

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)



Manufacturing Part Numbers: E4440-90227

Supersedes: E4440-90217
Printed in USA
December 2003

© Copyright 2001-2003 Agilent Technologies, Inc.

The information in this document is subject to change without notice.

Agilent Technologies makes no warranty of any kind with regard to this material, including but not limited to, the implied warranties of merchantability and fitness for a particular purpose. Agilent Technologies shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material.

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>

Table of Contents

1	PSA Specifications	11
	Definitions and Requirements	12
	Definitions	12
	Conditions Required to Meet Specifications	12
	Certification.....	12
	Frequency.....	13
	E4443A.....	13
	E4445A.....	13
	E4440A.....	14
	E4446A.....	15
	E4448A.....	15
	External Mixing (Option AYZ)	16
	Frequency Reference.....	17
	Frequency Readout Accuracy	18
	Frequency Span.....	19
	Sweep Time	20
	Gated FFT	20
	Gated Sweep.....	21
	Measurement Time vs. Span (nominal).....	22
	Number of Frequency Display Trace Points (buckets).....	22
	Resolution Bandwidth (RBW)	23
	Information Bandwidth	24
	Typical Dynamic Range vs. Offset Frequency vs. RBW.....	25
	Video Bandwidth (VBW).....	26
	Stability	26
	Nominal Phase Noise of Different LO Optimizations	28
	Nominal Phase Noise at Different Center Frequencies.....	29
	Amplitude.....	31
	Measurement Range	31
	Maximum Safe Input Level	31
	Gain Compression	32
	E4443A, E4445A, E4440A.....	32
	E4446A, E4448A.....	33
	Displayed Average Noise Level (DANL).....	34
	E4443A, E4445A, E4440A.....	34
	E4446A, E4448A.....	36

Display Range	37
Marker Readout	37
Frequency Response.....	38
E4443A, E4445A, E4440A.....	38
E4446A, E4448A.....	39
Input Attenuation Switching Uncertainty.....	41
Preamp (Option 1DS).....	41
Absolute Amplitude Accuracy	42
RF Input VSWR	43
E4443A, E4445A, E4440A.....	43
E4446A, E4448A.....	44
Resolution Bandwidth Switching Uncertainty.....	45
Reference Level	45
Display Scale Switching Uncertainty	46
Display Scale Fidelity	46
General Spurious Responses	49
Second Harmonic Distortion.....	49
Third Order Intermodulation Distortion	50
E4443A, E4445A, E4440A.....	50
E4446A, E4448A.....	51
Other Input Related Spurious.....	52
Dynamic Range	53
E4443A, E4445A, E4440A.....	53
E4446A, E4448A: Bands 0–4	54
E4446A, E4448A: Bands 5–6	55
Power Suite Measurements.....	56
Channel Power	56
Occupied Bandwidth	56
Adjacent Channel Power (ACP).....	57
Multi-Carrier Power.....	60
Power Statistics CCDF	60
Harmonic Distortion	61
Burst Power.....	61
Spurious Emissions W-CDMA signals.....	61
Spectrum Emission Mask	62
Options	63
General	64
Calibration Cycle.....	64
Temperature Range	64
Acoustic Emissions (ISO 7779).....	64

Military Specification.....	64
EMI Compatibility	65
Immunity Testing	65
Power Requirements.....	65
Measurement Speed.....	66
Display	66
Volume Control and Headphone Jack.....	66
Data Storage.....	67
Weight.....	67
Cabinet Dimensions	67
Inputs/Outputs (Front Panel).....	68
RF Input	68
E4443A, E4445A, E4440A.....	68
RF Input	68
E4446A, E4448A.....	68
RF Input	68
Probe Power.....	69
Ext Trigger Input	69
Option AYZ External Mixing.....	69
IF Input.....	69
Mixer Bias Current.....	69
Mixer Bias Voltage	69
Option AYZ External Mixing.....	70
LO Output.....	70
Rear Panel	71
10 MHz Out (Switched).....	71
Ext Ref In.....	71
Trigger In.....	71
Keyboard.....	72
Trigger 1 and Trigger 2 Outputs	72
Monitor Output	72
Pre-Sel Tune Out.....	73
Option AYZ External Mixing.....	73
Preselector Tune Voltage	73
Noise Source Drive Output.....	73
GPIB Interface	73
Serial Interface.....	73
Parallel Interface	73
LAN TCP/IP Interface.....	73
321.4 MHz IF Output.....	74
SCSI Interface	74

Regulatory Information	75
Declaration of Conformity	76
2 Digital Communications Basic Measurement Personality	77
Additional Definitions and Requirements	78
Option B7J, Digital Communications Basic Measurement Personality	79
Frequency Range.....	79
Frequency Response.....	79
Electronic Input Attenuator	79
Absolute Amplitude Accuracy	80
LO emissions < 3 GHz.....	81
Measurement Range	81
Measurements.....	82
Spectrum.....	82
Waveform.....	83
Waveform.....	83
Both Spectrum and Waveform	84
Inputs and Outputs.....	85
Front Panel.....	85
RF Input	85
3 GSM/EDGE Specifications	87
Additional Definitions and Requirements.....	88
Option 202, GSM/Edge	89
EDGE Error Vector Magnitude (EVM).....	89
Power vs. Time and EDGE Power vs. Time.....	90
Phase and Frequency Error.....	91
Output RF Spectrum and EDGE Output RF Spectrum.....	92
In-Band Frequency Ranges	94
Alternative Frequency Ranges	94
Trigger	95
Burst Sync	95
Range Control.....	95
4 W-CDMA Specifications	97
Additional Definitions and Requirements.....	98
Conformance With 3GPP TS 25.141 Base Station Requirements for a Manufacturing Environment	99
Channel Power	101
Adjacent Channel Power Ratio (ACPR; ACLR).....	102
Multi-Carrier Power.....	103

Power Statistics CCDF	104
Intermodulation	104
Occupied Bandwidth	105
Spectrum Emission Mask	105
Power Control and Power vs. Time	111
Frequency	112
In-Band Frequency Range	112
General	112
Trigger	112
Range Control.....	112
5 HSDPA Specifications	113
Additional Definitions and Requirements	114
Option 210, HSDPA Measurement Personality	115
Frequency	119
General	119
6 cdmaOne Specifications	121
Additional Definitions and Requirements	122
Option BAC, cdmaOne Measurements Personality	123
Code Domain (Base Station).....	124
Modulation Accuracy.....	125
Adjacent Channel Power Ratio.....	126
Spur Close.....	127
In-Band Frequency Ranges	127
7 cdma2000 Specifications	129
Additional Definitions and Requirements	130
Option B78, cdma2000 Measurement Personality.....	131
Channel Power	131
Adjacent Channel Power Ratio.....	132
Power Statistics CCDF	133
Intermodulation	133
Occupied Bandwidth	133
Spectrum Emission Mask	134
Code Domain	135
QPSK EVM.....	136
Modulation Accuracy (Composite Rho)	137
In-Band Frequency Range	138
General	139

	Trigger	139
8	1xEV-DV Specifications	141
	Additional Definitions and Requirements	142
	Test model signal for 1xEV-DV	143
	Option 204,1xEV-DV Measurements Personality	144
	General	148
9	1xEV-DO Specifications	149
	Additional Definitions and Requirements	150
	Option 204,1xEV-DO Measurements Personality	151
	Power Statistics CCDF	152
	Intermod	152
	Occupied Bandwidth	152
	Spurious Emissions and ACP	153
	Code Domain	154
	QPSK EVM	154
	Modulation Accuracy (Composite Rho)	155
	Power vs. Time (PvT)	156
	Frequency	157
	Alternative Frequency Ranges	157
	Alternative Frequency Ranges	157
	General	158
	Trigger	158
10	NADC Specifications	159
	Additional Definitions and Requirements	160
	NADC Measurement Personality	161
	Adjacent Channel Power Ratio	161
	Error Vector Magnitude (EVM)	162
	In-Band Frequency Range	163
	General	163
	Trigger	163
	Range Control	163
11	PDC Specifications	165
	Additional Definitions and Requirements	166
	PDC Measurement Personality	167
	Adjacent Channel Power Ratio	167
	Error Vector Magnitude (EVM)	168

Occupied Bandwidth	169
In-Band Frequency Range	169
General	170
Trigger	170
Range Control.....	170
12 Phase Noise Measurement Personality Specifications	171
Phase Noise	172
Carrier Frequency Range	172
Measurement Characteristics	172
Offset Frequency	173
Measurement Accuracy.....	173
Amplitude Repeatability.....	174
Frequency Offset Accuracy	175
13 Noise Figure Measurement Personality Specifications.....	177
Noise Figure	178
Gain.....	181
Noise Figure Uncertainty Calculator.....	182
Nominal Instrument Noise Figure.....	183
Nominal Instrument Input VSWR.....	184

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.
- Front-panel 1st LO OUT connector terminated in 50 Ohms.
- 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	20 MHz to 6.7 GHz	
Internal Mixing Bands		Harmonic Mixing Mode (N) ^a
0	3 Hz to 3.0 GHz (DC Coupled)	1–
0	20 MHz to 3.0 GHz (AC Coupled)	1–
1	2.85 to 6.6 GHz	1–
2	6.2 to 6.7 GHz	2–
Preamp On (<i>Option 1DS</i>)	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	20 MHz to 13.2 GHz	
Internal Mixing Bands		Harmonic Mixing Mode (N) ^a
0	3 Hz to 3.0 GHz (DC Coupled)	1–
0	20 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 (<i>Option 1DS</i>)	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.

E4440A

Description	Specifications	Supplemental Information
Frequency Range		
DC Coupled	3 Hz to 26.5 GHz	
AC Coupled	20 MHz to 26.5 GHz	
Internal Mixing Bands		Harmonic Mixing Mode (N) ^a
0	3 Hz to 3.0 GHz (DC Coupled)	1-
0	20 MHz to 3.0 GHz (AC Coupled)	1-
1	2.85 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 (<i>Option 1DS</i>)	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 (<i>Option 1DS</i>)	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) ^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 50.0 GHz	8–
Preamp On (<i>Option 1DS</i>)	100 kHz to 3.0 GHz ^b	1–

- a. N is the harmonic mixing mode. Most mixing modes are negative (as indicated by the “–”), where the desired first LO harmonic is higher than the tuned frequency by the first IF (3.9214 GHz for Bands 0, 5 and 6, 321.4 MHz for all other bands). A positive mixing mode (indicated by “+”) is one in which the tuned frequency is higher than the desired first LO harmonic by the first IF (3.9214 GHz for band 5).
- b. The low frequency range of the preamp extends to 100 kHz when the RF coupling is set to DC, and to 10 MHz when RF coupling is set to AC.

External Mixing (Option AYZ)

Description	Specifications		Supplemental Information
Frequency Range External Mixing <i>Option AYZ</i>	18 GHz to 325 GHz		
	Harmonic Mixing Mode (N ^a)		
Band	Preselected	Unpreselected	
K (18.0 GHz to 26.5 GHz)	n/a	6–	
A (26.5 GHz to 40.0 GHz)	8+	8–	
Q (33.0 GHz to 50.0 GHz)	10+	10–	
U (40.0 GHz to 60.0 GHz)	10+	10–	
V (50.0 GHz to 75.0 GHz)	14+	14–	
E (60.0 GHz to 90.0 GHz)	n/a	16–	
W (75.0 GHz to 110.0 GHz)	n/a	18–	
F (90.0 GHz to 140.0 GHz)	n/a	22–	
D (110.0 GHz to 170.0 GHz)	n/a	26–	
G (140.0 GHz to 220.0 GHz)	n/a	32–	
Y (170.0 GHz to 260.0 GHz)	n/a	38–	
J (220.0 GHz to 325.0 GHz)	n/a	48–	

- a. N is the harmonic mixing mode. For negative mixing modes (as indicated by the “–”), the desired 1st LO harmonic is higher than the tuned frequency by the 1st IF (321.4 MHz for all external mixing bands) For positive mixing modes, the desired 1st LO harmonic is lower than the tuned frequency by 321.4 MHz.

Description	Specifications	Supplemental Information
Frequency Reference Accuracy Temperature Stability 20 to 30 °C 0 to 55 °C Aging Rate Settability Warm-up and Retrace ^c 300 s after turn on 900 s after turn on Achievable Initial Calibration Accuracy ^d	$\pm[(\text{time since last adjustment} \times \text{aging rate}) + \text{temperature stability} + \text{calibration accuracy}^a]$ $\pm 1 \times 10^{-8}$ $\pm 5 \times 10^{-8}$ $\pm 1 \times 10^{-7}/\text{year}^b$ $\pm 2 \times 10^{-9}$ $\pm 7 \times 10^{-8}$	$\pm 5 \times 10^{-10}/\text{day}$ (nominal) $\pm 1 \times 10^{-7}$ of final frequency (nominal) $\pm 5 \times 10^{-8}$ of final frequency (nominal)

- 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	$\pm(\text{marker freq.} \times \text{freq. ref. accy} + 0.25 \% \times \text{span} + 5 \% \times \text{RBW}^a + 2 \text{ Hz} + 0.5 \times \text{horizontal resolution})^b$	See note ^c

Description	Specifications	Supplemental Information
Frequency Counter^d Count Accuracy	$\pm(\text{marker freq.} \times \text{freq. ref. accy.} + 0.100 \text{ Hz})$	See note ^e
Delta Count Accuracy	$\pm(\text{delta freq.} \times \text{freq. ref. accy.} + 0.141 \text{ Hz})$	
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 % × RBW term contributes only 55 kHz to the total frequency readout accuracy, compared to 300 kHz for the 0.25 % × span term, for a total of 355 kHz. In this example, if an instrument had an unusually high RBW centering error of 7 % of RBW (77 kHz) and a span error of 0.20 % of span (240 kHz), the total actual error (317 kHz) would still meet the computed specification (355 kHz). *Second example:* a 20 MHz span, with a 4 MHz RBW. The specification equation does not apply because the Span:RBW ratio is not autocoupled. If the equation did apply, it would allow 50 kHz of error (0.25 %) due to the span and 200 kHz error (5 %) due to the RBW. For this non-autocoupled RBW, the RBW error is nominally 30 %, or 1200 kHz.
- b. Horizontal resolution is due to the marker reading out one of the trace points. The points are spaced by $\text{span}/(\text{Npts} - 1)$, where Npts is the number of sweep points. For example, with the factory preset value of 601 sweep points, the horizontal resolution is $\text{span}/600$. However, there is an exception: When both the detector mode is "normal" and the $\text{span} > 0.25 \times (\text{Npts} - 1) \times \text{RBW}$, peaks can occur only in even-numbered points, so the effective horizontal resolution becomes doubled, or $\text{span}/300$ 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	$\pm(0.2\% \times \text{span} + \text{horizontal resolution}^a)$	See note ^b
FFT	$\pm(0.2\% \times \text{span} + \text{horizontal resolution}^a)$	

