHz	

General

Description	Specifications	Supplemental Information
Trigger		
Trigger source		RF burst (wideband), Video (IF envelope), Ext Front, Ext Rear. Actual choices are dependent on measurement.
Trigger delay, level, & slope		Each trigger source has separate set of these parameters.
Trigger delay Range Repeatability Resolution	 –100 to +500 ms ±33 ns 33 ns	
External trigger inputs Level Impedance		 –5 V to +5 V (characteristic) 10 kΩ (nominal)
Range Control		RF Input Autorange[a] Manually set **Max Total Pwr** Manually set **Input Atten**

a. Autorange is *not* continuous with each measurement acquisition; it will run only once immediately following a measurement restart, initiated either by pressing the **Restart** hardkey, or by sending the GPIB command `INIT:IMM`. This behavior was chosen to maintain best measurement speed, but it requires caution when input power levels change. If the input signal power changes, the analyzer will not readjust the input attenuators for optimal dynamic range unless a measurement restart is initiated. For example, if a sequence of power measurements is made, beginning with a maximum power level that is large enough to require non-zero input attenuation, it is advisable to do a measurement restart to automatically set a lower input attenuator value to maintain optimal dynamic range for approximately every 3 dB the input signal power level is reduced, or smaller, depending upon how precisely dynamic range needs to be optimized. Conversely, if the input signal power increases to a high enough level, input overloading will occur if the input attenuators are not readjusted by doing a measurement restart.

5 cdmaOne Specifications

This chapter contains specifications for the PSA Series, *Option BAC*, cdmaOne Measurement Personality.

Additional Definitions and Requirements

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

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

The specifications for this chapter apply to the E4440A, E4443A and E4445A spectrum analyzers. For the E4446A and E4448A, the performance is nominal only and not subject to any warranted specifications.

The measurement performance is only slightly different in the E4446A and E4448A when compared to the performance of the E4440A, E4443A and E4445A analyzers. Because the hardware performance of the analyzers is very similar but not identical, you can estimate the nominal performance of the measurements from the specifications in this chapter.

Description	Specifications	Supplemental Information
Channel Power Measurement 1.23 MHz Integration BW		
Minimum power at RF Input		–75 dBm (nominal)
Absolute power accuracy[a] 20 °C to 30 °C attenuation > 2 dB[b] attenuation ≤ 2 dB[b]	 ±0.67 dB ±0.76 dB	 ±0.18 dB (typical) ±0.24 dB (typical)
Measurement floor[c]		–86 dBm + Input Attenuation (nominal)
Relative power accuracy Fixed channel Fixed input attenuator	±0.08 dB	±0.03 dB (typical)
Mixer level –52 to –12 dB[d]		

a. Absolute power accuracy includes all error sources for in-band signals except mismatch errors. There are two cases listed.

b. The absolute power accuracy depends on the setting of the electronic input attenuator as well as the signal-to-noise ratio. For high input levels, the Auto setting of RF Input Range will result in high signal-to-noise ratios and Input Atten > 2 dB, for which the absolute power accuracy is best. At moderate levels, manually setting the Input Atten can give better accuracy than the automatic setting. At very low levels, automatic or manual setting of the Input Atten to 0 dB optimizes the accuracy by maximizing the signal-to-noise ratio.
For cdmaOne, "high levels" would nominally be levels above –14.7 dBm, and "very low levels" would nominally be below –66 dBm.
The error due to very low signals levels is a function of the signal (channel power) to noise (measurement floor) ratio, SN, in decibels.
The function is:
$$\text{error} = 10 \times \log(1 + 10^{(-SN/10)})$$
For example, if the mixer level (input power minus attenuation) is 26.4 dB above the measurement floor, the error due to adding the analyzer's noise to the UUT is only 0.01 dB.

c. Measurement floor is the channel power measured due only to the noise of the analyzer. The measurement floor nominally changes by +1 dB/GHz for signal frequencies different from the 1 GHz frequency for which this nominal floor was determined.

d. The relative accuracy is the ratio of the accuracy of amplitude measurements of two different transmitter power levels. Mixer level is defined to be the input power minus the attenuation. This specification is equivalent to the difference between two points on the scale fidelity curve shown in the PSA Specifications Guide. The error sources of scale fidelity are almost all monotonic with input level, so the relative error between two levels is nearly (within 0.01 dB) identical to the "error relative to –35 dBm" specified in the Guide.

Description	Specifications	Supplemental Information
Code Domain (Base Station)		
Minimum power at RF Input		–40 dBm (nominal)
Measurement interval range	0.5 to 30 ms	
Code domain power Dynamic Range		Measurement interval ≥ 2.0 ms 50 dB (nominal)
Relative Power Accuracy	±0.3 dB	Walsh channel power within 20 dB of total power
Other reported power parameters	Average active traffic Maximum inactive traffic Average inactive traffic Pilot, paging, sync channels	dB readings for these power measurements are referenced to total power
Frequency error Input frequency error range Accuracy	 ±900 Hz ±10 Hz + (transmitter frequency × frequency reference accuracy)	Measurement interval ≥ 2.0 ms
Pilot time offset Range Accuracy Resolution	 –13.33 ms to +13.33 ms ±300 ns 10 ns	From even second signal to start of PN sequence
Code domain timing Range Accuracy Resolution	 ±200 ns ±10 ns 0.1 ns	Pilot to code channel time tolerance; measurement interval ≥ 2.0 ms
Code domain phase Range Accuracy Resolution	 ±200 mrad ±10 mrad 0.1 mrad	Pilot to code channel phase tolerance; measurement interval ≥ 2.0 ms

Description	Specifications	Supplemental Information
Modulation Accuracy		
Minimum power at RF Input		–40 dBm (nominal)
Measurement interval range	0.5 to 30 ms	
Rho (waveform quality)		Measurement interval ≥ 2.0 ms
Range Accuracy 0.9 < Rho < 1.0 Resolution	0.9 to 1.0 ±0.001 0.0001	Operating range 0.5 to 1.0
Frequency error Input frequency error range Accuracy	 ±900 Hz ±10 Hz + (transmitter frequency × frequency reference accuracy)	Measurement interval ≥ 2.0 ms
Base station pilot time offset		From even second signal to start of PN sequence
Range Accuracy Resolution	–13.33 ms to +13.33 ms ±300 ns 10 ns	
EVM (RMS)		Measurement interval ≥ 2.0 ms
Floor Accuracy[a] Range 0 to 14 %	2.0 % ±0.5 %	1.5 % (typical)
Carrier feedthrough Floor Accuracy	 –55 dBc ±2.0 dB	

a. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows: error = $\mathrm{sqrt}(EVMUUT^2 + EVMsa^2) - EVMUUT$, where EVMUUT is the EVM of the UUT in percent, and EVMsa is the EVM floor of the analyzer in percent. For example, if the EVM of the UUT is 7 %, and the floor is 2.5 %, the error due to the floor is 0.43 %. The total error can cause a reading as high as EVMUUT + floorerror + accyerror, or as low as EVMUUT – accyerror, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.

Description		Specifications	Supplemental Information
Adjacent Channel Power Ratio			
Minimum power at RF Input			–39 dBm (nominal)
Dynamic Range[a]			Referenced to average power in 1.23 MHz BW
Offset Freq. (kHz)	Integ. BW (kHz)		
750	30	–86.7 dB	Mixer level = –12 dBm
885	30	–86.3 dB	Mixer level = –12 dBm
1256.25	12.5	–90.8 dB	Mixer level = –12 dBm
1265	30	–87.0 dB	Mixer level = –12 dBm
1980	30	–87.8 dB	
2750	1000	–72.7 dB	
ACPR Relative Accuracy			
Offsets < 1.30 MHz[b]		±0.09 dB	
Offsets > 1.85 MHz[c]		±0.09 dB	

a. The optimum mixer level (mixer level is defined to be the average input power minus the input attenuation) is different for optimum ACPR dynamic range than the Auto setting of RF Input Level. For optimum dynamic range, the ideal mixer level is about –12 dBm for the 750 kHz offset, which is close to the input overload threshold. The setting for mixer level when RF Input Level is set to Auto is about –17 dBm. The advantage of the Auto setting is that it gives a greater range of allowable input peak-to-average ratios without registering an input overload.

b. 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 –67 dB and the measurement floor is –87 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.

c. As in footnote b, 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 b, however, the spectral components from the analyzer will be noncoherent with the components from the UUT. Because of this, 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:

$$\text{error} = 10 \times \log(1 + 10^{(-SN/10)})$$

For example, if the UUT ACPR is –78 dB and the measurement floor is –88 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.

Description	Specifications	Supplemental Information
Spur Close		
Minimum power at RF Input		–35 dBm (nominal)
Minimum spurious emission power sensitivity at RF Input[a]		–95 dBm + Input Attenuation
Representative Amplitude Accuracies[b]		
Example Absolute Accuracy[c] Example Relative Accuracy[d]	±0.89 dB ±0.09 dB	
Spectrum (Frequency Domain)	See Spectrum on page 78.	
Waveform (Time Domain)	See Waveform on page 79.	