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

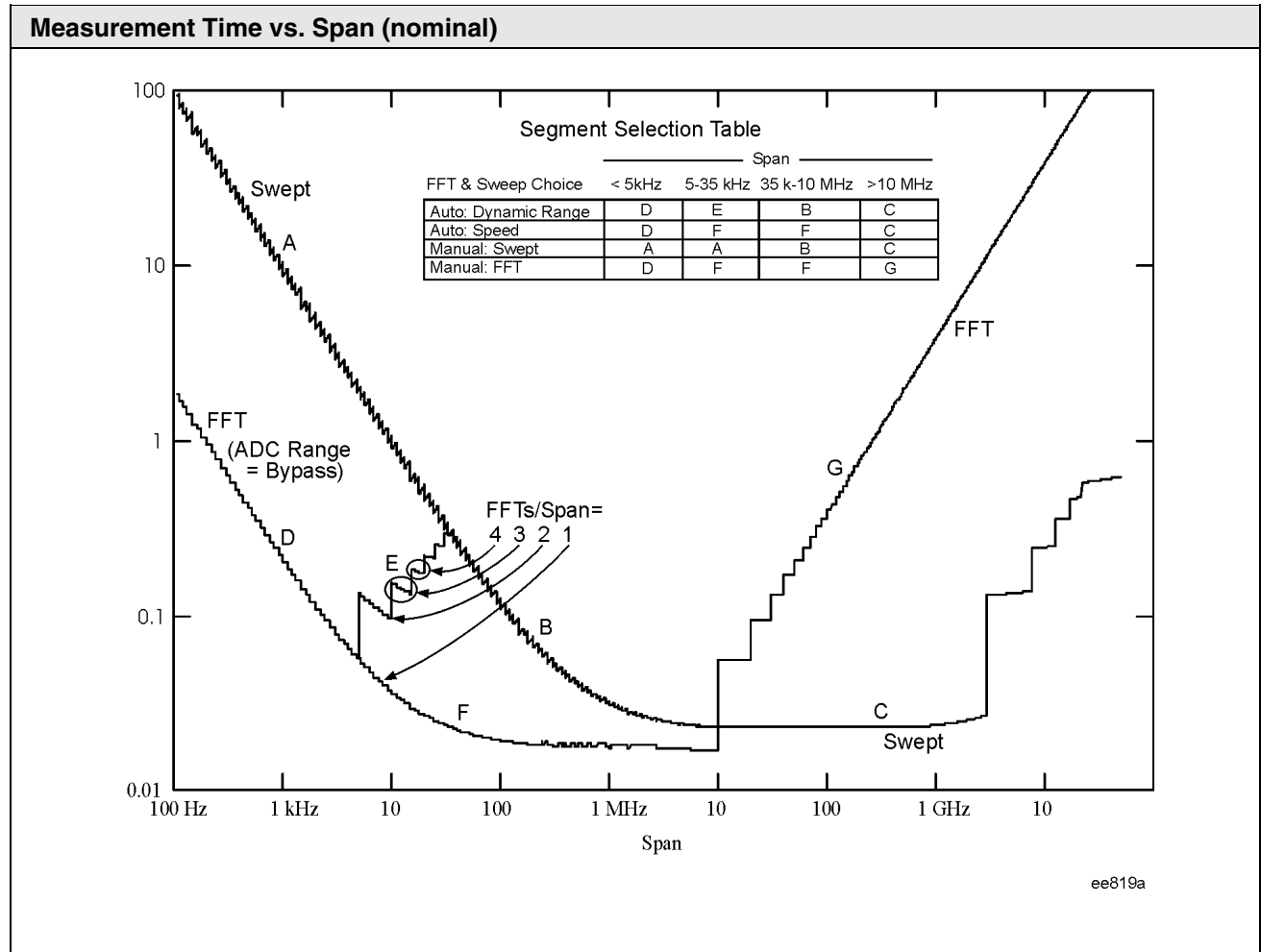
Description	Specifications	Supplemental Information
Sweep Time Range Span = 0 Hz Span ≥ 10 Hz Accuracy Span ≥ 10 Hz, swept Span ≥ 10 Hz, FFT Span = 0 Hz Sweep Trigger Delayed Trigger ^a Range Span ≥ 10 Hz, swept Span = 0 Hz or FFT Resolution	1 μs to 6000 s 1 ms to 2000 s Free Run, Line, Video, External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

Description	Specifications	Supplemental Information
Gated FFT^b Delay Range Delay Resolution Gate Duration	-150 to +500 ms 100 ns or 4 digits, whichever is greater	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.

Description	Specifications	Supplemental Information
Gated Sweep		
Span Range	Any span	
Gate Delay Range	0 to 500.0 ms	
Gate Delay Settability	4 digits, ≥ 100 ns	
Gate Delay Jitter		33.3 ns p-p (nominal)
Gate Length Range	10.0 μs^{a} to 500.0 ms	
Gated Freq Readout Errors ^b		
At seams ^c		$\pm 0.2\%$ of span $\times N$ (nominal)
Short Gate Length ^d		$\pm 0.2\%$ of span $\times N$ (nominal)
Gated Amplitude Errors		Normal^e Accy^e
Low band ^f		± 0.5 dB ± 0.05 dB
High band ^g		± 5 dB ± 2 dB
Gate Sources		Pos or neg edge triggered
Ext Front or Rear		Thresholds independently settable over ± 5 V range (nominal)
RF Burst (Wideband)		Threshold -22 dB relative to peak (nominal); ± 20 MHz bandwidth (nominal)

- a. Gate lengths of 15 μs or less give increased amplitude errors in bands 1 through 4.
- b. Additional errors in frequency readout occur due to LO Gating. These errors are in addition to those described in the Frequency Readout Uncertainty specification.
- c. Errors occur at the seams in Gated LO measurements. These seams occur at the point where the LO stops (at the end of the gate length) and restarts. An exception to the listed nominal performance occurs when the LO mode is single-loop narrow and the span is 2 to 3 MHz inclusive. In single-loop narrow mode, the error is nominally ± 6 kHz, which is $\pm 0.3\%$ of span or less. Single-loop narrow mode occurs whenever the Span is ≥ 2 MHz and the Phase Noise Optimization is set to either "Optimize Phase Noise for $f < 50$ kHz" or "Optimize Phase Noise for $f > 50$ kHz." All errors are multiplied by N, the harmonic mixing number.
- d. Short gate lengths cause frequency location inaccuracies that accumulate randomly with increasing numbers of seams. The standard deviation of the frequency error can nominally be described as $200 \text{ ns} \times N \times (\text{Span} / \text{SweepTime}) \times \text{sqrt}(\text{SpanPosition} \times \text{SweepTime} / \text{GateLength})$. In this expression, SpanPosition is the location of the signal across the screen, with 0 being the left edge and 1 being the right edge of the span. For a sweep time of 5 ms (such as a 10 MHz to 3 GHz span) and a gate length of 10 μs , this expression evaluates to a standard deviation of 0.09 % of span. N is the harmonic mixing number.
- e. The "Normal" and "Accy" columns refer to the sweep times selected when the sweep time is set to Auto and the "Auto Sweep Time" key is set to normal or accuracy. The specifications in these columns are nominal.
- f. Additional amplitude errors occur due to LO Gating. In band 0 (frequencies under 3 GHz), these errors occur at the seams in Gated LO measurements. These seams occur at the point where the LO stops (at the end of the gate length) and restarts. The size of these errors depends on the sweep rate. For example, with $\text{RBW} = \text{VBW}$, the error nominally is within $\pm 0.63 \text{ dB} \times \text{Span} / (\text{Sweeptime} \times \text{RBW}^2)$.
- g. Additional errors due to LO Gating in high band (above 3 GHz) occur due to high sweep rates of the YIG-tuned preselector (YTF). The autocoupled sweep rate is reduced in high band when gating is turned on in order to keep errors from exceeding those shown. With gating off, YTF sweep rates may go as high as 400 to 600 MHz/ms. With gating on, these rates are reduced to 100 MHz/ms (Normal) and 50 MHz/ms (Accy) below 19.2 GHz and half that for 19.2 to 26.5 GHz. Furthermore, additional errors of 10 dB and more can occur for Gate Lengths under 15 μs .



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	

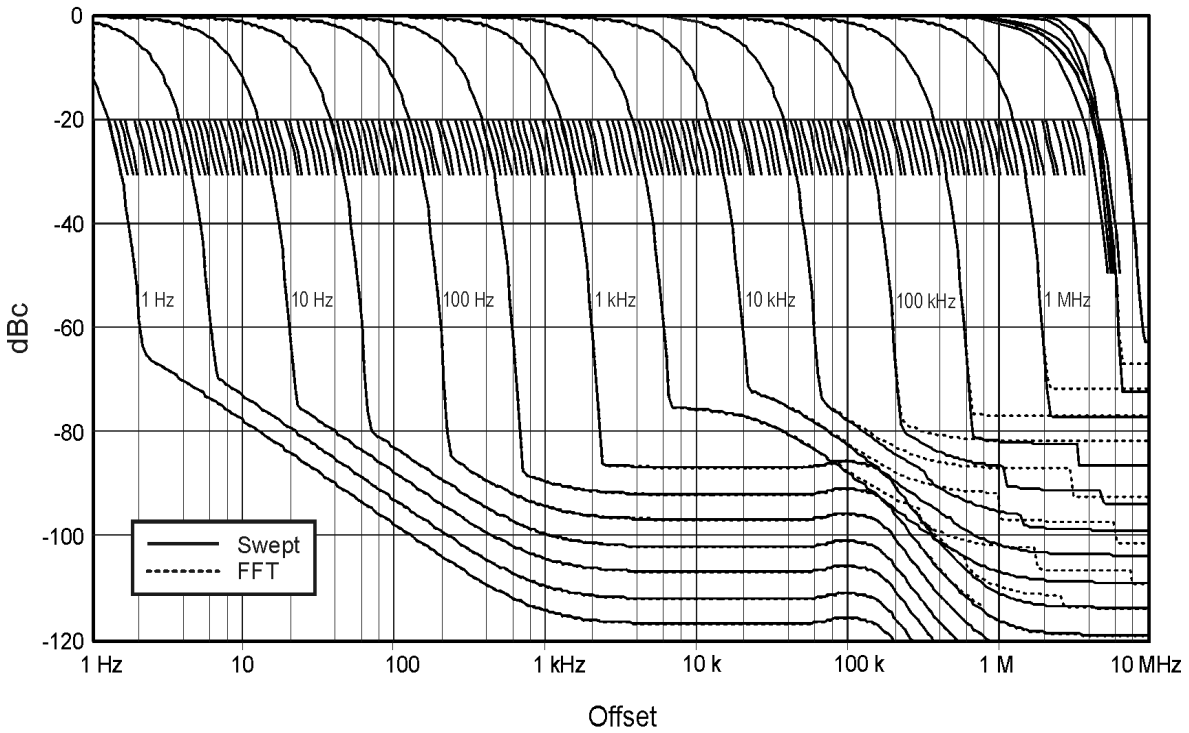
Description	Specifications	Supplemental Information
Resolution Bandwidth (RBW)		
Range (–3.01 dB bandwidth)	1 Hz to 8 MHz. Bandwidths > 3 MHz = 4, 5, 6, and 8 MHz. Bandwidths 1 Hz to 3 MHz are spaced at 10 % spacing, 24 per decade: 1.0, 1.1, 1.2, 1.3, 1.5, 1.6, 1.8, 2.0, 2.2, 2.4, 2.7, 3.0, 3.3, 3.6, 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 – 1.1 MHz < 3 GHz	±1.0 %	Equivalent to ±0.044 dB
1.2 – 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)		±7 % (nominal)
(CF > 3 GHz)		±8 % (nominal)
4 MHz to 8 MHz RBW		
(CF ≤ 3 GHz)		±15 % (nominal)
(CF > 3 GHz)		±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
<p>Information Bandwidth</p> <p>Maximum FFT width</p> <p>(<i>Option B7J</i>) I/Q Waveform digital bandwidths</p> <p>321.4 MHz rear panel output bandwidth</p> <p>At -1 dB BW</p> <p> Low band (0 to 3 GHz)</p> <p> High band (2.85 to 26.5 GHz)</p> <p> mm band (26.4 to 50 GHz)</p> <p> External mixing</p> <p>At -3 dB BW</p> <p> Low band (0 to 3 GHz)</p> <p> High band (2.85 to 26.5 GHz)</p> <p> mm band (26.5 to 50 GHz)</p> <p> External mixing</p> <p>(<i>Option H70</i>) bandwidth</p>	<p>10 MHz</p> <p>10 MHz</p>	<p>Nominal</p> <p>30 MHz</p> <p>20 to 30 MHz^a</p> <p>30 MHz</p> <p>30 MHz</p> <p>40 MHz</p> <p>30 to 60 MHz^a</p> <p>40 MHz</p> <p>60 MHz</p> <p>Same as 321.4 MHz bandwidth</p>

-
- 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 \leq 1 kHz shown with
 phase noise optimized for $f_m < 50$ kHz
 RBWs \geq 3 kHz shown with
 phase noise optimized for $f_m > 50$ kHz

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

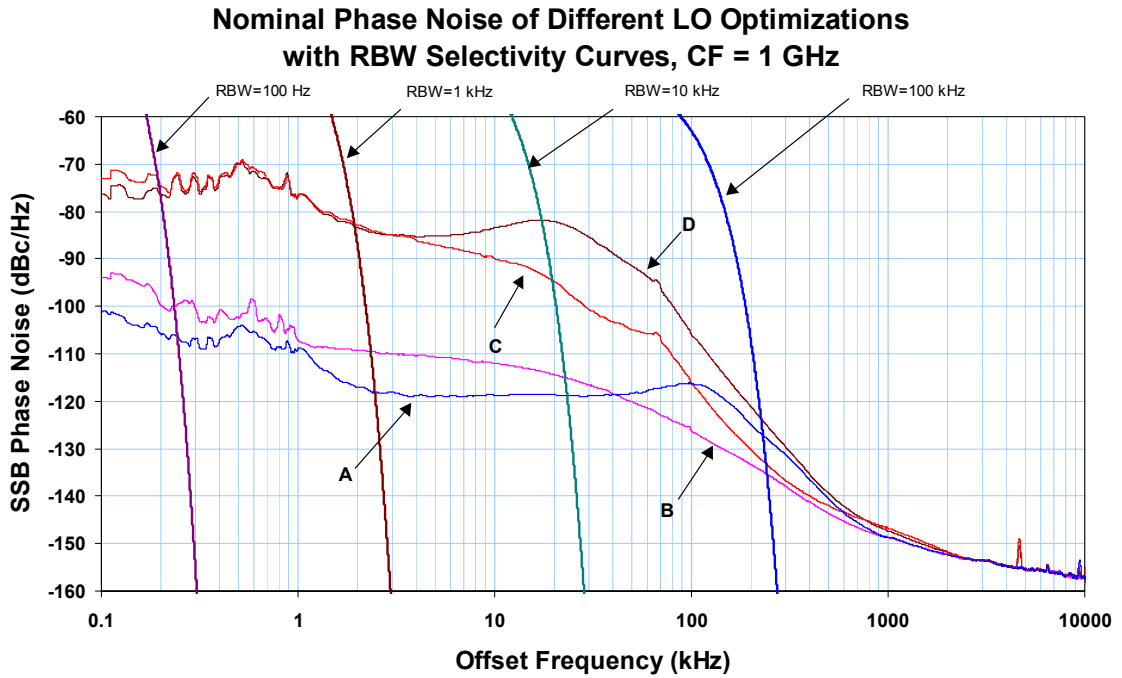
Description	Specifications		Supplemental Information	
Stability Noise Sidebands Center Frequency = 1 GHz ^b Best-case Optimization ^c	20 to 30 °C	0 to 55 °C		
Newest Instruments ^d Offset			Typical	Nominal
100 Hz	-91 dBc/Hz	-90 dBc/Hz	-96 dBc/Hz	
1 kHz	-103 dBc/Hz	-100 dBc/Hz	-108 dBc/Hz	
10 kHz	-116 dBc/Hz	-115 dBc/Hz	-118 dBc/Hz	
30 kHz	-116 dBc/Hz	-115 dBc/Hz	-118 dBc/Hz	
100 kHz	-122 dBc/Hz	-121 dBc/Hz	-124 dBc/Hz	
1 MHz	-145 dBc/Hz	-144 dBc/Hz	-147 dBc/Hz ^e	-148 dBc/Hz ^e
6 MHz	-153 dBc/Hz	-152 dBc/Hz	-155 dBc/Hz ^e	-156 dBc/Hz ^e
10 MHz	-155 dBc/Hz	-153 dBc/Hz	-156 dBc/Hz ^e	-157.5 dBc/Hz ^e

- 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.
- 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 $20 \times \log N$, where N is the harmonic mixer mode. For offsets below 1 kHz, and center frequencies above 1 GHz, the phase noise increases nominally as $20 \times \log CF$, where CF is the center frequency in GHz.
- Noise sidebands for offsets of 30 kHz and below are shown for phase noise optimization set to optimize $\mathcal{L}(f)$ for $f < 50$ kHz; for offsets of 100 kHz and above, the optimization is set for $f > 50$ kHz.
- Instruments with serial numbers of MY43490000 or higher, or US43490000 or higher are the newest instruments. Instruments with lower serial numbers are the older instruments. The transition between these occurred around December 2003. Press System, Show System to read out the serial number.
- “Typical” results include the effect of the signal generator used in verifying performance; nominal results show performance observed during development with specialized signal sources.

Description	Specifications		Supplemental Information	
Oldest Instruments ^a			Typical	Nominal
Offset				
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 ^b	-148 dBc/Hz ^e
6 MHz	-151 dBc/Hz	-150 dBc/Hz	-152 dBc/Hz ^e	-156 dBc/Hz ^e
10 MHz	-151 dBc/Hz	-150 dBc/Hz	-152 dBc/Hz ^e	-157.5 dBc/Hz ^e
Residual FM			<(1 Hz × N ^c) p-p in 1 s	

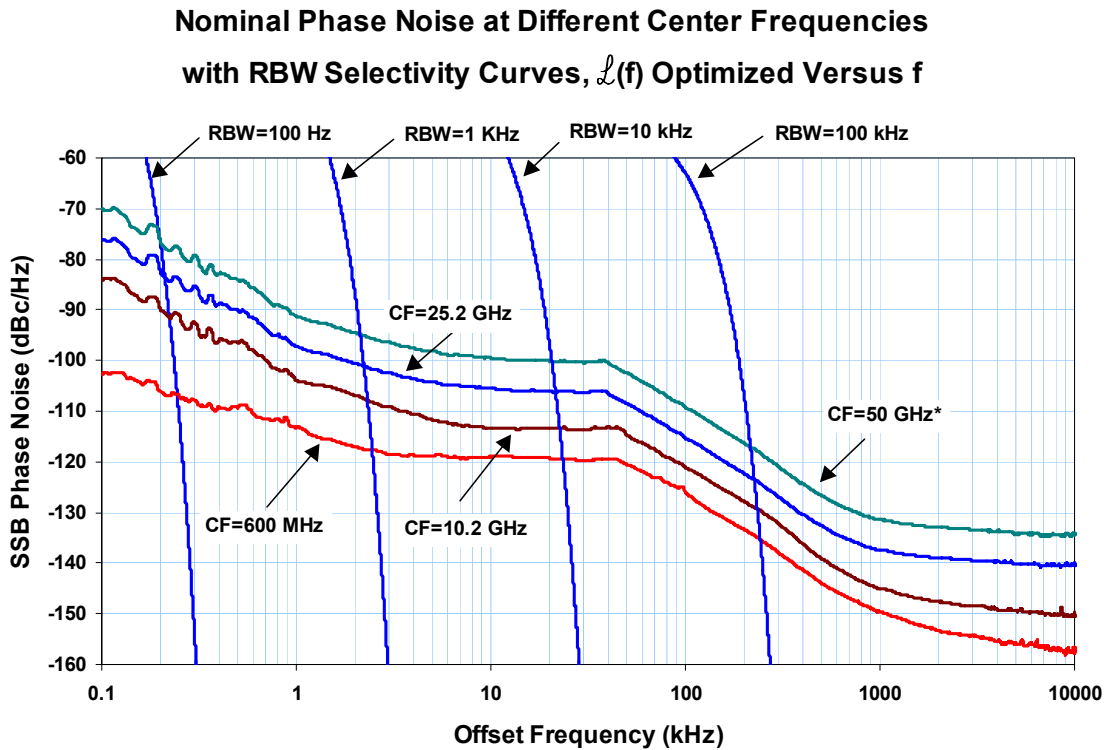
- a. Instruments with serial numbers of MY43490000 or higher, or US43490000 or higher are the newest instruments. Instruments with lower serial numbers are the older instruments. The transition between these occurred around December 2003. Press System, Show System to read out the serial number.
- b. “Typical” results include the effect of the signal generator used in verifying performance; nominal results show performance observed during development with specialized signal sources.
- c. N is the harmonic mixing mode.

Nominal Phase Noise of Different LO Optimizations



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

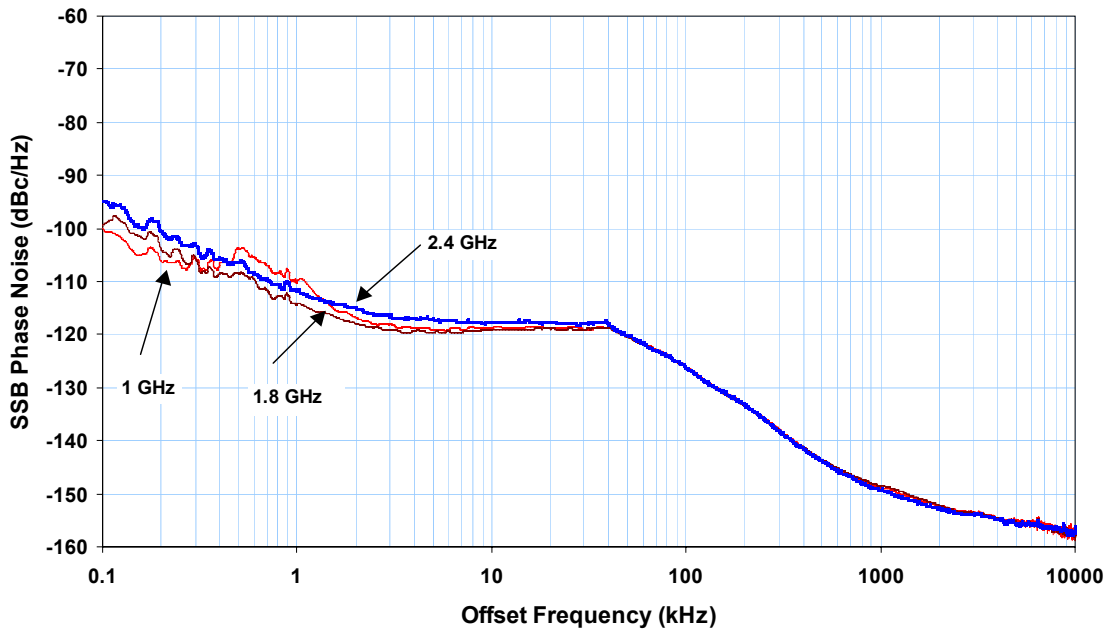
Nominal Phase Noise at Different Center Frequencies



*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

Nominal Phase Noise at Common Cellular Communication Frequencies,
 $L(f)$ Optimized Versus f



Amplitude

Description	Specifications	Supplemental Information
Measurement Range Preamp On (<i>Option 1DS</i>)	Displayed Average Noise Level to +30 dBm 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 Average Total Power Peak Pulse Power <10 μ s pulse width, <1 % duty cycle, and input attenuation \geq 30 dB DC volts DC Coupled AC Coupled (E4443A, E4445A, E4440A)	 +30 dBm (1 W) +50 dBm (100 W) \pm 0.2 Vdc \pm 100 Vdc	Applies with or without preamp (<i>Option 1DS</i>)

Gain Compression

E4443A, E4445A, E4440A

Description	Specifications	Supplemental Information	
1 dB Gain Compression Point (Two-tone)^{abc} 20 to 200 MHz 200 MHz to 3.0 GHz 3.0 to 6.6 GHz 6.6 to 26.5 GHz	Maximum power at mixer ^d	Nominal ^e	
	0 dBm	+3 dBm	
	+3 dBm	+7 dBm	
	+3 dBm	+4 dBm	
	-2 dBm	0 dBm	
Typical Gain Compression (Two-tone) 20 to 200 MHz 200 MHz to 6.6 GHz 6.6 to 26.5 GHz		Mixer Level	Typical ^e Compression
		0 dBm	< 0.5 dB
		+3 dBm	< 0.5 dB
		-2 dBm	< 0.4 dB
Preamp On (<i>Option 1DS</i>) Maximum power at the preamp ^f for 1 dB gain compression 10 to 200 MHz 200 MHz to 3 GHz		-30 dBm (nominal)	
		-25 dBm (nominal)	

- 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.
- Tone spacing > 15 times RBW, with a minimum of 30 kHz of separation
- 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.
- Mixer power level (dBm) = input power (dBm) – input attenuation (dB).
- 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.
- 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)^{abc}	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 (<i>Option 1DS</i>)		
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			
3 Hz to 1 kHz				Nominal -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 (typical)
	20 to 30 °C	0 to 55 °C	20 to 30 °C	
10 to 100 kHz ^c	-137 dBm	-137 dBm	-137 dBm	-141 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 (<i>Option 1DS</i>)				
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.
 - c. Specifications are shown for instruments with serial numbers of MY43490000 or higher, or US43490000 or higher. For instruments with lower serial numbers, the specifications are -135 dBm and the typical is -142 dBm. The transition between these occurred around December 2003. Press System, Show System to read out the serial number.

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				
3 Hz to 1 kHz	-110 dBm				Nominal -110 dBm
1 to 10 kHz	-130 dBm				-130 dBm
	Zero span & swept Normalized^a to 1 Hz		FFT Only Actual^b 1 Hz		Zero span & swept (typical)
	20 to 30 °C	0 to 55 °C	20 to 30 °C	0 to 55 °C	
10 to 100 kHz ^c	-137 dBm	-137 dBm	-137 dBm	-137 dBm	-141 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 (<i>Option 1DS</i>)					
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.
- c. Specifications are shown for instruments with serial numbers of MY43490000 or higher, or US43490000 or higher. For instruments with lower serial numbers, the specifications are -140 dBm and the typical is -143 dBm. The transition between these occurred around December 2003. Press System, Show System to read out the serial number.

Description	Specifications	Supplemental Information
Display Range Log Scale Linear 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 Ten divisions	
Marker Readout^a Log units resolution Average Off, on-screen Average On or remote Linear units resolution	 0.01 dB 0.001 dB	 $\leq 1\%$ 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 × FFT width ^e)] to a max. of ±0.40 dB		
Preamp On (<i>Option 1DS</i>)			
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

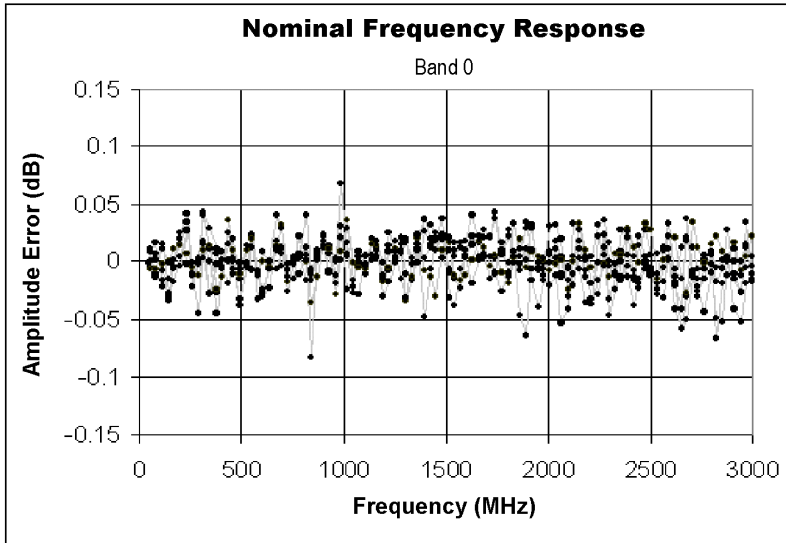
- a. Specifications for frequencies > 3 GHz apply for sweep rates < 100 MHz/ms.
- b. Preselector centering applied.
- c. FFT frequency response errors are specified relative to swept measurements.
- d. This error need not be included in Absolute Amplitude Accuracy error budgets when the difference between 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 3 Hz to 3.0 GHz 3.0 to 6.6 GHz ^b 6.6 to 13.2 GHz ^b 13.2 to 22.0 GHz ^b 22.0 to 26.8 GHz ^b 26.4 to 31.15 GHz ^b 31.15 to 50.0 GHz ^b Additional frequency response error, FFT mode ^{cd} Preamp On (<i>Option 1DS</i>) 100 kHz to 3.0 GHz	20 to 30 °C ±0.38 dB ±1.50 dB ±2.00 dB ±2.00 dB ±2.50 dB ±1.75 dB ±2.50 dB ±[0.15 dB + (0.1 dB/MHz × FFT width ^e)] to a max. of ±0.40 dB ±0.70 dB	0 to 55°C ±0.70 dB ±2.00 dB ±3.00 dB ±2.50 dB ±3.50 dB ±2.75 dB ±3.50 dB ±0.80 dB	Typical (at worst observed frequency) ±0.15 dB ±0.6 dB ±1.0 dB ±1.2 dB ±1.3 dB ±0.6 dB ±1.0 dB ±0.30 dB
Frequency Response at Attenuation ≠ 10 dB Atten = 20, 30 or 40 dB 10 MHz to 2.2 GHz 2.2 to 3 GHz Other atten settings	20 to 30 °C ±0.53 dB ±0.69 dB	0 to 55 °C ±0.68 dB ±0.84 dB	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 <i>Option 1DS</i> Frequency Range 50 MHz (reference frequency) Atten = 12 to 40 dB Other settings ≥ 2 dB Atten = 0 dB 3 Hz to 3.0 GHz 3.0 to 13.2 GHz 13.2 to 26.8 GHz 26.8 to 50 GHz	 ± 0.14 dB ± 0.18 dB ± 0.20 dB 	 ± 0.037 dB (typical) ± 0.053 dB (typical) ± 0.083 dB (typical) ± 0.3 dB (nominal) ± 0.5 dB (nominal) ± 0.7 dB (nominal) ± 1.0 dB (nominal)

Description	Specifications	Supplemental Information
Preamp (<i>Option 1DS</i>)^a Gain Noise figure 10 MHz to 1.5 GHz 1.5 to 3.0 GHz		 $+28$ dB (nominal) 6 dB (nominal) 7 dB (nominal)

- a. The preamp follows the input attenuator, AD/DC coupling control, and 3 GHz low-pass filtering. It precedes the input mixer.

Description	Specifications	Supplemental Information
Absolute Amplitude Accuracy		
At 50 MHz ^a		
20 to 30 °C	±0.24 dB	±0.06 dB (typical)
0 to 55 °C	±0.28 dB	
At all frequencies ^a		
20 to 30 °C	±(0.24 dB + frequency response)	±(0.06 dB + frequency response) (typical)
0 to 55 °C	±(0.28 dB + frequency response)	
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
<p>RF Input VSWR at tuned frequency 10 dB attenuation, 50 MHz ≥ 8 dB input attenuation 50 MHz to 3 GHz 3 to 18 GHz 18 to 26.5 GHz 2 to 6 dB input attenuation 50 MHz to 3 GHz 3 to 26.5 GHz 0 dB input attenuation 50 MHz to 3 GHz 3 to 26.5 GHz Preamp On (<i>Option 1DS</i>) 50 MHz to 3 GHz ≥ 10 dB input attenuation < 10 dB input attenuation Internal 50 MHz calibrator is On Alignments running</p>		<p>Nominal 1.07:1 < 1.2:1 < 1.6:1 < 1.9:1 < 1.6:1 < 1.9:1 < 1.9:1 < 1.9:1 < 1.2:1 < 1.5:1 Open input Open input</p>

E4446A, E4448A

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

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

Description	Specifications	Supplemental Information
Reference Level^b Range Log Units Linear Units Accuracy	-170 to +30 dBm, in 0.01 dB steps 707 pV to 7.07 V, in 0.1 % steps 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	±0.07 dB			
≤ -10 dBm	±0.13 dB			
Relative Fidelity ^f				
Equation for error ± A ± ((B1 + B2) × ΔP) to a maximum of (C1 + C2)				
Level of larger signal		A	B1	C1
-20 dBm < ML < -12 dBm		0.011 dB	0.007	0.08 dB
-29 dBm < ML < -20 dBm		0.011 dB	0.0015	0.04 dB
Noise < ML < -29 dBm		0.001 dB	0.001	0.04 dB
RBW		B2	C2	
≥ 10 kHz		0.000	0.000 dB	
≤ 2 kHz		0.0035	0.038 dB	
others (RBW in Hz)		7/RBW	76 dB/RBW	