Description	Specifications	Supplemental Information
In-Band Frequency Ranges	824 to 849 MHz 869 to 894 MHz	IS-95 IS-95
	1850 to 1910 MHz 1930 to 1990 MHz	J-STD-008 J-STD-008

a. The sensitivity is the smallest CW signal that can be reliable detected, using the 30 kHz RBW, not including the effects of phase noise.

b. The range of possible channel powers, and levels, frequencies and spacings of spurious signals makes complete specification of amplitude uncertainty as complex as it is for any spectrum analysis measurement. The error sources for arbitrary signals are given in the “Specifications Applicable to All Digital Communications Personalities” section. Therefore, just two examples will be specified.

c. The absolute power accuracy example is a base station test measuring a spurious signal at a typical specification limit of –13 dBm in a 30 kHz bandwidth 2 MHz offset from the center of the channel. The base station power is +40 dBm feed through an ideal 20 dB external attenuator. The specified accuracy excludes mismatch errors.

d. The relative power accuracy example is a base station test measuring a spurious signal 750 kHz offset from the center of the channel, at the typical specification limit of –45 dBc in a 30 kHz bandwidth, relative to the power in the channel. The base station power is +20 dBm at the RF input.

6 cdma2000 Specifications

This chapter contains specifications for the PSA Series, *Option B78*, cdma2000 Measurement Personality.

Additional Definitions and Requirements

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

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

The specifications for this chapter apply to the E4440A, E4443A and E4445A spectrum analyzers. For the E4446A and E4448A, the performance is nominal only and not subject to any warranted specifications.

The measurement performance is only slightly different in the E4446A and E4448A when compared to the performance of the E4440A, E4443A and E4445A analyzers. Because the hardware performance of the analyzers is very similar but not identical, you can estimate the nominal performance of the measurements from the specifications in this chapter.

Description	Specifications	Supplemental Information
Channel Power 1.23 MHz Integration BW		
Minimum power at RF input		–74 dBm (nominal)
Absolute power accuracy[a] 20 to 30 °C attenuation > 2 dB[b] attenuation ≤ 2 dB[b]	 ±0.67 dB ±0.76 dB	 ±0.18 dB (typical) ±0.24 dB (typical)
Measurement floor[c]		–85 dBm (nominal)
Relative power accuracy Fixed channel Fixed input attenuator Mixer level –52 to –12 dBm[d]	±0.08 dB	±0.03 dB (typical)

a. Absolute power accuracy includes all error sources for in-band signals except mismatch errors. There are two cases listed.

b. The absolute power accuracy depends on the setting of the electronic input attenuator as well as the signal-to-noise ratio. For high input levels, the Auto setting of RF Input Range will result in high signal-to-noise ratios and Input Atten> 2 dB, for which the absolute power accuracy is best. At moderate levels, manually setting the Input Atten can give better accuracy than the automatic setting. At very low levels, automatic or manual setting of the Input Atten to 0 dB optimizes the accuracy by maximizing the signal-to-noise ratio.
For cdmaOne, “high levels” would nominally be levels above –14.7 dBm, and “very low levels” would nominally be below –66 dBm.
The error due to very low signals levels is a function of the signal (channel power) to noise (measurement floor) ratio, SN, in decibels.
The function is:

$$\text{error} = 10 \times \log(1 + 10^{(-SN/10)})$$

For example, if the mixer level (input power minus attenuation) is 26.4 dB above the measurement floor, the error due to adding the analyzer's noise to the UUT is only 0.01 dB.

c. Measurement floor is the channel power measured due only to the noise of the analyzer. The measurement floor nominally changes by +1 dB/GHz for signal frequencies different from the 2 GHz frequency for which this nominal floor was determined.

d. The relative accuracy is the ratio of the accuracy of amplitude measurements of two different transmitter power levels. Mixer level is defined to be the input power minus the attenuation. This specification is equivalent to the difference between two points on the scale fidelity curve shown in the PSA Specifications Guide. Because the error sources of scale fidelity are almost all monotonic with input level, the relative error between two levels is nearly (within 0.01 dB) identical to the “error relative to –35 dBm” specified in the Guide.

Description		Specifications	Supplemental Information
Adjacent Channel Power Ratio			
Minimum power at RF input			–38 dBm (nominal)
Dynamic range[a]			Referenced to average power of carrier in 1.23 MHz bandwidth
Offset Freq.	Integ. BW		
750 kHz	30 kHz	–84.9 dBc	Optimum mixer level[b] = –12 dBm
885 kHz	30 kHz	–85.2 dBc	Optimum mixer level[b] = –12 dBm
1256.25 kHz	12.5 kHz	–89.6 dBc	Optimum mixer level[b] = –12 dBm
1980 kHz	30 kHz	–86.8 dBc	
2750 kHz	1000 kHz	–71.7 dBc	
ACPR Relative Accuracy			
Offsets < 1300 kHz[c] Offsets > 1.85 MHz[d]		±0.09 dB ±0.09 dB	

a. The optimum mixer level (mixer level is defined to be the average input power minus the input attenuation) is different for optimum ACPR dynamic range than the Auto setting of RF Input Level. For optimum dynamic range, the ideal mixer level is about –12 dBm for the 750 kHz offset, which is close to the input overload threshold. The setting for mixer level when RF Input Level is set to Auto is about –17 dBm. The advantage of the Auto setting is that it gives a greater range of allowable input peak-to-average ratios without registering an input overload

b. These specifications apply with an apparent mixer level of –17 dBm. Mixer level is defined to be input power minus input attenuation. The apparent mixer level is different from the actual mixer level because the actual attenuation is decreased by 5 dB, compared to the attenuation shown, when measuring the adjacent channels, in order to improve dynamic range. Therefore, these specifications only apply when the input attenuation is 5 dB or more and the apparent mixer level is –17 dBm.

c. 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 $\text{error} = 20 \times \log(1 + 10^{(-SN/20)})$. 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.

d. As in footnote b, 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 a, though, the spectral components from the analyzer will be non-coherent 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 $\text{error} = 10 \times \log(1 + 10^{(-SN/10)})$. 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.

Description	Specification	Supplemental Information
Power Statistics CCDF		
Minimum power at RF Input		–40 dBm (nominal)
Histogram Resolution	0.01 dB[a]	

Description	Specification	Supplemental Information
Intermodulation		
Minimum carrier power at RF Input		–30 dBm (nominal)
Third-order intercept		
CF = 1 GHz		TOI + 7.2 dB[b]
CF = 2 GHz		TOI + 7.5 dB[b]

Description	Specification	Supplemental Information
Occupied Bandwidth		
Minimum carrier power at RF Input		–40 dBm (nominal)
Frequency resolution	100 Hz	
Frequency accuracy		$\frac{1.2\%}{\sqrt{N_{avg}}}$ (nominal)[c]

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.

b. The third-order intercept (TOI) of the analyzer as configured for the cdma2000 personality is higher than the third-order intercept specified for the analyzer without the personality, due to the configuration of loss elements in front of the input mixer. The personality configures the mechanical attenuator to be in a fixed 6 dB attenuation position, and has additional loss in the electronic attenuator. The TOI increases by the nominal amount shown due to these losses when the electronic attenuator is set to 0 dB, and further increases proportional to the setting of the electronic attenuator.

c. The errors in Occupied Bandwidth measurement are mostly due to the noisiness of any measurement of a noise-like signal, such as the cdma2000 signal. The observed standard deviation of the OBW measurement is 14 kHz (1.2 %), so with 100 averages, the standard deviation should be about 1.4 kHz, or 0.1 %.

Description	Specifications	Supplemental Information
Spectrum Emission Mask		
Minimum carrier power a RF Input		–20 dBm (nominal)
Dynamic Range, relative[a]		
750 kHz offset[b] 1980 MHz region[c]	–84.7 dB –80.7 dB	–86.4 dB (typical) –83.0 dB (typical)
Sensitivity, absolute[d]		
750 kHz offset[e] 1980 MHz region[f]	–97.9 dBm –81.9 dBm	–99.9 dBm (typical) –83.9 dBm (typical)
Accuracy, relative 750 kHz offset[g] 1980 MHz region[h]	 ±0.14 dB ±0.56 dB	

a. The dynamic range specification is the ratio of the channel power to the power in the offset and region specified. The dynamic range depends on the measurement settings, such as peak power or integrated power. This specification is derived from other analyzer performance limitations such as third-order intermodulation, DANL and phase noise. Dynamic range specifications are based on default measurement settings, with detector set to average, and depend on the mixer level. Mixer level is defined to be the input power minus the input attenuation.

b. Default measurement settings include 30 kHz RBW. This dynamic range specification applies for the optimum mixer level, which is about –11 dBm.

c. Default measurement settings include 1200 kHz RBW. This dynamic range specification applies for a mixer level of 0 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 PSA Specifications Guide; the levels into the mixer are nominally 8 dB lower in this application when the center frequency is 2 GHz.

d. The sensitivity is specified with 0 dB input attenuation. It represents the noise limitations of the analyzer. It is tested without an input signal.

e. The sensitivity at this offset is specified for the default 30 kHz RBW, at a center frequency of 2 GHz.

f. The sensitivity for this region is specified for the default 1200 kHz bandwidth, at a center frequency of 2 GHz.

g. 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.

h. The relative accuracy is a measure of the ratio of the power in the region to the main channel power. It applies for spurious emission levels in the regions that are well above the dynamic range limitation.