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

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

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

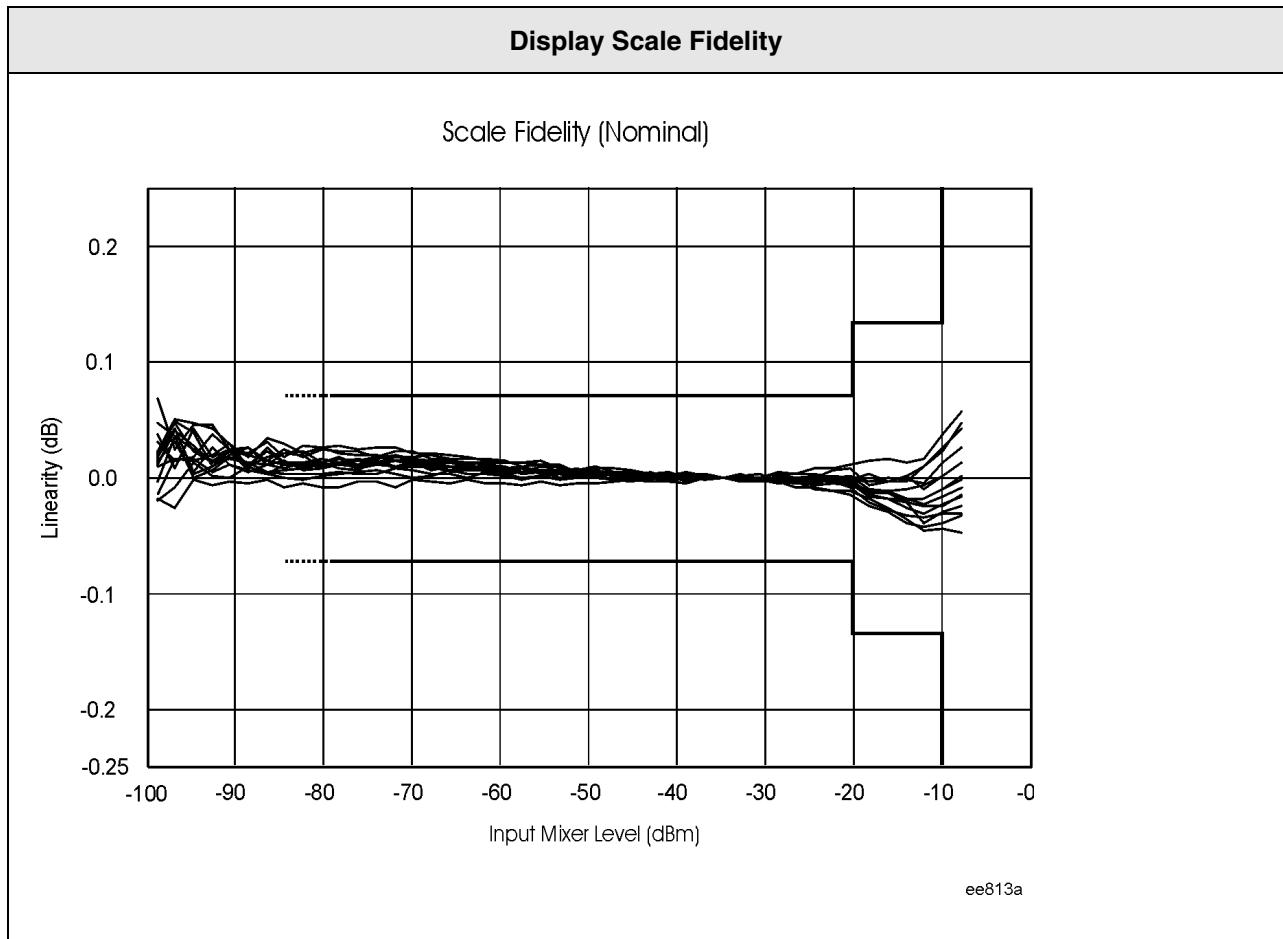
- b. Display scale fidelity and resolution bandwidth switching uncertainty interact slightly. See the footnote for RBW switching. RBW switching applies at only one level on the scale fidelity curve, but scale fidelity applies for all RBWs.
- c. Scale fidelity is warranted with ADC dither turned on. Turning 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: $\pm 0.011 \text{ dB} \pm (0.0093 \times \Delta P)$ 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.



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

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

- a. Mixer level = Input Level – Input Attenuation
b. N = LO mixing harmonic
c. Mixer level = Input Level – Input Attenuation
d. 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.
e. 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 <i>not</i> set to FFT			Verification conditions ^a
		Distortion^b	TOI^c
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 (<i>Option 1DS</i>)			Verification conditions ^d
			TOI (nominal)
10 to 500 MHz			–15 dBm
500 MHz to 3 GHz			–13 dBm

- TOI is verified with two tones, each at –18 dBm at the mixer, spaced by 100 kHz.
- Distortion for two tones that are each at –30 dBm is computed from TOI.
- 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.
- 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 <i>not</i> set to FFT			Verification conditions ^a
			TOI (typical)
20 to 30 °C	Distortion^b	TOI^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 (<i>Option 1DS</i>)			Verification conditions ^d
			TOI (nominal)
10 to 500 MHz			-15 dBm
500 MHz to 3 GHz			-13 dBm

- TOI is verified with two tones, each at -18 dBm at the mixer, spaced by 100 kHz.
- Distortion for two tones that are each at -30 dBm is computed from TOI.
- 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.
- 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)

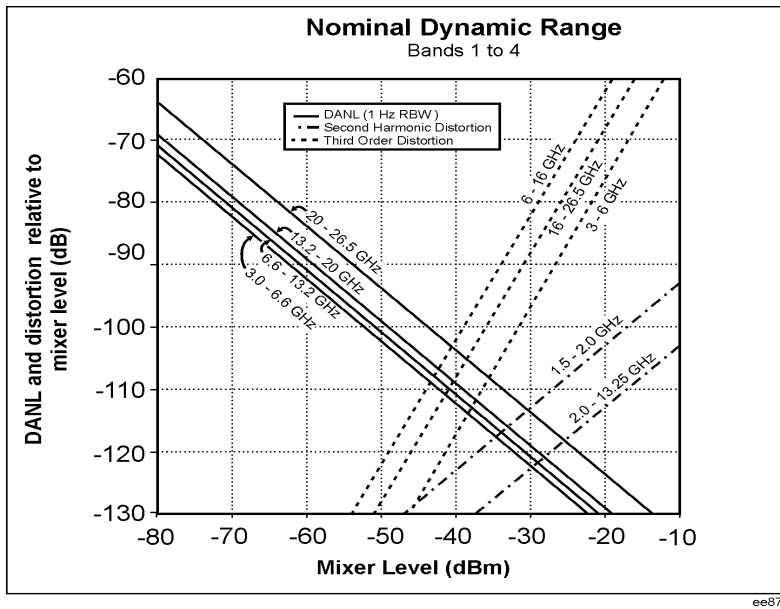
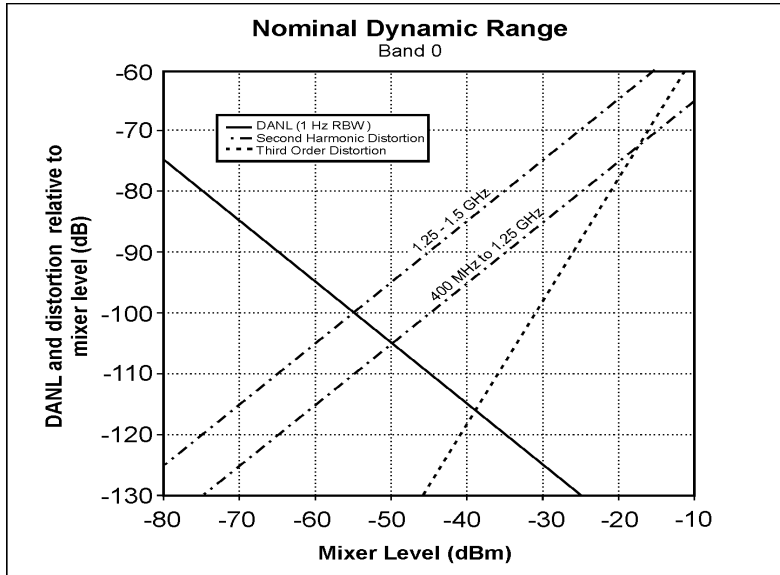
a. Mixer Level = Input Level – Input Attenuation.

b. Input terminated, 0 dB input attenuation.

Dynamic Range

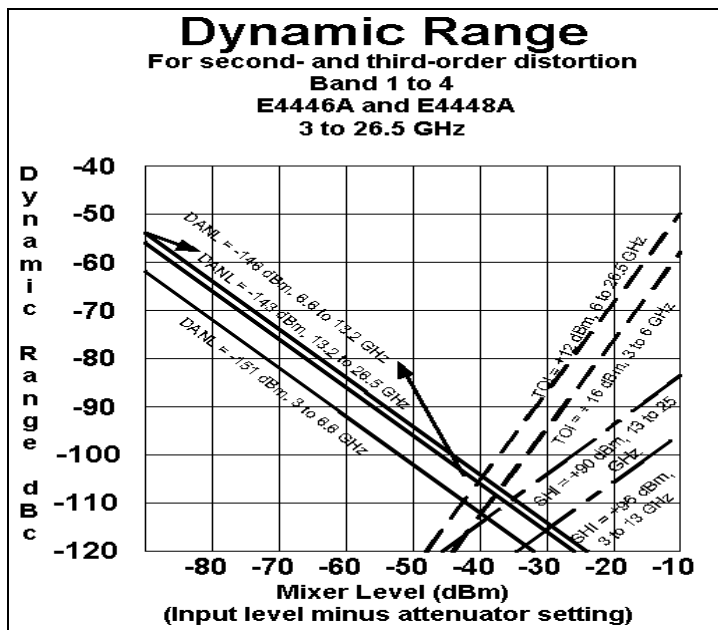
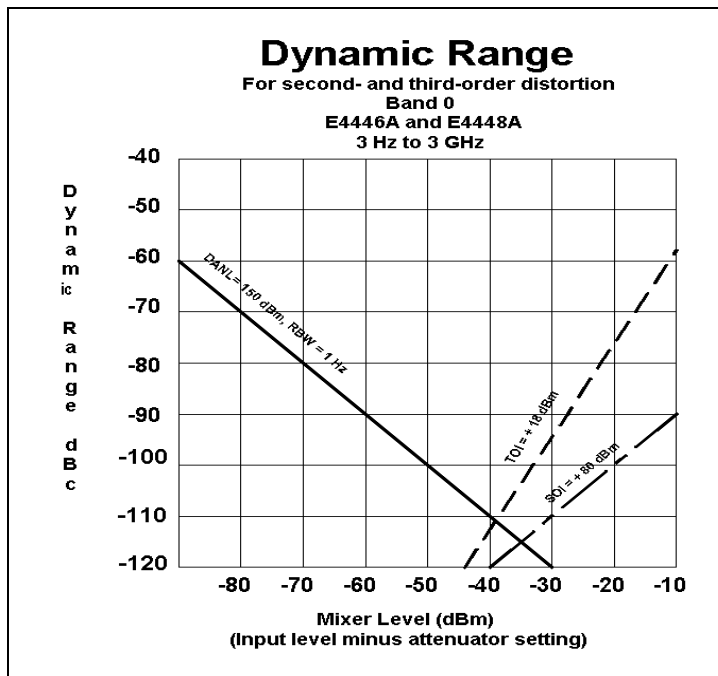
E4443A, E4445A, E4440A

Nominal Dynamic Range



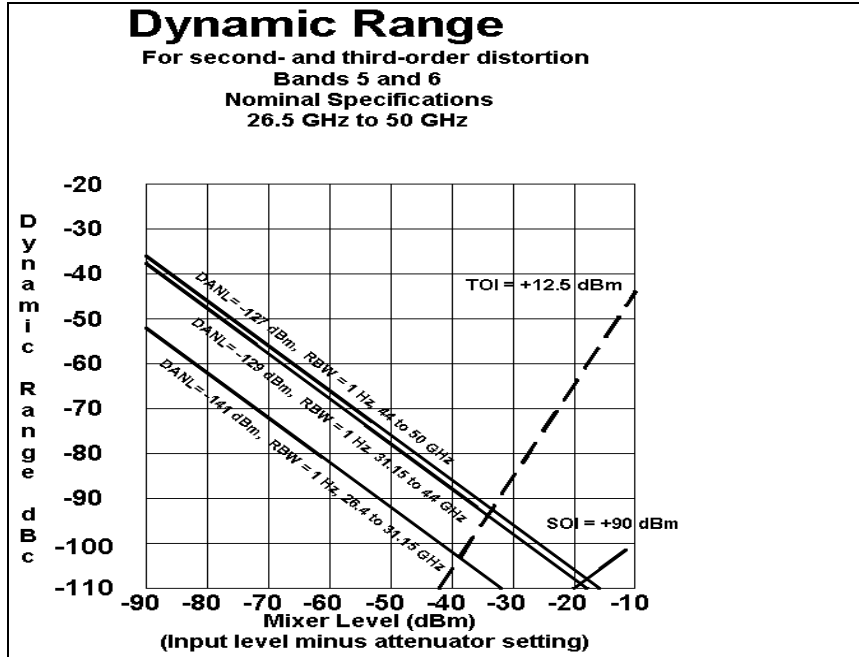
E4446A, E4448A: Bands 0–4

Dynamic Range



E4446A, E4448A: Bands 5–6

Dynamic Range



Power Suite Measurements

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

Description	Specifications	Supplemental Information
<p>Occupied Bandwidth Frequency Accuracy</p>		<p>±(Span/600) (nominal)</p>

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

Description	Specifications	Supplemental Information
Adjacent Channel Power (ACP)		
Radio Std = None		
Accuracy of ACP Ratio (dBc)		Display Scale Fidelity ^a
Accuracy of ACP Absolute Power (dBm or dBm/Hz)		Absolute Amplitude Accuracy ^b + Power Bandwidth Accuracy ^{cd}
Accuracy of Carrier Power (dBm), or Carrier Power PSD (dBm/Hz)		Absolute Amplitude Accuracy ^b + Power Bandwidth Accuracy ^{cd}
Passband width ^e	-3 dB	
Radio Std = 3GPP W-CDMA (ACPR; ACLR) ^f		
Minimum power at RF Input		-36 dBm (nominal)
ACPR Accuracy ^g		RRC weighted, 3.84 MHz noise bandwidth.
Radio Offset Freq		
MS (UE) 5 MHz	±0.12 dB	At ACPR range of -30 to -36 dBc with optimum mixer level ^h
MS (UE) 10 MHz	±0.17 dB	At ACPR range of -40 to -46 dBc with optimum mixer level ⁱ
BTS 5 MHz	±0.22 dB	At ACPR range of -42 to -48 dBc with optimum mixer level ^j
BTS 10 MHz	±0.22 dB	At ACPR range of -47 to -53 dBc with optimum mixer level ⁱ
BTS 5 MHz	±0.17 dB	At -48 dBc non-coherent ACPR ^k
Dynamic Range		RRC weighted, 3.84 MHz noise bandwidth
Noise Correction Offset Freq		
off 5 MHz		-74.5 dB (typical) ^{lm}
off 10 MHz		-82 dB (typical) ^{lm}
on 5 MHz		-81 dB (typical) ^{ln}
on 10 MHz		-88 dB (typical) ^{lm}
RRC Weighting Accuracy ^o		
White noise in Adjacent Channel		0.00 dB nominal
TOI-induced spectrum		0.004 dB nominal
rms CW error		0.023 dB nominal
Radio Std = IS-95 or J-STD-008		
Method		RBW method ^p
ACPR Relative Accuracy		
Offsets < 1300 kHz ^q	±0.10 dB	
Offsets > 1.85 MHz ^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 $x - 0.572 \times \text{RBW}$.
- f. Most versions of adjacent channel power measurements use negative numbers, in units of dBc, to refer to the power in an adjacent channel relative to the power in a main channel, in accordance with ITU standards. The standards for W-CDMA analysis include ACLR, a positive number represented in dB units. In order to be consistent with other kinds of ACP measurements, this measurement and its specifications will use negative dBc results, and refer to them as ACPR, instead of positive dB results referred to as ACLR. The ACLR can be determined from the ACPR reported by merely reversing the sign.
- g. The accuracy of the Adjacent Channel Power Ratio will depend on the mixer drive level and whether the distortion products from the analyzer are coherent with those in the UUT. These specifications apply even in the worst case condition of coherent analyzer and UUT distortion products. For ACPR levels other than those in this specifications table, the optimum mixer drive level for accuracy is approximately -37 dBm - (ACPR/3), where the ACPR is given in (negative) decibels.
- h. To meet this specified accuracy when measuring mobile station (MS) or user equipment (UE) within 3 dB of the required -33 dBc ACPR, the mixer level (ML) must be optimized for accuracy. This optimum mixer level is -26 dBm, 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 PSA analyzers for dynamic range in the factory production process. This measurement requires a near-ideal signal, which is impractical for field and customer use. Because field verification is impractical, 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 cdmaOne 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 $\text{error} = 20 \times \log(1 + 10^{(-\text{SN}/20)})$

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

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																									
<p>Multi-Carrier Power</p> <p>Radio Std = 3GPP W-CDMA</p> <p>ACPR Dynamic Range 5 MHz offset Two carriers</p> <p>ACPR Accuracy Two carriers 5 MHz offset, -48 dBc ACPR</p> <p>ACPR Accuracy 4 carriers</p> <table border="0"> <tr> <td>Radio</td> <td>Offset</td> <td>Coher^a</td> <td>NC</td> </tr> <tr> <td>BTS</td> <td>5 MHz</td> <td>no</td> <td>Off</td> </tr> <tr> <td>BTS</td> <td>5 MHz</td> <td>no</td> <td>On</td> </tr> </table> <p>ACPR Dynamic Range 4 carriers 5 MHz offset</p> <p>Noise Correction (NC) off</p> <p>Noise Correction (NC) on</p>	Radio	Offset	Coher ^a	NC	BTS	5 MHz	no	Off	BTS	5 MHz	no	On	<p>±0.24 dB</p> <p>±0.09 dB</p>	<p>RRC weighted, 3.84 MHz noise bandwidth -70 dB (nominal)</p> <p>±0.38 dB (nominal)</p> <table border="0"> <tr> <td>UUT ACPR Range</td> <td>MLOpt^b</td> </tr> <tr> <td>-42 to -48 dB</td> <td>-14 dBm</td> </tr> <tr> <td>-42 to -48 dB</td> <td>-17 dBm</td> </tr> </table> <table border="0"> <tr> <td>Nominal DR</td> <td>Nominal MLOpt^b</td> </tr> <tr> <td>66 dB</td> <td>-14 dBm</td> </tr> <tr> <td>76 dB</td> <td>-17 dBm</td> </tr> </table>		UUT ACPR Range	MLOpt ^b	-42 to -48 dB	-14 dBm	-42 to -48 dB	-17 dBm	Nominal DR	Nominal MLOpt ^b	66 dB	-14 dBm	76 dB	-17 dBm
Radio	Offset	Coher ^a	NC																								
BTS	5 MHz	no	Off																								
BTS	5 MHz	no	On																								
UUT ACPR Range	MLOpt ^b																										
-42 to -48 dB	-14 dBm																										
-42 to -48 dB	-17 dBm																										
Nominal DR	Nominal MLOpt ^b																										
66 dB	-14 dBm																										
76 dB	-17 dBm																										

Description	Specifications	Supplemental Information
<p>Power Statistics CCDF</p> <p>Histogram Resolution^c</p>	<p>0.1 dB</p>	

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

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

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

Description	Specifications	Supplemental Information
Spurious Emissions W-CDMA signals Dynamic Range, relative 1980 MHz region ^a Sensitivity, absolute 1980 MHz region ^b	 80.6 dB -89.7 dBm	Table-driven spurious signals; search across regions 82.4 dB (typical) -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
<p>Spectrum Emission Mask</p> <p>Radio Std = cdma2000</p> <p>Dynamic Range, relative 750 kHz offset^{ab}</p> <p>Sensitivity, absolute 750 kHz offset^c</p> <p>Accuracy, relative 750 kHz offset^d</p> <p>Radio Std = 3GPP W-CDMA</p> <p>Dynamic Range, relative 2.515 MHz offset^{ae}</p> <p>Sensitivity, absolute 2.515 MHz offset^c</p> <p>Accuracy, relative 2.515 MHz offset^d</p>	<p>85.3 dB</p> <p>-105.7 dBm</p> <p>±0.09 dB</p> <p>87.3 dB</p> <p>-105.7 dBm</p> <p>±0.10 dBm</p>	<p>Table-driven spurious signals; measurement near carriers</p> <p>88.3 dB (typical)</p> <p>-107 dBm (typical)</p> <p>89.5 dB (typical)</p> <p>-107.7 dBm (typical)</p>

- 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:	1xEV-DO Measurement Personality
Option 210:	HSDPA Measurement Personality
Option 214:	1xEV-DV Measurement Personality
Option 219:	Noise Figure Measurement Personality
Option 226:	Phase Noise Measurement Personality
Option 266:	HP 8566B/68B Code Compatibility Measurement Personality
Option AYZ:	External Mixing
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 Storage Altitude	0 to 55 °C -40 to 75 °C 4600 meters (approx. 15,000 feet)	Floppy disk 10 to 40 °C

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	<p>Conducted emission is in compliance with CISPR Pub. 11/1990 Group 1 Class A.</p> <p>Radiated emission is in compliance with CISPR Pub. 11/1990 Group 1 Class B.</p>	

Description	Specifications	Supplemental Information
<p>Immunity Testing</p> <p>Radiated Immunity</p> <p>Electrostatic Discharge</p>		<p>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.</p> <p>When radiated at the immunity test frequency of 321.4 MHz ± selected RBW the displayed average noise level may rise by approximately 10 dB.</p> <p>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.</p>

Description	Specifications	Supplemental Information
Power Requirements		
Voltage, Frequency	<p>100 to 132 Vrms, 47 to 66 Hz or 360 to 440 Hz</p> <p>195 to 250 Vrms, 47 to 66 Hz</p>	
Power Consumption, On	<p>No Options All Options</p> <p>< 260 W < 450 W</p>	
Power Consumption, Standby	< 20 W	

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

Description	Specifications	Supplemental Information
Display^c Resolution Size Scale Log Scale Linear Scale	640 × 480 0.1, 0.2, 0.3...1.0, 2.0, 3.0...20 dB per division 10 % of reference level per division	213 mm (8.4 in) diagonal (nominal)

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 IBM 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 six 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 Floppy Drive (10 to 40 °C)		2 MB (nominal) 3.5" 1.44 MB, MS-DOS® compatible

Description	Specifications	Supplemental Information
Weight <i>(without options)</i> Net E4440A, E4443A, E4445A Net E4446A, E4448A Shipping Cabinet Dimensions Height Width Length	 177 mm (7.0 in) 426 mm (16.8 in) 483 mm (19 in)	 23 kg (50 lb) (nominal) 24 kg (53 lb) (nominal) 33 kg (73 lb) (nominal) Cabinet dimensions exclude front and rear protrusions.

Inputs/Outputs (Front Panel)

RF Input

E4443A, E4445A, E4440A

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

E4446A, E4448A

Description	Specifications	Supplemental Information
RF Input Connector Impedance First LO Emission Level ^b	2.4 mm male	Nominal 50 Ω (see RF Input VSWR) Band 0 Bands \geq 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, $\pm 7\%$ at 150 mA max (nominal) -12.6 Vdc, $\pm 10\%$ at 150 mA max (nominal) GND
Ext Trigger Input Connector Impedance Trigger Level Range	BNC female -5 to +5 V	Trigger source may be selected from front or rear. 10 k Ω (nominal) 1.5 V (TTL) factory preset

Option AYZ External Mixing

Description	Specifications	Supplemental Information
IF Input Connector Impedance Center Frequency 3 dB bandwidth Maximum Safe Input Level Absolute Amplitude Accuracy VSWR 1 dB Gain Compression Mixer Bias Current Range Resolution Accuracy Output Impedance Mixer Bias Voltage Range	SMA, female 321.4 MHz +10 dBm 20-30 °C 0-55 °C ± 1.2 dB ± 2.5 dB ±10 mA 0.01 mA	50 Ω (nominal) 60 MHz (nominal) <1.5:1 (nominal) 0 dBm (nominal) ±0.02 mA (nominal) 477 Ω (nominal) ±3.7 V (measured in an open circuit)

Option AYZ External Mixing

Description	Specifications		Supplemental Information
LO Output			
Connector	SMA, female		
Impedance			50 Ω (nominal)
Frequency Range	3.05 to 6.89 GHz		
VSWR			<2.0:1 (nominal)
Power Out	20 to 30 °C	0 to 55 °C	
E4440A	+14.5 to +18.5 dBm	+14.5 to +19.0 dBm	
E4446A, E4448A			
3.05 to 3.2 GHz	+14.5 to +20 dBm	+14.0 to +20.5 dBm	
3.2 to 6.7 GHz	+14.5 to +18.8 dBm	+14.0 to +19.3 dBm	
6.7 to 6.89 GHz			+14.5 to +18.5 dBm (nominal)

Rear Panel

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

Description	Specifications	Supplemental Information
Ext Ref In Connector Impedance Input Amplitude Range Input Frequency Lock range	BNC female ±5 × 10 ⁻⁶ of selected external reference input frequency	<i>Note:</i> Analyzer noise sidebands and spurious response performance may be affected by the quality of the external reference used. 50 Ω (nominal) -5 to +10 dBm (nominal) 1 to 30 MHz (nominal) (selectable to 1 Hz resolution)

Description	Specifications	Supplemental Information
Trigger In Connector External Trigger Input Impedance Trigger Level Range	BNC female -5 to +5 V	Trigger source may be selected from front or rear. 10 kΩ (nominal) 1.5 V (TTL) factory preset

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 Trigger 1 Output Impedance Level Trigger 2 Output	BNC female	HSWP (High = sweeping) 50 Ω (nominal) 5 V TTL

Description	Specifications	Supplemental Information
Monitor Output Connector Format Resolution	VGA compatible, 15-pin mini D-SUB 640 × 480	VGA (31.5 kHz horizontal, 60 Hz vertical sync rates, non-interlaced) Analog RGB

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

Option AYZ External Mixing

Description	Specifications	Supplemental Information
Preselector Tune Voltage		1.5 V/GHz of tuned LO frequency (nominal)

Description	Specifications	Supplemental Information
Noise Source Drive Output Connector Output Voltage On Off	BNC female 28.0 \pm 0.1 V < 1 V	Used by <i>Option 219</i> 60 mA maximum

Description	Specifications	Supplemental Information
GPIB Interface Connector GPIB Codes	IEEE-488 bus connector	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	

Description	Specifications	Supplemental Information
321.4 MHz IF Output Connector Impedance Frequency Conversion Gain ^a	SMA female	50 Ω (nominal) 321.4 MHz (nominal) +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	
<u>Standard</u>	<u>Limit</u>
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, HSDPA, GSM with EDGE, cdma2000, 1xEV-DO, 1xEV-DV, 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.

Option B7J, Digital Communications Basic Measurement Personality

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

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

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

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

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.

Option 202, GSM/Edge

Description	Specifications	Supplemental Information
EDGE Error Vector Magnitude (EVM)		$3\pi/8$ shifted 8PSK modulation
Carrier Power Range at RF Input		Specifications based on 200 bursts
EVM		+24 to -45 dBm (nominal)
Operating range ^a		0 to 25 % (nominal)
Floor (RMS)	0.5 %	0.3 % (typical)
Accuracy ^b (RMS)	±0.5 %	+24 to -12 dBm power range at RF input
EVM range 1 % to 10 %		
Frequency Error		
Accuracy	±1 Hz + tfa ^c	
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: $\text{floorerror} = \sqrt{\text{EVMUUT}^2 + \text{EVMsa}^2} - \text{EVMUUT}$, 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 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 $\text{EVMUUT} + \text{floorerror} + \text{accyerror}$, or as low as $\text{EVMUUT} - \text{accyerror}$, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.
- c. tfa = transmitter frequency × frequency reference accuracy

Description	Specifications	Supplemental Information
<p>Power vs. Time and EDGE Power vs. Time</p> <p>Minimum carrier power at RF Input for GSM and EDGE</p> <p>Absolute power accuracy for in-band signal (excluding mismatch error)^a</p> <p>20 to 30 °C; attenuation > 2 dB^b</p> <p>20 to 30 °C; attenuation ≤ 2 dB^b</p> <p>0 to 55 °C; attenuation > 2 dB^b</p> <p>Power ramp relative accuracy</p> <p>RF Input Range = Auto^c +6 dB to noise^{cd}</p> <p>Mixer Level ≤ -12 dBm^c 0 to +6 dB 0 to noise^{cd}</p> <p>Mixer Level ≤ -18 dBm^c +6 dB to noise^d</p> <p>Measurement floor</p> <p>Time resolution</p> <p>Burst to mask uncertainty</p> <p>Trigger to T0 time offset Relative offset accuracy</p>	<p></p> <p>-0.11 ±0.66 dB</p> <p>-0.11 ±0.75 dB</p> <p>-0.11 ±0.90 dB</p> <p></p> <p>±0.13 dB</p> <p>±0.13 dB</p> <p>±0.08 dB</p> <p>±0.08 dB</p> <p></p> <p>200 ns</p> <p>±0.2 bit (approx ±0.7 μs)</p> <p></p>	<p>GMSK modulation (GSM) 3π/8 shifted 8PSK modulation (EDGE)</p> <p>Measures mean transmitted RF carrier power during the useful part of the burst (GSM method) and the power vs. time ramping. 510 kHz RBW -40 dBm (nominal)</p> <p></p> <p>Referenced to mean transmitted power</p> <p>-0.11 ±0.18 dB (typical)</p> <p>-0.11 ±0.24 dB (typical)</p> <p></p> <p>-88 dBm + Input Attenuation (nominal)</p> <p></p> <p>±5.0 ns (nominal) (EDGE Power vs Time Only)</p>

- 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 $-0.11 \text{ dB} \times ((510 \text{ kHz}/\text{RBW})^3)$. 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 $\text{error} = 10 \times \log(1 + 10^{-SN/10})$.

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. 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 $\text{error} = 10 \times \log(1 + 10^{-SN/10})$. 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)
Carrier power range at RF Input		Specifications based on 3GPP essential conformance requirements, and 200 bursts
Phase error		+27 to -45 dBm (nominal)
Floor (RMS)	0.5 °	
Accuracy (RMS)	±0.5 °	
Phase error range	1 ° to 15 °	
Peak phase error		
Accuracy	±2.0 °	
Phase error range	3 ° to 25 °	
Frequency error		
Initial frequency error range		±75 kHz (nominal)
Accuracy	±5 Hz + tfa ^a	
I/Q Origin Offset		
Range		-15 to -50 dBc (nominal)
Burst sync time uncertainty	±0.1 bit (approx ±0.4 μs)	
Trigger to T0 time offset		
Relative offset accuracy		±5.0 ns (nominal)

a. tfa = transmitter frequency × frequency reference accuracy

Specifications Guide
GSM/EDGE Specifications

Description	Specifications	Supplemental Information
Output RF Spectrum and EDGE Output RF Spectrum		GMSK modulation (GSM) 3 π /8 shifted 8PSK modulation (EDGE)
Minimum carrier power at RF Input		-20 dBm (nominal)
ORFS Relative RF Power Uncertainty ^a		
Due to modulation		
Offsets \leq 1.2 MHz	± 0.15 dB	
Offsets \geq 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 \leq 2 dB ^d	± 0.81 dB	± 0.24 dB (typical)
Dynamic Range, Spectrum due to modulation ^e		5-pole sync-tuned filters ^f Methods: Direct Time ^g and FFT ^h
20 to 30 °C		
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
1.8 MHz ^j	90.3 dB 90.2 dB	GSM (nominal) EDGE (nominal) 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	
1.2 MHz	80.2 dB	
1.8 MHz	84.6 dB	

Spectrum (Frequency Domain)	See Spectrum on page 82.
Waveform (Time Domain)	See Waveform on page 83.

- 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 $\pm 0.5\%$ 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 $\pm 0.5\%$. 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 $\pm 10\%$ 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
<p>Trigger</p> <p>Trigger source</p> <p>Trigger delay, level, and slope</p> <p>Trigger delay</p> <p> Range</p> <p> Repeatability</p> <p> Resolution</p> <p>External trigger inputs</p> <p> Level Range</p> <p> Impedance</p>	<p>–100 to +500 ms</p> <p>±33 ns</p> <p>33 ns</p> <p>–5 to +5 V</p>	<p>RF burst (wideband), Video (IF envelope), Ext Front, Ext Rear, Frame Timer. Actual available choices dependent on measurement.</p> <p>Each trigger source has a separate set of these parameters.</p> <p>10 kΩ (nominal)</p>
<p>Burst Sync</p> <p>Source</p> <p>Training sequence code</p> <p>Burst type</p>		<p>Training sequence, RF amplitude, None. Actual available choices dependent on measurement.</p> <p>GSM defined 0 to 7</p> <p>Auto (search) or Manual</p> <p>Normal (TCH & CCH)</p> <p>Sync (SCH)</p> <p>Access (RACH)</p>
<p>Range Control</p>		<p>RF Input Autorange^a</p> <p>Manually set Max Total Pwr</p> <p>Manually set Input Atten</p>

- 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 0.5 dB step Ten 1 dB steps Ten 0.5 dB steps	±0.1 dB (95 %) ±0.1 dB (95 %) ±0.1 dB (95 %) ±0.1 dB (95 %)	±0.03 dB (95 %) ±0.03 dB (95 %) ±0.03 dB (95 %) ±0.03 dB (95 %)	Test Model 2 Test Model 2 Test Model 2 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 10 MHz offset	±0.8 dB (95 %) ±0.8 dB (95 %)	±0.22 dB (100 %) ±0.22 dB (100 %)	
6.5.3	Spurious Emissions f < 3 GHz 3 GHz < f < 4 GHz 4 GHz < f < 12.6 GHz	±1.5 to 2.0 dB (95 %) ±2.0 dB (95 %) ±4.0 dB (95 %)	±0.65 dB (100 %) ±1.77 dB (100 %) ±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	±0.71 dB	±0.19 dB (typical)
20 to 30 °C, Attenuation ≤ 2 dB ^b	±0.80 dB	±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 $\text{error} = 10 \times \log(1 + 10^{-SN/10})$. 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.