Description	Specifications	Supplemental Information
Code Domain		Specifications apply to BTS and where the mixer level (RF input power minus attenuation) is between –25 and –15 dBm.
Code domain power		
Power range at RF input Preamplifier On		–80 to –40 dBm (nominal)[a]
The following specifications are applicable with the Preamplifier (*Option 1DS*) Off.		
Code domain power		
Minimum power at RF input		–60 dBm (nominal)[bc]
Relative power accuracy		
Code domain power range 0 to –10 dBc –10 to –30 dBc –30 to –40 dBc	 ±0.015 dB ±0.18 dB ±0.51 dB	
Symbol power vs. time		
Minimum power at RF Input		–40 dBm (nominal)[bc]
Accuracy	±0.1 dB	Specified for code channel power ≥ –20 dBc
Symbol error vector magnitude		
Minimum power at RF Input Accuracy	 ±0.1 %	–20 dBm (nominal)[bc]

a. Pilot synchronization requires a minimum RF input power of –80 dBm. Pilot synchronization can be obtained above –40 dBm, but TOI products will begin to raise the code domain noise floor. The power range that is free from TOI-induced noise floor problems can be extended up to 20 dB by increasing the input attenuation above the factory preset setting of 0 dB when using the preamplifier. There is no auto mode for setting input attenuation when the preamplifier is On.

b. At low signal-to-noise ratios where the RF input power is below –65 dBm, the auto channel ID algorithm may not accurately detect an active code channel as turned on.

c. Nominal operating range. Accuracy specification applies when mixer level (RF input power minus attenuation) is between –25 and –15 dBm.

Description	Specifications	Supplemental Information
QPSK EVM		
Minimum power at RF input Preamplifier (*Option 1DS*) Off, except as noted		–20 dBm (nominal)
EVM Operating range		0 to 18 % (nominal)
Floor		
Preamplifier (*Option 1DS*) Off		1.5 % (nominal)
Preamplifier (*Option 1DS*) On	1.5 %	RF input power = –50 dBm, Attenuator = 0 dB
Accuracy[a]		±1.0 % (nominal)
I/Q origin offset Range		–10 to –45 dBc (nominal)
Frequency Error Range		±5.0 kHz (nominal)
Accuracy		±10 Hz + (transmitter frequency × frequency reference accuracy)

a. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows: error = $\text{sqrt}(\text{EVMUUT}^2 + \text{EVMsa}^2) - \text{EVMUUT}$, where EVMUUT is the EVM of the UUT in percent, and EVMsa is the EVM floor of the analyzer in percent. For example, if the EVM of the UUT is 7 %, and the floor is 2.5 %, the error due to the floor is 0.43 %. The total error can cause a reading as high as EVMUUT + floorerror + accyerror, or as low as EVMUUT – accyerror, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.

Description	Specifications	Supplemental Information
Modulation Accuracy (Composite EVM)		Specifications apply to BTS for 9 active channels as defined in 3GPP-II, and where the mixer level (RF input power minus attenuation) is between –25 and –15 dBm.
Power range at RF Input Preamplifier (*Option 1DS*) On		–80 to –40 dBm (nominal)[a]
Minimum power at RF Input Preamplifier (*Option 1DS*) Off		–60 dBm (nominal)[bc]
The following specifications are applicable with the Preamplifier (*Option 1DS*) Off.		
Global EVM Range	0 to 25 %	
Floor	1.5 %	
Accuracy[d]	±0.75 %	
Rho Range	0.9 to 1.0	
Accuracy	±0.0015	
Resolution	0.0001	
Pilot time offset Range	–13.33 to +13.33 ms	From even second signal to start of PN sequence
Accuracy	±300 ns	
Resolution	10 ns	
Code domain timing Range	±200 ns	Pilot to code channel time tolerance
Accuracy	±1.25 ns	
Resolution	0.1 ns	
Code domain phase Range	±200 mrad	Pilot to code channel phase tolerance
Accuracy	±10 mrad	
Resolution	0.1 mrad	
Peak code domain error Accuracy		±1.0 dB (nominal)
I/Q origin offset Range		–10 to –50 dBc (nominal)
Frequency error Range	±900 Hz	
Accuracy	±10 Hz + (transmitter frequency × frequency reference accuracy)	
Spectrum (Frequency Domain)	See Spectrum on page 78.	
Waveform (Time Domain)	See Waveform on page 79.	

a. Pilot synchronization requires a minimum RF input power of –80 dBm. Pilot synchronization can be obtained above –40 dBm, but TOI products will begin to raise the EVM floor. The power range that is free from TOI-induced noise floor problems can be extended up to 20 dB by increasing the input attenuation above the factory preset setting of 0 dB when using the preamplifier. There is no auto mode for setting input attenuation when the preamplifier is On.

b. At low signal-to-noise ratios where the RF input power is below –65 dBm, the auto channel ID algorithm may not accurately detect an active code channel as turned on.

c. Nominal operating range. Accuracy specification applies when mixer level (RF input power minus attenuation) is between –25 and –15 dBm.

d. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows: floorerror = $sqrt(EVMUUT^2 + EVMsa^2)$ – EVMUUT, where EVMUUT is the EVM of the UUT in percent, and EVMsa is the EVM floor of the analyzer in percent. For example, if the EVM of the UUT is 7 %, and the floor is 2.5 %, the error due to the floor is 0.43 %. The total error can cause a reading as high as EVMUUT + floorerror + accyerror, or as low as EVMUUT – accyerror, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.

Description	Specifications	Supplemental Information
In-Band Frequency Range		
Band Class 0 (North American Cellular)	869 to 894 MHz 824 to 849 MHz	
Band Class 1 (North American PCS)	1930 to 1990 MHz 1850 to 1910 MHz	
Band Class 2 (TACS)	917 to 960 MHz 872 to 915 MHz	
Band Class 3 (JTACS)	832 to 870 MHz 887 to 925 MHz	
Band Class 4 (Korean PCS)	1840 to 1870 MHz 1750 to 1780 MHz	
Band Class 6 (IMT–2000)	2110 to 2170 MHz 1920 to 1980 MHz	

General

Description	Specifications	Supplemental Information
Trigger		
Trigger source		RF burst (wideband), Video (IF envelope), Ext Front, Ext Rear. Actual available choices are dependent on measurement.
Trigger delay, level, and slope		Each trigger source has a separate set of these parameters.
Trigger delay Range Repeatability Resolution	 –100 to +500 ms ±33 ns 33 ns	
External trigger inputs Level Impedance		 –5 V to +5 V, characteristic 10 kΩ (nominal)
Range Control		RF Input Autorange[a] Manually set **Max Total Pwr** Manually set **Input Atten**

a. Autorange is *not* continuous with each measurement acquisition; it will run only once immediately following a measurement restart, initiated either by pressing the **Restart** hardkey, or by sending the GPIB command `INIT:IMM`. This behavior was chosen to maintain best measurement speed, but it requires caution when input power levels change. If the input signal power changes, the analyzer will not readjust the input attenuators for optimal dynamic range unless a measurement restart is initiated. For example, if a sequence of power measurements is made, beginning with a maximum power level that is large enough to require non-zero input attenuation, it is advisable to do a measurement restart to automatically set a lower input attenuator value to maintain optimal dynamic range for approximately every 3 dB the input signal power level is reduced, or smaller, depending upon how precisely dynamic range needs to be optimized. Conversely, if the input signal power increases to a high enough level, input overloading will occur if the input attenuators are not readjusted by doing a measurement restart.

7 1xEV-DO Specifications

This chapter contains specifications for the PSA Series, *Option 204*, 1xEV-DO Measurement Personality.

Additional Definitions and Requirements

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

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

The specifications for this chapter apply to the E4440A, E4443A and E4445A spectrum analyzers. For the E4446A and E4448A, the performance is nominal only and not subject to any warranted specifications.

The measurement performance is only slightly different in the E4446A and E4448A when compared to the performance of the E4440A, E4443A and E4445A analyzers. Because the hardware performance of the analyzers is very similar but not identical, you can estimate the nominal performance of the measurements from the specifications in this chapter.

Description	Specifications	Supplemental Information
Channel Power 1.23 MHz Integration BW		Input signal must not be bursted
Minimum power at RF input		–74 dBm (nominal)
Absolute power accuracy[a] 20 °C to 30 °C attenuation > 2 dB[b] attenuation ≤ 2 dB[b]	 ±0.67 dB ±0.76 dB	 ±0.18 dB (typical) ±0.24 dB (typical)
Measurement floor[c]		–85 dBm (nominal)
Relative power accuracy Fixed channel Fixed input attenuator Mixer level –52 to –12 dBm[d]	±0.08 dB	±0.03 dB (typical)

a. Absolute power accuracy includes all error sources for in-band signals except mismatch errors. There are two cases listed.

b. The absolute power accuracy depends on the setting of the electronic input attenuator as well as the signal-to-noise ratio. For high input levels, the Auto setting of RF Input Range will result in high signal-to-noise ratios and Input Atten > 2 dB, for which the absolute power accuracy is best. At moderate levels, manually setting the Input Atten can give better accuracy than the automatic setting. At very low levels, automatic or manual setting of the Input Atten to 0 dB optimizes the accuracy by maximizing the signal-to-noise ratio.
For cdmaOne, “high levels” would nominally be levels above –14.7 dBm, and “very low levels” would nominally be below –66 dBm.
The error due to very low signals levels is a function of the signal (channel power) to noise (measurement floor) ratio, SN, in decibels.
The function is:
$$\text{error} = 10 \times \log(1 + 10^{(-SN/10)})$$
For example, if the mixer level (input power minus attenuation) is 26.4 dB above the measurement floor, the error due to adding the analyzer's noise to the UUT is only 0.01 dB.

c. Measurement floor is the channel power measured due only to the noise of the analyzer. The measurement floor nominally changes by +1 dB/GHz for signal frequencies different from the 2 GHz frequency for which this nominal floor was determined.

d. The relative accuracy is the ratio of the accuracy of amplitude measurements of two different transmitter power levels. Mixer level is defined to be the input power minus the attenuation. This specification is equivalent to the difference between two points on the scale fidelity curve shown in the PSA Specifications Guide. Because the error sources of scale fidelity are almost all monotonic with input level, the relative error between two levels is nearly (within 0.01 dB) identical to the “error relative to –35 dBm” specified in the Guide.