Description		Specifications	Supplemental Information
Adjacent Channel Power Ratio (ACPR; ACLR)^a			Specifications apply for Sweep Method = FFT or Swp
Minimum power at RF Input			-27 dBm (nominal)
ACPR Accuracy ^b			RRC weighted, 3.84 MHz noise bandwidth
Radio	Offset Freq.		
MS (UE)	5 MHz	±0.12 dB	At ACPR range of -30 to -36 dBc with optimum mixer level ^c
MS (UE)	10 MHz	±0.17 dB	At ACPR range of -40 to -46 dBc with auto-ranged ^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 auto-ranged ^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 (nominal) ^g
10 MHz			-82 dB (nominal) ^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 RF Input Range is set to Auto.
- e. In order 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 averaged input power level should be at least -1 dBm and RF Input Range is set to Auto

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

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

Description	Specifications	Supplemental Information
Intermodulation Minimum Carrier Power at RF Input Third-order Intercept CF = 1 GHz CF = 2 GHz		-30 dBm (nominal) TOI + 7.2 dB ^b 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 Frequency Resolution Frequency Accuracy	100 Hz	-40 dBm (nominal) $\frac{1.4\%}{\sqrt{N_{\text{avg}}}}$ (nominal) ^a
Spectrum Emission Mask Minimum power at RF Input Dynamic Range, relative ^b 2.515 MHz offset ^c 1980 MHz region ^d Sensitivity, absolute ^e 2.515 MHz offset ^f 1980 MHz region ^g Accuracy, relative Display = Abs Peak Pwr Display = Rel Peak Pwr	 -86.7 dB -80.7 dB -97.9 dB -81.9 dB ±0.14 dB ±0.56 dB	-20 dBm (nominal) -88.9 dB (typical) -83.0 dB (typical) -99.9 dBm (typical) -83.9 dBm (typical)

- 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
<p>Code Domain</p> <p>BTS Measurements $-25 \text{ dBm} \leq \text{ML}^a \leq -15 \text{ dBm}$ 25 to 35 °C^b, Preamp (<i>Option 1DS</i>) Off, except as noted</p> <p>Code domain power</p> <p>Minimum power at RF input Preamp (<i>Option 1DS</i>) Off Preamp (<i>Option 1DS</i>) On</p> <p>Maximum power at RF input Preamp (<i>Option 1DS</i>) On</p> <p>Relative accuracy^h</p> <p>Test signal</p> <p>Test Model 2 Code domain power range</p> <p>0 to -10 dBc -10 to -30 dBc -30 to -40 dBc</p> <p>Test Model 1 with 32 DPCH Code domain power range</p> <p>0 to -10 dBc -10 to -30 dBc -30 to -40 dBc</p> <p>Symbol power vs. timeⁱ</p> <p>Minimum power at RF Input</p> <p>Relative accuracy</p> <p>Test signal</p> <p>Test Model 1 with 32 DPCH signal Code domain power range</p> <p>0 to -25 dBc -25 to -40 dBc</p>		<p>Following specifications are 95 %^c, unless stated as (nominal).</p> <p>-75 dBm (nominal)^{de} -102 dBm (nominal)^f</p> <p>-45 dBm (nominal)^g</p> <p>±0.015 dB ±0.06 dB ±0.07 dB</p> <p>±0.015 dB ±0.08 dB ±0.15 dB</p> <p>-50 dBm (nominal)^{de}</p> <p>±0.10 dB ±0.50 dB</p>

Description	Specifications	Supplemental Information
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		-50 dBm (nominal) ^{de} Input signal power > -50 dBm, Relative code channel at -20 dB ±1.0 %

- 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:

$$\text{SCH leakage effect} = 10 \log (10^{S/10}/(10F) + 10^{C/10}) - C$$
 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 applies but the signal being measured will include the noise-like contribution of the SCH power.

Description	Specifications	Supplemental Information
QPSK EVM Preamp (<i>Option 1DS</i>) Off, except as noted.		
Minimum power at RF Input		-20 dBm (nominal)
QPSK Downlink		
EVM		0 to 25 % (nominal)
Operating range		
Floor		1.5 % (nominal)
Preamp (<i>Option 1DS</i>) Off	1.5 %	RF input power = -50 dBm, Attenuator = 0 dB
Preamp (<i>Option 1DS</i>) On		
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) + tfa ^b
12.2 k RMC Uplink		
EVM		0 to 20 % (nominal)
Operating range		
Floor		1.5 % (nominal)
Accuracy ^a		±1.0 % (nominal) at EVM of 10 %
I/Q origin offset		
Range		-10 to -50 dBc (nominal)
Frequency error		
Range		±20 kHz (nominal)
Accuracy		±10 Hz (nominal) + tfa ^b

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: $\text{error} = \sqrt{\text{EVMUUT}^2 + \text{EVMsa}^2} - \text{EVMUUT}$, 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 $\text{EVMUUT} + \text{floorerror} + \text{accyerror}$, or as low as $\text{EVMUUT} - \text{accyerror}$, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.

b. tfa = transmitter frequency × frequency reference accuracy

Description	Specifications	Supplemental Information
<p>Modulation Accuracy (Composite EVM) BTS Measurements $-25 \text{ dBm} \leq \text{ML}^{\text{a}} \leq -15 \text{ dBm}$ Preamp (Option 1DS) Off, except as noted Composite EVM</p> <p>Minimum power at RF input Preamp (Option 1DS) Off Preamp (Option 1DS) On</p> <p>Maximum power at RF input Preamp (Option 1DS) On</p> <p>Test Model 4 Range Floor Accuracy^g</p> <p>Test Model 1 with 32 DPCH Range Floor Accuracy^h</p> <p>Peak Code Domain Error Using Test Model 3 with 16 DPCH signal spreading code 256 Accuracy</p> <p>I/Q Origin Offset Range</p> <p>Frequency Error Specified for CPICH power $\geq -15 \text{ dBc}$</p> <p>Range Accuracy</p> <p>Time offset Absolute frame offset accuracy Relative frame offset accuracy Relative offset accuracy (for STTD diff mode)^j</p>	<p>0 to 25 % 1.5 %</p> <p>0 to 25 % 1.5 %</p> <p>$\pm 500 \text{ Hz}$ $\pm 2 \text{ Hz} + tfa^{\text{i}}$</p> <p>$\pm 150 \text{ ns}$ $\pm 1.25 \text{ ns}$</p>	<p>Following specifications are 95 %^b, unless stated as (nominal).</p> <p>-75 dBm (nominal)^{cd} -102 dBm (nominal)^e</p> <p>-45 dBm (nominal)^f</p> <p>$\pm 1.0 \%$</p> <p>$\pm 1.0 \%$</p> <p>$\pm 1.0 \text{ dB}$ (nominal)</p> <p>$-10 \text{ to } -50 \text{ dBc}$ (nominal)</p> <p>$\pm 5.0 \text{ ns}$ (nominal)</p>
Spectrum (Frequency Domain)	See Spectrum on page 82.	
Waveform (Time Domain)	See Waveform on page 83.	

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

b. All specifications given are derived from 95th percentile observations with 95 % confidence.

- c. 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.
- d. Nominal operating range. Accuracy specification applies when mixer level (Rf input power minus attenuation) is between -25 and -15 dBm.
- e. 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.
- f. 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.
- g. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows: $\text{error} = \sqrt{\text{EVMUUT}^2 + \text{EVMsa}^2} - \text{EVMUUT}$, 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 $\text{EVMUUT} + \text{floorerror} + \text{accyerror}$, or as low as $\text{EVMUUT} - \text{accyerror}$, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.
- h. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows: $\text{error} = \sqrt{\text{EVMUUT}^2 + \text{EVMsa}^2} - \text{EVMUUT}$, 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 $\text{EVMUUT} + \text{floorerror} + \text{accyerror}$, or as low as $\text{EVMUUT} - \text{accyerror}$, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.
- i. $\text{tfa} = \text{transmitter frequency} \times \text{frequency reference accuracy}$
- j. 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
<p>Power Control and Power vs. Time</p> <p>Absolute power measurement</p> <p>Accuracy</p> <p style="padding-left: 20px;">0 to -20 dBm</p> <p style="padding-left: 20px;">-20 to -60 dBm</p> <p>Relative power measurement</p> <p>Accuracy</p> <p style="padding-left: 20px;">Step range ± 1.5 dB</p> <p style="padding-left: 20px;">Step range ± 3.0 dB</p> <p style="padding-left: 20px;">Step range ± 4.5 dB</p> <p style="padding-left: 20px;">Step range ± 26.0 dB</p>		<p>Using 5 MHz resolution bandwidth</p> <p>± 0.7 dB (nominal)</p> <p>± 1.0 dB (nominal)</p> <p>± 0.1 dB (nominal)</p> <p>± 0.15 dB (nominal)</p> <p>± 0.2 dB (nominal)</p> <p>± 0.3 dB (nominal)</p>

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 Trigger delay, level, & slope Trigger delay Range Repeatability Resolution External trigger inputs Level Impedance	 -100 to +500 ms ±33 ns 33 ns	RF burst (wideband), Video (IF envelope), Ext Front, Ext Rear. Actual choices are dependent on measurement. Each trigger source has separate set of these parameters. -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.

5 HSDPA Specifications

This chapter contains specifications for the PSA Series, *Option 210*, HSDPA 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.

Option 210, HSDPA Measurement Personality

Description	Specifications	Supplemental Information
<p>Code Domain BTS Measurements $-25 \text{ dBm} \leq \text{ML}^a \leq -15 \text{ dBm}$ 25 to 35 °C^b Preamp (<i>Option 1DS</i>) Off, except as noted</p> <p>Code domain power</p> <p>Minimum power at RF input Preamp (<i>Option 1DS</i>) Off Preamp (<i>Option 1DS</i>) On</p> <p>Maximum power at RF input Preamp (<i>Option 1DS</i>) On</p> <p>Relative accuracy^e</p> <p>Test signal</p> <p>Test Model 2 Code domain power range 0 to -10 dBc -10 to -30 dBc -30 to -40 dBc</p> <p>Test Model 1 with 32 DPCH Code domain power range 0 to -10 dBc -10 to -30 dBc -30 to -40 dBc</p> <p>Test Model 5 with 8 HS-PDSCH Code domain power range 0 to -10 dBc -10 to -30 dBc -30 to -40 dBc</p> <p>Symbol power vs. time^h</p> <p>Minimum power at RF Input</p> <p>Relative accuracy</p> <p>Test signal Test Model 1 with 32 DPCH signal Code domain power range 0 to -25 dBc -25 to -40 dBc</p>		<p>Following specifications are 95 %^c, unless stated as (nominal).</p> <p>-75 dBm (nominal)^{cd} -102 dBm (nominal)^e</p> <p>-45 dBm (nominal)^f</p> <p>±0.015 dB ±0.06 dB ±0.07 dB</p> <p>±0.015 dB ±0.08 dB ±0.15 dB</p> <p>±0.015 dB (nominal) ±0.08 dB (nominal) ±0.15 dB (nominal)</p> <p>-50 dBm (nominal)^{ce}</p> <p>±0.10 dB ±0.50 dB</p>

Specifications Guide
HSDPA Specifications

Description	Specifications	Supplemental Information
Test Model 5 with 8 HS-PDSCH signal Code domain power range 0 to -25 dBc -25 to -40 dBc 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		±0.10 dB (nominal) ±0.50 dB (nominal) -50 dBm (nominal) Input signal power >-50 dBm, Relative code channel at -20 dB ±1.0 %

- 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. Nominal operating range. Accuracy specifications apply when mixer level (RF input power minus attenuation) is between -25 and -15 dBm.
- d. 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.
- e. 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.
- f. 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.
- g. 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:

$$\text{SCH leakage effect} = 10 \log (10^{S/10}/(10F) + 10^{C/10}) - C$$

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.

- h. Relative accuracy applies when examining data outside of where SCH is active.

Description	Specifications	Supplemental Information
<p>Modulation Accuracy (Composite EVM) BTS Measurements –25 dBm ≤ ML^a ≤ –15 dBm Preamp (<i>Option 1DS</i>) Off, except as noted</p> <p>Composite EVM</p> <p>Minimum power at RF input Preamp (<i>Option 1DS</i>) Off Preamp (<i>Option 1DS</i>) On</p> <p>Maximum power at RF input Preamp (<i>Option 1DS</i>) On</p> <p>Test Model 4 Range Floor Accuracy^f</p> <p>Test Model 1 with 32 DPCH Range Floor Accuracy^f</p> <p>Test Model 5 with 8 HS-PDSCH Range Floor Accuracy^f</p> <p>Peak Code Domain Error Accuracy Using Test Model 3 with 16 DPCH signal; spreading code 256 Using Test Model 5 with 8 HS-PDSCH signal; spreading code 256</p> <p>I/Q Origin Offset Range</p> <p>Frequency Error Specified for CPICH power ≥ –15 dBc Range Accuracy</p> <p>Time offset Absolute frame offset accuracy Relative frame offset accuracy Relative offset accuracy^h (for STTD diff mode)</p>	<p>0 to 25 % 1.5 %</p> <p>0 to 25 % 1.5 %</p> <p>±500 Hz ±2 Hz + tfa^g</p> <p>±150 ns ±1.25 ns</p>	<p>Following specifications are 95 %, unless stated as (nominal).</p> <p>–75 dBm (nominal)^{bc} –102 dBm (nominal)^d</p> <p>–45 dBm (nominal)^e</p> <p>±1.0 %</p> <p>±1.0 %</p> <p>0 to 25 % (nominal) 1.5 % (nominal) ±1.0 % (nominal)</p> <p>±1.0 % (nominal)</p> <p>±1.0 % (nominal)</p> <p>–10 to –50 dBc (nominal)</p> <p>± 5.0 ns (nominal)</p>
Spectrum (Frequency Domain)	See Spectrum on page 82.	
Waveform (Time Domain)	See Waveform on page 83.	

- 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 achieved for RF input power down to -112 dBm, but lock will not be consistent. 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: $\text{error} = \sqrt{\text{EVMUUT}^2 + \text{EVMsa}^2} - \text{EVMUUT}$, 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 $\text{EVMUUT} + \text{floorerror} + \text{accyerror}$, or as low as $\text{EVMUUT} - \text{accyerror}$, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.
- g. $\text{tfa} = \text{transmitter frequency} \times \text{frequency reference accuracy}$
- h. 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.

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 Trigger delay, level, & slope Trigger delay Range Repeatability Resolution External trigger inputs Level Impedance	 -100 to +500 ms ±33 ns 33 ns	RF burst (wideband), Video (IF envelope), Ext Front, Ext Rear. Actual choices are dependent on measurement. Each trigger source has separate set of these parameters. -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.

6 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.

Option BAC, cdmaOne Measurements Personality

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

- Absolute power accuracy includes all error sources for in-band signals except mismatch errors. There are two cases listed.
- 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.
- 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.
- 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		Measurement interval ≥ 2.0 ms
Dynamic Range		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		Measurement interval ≥ 2.0 ms
Input frequency error range	± 900 Hz	
Accuracy	± 10 Hz + tfa ^a	
Pilot time offset		From even second signal to start of PN sequence
Range	-13.33 ms to +13.33 ms	
Accuracy	± 300 ns	
Resolution	10 ns	
Code domain timing		Pilot to code channel time tolerance; measurement interval ≥ 2.0 ms
Range	± 200 ns	
Accuracy	± 10 ns	
Resolution	0.1 ns	
Code domain phase		Pilot to code channel phase tolerance; measurement interval ≥ 2.0 ms
Range	± 200 mrad	
Accuracy	± 10 mrad	
Resolution	0.1 mrad	

a. tfa = transmitter frequency \times frequency reference accuracy

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	0.9 to 1.0	Operating range 0.5 to 1.0
Accuracy		
0.9 < Rho < 1.0	± 0.001	
Resolution	0.0001	
Frequency error		Measurement interval ≥ 2.0 ms
Input frequency error range	± 900 Hz	
Accuracy	± 10 Hz + tfa ^a	
Base station pilot time offset		From even second signal to start of PN sequence
Range	-13.33 ms to +13.33 ms	
Accuracy	± 300 ns	
Resolution	10 ns	
EVM (RMS)		Measurement interval ≥ 2.0 ms
Floor	2.0 %	1.5 % (typical)
Accuracy ^b		
Range 0 to 14 %	± 0.5 %	
Carrier feedthrough		
Floor	-55 dBc	
Accuracy	± 2.0 dB	

a. tfa = transmitter frequency \times frequency reference accuracy

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: $\text{error} = \sqrt{\text{EVMUUT}^2 + \text{EVMsa}^2} - \text{EVMUUT}$, 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 $\text{EVMUUT} + \text{floorerror} + \text{accyerror}$, or as low as $\text{EVMUUT} - \text{accyerror}$, 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
885	30	-86.3 dB
1256.25	12.5	-90.8 dB
1265	30	-87.0 dB
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 $\text{error} = 20 \times \log(1 + 10^{(-\text{SN}/20)})$. 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:

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

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 Minimum spurious emission power sensitivity at RF Input ^a Representative Amplitude Accuracies ^b Example Absolute Accuracy ^c ±0.89 dB Example Relative Accuracy ^d ±0.09 dB		-35 dBm (nominal) -95 dBm + Input Attenuation
Spectrum (Frequency Domain)	See Spectrum on page 82.	
Waveform (Time Domain)	See Waveform on page 83.	

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

- a. The sensitivity is the smallest CW signal that can be reliably 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.

7 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.

Option B78, cdma2000 Measurement Personality

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	±0.67 dB	±0.18 dB (typical)
attenuation ≤ 2 dB ^b	±0.76 dB	±0.24 dB (typical)
Measurement floor ^c		-85 dBm (nominal)
Relative power accuracy	±0.08 dB	±0.03 dB (typical)
Fixed channel		
Fixed input attenuator		
Mixer level -52 to -12 dBm ^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:

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

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		±0.09 dB	
Offsets > 1.85 MHz ^d		±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 $\text{error} = 20 \times \log(1 + 10^{-\text{SN}/20})$. 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 $\text{error} = 10 \times \log(1 + 10^{-(\text{SN}/10)})$. 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 Histogram Resolution	0.01 dB ^a	-40 dBm (nominal)

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

Description	Specification	Supplemental Information
Occupied Bandwidth Minimum carrier power at RF Input Frequency resolution Frequency accuracy	100 Hz	-40 dBm (nominal) $\frac{1.2\%}{\sqrt{N_{\text{avg}}}}$ (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	-84.7 dB	-86.4 dB (typical)
1980 MHz region ^c	-80.7 dB	-83.0 dB (typical)
Sensitivity, absolute ^d		
750 kHz offset ^e	-97.9 dBm	-99.9 dBm (typical)
1980 MHz region ^f	-81.9 dBm	-83.9 dBm (typical)
Accuracy, relative		
750 kHz offset ^g	±0.14 dB	
1980 MHz region ^h	±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		
Code domain power Power range at RF input Preamplifier On		Specifications apply to BTS for 9 active channels as defined in 3GPP2, and where the mixer level (RF input power minus attenuation) is between -25 and -15 dBm. -80 to -40 dBm (nominal) ^a
The following specifications are applicable with the Preamplifier (<i>Option 1DS</i>) Off.		
Code domain power Minimum power at RF input		-60 dBm (nominal) ^{bc}
Relative power accuracy Code domain power range		
0 to -10 dBc	±0.015 dB	
-10 to -30 dBc	±0.18 dB	
-30 to -40 dBc	±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		-20 dBm (nominal) ^{bc}
Accuracy	±0.1 %	

- 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
<p>QPSK EVM</p> <p>Minimum power at RF input Preamplifier (<i>Option 1DS</i>) Off, except as noted</p> <p>EVM</p> <p>Operating range</p> <p>Floor</p> <p>Preamplifier (<i>Option 1DS</i>) Off</p> <p>Preamplifier (<i>Option 1DS</i>) On</p> <p>Accuracy^a</p> <p>I/Q origin offset</p> <p>Range</p> <p>Frequency Error</p> <p>Range</p> <p>Accuracy</p>	<p>1.5 %</p>	<p>–20 dBm (nominal)</p> <p>0 to 18 % (nominal)</p> <p>1.5 % (nominal)</p> <p>RF input power = –50 dBm, Attenuator = 0 dB</p> <p>±1.0 % (nominal)</p> <p>–10 to –45 dBc (nominal)</p> <p>±5.0 kHz (nominal)</p> <p>±10 Hz + tfa^b</p>

- 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: $\text{error} = \sqrt{\text{EVMUUT}^2 + \text{EVMsa}^2} - \text{EVMUUT}$, 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 $\text{EVMUUT} + \text{floorerror} + \text{accyerror}$, or as low as $\text{EVMUUT} - \text{accyerror}$, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.
- b. tfa = transmitter frequency × frequency reference accuracy

Description	Specifications	Supplemental Information
<p>Modulation Accuracy (Composite Rho)</p> <p>Power range at RF Input Preamplifier (<i>Option 1DS</i>) On</p> <p>Minimum power at RF Input Preamplifier (<i>Option 1DS</i>) Off</p> <p>All remaining Modulation Accuracy specifications are applicable with the Preamplifier (<i>Option 1DS</i>) Off.</p> <p>Global EVM</p> <p> Range</p> <p> Floor</p> <p> Accuracy^d</p> <p>Rho</p> <p> Range</p> <p> Floor</p> <p> Accuracy</p> <p>Pilot time offset</p> <p> Range</p> <p> Accuracy</p> <p> Resolution</p> <p>Code domain timing</p> <p> Range</p> <p> Accuracy</p> <p> Resolution</p> <p>Code domain phase</p> <p> Range</p> <p> Accuracy</p> <p> Resolution</p> <p>Peak code domain error</p> <p> Accuracy</p>	<p>0 to 25 %</p> <p>1.5 %</p> <p>±0.75 %</p> <p>0.9 to 1.0</p> <p>0.99978</p> <p>±0.0010</p> <p>±0.0035</p> <p>-13.33 to +13.33 ms</p> <p>±300 ns</p> <p>10 ns</p> <p>±200 ns</p> <p>±1.25 ns</p> <p>0.1 ns</p> <p>±200 mrad</p> <p>±10 mrad</p> <p>0.1 mrad</p>	<p>Specifications apply to BTS for 9 active channels as defined in 3GPP2, and where the mixer level (RF input power minus attenuation) is between -25 and -15 dBm.</p> <p>-80 to -40 dBm (nominal)^a</p> <p>-60 dBm (nominal)^{bc}</p> <p>at Rho 0.99751 (EVM 5 %)</p> <p>at Rho 0.94118 (EVM 25 %)</p> <p>From even second signal to start of PN sequence</p> <p>Pilot to code channel time tolerance</p> <p>Pilot to code channel phase tolerance</p> <p>±1.0 dB (nominal)</p>

Specifications Guide
cdma2000 Specifications

Description	Specifications	Supplemental Information
I/Q origin offset Range		-10 to -50 dBc (nominal)
Frequency error Range	±900 Hz	
Accuracy	±10 Hz + tfa ^e	
Spectrum (Frequency Domain)	See Spectrum on page 82.	
Waveform (Time Domain)	See Waveform on page 83.	

- 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.
- 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.
- Nominal operating range. Accuracy specification applies when mixer level (RF input power minus attenuation) is between -25 and -15 dBm.
- The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows: $\text{floorerror} = \sqrt{\text{EVMUUT}^2 + \text{EVMsa}^2} - \text{EVMUUT}$, 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 $\text{EVMUUT} + \text{floorerror} + \text{accyerror}$, or as low as $\text{EVMUUT} - \text{accyerror}$, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.
- tfa = transmitter frequency × frequency reference 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 Trigger delay, level, and slope Trigger delay Range Repeatability Resolution External trigger inputs Level Impedance Range Control	 -100 to +500 ms ±33 ns 33 ns	RF burst (wideband), Video (IF envelope), Ext Front, Ext Rear. Actual available choices are dependent on measurement. Each trigger source has a separate set of these parameters. -5 V to +5 V (nominal) 10 kΩ (nominal) 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 1xEV-DV Specifications

This chapter contains specifications for the PSA Series, *Option 214*, 1xEV-DV 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.

Test model signal for 1xEV-DV

3GPP2 defines the test model signal as 9 active channels for a cdma2000 forward link. However, it doesn't cover 1xEV-DV requirements. This means that we need to define the test signal with an appropriate configuration for our specifications in Code Domain and Mod Accuracy. For the 1xEV-DV 8PSK/16QAM modulation code signal, we define the test model signal with the following table.

Test Model Definition for 1xEV-DV:

	Walsh	Code#	N	Power	
				Linear	dB
Pilot	64	0	1	0.200	-7.0
Paging	64	1	1	0.338	-4.7
Sync	64	32	1	0.085	-10.7
F-FCH	64	8	1	0.169	-7.7
F-PDCCH	64	9	1	0.039	-14.0
F-PDCH	32	31	1	0.039	-14.0
F-PDCH	32	15	1	0.039	-14.0
F-PDCH	32	23	1	0.039	-14.0
F-PDCH	32	7	1	0.039	-14.0
F-PDCH	32	27	1	0.039	-14.0
F-PDCH	32	11	1	0.039	-14.0
F-PDCH	32	19	1	0.039	-14.0
F-PDCH	32	3	1	0.039	-14.0
F-PDCH	32	30	1	0.039	-14.0
F-PDCH	32	14	1	0.039	-14.0
F-PDCH	32	22	1	0.039	-14.0
F-PDCH	32	6	1	0.039	-14.0
F-PDCH	32	26	1	0.039	-14.0
F-PDCH	32	10	1	0.039	-14.0
F-PDCH	32	18	1	0.039	-14.0

Option 204, 1xEV-DV Measurements Personality

Description	Specifications	Supplemental Information
<p>Code Domain</p> <p>Code domain power Power range at RF input Preamplifier On</p> <p>The following specifications are applicable with the Preamplifier (<i>Option 1DS</i>) Off.</p> <p>Code domain power Minimum power at RF input Relative power accuracy QPSK modulation code signal Code domain power range 0 to -10 dBc -10 to -30 dBc -30 to -40 dBc</p> <p>8PSK/16QAM modulation code signal</p> <p>Code domain power range 0 to -10 dBc -10 to -30 dBc -30 to -40 dBc</p> <p>Symbol power vs. time Minimum power at RF Input QPSK modulation code signal Accuracy 8PSK/16QAM modulation code signal Accuracy</p> <p>Symbol error vector magnitude Minimum power at RF Input Accuracy</p>	<p></p> <p></p> <p></p> <p>± 0.015 dB ± 0.18 dB ± 0.51 dB</p> <p></p> <p></p> <p>± 0.1 dB</p> <p></p> <p>± 0.10 %</p>	<p>Specifications apply to BTS for 9 active channels as defined in 3GPP2 unless otherwise stated, and where the mixer level (RF input power minus attenuation) is between -25 and -15 dBm.</p> <p>-80 to -40 dBm (nominal)^a</p> <p>-60 dBm (nominal)^{bc}</p> <p>See Table Test model signal for 1xEV-DV</p> <p>± 0.015 dB (nominal) ± 0.18 dB (nominal) ± 0.51 dB (nominal)</p> <p>-40 dBm (nominal)^{bc} For code channel power ≥ -20 dBc</p> <p>See Table Test model signal for 1xEV-DV ± 0.1 dB (nominal)</p> <p>-20 dBm (nominal)</p>

- 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
<p>Modulation Accuracy (Composite Rho)</p> <p>Power range at RF Input Preamplifier (<i>Option IDS</i>) On</p> <p>Minimum power at RF Input Preamplifier (<i>Option IDS</i>) Off</p> <p>All remaining Modulation Accuracy specifications are applicable with the Preamplifier (<i>Option IDS</i>) Off.</p> <p>Global EVM</p> <p style="padding-left: 20px;">Range</p> <p style="padding-left: 20px;">Floor</p> <p style="padding-left: 20px;">Accuracy^d</p> <p>Rho</p> <p style="padding-left: 20px;">Range</p> <p style="padding-left: 20px;">Floor</p> <p style="padding-left: 20px;">Accuracy</p> <p>The following specifications for Global EVM and Rho apply for the test model signal for 1xEV-DV defined above.</p> <p>Global EVM</p> <p style="padding-left: 20px;">Range</p> <p style="padding-left: 20px;">Floor</p> <p style="padding-left: 20px;">Accuracy^e</p> <p>Rho</p> <p style="padding-left: 20px;">Range</p> <p style="padding-left: 20px;">Floor</p> <p style="padding-left: 20px;">Accuracy</p>	<p>0 to 25 %</p> <p>1.5 %</p> <p>± 0.75 %</p> <p>0.9 to 1.0</p> <p>0.99978</p> <p>± 0.0010</p> <p>± 0.0035</p>	<p>Specifications apply to BTS for 9 active channels as defined in 3GPP2 unless otherwise stated, and where the mixer level (RF input power minus attenuation) is between -25 and -15 dBm.</p> <p>-80 to -40 dBm (nominal)^a</p> <p>-60 dBm (nominal)^{bc}</p> <p>At Rho 0.99751 (EVM 5 %)</p> <p>At Rho 0.94118 (EVM 25 %)</p> <p>See Table Test model signal for 1xEV-DV</p> <p>0 to 25 % (nominal)</p> <p>1.5 % (nominal)</p> <p>± 0.75 % (nominal)</p> <p>0.9 to 1.0 (nominal)</p> <p>0.99978 (nominal)</p> <p>± 0.0010 (nominal) at Rho 0.99751 (EVM 5 %)</p> <p>± 0.0035 (nominal) at Rho 0.94118 (EVM 25 %)</p>

Description	Specifications	Supplemental Information
Pilot time offset		From even second signal to start of PN sequence
Range	–13.33 to +13.33 ms	
Accuracy	±300 ns	
Resolution	10 ns	
Code domain timing		Pilot to code channel time tolerance
Range	±200 ns	
Accuracy	±1.25 ns	
Resolution	0.1 ns	
Code domain phase		Pilot to code channel phase tolerance
Range	±200 mrad	
Accuracy	±10 mrad	
Resolution	0.1 mrad	
Peak code domain error		
Accuracy		±1.0 dB (nominal)
9 active channels		
Test model signal for 1xEV-DV See Test model signal for 1xEV-DV on page 143		±1.0 dB (nominal)
I/Q origin offset		
Range		–10 to –50 dBc (nominal)
Frequency error		
Range	±900 Hz	
Accuracy	±10 Hz + tfa ^f	
Spectrum (Frequency Domain)	See Spectrum on page 82.	
Waveform (Time Domain)	See Waveform on page 83.	

- 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: $\text{floorerror} = \sqrt{\text{EVMUUT}^2 + \text{EVMsa}^2} - \text{EVMUUT}$, 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 $\text{EVMUUT} + \text{floorerror} + \text{accyerror}$, or as low as $\text{EVMUUT} - \text{accyerror}$, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.

- e. The accuracy specification applies when the EVM to be measured is well above the measurement floor. When the EVM does not greatly exceed the floor, the errors due to the floor add to the accuracy errors. The errors due to the floor are noise-like and add incoherently with the UUT EVM. The errors depend on the EVM of the UUT and the floor as follows: $\text{floorerror} = \sqrt{\text{EVMUUT}^2 + \text{EVMsa}^2} - \text{EVMUUT}$, 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 $\text{EVMUUT} + \text{floorerror} + \text{accyerror}$, or as low as $\text{EVMUUT} - \text{accyerror}$, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.
- f. $\text{tfa} = \text{transmitter frequency} \times \text{frequency reference accuracy}$

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

- 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 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.