Description	Specifications	Supplemental Information
Power Statistics CCDF		
Minimum power at RF Input		–40 dBm (nominal)
Histogram Resolution	0.01 dB[a]	

Description	Specifications	Supplemental Information
Intermod		Input signal must not be bursted
Minimum carrier power at RF Input		–30 dBm (nominal)
Third-order intercept		
CF = 1 GHz		TOI + 7.2 dB[b]
CF = 2 GHz		TOI + 7.5 dB[b]

Description	Specifications	Supplemental Information
Occupied Bandwidth		Input signal must not be bursted
Minimum carrier power a RF Input		–40 dBm (nominal)
Frequency resolution	100 Hz	
Frequency accuracy		$\frac{1.2\,\%}{\sqrt{N_{avg}}}$ (nominal)[c]

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.

b. The third-order intercept (TOI) of the analyzer as configured for the cdma2000 personality is higher than the third-order intercept specified for the analyzer without the personality, due to the configuration of loss elements in front of the input mixer. The personality configures the mechanical attenuator to be in a fixed 6 dB attenuation position, and has additional loss in the electronic attenuator. The TOI increases by the nominal amount shown due to these losses when the electronic attenuator is set to 0 dB, and further increases proportional to the setting of the electronic attenuator.

c. The errors in Occupied Bandwidth measurement are mostly due to the noisiness of any measurement of a noise-like signal, such as the 1xEV signal. The observed standard deviation of the OBW measurement is 14 kHz (1.2 %), so with 100 averages, the standard deviation should be about 1.4 kHz, or 0.1 %.

Description	Specifications	Supplemental Information
Spurious Emissions and ACP		
Minimum carrier power a RF Input		–20 dBm (nominal)
Dynamic Range, relative[a]		
750 kHz offset[b] 1980 MHz region[c]	–84.7 dB –80.7 dB	–86.4 dB (typical) –83.0 dB (typical)
Sensitivity, absolute[d]		
750 kHz offset[e] 1980 MHz region[f]	–97.9 dBm –81.9 dBm	–99.9 dBm (typical) –83.9 dBm (typical)
Accuracy, relative 750 kHz offset[g] 1980 MHz region[h]	 ±0.14 dB ±0.56 dB	

a. The dynamic range specification is the ratio of the channel power to the power in the offset and region specified. The dynamic range depends on the measurement settings, such as peak power or integrated power. This specification is derived from other analyzer performance limitations such as third-order intermodulation, DANL and phase noise. Dynamic range specifications are based on default measurement settings, with detector set to average, and depend on the mixer level. Mixer level is defined to be the input power minus the input attenuation.

b. Default measurement settings include 30 kHz RBW. This dynamic range specification applies for the optimum mixer level, which is about –11 dBm.

c. Default measurement settings include 1200 kHz RBW. This dynamic range specification applies for a mixer level of 0 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 PSA Specifications Guide; the levels into the mixer are nominally 8 dB lower in this application when the center frequency is 2 GHz.

d. The sensitivity is specified with 0 dB input attenuation. It represents the noise limitations of the analyzer. It is tested without an input signal.

e. The sensitivity at this offset is specified for the default 30 kHz RBW, at a center frequency of 2 GHz.

f. The sensitivity for this region is specified for the default 1200 kHz bandwidth, at a center frequency of 2 GHz.

g. 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.

h. The relative accuracy is a measure of the ratio of the power in the region to the main channel power. It applies for spurious emission levels in the regions that are well above the dynamic range limitation.

Description	Specifications	Supplemental Information
Code Domain		
Specification applies at 0 dBm input power.		For Pilot, 2 MAC channels, and 16 channels of QPSK data
Relative power accuracy	±0.15 dB	

Description	Specifications	Supplemental Information
QPSK EVM		
Minimum power at RF input		–20 dBm (nominal)
EVM Operating range		0 to 15 % (nominal)
Floor		1.5 % (nominal)
Accuracy[a]		±1.0 % (nominal)
I/Q origin offset Range		–10 to –50 dBc (nominal)
Frequency Error Range		±5.0 kHz (nominal)
Accuracy		±10 Hz (nominal) + (transmitter frequency × frequency reference accuracy)

a. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows: error = sqrt(EVMUUT^2 + EVMsa^2) – EVMUUT, where EVMUUT is the EVM of the UUT in percent, and EVMsa is the EVM floor of the analyzer in percent. For example, if the EVM of the UUT is 7 %, and the floor is 2.5 %, the error due to the floor is 0.43 %. The total error can cause a reading as high as EVMUUT + floorerror + accyerror, or as low as EVMUUT – accyerror, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.

Description	Specifications	Supplemental Information
Modulation Accuracy (Composite Rho) Specifications apply at 0 dBm input power, unless otherwise indicated		For Pilot, 2 MAC channels, and 16 channels of QPSK data
Minimum carrier power at RF Input		–50 dBm (nominal)
Composite EVM Operating range		0 to 25 % (nominal)
Floor	2.5 %	2.5 %, nominal, at –45 dBm input power, and ADC gain set to +18 dB
Accuracy[a]	±1.0 %	At the range of 5 % to 25 %
Rho Range	0.9 to 1.0	
Floor	0.99938	0.9994, nominal, at –45 dBm input power, and ADC gain set to +18 dB
Accuracy	±0.0010 % ±0.0044 %	at Rho 0.99751 (EVM 5 %) at Rho 0.94118 (EVM 25 %)
I/Q origin offset range		–10 to –50 dBc (nominal)
Frequency error Range	±600 Hz	
Accuracy	±1 Hz + (transmitter freq. × frequency reference accuracy)	

a. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows: error = $\text{sqrt}(\text{EVMUUT}^2 + \text{EVMsa}^2) - \text{EVMUUT}$, where EVMUUT is the EVM of the UUT in percent, and EVMsa is the EVM floor of the analyzer in percent. For example, if the EVM of the UUT is 7 %, and the floor is 2.5 %, the error due to the floor is 0.43 %. The total error can cause a reading as high as EVMUUT + floorerror + accyerror, or as low as EVMUUT – accyerror, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.

Description	Specifications	Supplemental Information
Power vs. Time (PVT)		
Minimum power at RF input		–73 dBm (nominal)
Absolute power accuracy[a] 20 °C to 30 °C attenuation > 2 dB[b] attenuation ≤ 2 dB[b]		 ±0.24 dB (nominal) ±0.30 dB (nominal)
Measurement floor[c]		–84 dBm (nominal)
Relative power accuracy Fixed channel Fixed input attenuator Mixer level –52 to –12 dBm[d]		±0.03 dB (nominal)
Spectrum (Frequency Domain)	See Spectrum on page 78.	
Waveform (Time Domain)	See Waveform on page 79.	

a. Absolute power accuracy includes all error sources for in-band signals except mismatch errors. There are two cases listed.

b. The absolute power accuracy depends on the setting of the electronic input attenuator as well as the signal-to-noise ratio. For high input levels, the Auto setting of RF Input Range will result in high signal-to-noise ratios and Input Atten> 2 dB, for which the absolute power accuracy is best. At moderate levels, manually setting the Input Atten can give better accuracy than the automatic setting. At very low levels, automatic or manual setting of the Input Atten to 0dB optimizes the accuracy by maximizing the signal-to-noise ratio.
For cdmaOne, "high levels" would nominally be levels above –14.7 dBm, and "very low levels" would nominally be below –66 dBm.
The error due to very low signals levels is a function of the signal (channel power) to noise (measurement floor) ratio, SN, in decibels.
The function is:
$$\text{error} = 10 \times \log(1 + 10^{(-SN/10)})$$
For example, if the mixer level (input power minus attenuation) is 26.4 dB above the measurement floor, the error due to adding the analyzer's noise to the UUT is only 0.01 dB.

c. Measurement floor is the channel power measured due only to the noise of the analyzer. The measurement floor nominally changes by +1 dB/GHz for signal frequencies different from the 2 GHz frequency for which this nominal floor was determined.

d. The relative accuracy is the ratio of the accuracy of amplitude measurements of two different transmitter power levels. Mixer level is defined to be the input power minus the attenuation. This specification is equivalent to the difference between two points on the scale fidelity curve shown in the PSA Specifications Guide. Because the error sources of scale fidelity are almost all monotonic with input level, the relative error between two levels is nearly (within 0.01 dB) identical to the "error relative to –35 dBm" specified in the Guide.

Frequency

Description	Specifications	Supplemental Information
In-Band Frequency Range (Access Network Only)		
Band Class 0	869 to 894 MHz	North American and Korean Cellular Bands
Band Class 1	1930 to 1990 MHz	North American PCS Band
Band Class 2	917 to 960 MHz	TACS Band
Band Class 3	832 to 869 MHz	JTACS Band
Band Class 4	1840 to 1870 MHz	Korean PCS Band
Band Class 6	2110 to 2170 MHz	IMT-2000 Band
Band Class 8	1805 to 1880 MHz	1800-MHz Band
Band Class 9	925 to 960 MHz	900-MHz Band

Alternative Frequency Ranges

Description	Specifications	Supplemental Information
Alternative Frequency Ranges[a] (Access Network Only)		
Band Class 5	421 to 430 MHz 460 to 470 MHz 489 to 194 MHz	NMT–450 Band
Band Class 7	746 to 764 MHz	North American 700-MHz Cellular Band

a. Frequency ranges with tuning plans but degraded specifications for absolute power accuracy. The degradation should be nominally ±0.30 dB

General

Description	Specifications	Supplemental Information
Trigger		
Trigger source		RF burst (wideband), Video (IF envelope), Ext Front, Ext Rear. Actual available choices are dependent on measurement selection.
Trigger delay, level, and slope		Each trigger source has a separate set of these parameters.
Trigger delay Range Repeatability Resolution	 –100 to +500 ms ±33 ns 33 ns	
External trigger inputs Level Impedance		 –5 V to +5 V, characteristic 10 kΩ (nominal)
Range Control		RF Input Autorange[a] Manually set `Max Total Pwr` Manually set `Input Atten`

a. Autorange is *not* continuous with each measurement acquisition; it will run only once immediately following a measurement restart, initiated either by pressing the `Restart` hardkey, or by sending the GPIB command `INIT:IMM`. This behavior was chosen to maintain best measurement speed, but it requires caution when input power levels change. If the input signal power changes, the analyzer will not readjust the input attenuators for optimal dynamic range unless a measurement restart is initiated. For example, if a sequence of power measurements is made, beginning with a maximum power level that is large enough to require non-zero input attenuation, it is advisable to do a measurement restart to automatically set a lower input attenuator value to maintain optimal dynamic range for approximately every 3 dB the input signal power level is reduced, or smaller, depending upon how precisely dynamic range needs to be optimized. Conversely, if the input signal power increases to a high enough level, input overloading will occur if the input attenuators are not readjusted by doing a measurement restart.

8 NADC Specifications

This chapter contains specifications for the PSA Series, *Option BAE*, NADC Measurement Personality.

Additional Definitions and Requirements

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

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

The specifications for this chapter apply to the E4440A, E4443A and E4445A spectrum analyzers. For the E4446A and E4448A, the performance is nominal only and not subject to any warranted specifications.

The measurement performance is only slightly different in the E4446A and E4448A when compared to the performance of the E4440A, E4443A and E4445A analyzers. Because the hardware performance of the analyzers is very similar but not identical, you can estimate the nominal performance of the measurements from the specifications in this chapter.

Description	Specifications	Supplemental Information
Adjacent Channel Power Ratio		
Minimum Power at RF Input		–50 dBm (nominal)
ACPR Dynamic Range		
At 30 kHz offset[a]		
At 60 kHz offset		74 dB (nominal)
At 90 kHz offset		77 dB (nominal)
ACPR Relative Accuracy	±0.08 dB[b]	

a. An ideal NADC signal, filtered by a perfect root-raised-cosine filter, shows about –35.4 dB ACPR at the 30 kHz offset. The added noise power due to intermodulation distortions and phase noise in the analyzer is well below this level. Therefore, measurement accuracy at 30 kHz offset is not significantly impacted by the dynamic range of the analyzer.

b. The specified ACPR accuracy applies if the measured ACPR substantially exceeds the analyzer dynamic range at the specified offset. At the nominal test limits for the offsets (–26, –45 and –45 dBc for 30, 60 and 90 kHz offsets), for RF power above –25 dBm, this condition is met. When this condition is not met, there are additional errors due to the addition of analyzer spectral components to UUT spectral components. The spectral components from the analyzer will be non-coherent with the components from the UUT at the 60 and 90 kHz offsets. Because of this, 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:
$$\text{error} = 10 \times \log(1 + 10^{-SN/10})$$
For example, if the UUT ACPR is –64 dB and the measurement floor is –74 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.

Description	Specifications	Supplemental Information
Error Vector Magnitude (EVM)		
Minimum Power at RF Input		–45 dBm (nominal)
EVM		
Operating range		0 to 18 % (nominal)
Floor	0.5 %	
Accuracy[a]		±0.6 % (nominal)
Frequency Error		
Accuracy		±2.0 Hz (nominal) + (transmitter frequency × frequency reference accuracy)
I/Q Origin offset		
Range		–10 to –50 dBc (nominal)
Spectrum (Frequency Domain)	See Spectrum on page 78.	
Waveform (Time Domain)	See Waveform on page 79.	

a. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows: error = $\text{sqrt}(EVMUUT^2 + EVMsa^2) - EVMUUT$, where EVMUUT is the EVM of the UUT in percent, and EVMsa is the EVM floor of the analyzer in percent. For example, if the EVM of the UUT is 7 %, and the floor is 2.5 %, the error due to the floor is 0.43 %. The total error can cause a reading as high as EVMUUT + floorerror + accyerror, or as low as EVMUUT – accyerror, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.

Description	Specifications	Supplemental Information
In-Band Frequency Range		
Cellular Band	824 to 849 MHz 869 to 894 MHz	
PCS Band	1850 to 1910 MHz 1930 to 1990 MHz	

General

Description	Specifications	Supplemental Information
Trigger		
Trigger source		RF burst (wideband), Video (IF envelope), Ext Front, Ext Rear. Actual available choices dependent on measurement.
Trigger delay, level, and slope		Each trigger source has a separate set of these parameters.
Trigger delay Range Repeatability Resolution	 –100 to +500 ms ±33 ns 33 ns	
External trigger inputs Level Impedance		 –5 V to +5 V (nominal) 10 kΩ (nominal)
Range Control		RF Input Autorange[a] Manually set **Max Total Pwr** Manually set **Input Atten**

a. Autorange is *not* continuous with each measurement acquisition; it will run only once immediately following a measurement restart, initiated either by pressing the **Restart** hardkey, or by sending the GPIB command `INIT:IMM`. This behavior was chosen to maintain best measurement speed, but it requires caution when input power levels change. If the input signal power changes, the analyzer will not readjust the input attenuators for optimal dynamic range unless a measurement restart is initiated. For example, if a sequence of power measurements is made, beginning with a maximum power level that is large enough to require non-zero input attenuation, it is advisable to do a measurement restart to automatically set a lower input attenuator value to maintain optimal dynamic range for approximately every 3 dB the input signal power level is reduced, or smaller, depending upon how precisely dynamic range needs to be optimized. Conversely, if the input signal power increases to a high enough level, input overloading will occur if the input attenuators are not readjusted by doing a measurement restart.

9 PDC Specifications

This chapter contains specifications for the PSA Series, *Option BAE*, PDC Measurement Personality.

Additional Definitions and Requirements

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

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

The specifications for this chapter apply to the E4440A, E4443A and E4445A spectrum analyzers. For the E4446A and E4448A, the performance is nominal only and not subject to any warranted specifications.

The measurement performance is only slightly different in the E4446A and E4448A when compared to the performance of the E4440A, E4443A and E4445A analyzers. Because the hardware performance of the analyzers is very similar but not identical, you can estimate the nominal performance of the measurements from the specifications in this chapter.

Description	Specifications	Supplemental Information
Adjacent Channel Power Ratio		
Minimum Power at RF Input		–36 dBm (nominal)
ACPR Dynamic Range At 50 kHz offset At 100 kHz offset		 74 dB (nominal) 78 dB (nominal)
ACPR Relative Accuracy	±0.08 dB[a]	

a. 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. The spectral components from the analyzer will be noncoherent with the components from the UUT. Because of this, 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 –64 dB and the measurement floor is –74 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.
With the nominal dynamic ranges shown, and with ACP at the nominal test limits of –45 and –60 dB, and with an input RF power well above –18 dBm, the errors due to dynamic range limitations are nominally ±0.005 dB at 50 kHz offset and ±0.07 dB at 100 kHz offset.

Description	Specifications	Supplemental Information
Error Vector Magnitude (EVM)		
Minimum Power at RF Input		–50 dBm (nominal)
EVM Operating range Floor Accuracy[a]	 0.5 %	 0 to 18 % (nominal) ±0.6 % (nominal)
I/Q Origin offset Range		 –12 to –50 dBc (nominal)
Frequency Error Accuracy		 ±2.0 Hz + (transmitter frequency × frequency reference accuracy)
Spectrum	See Spectrum on page 78.	
Waveform (Time Domain)	See Waveform on page 79.	

a. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows: error = sqrt($EVMUUT^2$ + $EVMsa^2$) – EVMUUT, where EVMUUT is the EVM of the UUT in percent, and EVMsa is the EVM floor of the analyzer in percent. For example, if the EVM of the UUT is 7 %, and the floor is 2.5 %, the error due to the floor is 0.43 %. The total error can cause a reading as high as EVMUUT + floorerror + accyerror, or as low as EVMUUT – accyerror, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.

Description	Specifications	Supplemental Information
Occupied Bandwidth		
Minimum power at RF Input		–60 dBm (nominal)
Frequency Resolution	100 Hz	
Frequency Accuracy		–50 to –150 Hz (nominal)[a]

Description	Specifications	Supplemental Information
In-Band Frequency Range		
800 MHz Band #1	810 to 828 MHz 940to 958 MHz	
800 MHz Band #2	870 to 885 MHz 925 to 940 MHz	
800 MHz Band #3	838 to 840 MHz 893 to 895 MHz	
1500 MHz Band	1477 to 1501 MHz 1429 to 1453 MHz	

a. The errors in the Occupied Bandwidth measurement are mostly due to the noisiness of any measurement of a noise-like signal, such as the PDC signal. The observed standard deviation of the OBW measurement is 270 Hz, so with 100 averages, the standard deviation should be well under the display resolution. The frequency errors due to the FFT processing are computed to be only 2.9 Hz with the narrow RBW (140 Hz) used. For large numbers of averages, the error is within the quantization error shown.

General

Description	Specifications	Supplemental Information
Trigger		
Trigger source		RF burst (wideband), Video (IF envelope), Ext Front, Ext Rear, Frame Timer. Actual available choices dependent on measurement.
Trigger delay, level, and slope		Each trigger source has a separate set of these parameters.
Trigger delay Range Repeatability Resolution	 –100 to +500 ms ±33 ns 33 ns	
External trigger inputs Level Impedance		 –5 V to +5 V (nominal) 10 kΩ (nominal)
Range Control		RF Input Autorange[a] Manually set **Max Total Pwr** Manually set **Input Atten**

a. Autorange is *not* continuous with each measurement acquisition; it will run only once immediately following a measurement restart, initiated either by pressing the **Restart** hardkey, or by sending the GPIB command `INIT:IMM`. This behavior was chosen to maintain best measurement speed, but it requires caution when input power levels change. If the input signal power changes, the analyzer will not readjust the input attenuators for optimal dynamic range unless a measurement restart is initiated. For example, if a sequence of power measurements is made, beginning with a maximum power level that is large enough to require non-zero input attenuation, it is advisable to do a measurement restart to automatically set a lower input attenuator value to maintain optimal dynamic range for approximately every 3 dB the input signal power level is reduced, or smaller, depending upon how precisely dynamic range needs to be optimized. Conversely, if the input signal power increases to a high enough level, input overloading will occur if the input attenuators are not readjusted by doing a measurement restart.

10 Phase Noise Measurement Personality Specifications

This chapter contains specifications for the PSA, *Option 226*, Phase Noise Measurement Personality.

Phase Noise

Description	Specifications	Supplemental Information
Carrier Frequency Range		
PSA Series Analyzers		
E4440A	1 MHz to 26.5 GHz	
E4443A	1 MHz to 6.7 GHz	
E4445A	1 MHz to 13.2 GHz	
E4446A	1 MHz to 44 GHz	
E4448A	1 MHz to 50 GHz	

Description	Specifications	Supplemental Information
Measurement Characteristics		
Measurements	Log plot Spot frequency RMS noise RMS jitter Residual FM	
Maximum number of decades	7 (whole decades only)	
Filtering (ratio of video bandwidth to resolution bandwidth)	None (VBW/RBW = 1.0) Little (VBW/RBW = 0.3) Medium (VBW/RBW = 0.1) Maximum (VBW/RBW = 0.03)	

Description	Specifications	Supplemental Information
Offset Frequency		
Range	10 Hz to 100 MHz	The minimum offset is limited to 10 times the narrowest RBW of the analyzer.

Description	Specifications	Supplemental Information
Measurement Accuracy		
Amplitude Accuracy[a] (carrier frequency 1 MHz to 3.0 GHz)		±0.29 dB[b]

a. Amplitude accuracy is derived from analyzer specification and characteristics. It is based on a 1 GHz signal at 0 dBm while running the log plot measurement with all other measurement and analyzer settings at their factory defaults.

b. This does not include the effect of system noise floor. This error is a function of the signal (phase noise of the DUT) to noise (analyzer noise floor due to phase noise and thermal noise) ratio, SN, in decibels.

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

For example, if the phase noise being measured is 10 dB above the measurement floor, the error due to adding the analyzer's noise to the UUT is 0.41 dB.

Description	Specifications	Supplemental Information			
Amplitude Repeatability					
		Standard Deviation[a][b]			
		No Filtering	Little Filtering	Medium Filtering	Maximum Filtering
No Smoothing					
Offset					
100 Hz		5.4 dB	3.4 dB	3.9 dB	3.4 dB
1 kHz		5.2 dB	3.7 dB	2.3 dB	2.1 dB
10 kHz		5.1 dB	3.5 dB	2.0 dB	1.2 dB
100 kHz		4.5 dB	2.9 dB	1.9 dB	1.0 dB
1 MHz		4.1 dB	2.7 dB	1.7 dB	0.95 dB
4 % Smoothing[c]					
Offset					
100 Hz		1.7 dB	1.1 dB	1.1 dB	0.88 dB
1 kHz		1.3 dB	0.78 dB	0.53 dB	0.37 dB
10 kHz		1.1 dB	0.78 dB	0.34 dB	0.29 dB
100 kHz		0.86 dB	0.40 dB	0.40 dB	0.23 dB
1 MHz		0.34 dB	0.32 dB	0.16 dB	0.11 dB

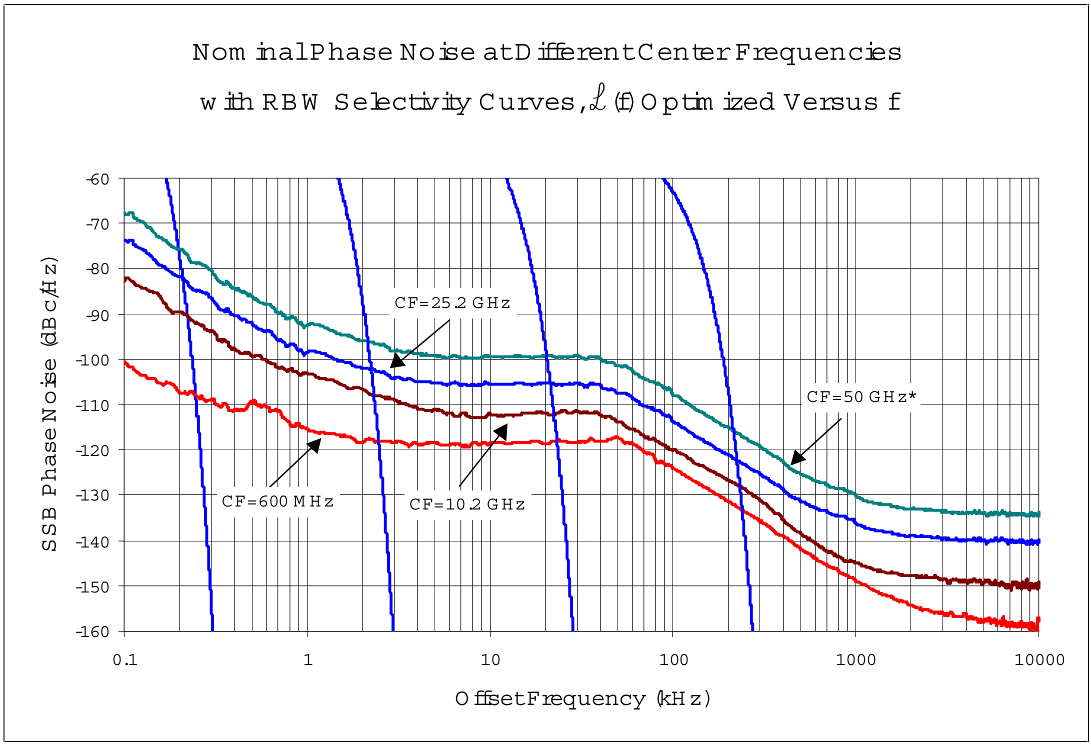
a. Amplitude repeatability is the nominal standard deviation of the measured phase noise. This table comes from an observation of 30 log plot measurements using a 1 GHz, 0 dBm signal with the filtering and smoothing settings shown. All other analyzer and measurement settings are set to their factory defaults.

b. The standard deviation can be further reduced by applying averaging. The standard deviation will improve by a factor of the square root of the number of averages. For example, 10 averages will improve the standard deviation by a factor of 3.2.

c. Smoothing can cause additional amplitude errors near rapid transitions of the data, such as with discrete spurious signals and impulsive noise. The effect is more pronounced as the number of points smoothed increases.

Description	Specifications	Supplemental Information
Frequency Offset Accuracy[a]	±1.4 %	0.02 octave

Nominal Phase Noise Normalized to 1 Hz Versus Offset Frequency[b]



a. The frequency offset error in octaves causes an additional amplitude accuracy error proportional to the product of the frequency error and slope of the phase noise. For example, a 0.01 octave frequency error combined with an 18 dB/octave slope gives 0.18 dB additional amplitude error.

b. 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 in the Frequency chapter for the details of phase noise performance versus center frequency.

11 Noise Figure Measurement Personality Specifications

This chapter contains specifications for the PSA series, *Option 219*, Noise Figure Measurement Personality.

Description	Specifications		Supplemental Information	
Noise Figure			Uncertainty Calculator[a]	
200 kHz to 10 MHz[b]			Using internal preamp (*Option 1DS*)	
Noise Source ENR			Measurement Range (nominal)	Instrument Uncertainty[c] (nominal)
4 – 7 dB			0 – 20 dB	±0.05 dB
12 – 17 dB			0 – 30 dB	±0.05 dB
20 – 22 dB			0 – 35 dB	±0.10 dB
10 MHz to 3 GHz			Using internal preamp (*Option 1DS*), and RBW=1 MHz	
Noise Source ENR	Measurement Range	Instrument Uncertainty [c]		
4 – 7 dB	0 – 20 dB	±0.05 dB		
12 – 17 dB	0 – 30 dB	±0.05 dB		
20 – 22 dB	0 – 35 dB	±0.10 dB		
3 to 19 GHz[d]				
Noise Figure Uncertainty ENR = 15 dB e.g. Agilent 346C			±0.15 dB (nominal)	
19 to 26.5 GHz[d]				
Noise Figure Uncertainty ENR = 15 dB e.g. Agilent 346C			±0.3 dB (nominal)	

a. The figures given in the table are for the uncertainty added by the PSA instrument only. To get an overall uncertainty figure for your measurement, you need to take into account other factors including DUT NF, Gain and match. To work this out the *Option 219* has an uncertainty calculator built in. Go to **Mode Setup** then select **Uncertainty Calculator**. Similar calculators are also available on the Agilent web site; go to www.agilent.com/find/nfu.

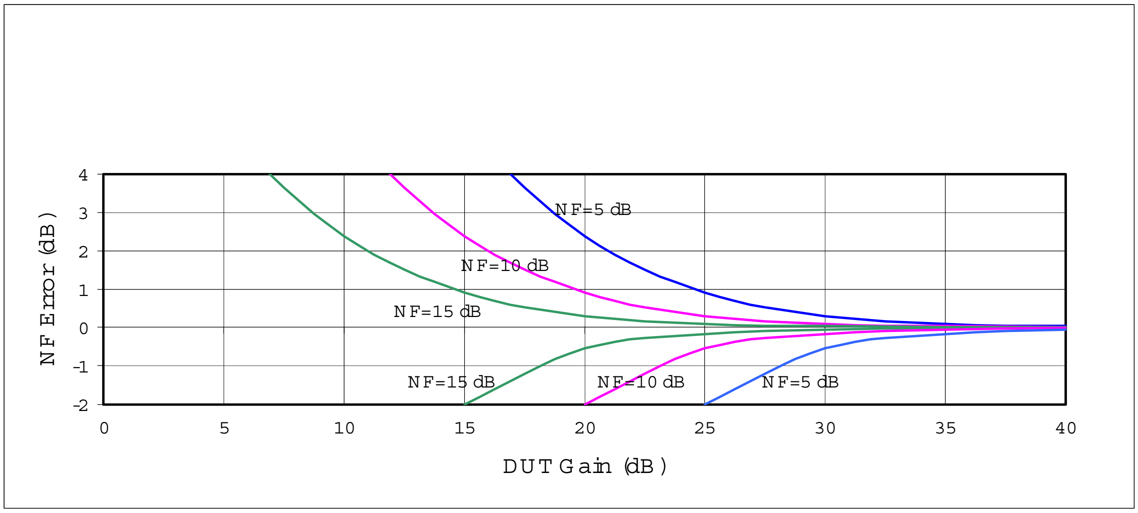
b. See the FAQ for current information on the availability of noise sources for this frequency range. To find the FAQ, choose any PSA Series model number from www.agilent.com/find/psa, and look for the FAQ link under "In the Library".

c. "Instrument Uncertainty" is defined for noise figure analysis as uncertainty due to relative amplitude uncertainties encountered in the analyzer when making the measurements required for a noise figure or gain computation. The relative amplitude uncertainty is given by the relative display scale fidelity, also known as relative log fidelity. The uncertainty of the analyzer is multiplied within the computation by an amount that depends on the Y factor to give the uncertainty of the noise figure or gain.
The relative fidelity of two measurements is only warranted to be twice the absolute display scale fidelity because the performance of the analyzer for relative scale fidelity is so good that it cannot be practically verified. See specifications and the footnote in display scale fidelity/relative fidelity for details. In most cases, instrument uncertainty can be ignored because VSWR effects dominate the total error budget. See Agilent App Note 57-2, literature number 5952-3706E for details on the use of this specification.
Jitter can affect the accuracy of results. It is important as a rule of thumb to have as many averages set as time permits and have the resolution bandwidth set high. If the Resolution BW has to be low, more averaging would be advised. PSA has 1 MHz set as default since this is the widest bandwidth with uncompromised accuracy. For true Gaussian noise, jitter reduces with increased averaging by a factor of 1/squareroot (number of averages).

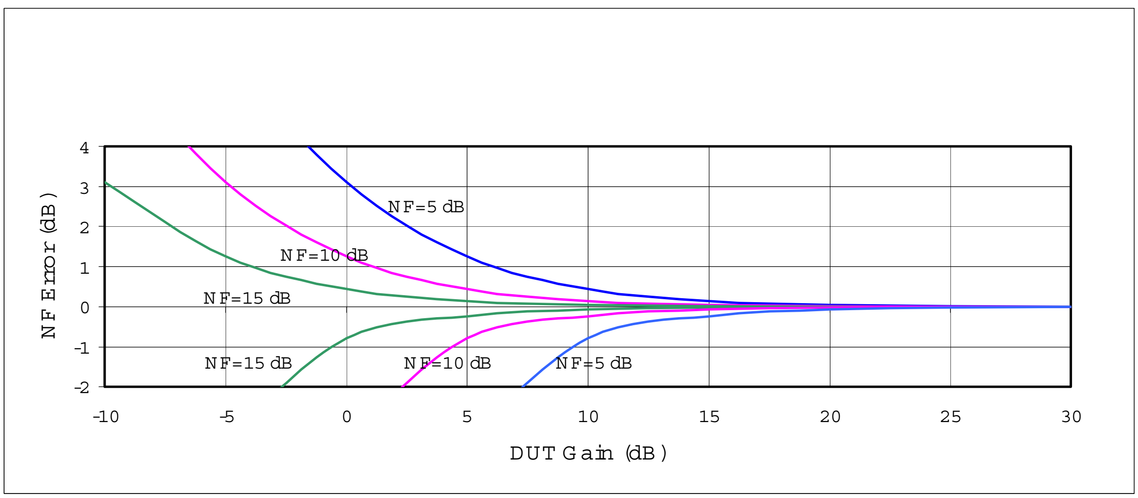
d. For this frequency range the preselector amplitude error does not allow more accurate specifications. Therefore a nominal specification for a particular DUT is given. The DUT in this case was an Agilent 83006A. This DUT has approximately 20 dB gain and 8-13 dB NF. No preamp was used. The following graphs give an idea of what sort of accuracy you will get when measuring your DUT. The first graph is with no preamp, and gain in your DUT is essential to get accurate results. The second is when using an external preamp with about 24 dB gain and 6 dB NF. See *User's Programming and Reference Guide*.

Noise Figure Error Range vs. DUT Gain, Non-warranted Frequency Range (>3 GHz)

Nominal NF Error Range vs. DUT Gain, Non-warranted Frequency Range (>3 GHz)
Assumptions: no external preamp, PSA NF = 28 dB, Attenuation = 0 dB
Positive and negative error ranges shown for DUT noise figures of 5, 10 and 15 dB



Nominal NF Error Range vs. DUT Gain, Non-warranted Frequency Range (>3 GHz)
Assumptions: external preamp, preamp + PSA NF = 10 dB
Positive and negative error ranges shown for DUT noise figures of 5, 10 and 15 dB



Description	Specifications	Supplemental Information
Gain		
200 kHz to 10 MHz[a]		Using internal preamp (*Option 1DS*)
Noise Source ENR		Measurement Range (nominal) / Instrument Uncertainty[b] (nominal)
4 – 7 dB		20 – 40 dB / ±0.17 dB
12 – 17 dB		20 – 40 dB / ±0.17 dB
20 – 22 dB		20 – 40 dB / ±0.17 dB
10 MHz to 3 GHz		Using internal preamp (*Option 1DS*), and RBW=1 MHz
Noise Source ENR	Measurement Range / Instrument Uncertainty[b]	
4 – 7 dB	20 – 40 dB / ±0.17 dB	
12 – 17 dB	20 – 40 dB / ±0.17 dB	
20 – 22 dB	20 – 40 dB / ±0.17 dB	
3 to 19 GHz[c]		
Gain Uncertainty ENR = 15 dB e.g. Agilent 346C		±1.0 dB (nominal)
19 to 26.5 GHz[c]		
Gain Uncertainty ENR = 15 dB e.g. Agilent 346C		±2.0 dB (nominal)

a. See the FAQ for current information on the availability of noise sources for this frequency range. To find the FAQ, choose any PSA Series model number from www.agilent.com/find/psa, and look for the FAQ link under “In the Library”.

b. See the “Instrument Uncertainty” footnote c on page 158.

c. For this frequency range the preselector amplitude error does not allow more accurate specifications. Therefore a nominal specification for a particular DUT is given. The DUT in this case was an Agilent 83006A. This DUT has approximately 20 dB gain and 8-13 dB NF. No preamp was used.

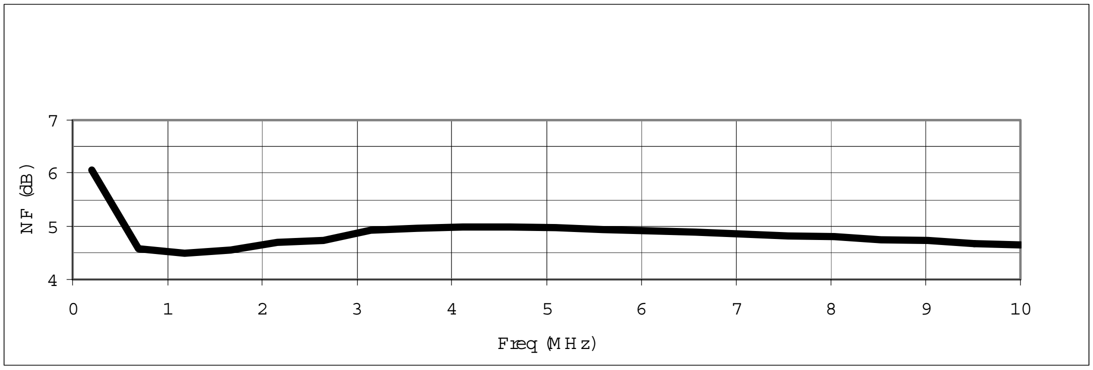
Description	Specifications	Supplemental Information
Noise Figure Uncertainty Calculator[a]		
Noise Figure Instrument Uncertainty	See **Noise**	
Gain Instrument Uncertainty	See **Gain**	
Instrument Noise Figure		See graphs, Nominal Noise Figure DANL +176.15, nominal[b]
Instrument Input Match		See graphs, Nominal VSWR

a. Noise figure uncertainty calculations require the parameters shown in order to calculate the uncertainty.

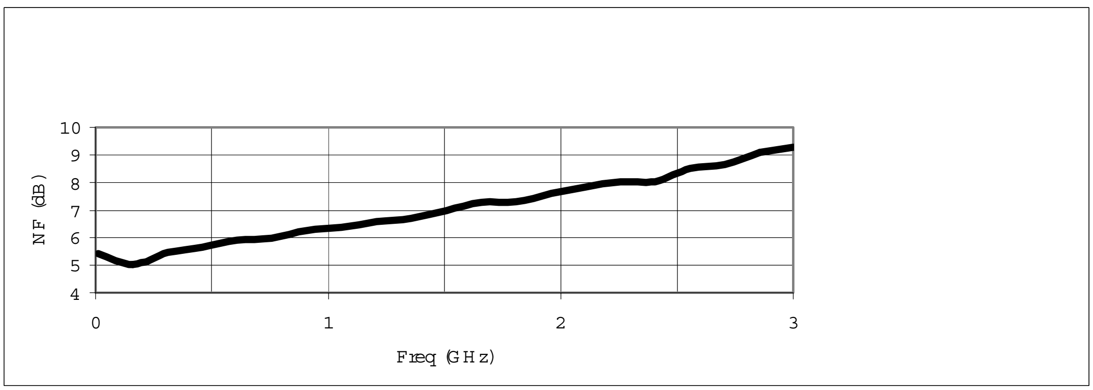
b. Nominally, the noise figure of the spectrum analyzer is given by the DANL (displayed average noise level) minus kTB (–173.88 dB in a 1 Hz bandwidth at 25 °C) plus 2.51 dB (the effect of log averaging used in DANL verifications) minus 0.24 dB (the ratio of the noise bandwidth of the 1 Hz RBW filter with which DANL is specified to a 1 Hz noise bandwidth for which kTB is given). The actual NF will vary from the nominal due to frequency response errors.

Nominal Instrument Noise Figure

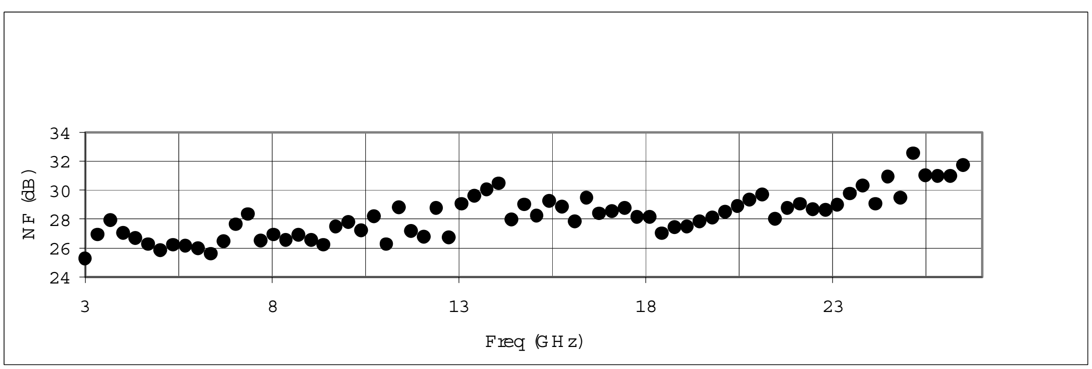
Nominal Instrument Noise Figure 200 kHz to 10 MHz
Preamp On



Nominal Instrument Noise Figure 10 MHz to 3 GHz
Preamp On

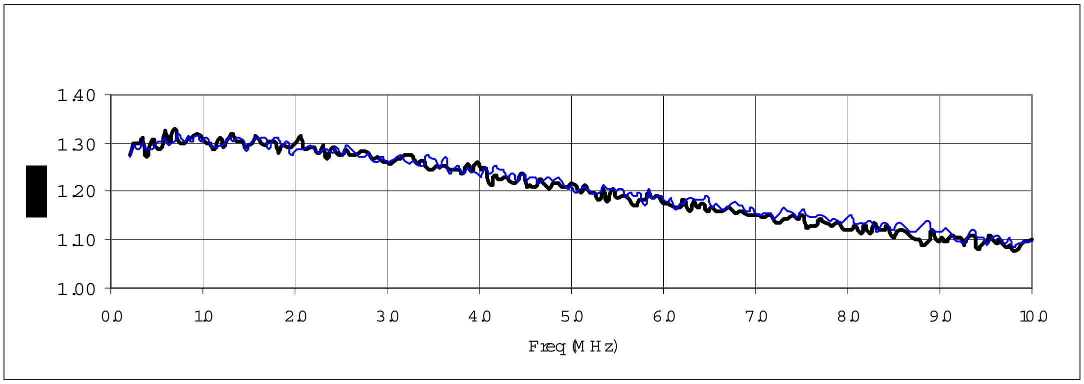


Nominal Instrument Noise Figure 3 to 26.5 GHz
No Preamp

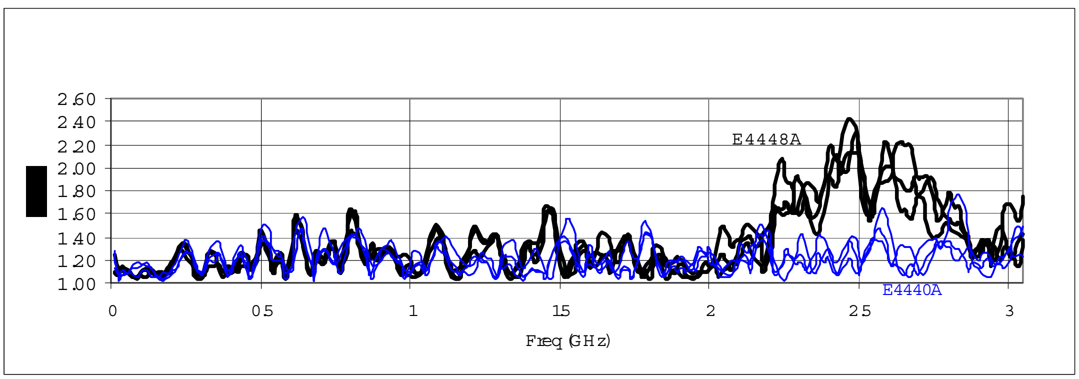


Nominal Instrument Input VSWR

Nominal Instrument Input VSWR 200 kHz to 10 MHz; Preamp On, Attenuation = 0 dB
VSWR of two instruments shown. One was an E4440A and one was an E4448A. All PSA models have similar VSWR behavior in this frequency range.



Nominal Instrument Input VSWR 10 MHz to 3 GHz; Preamp On, Attenuation = 0 dB
VSWR of six instruments shown. Three graphs are representative of E4440/3/5 models, and three of E4446/8 models.



Nominal Instrument Input VSWR 3 to 26.5 GHz; No Preamp, Attenuation = 0 dB
VSWR of six instruments shown. Three graphs are representative of E4440/3/5 models, and three of E4446/8 models.