Option 204, 1xEV-DO Measurements Personality

Description	Specifications	Supplemental Information
Channel Power 1.23 MHz Integration BW Minimum power at RF input Absolute power accuracy ^a 20 °C to 30 °C attenuation > 2 dB ^b attenuation ≤ 2 dB ^b Measurement floor ^c Relative power accuracy Fixed channel Fixed input attenuator Mixer level -52 to -12 dBm ^d	 ±0.67 dB ±0.76 dB ±0.08 dB	Input signal must not be bursted -74 dBm (nominal) ±0.18 dB (typical) ±0.24 dB (typical) -85 dBm (nominal) ±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 Histogram Resolution	0.01 dB ^a	-40 dBm (nominal)

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

Description	Specifications	Supplemental Information
Occupied Bandwidth Minimum carrier power a RF Input Frequency resolution Frequency accuracy	100 Hz	Input signal must not be bursted -40 dBm (nominal) $\frac{1.2\%}{\sqrt{N_{\text{avg}}}}$ (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	-84.7 dB	-86.4 dB (typical)
1980 MHz region ^c	-80.7 dB	-83.0 dB (typical)
Sensitivity, absolute ^d		
750 kHz offset ^e	-97.9 dBm	-99.9 dBm (typical)
1980 MHz region ^f	-81.9 dBm	-83.9 dBm (typical)
Accuracy, relative		
750 kHz offset ^g	±0.14 dB	
1980 MHz region ^h	±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. Relative power accuracy	±0.15 dB	For Pilot, 2 MAC channels, and 16 channels of QPSK data

Description	Specifications	Supplemental Information
QPSK EVM Minimum power at RF input EVM Operating range Floor Accuracy ^a I/Q origin offset Range Frequency Error Range Accuracy		-20 dBm (nominal) 0 to 15 % (nominal) 1.5 % (nominal) ±1.0 % (nominal) -10 to -50 dBc (nominal) ±5.0 kHz (nominal) ±10 Hz (nominal) + tfa ^b

- 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: $\text{error} = \sqrt{\text{EVM}_{\text{UUT}}^2 + \text{EVM}_{\text{sa}}^2} - \text{EVM}_{\text{UUT}}$, where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} 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 $\text{EVM}_{\text{UUT}} + \text{floorerror} + \text{accyerror}$, or as low as $\text{EVM}_{\text{UUT}} - \text{accyerror}$, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.
- b. $\text{tfa} = \text{transmitter frequency} \times \text{frequency reference accuracy}$

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

- 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: $\text{error} = \sqrt{\text{EVMUUT}^2 + \text{EVMsa}^2} - \text{EVMUUT}$, 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 $\text{EVMUUT} + \text{floorerror} + \text{accyerror}$, or as low as $\text{EVMUUT} - \text{accyerror}$, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.
- b. tfa = transmitter frequency × frequency reference accuracy

Description	Specifications	Supplemental Information
<p>Power vs. Time (PvT)</p> <p>Minimum power at RF input</p> <p>Absolute power accuracy^a 20 °C to 30 °C attenuation > 2 dB^b attenuation ≤ 2 dB^b</p> <p>Measurement floor^c</p> <p>Relative power accuracy Fixed channel Fixed input attenuator Mixer level -52 to -12 dBm^d</p>		<p>-73 dBm (nominal)</p> <p>±0.24 dB (nominal) ±0.30 dB (nominal)</p> <p>-84 dBm (nominal)</p> <p>±0.03 dB (nominal)</p>
<p>Spectrum (Frequency Domain)</p>	<p>See Spectrum on page 82.</p>	
<p>Waveform (Time Domain)</p>	<p>See Waveform on page 83.</p>	

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

- 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 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.

NADC Measurement Personality

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

- 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:

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

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 EVM Operating range Floor Accuracy ^a Frequency Error Accuracy I/Q Origin offset Range	0.5 %	-45 dBm (nominal) 0 to 18 % (nominal) ±0.6 % (nominal) ±2.0 Hz (nominal) + tfa ^b -10 to -50 dBc (nominal)
Spectrum (Frequency Domain)	See Spectrum on page 82.	
Waveform (Time Domain)	See Waveform on page 83.	

- 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: $\text{error} = \sqrt{\text{EVM}_{\text{UUT}}^2 + \text{EVM}_{\text{sa}}^2} - \text{EVM}_{\text{UUT}}$, where EVM_{UUT} is the EVM of the UUT in percent, and EVM_{sa} 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 $\text{EVM}_{\text{UUT}} + \text{floorerror} + \text{accyerror}$, or as low as $\text{EVM}_{\text{UUT}} - \text{accyerror}$, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.
- b. tfa = transmitter frequency × frequency reference 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	-100 to +500 ms	
Repeatability	±33 ns	
Resolution	33 ns	
External trigger inputs		
Level		-5 V to +5 V (nominal)
Impedance		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.

11 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.

PDC Measurement Personality

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

- 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: $\text{error} = 10 \times \log(1 + 10^{-\text{SN}/10})$
- 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 EVM Operating range Floor Accuracy ^a I/Q Origin offset Range Frequency Error Accuracy	0.5 %	-50 dBm (nominal) 0 to 18 % (nominal) ±0.6 % (nominal) -12 to -50 dBc (nominal) ±2.0 Hz + tfa ^b
Spectrum	See Spectrum on page 82.	
Waveform (Time Domain)	See Waveform on page 83.	

- 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: $\text{error} = \sqrt{\text{EVMUUT}^2 + \text{EVMsa}^2} - \text{EVMUUT}$, 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 $\text{EVMUUT} + \text{floorerror} + \text{accyerror}$, or as low as $\text{EVMUUT} - \text{accyerror}$, where floorerror is the result of the error computation due to the floor, and accyerror is the specified accuracy.
- b. tfa = transmitter frequency × frequency reference accuracy

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

Description	Specifications	Supplemental Information
In-Band Frequency Range 800 MHz Band #1 800 MHz Band #2 800 MHz Band #3 1500 MHz Band	810 to 828 MHz 940 to 958 MHz 870 to 885 MHz 925 to 940 MHz 838 to 840 MHz 893 to 895 MHz 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
<p>Trigger</p> <p>Trigger source</p> <p>Trigger delay, level, and slope</p> <p>Trigger delay</p> <p> Range</p> <p> Repeatability</p> <p> Resolution</p> <p>External trigger inputs</p> <p> Level</p> <p> Impedance</p>	<p>–100 to +500 ms</p> <p>±33 ns</p> <p>33 ns</p>	<p>RF burst (wideband), Video (IF envelope), Ext Front, Ext Rear, Frame Timer. Actual available choices dependent on measurement.</p> <p>Each trigger source has a separate set of these parameters.</p> <p>–5 V to +5 V (nominal)</p> <p>10 kΩ (nominal)</p>
<p>Range Control</p>		<p>RF Input Autorange^a</p> <p>Manually set Max Total Pwr</p> <p>Manually set Input Atten</p>

-
- 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.

12 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 E4443A E4445A E4446A E4448A	1 MHz to 26.5 GHz 1 MHz to 6.7 GHz 1 MHz to 13.2 GHz 1 MHz to 44 GHz 1 MHz to 50 GHz	

Description	Specifications	Supplemental Information
Measurement Characteristics Measurements Maximum number of decades Filtering (ratio of video bandwidth to resolution bandwidth)	Log plot Spot frequency RMS noise RMS jitter Residual FM 7 (whole decades only) 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.

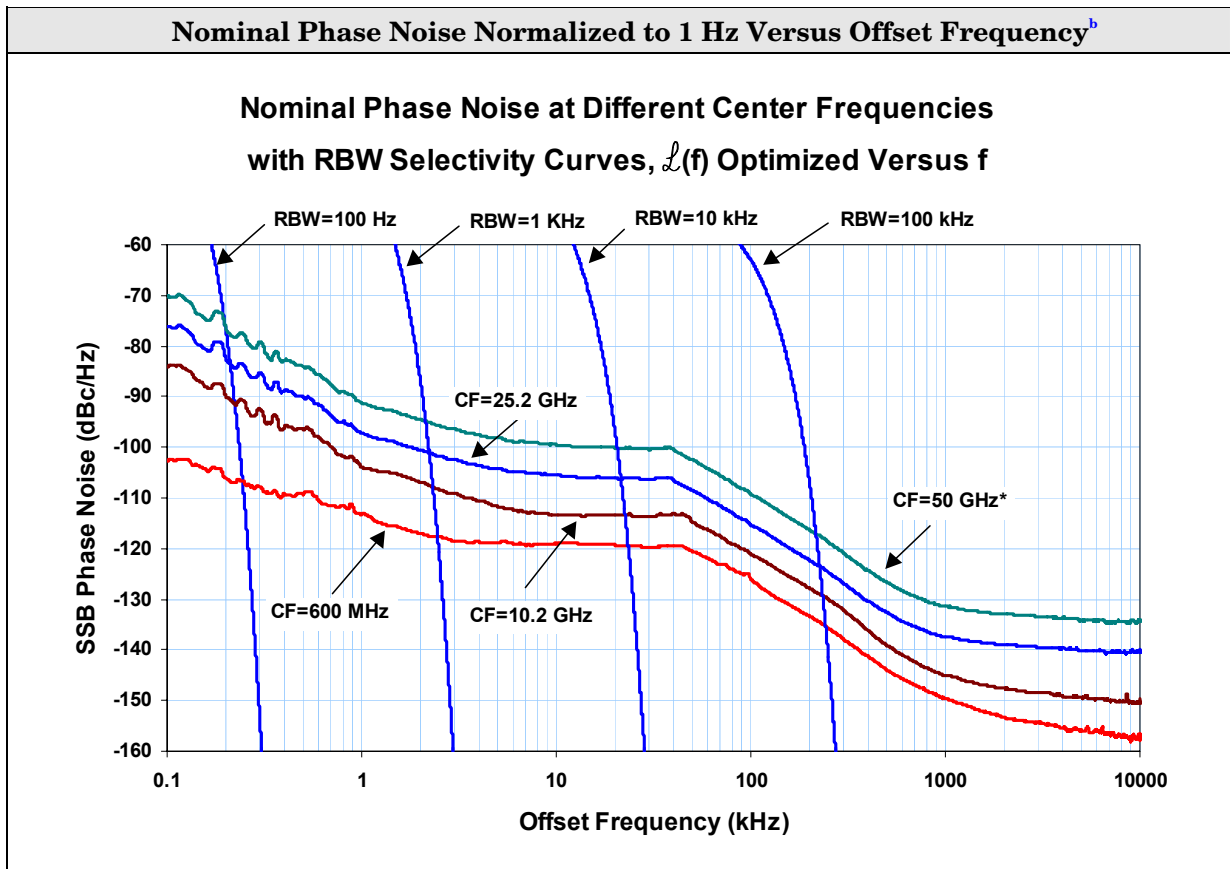
The function is: $\text{error} = 10 \times \log(1 + 10^{-\text{SN}/10})$

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 No Smoothing Offset 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 4 % Smoothing ^c Offset 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz		Standard Deviation ^{ab}			
	No Filtering	Little Filtering	Medium Filtering	Maximum Filtering	
	5.4 dB	3.4 dB	3.9 dB	3.4 dB	
	5.2 dB	3.7 dB	2.3 dB	2.1 dB	
	5.1 dB	3.5 dB	2.0 dB	1.2 dB	
	4.5 dB	2.9 dB	1.9 dB	1.0 dB	
	4.1 dB	2.7 dB	1.7 dB	0.95 dB	
	1.7 dB	1.1 dB	1.1 dB	0.88 dB	
	1.3 dB	0.78 dB	0.53 dB	0.37 dB	
	1.1 dB	0.78 dB	0.34 dB	0.29 dB	
	0.86 dB	0.40 dB	0.40 dB	0.23 dB	
	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	$\pm 1.4\%$	0.02 octave



- 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.

13 Noise Figure Measurement Personality Specifications

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

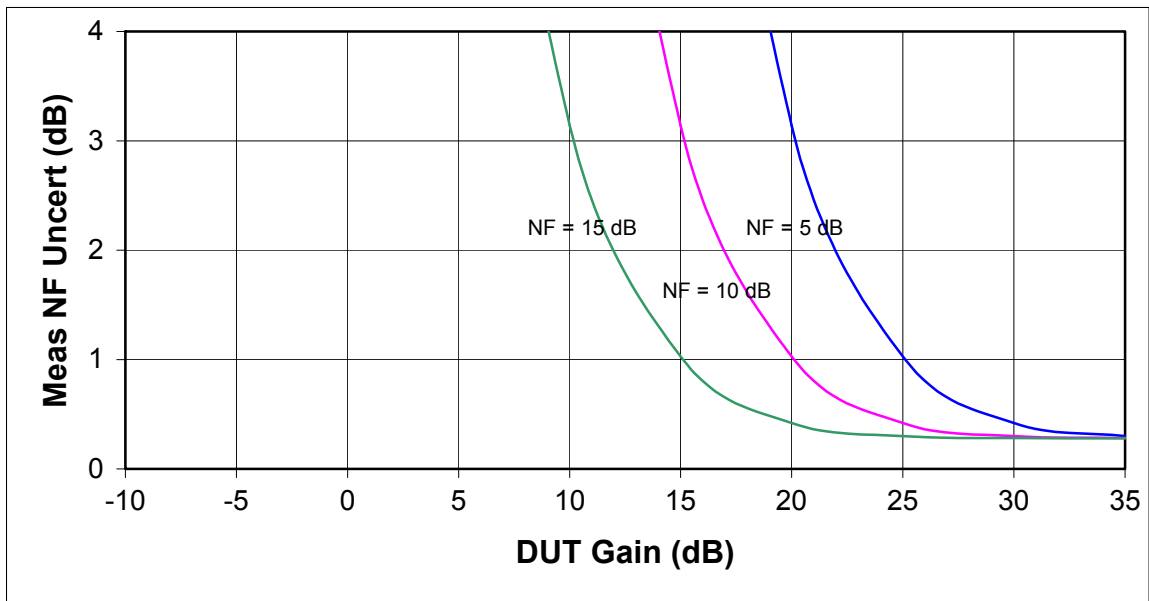
Description	Specifications		Supplemental Information
Noise Figure 200 kHz to 10 MHz ^b Noise Source ENR 4 – 7 dB 12 – 17 dB 20 – 22 dB			Uncertainty Calculator ^a Using internal preamp (<i>Option IDS</i>) Measurement Range (nominal) Instrument Uncertainty ^c (nominal) 0 – 20 dB ±0.05 dB 0 – 30 dB ±0.05 dB 0 – 35 dB ±0.10 dB
10 MHz to 3 GHz Noise Source ENR 4 – 7 dB 12 – 17 dB 20 – 22 dB	Measurement Range 0 – 20 dB 0 – 30 dB 0 – 35 dB	Instrument Uncertainty ^c ±0.05 dB ±0.05 dB ±0.10 dB	Using internal preamp (<i>Option IDS</i>), and RBW=1 MHz
3 to 26.5 GHz ^d Instrument Uncertainty 3 to 10 GHz 10 to 20 GHz 20 to 26.5 GHz			No internal preamp Nominally the same as for the 10 MHz to 3 GHz range; External preamp caution ^e Well-controlled preselector ^f Good preselector stability ^g Preselector Drift Effects ^h

- The figures given in the table are for the uncertainty added by the PSA instrument only. To compute the total uncertainty for your noise figure measurement, you need to take into account other factors including: DUT NF, Gain, Gain Uncertainty and Match; Noise source ENR uncertainty and Match. The computations can be performed with the uncertainty calculator included with the Noise Figure Measurement Personality. Go to **Mode Setup** then select **Uncertainty Calculator**. Similar calculators are also available on the Agilent web site; go to www.agilent.com/find/nfu.
- 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”.
- “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 incremental log fidelity. The uncertainty of the analyzer is multiplied within the computation by an amount that depends on the Y factor to give the total uncertainty of the noise figure or gain measurement.
 See Agilent App Note 57-2, literature number 5952-3706E for details on the use of this specification.
 Jitter (amplitude variations) will also affect the accuracy of results. The standard deviation of the measured result decreases by a factor of the square root of the Resolution Bandwidth used and by the square root of the number of averages. PSA uses the 1 MHz resolution Bandwidth as default since this is the widest bandwidth with uncompromised accuracy.

- d. For this frequency range, the Instrument Noise Figure Uncertainty is still well controlled, but other accuracy issues become critical. Because there is no internal preamplifier in this range, the Instrument Noise Figure is much higher than in the range below 3 GHz. This causes the effect on total measurement Noise Figure Uncertainty of the Instrument Gain Uncertainty to be much higher, and that Instrument Gain Uncertainty is in turn much higher than in the range below 3 GHz because of the effects of the preselector, explained in subsequent footnotes. As a result, when the DUT has high gain, the total measurement Noise Figure Uncertainty computed with the Uncertainty Calculator can still be excellent, but modest and low gain devices can have very high uncertainties of noise figure. Graphs that follow demonstrate. The first graph shows the error in NF with no preamp, and shows how much gain is required to achieve good accuracy. The second graph shows NF Error when using an external preamp with 23 dB gain and 6 dB NF.
- e. An external preamp can reduce the total NF measurement uncertainty substantially because it will reduce the effective noise figure of the measurement system, and thus it will reduce the sensitivity of the total NF uncertainty to the Instrument Gain Uncertainty. But if the signal levels into such an external preamp are large enough, that external preamp may experience some compression. The compression differences between the noise-source-on and noise-source-off states causes an error that must be added to Instrument Noise Figure Uncertainty for use in the Noise Figure Uncertainty Calculator. Such signal levels are quite likely for the case where the DUT has some combination of high gain, high noise figure and wide bandwidth.
- As an example, we will use the Agilent 83006A as the external preamplifier. The measurement will be made at 18 GHz. The typical gain is 25 dB and the noise figure is 7 dB. We will assume the DUT has 20 dB gain, a 10 dB NF, and a passband from 5 to 30 GHz. We will use a noise source with 17 dB ENR. When the noise source is on, the DUT output can be computed by starting with kT (-174 dBm/Hz) and adding $10 \log(30 \text{ GHz} - 5 \text{ GHz})$ or 104 dB, giving -70 dBm for the thermal noise. Add to this the ENR of the noise source (17 dB) combined with the NF of the DUT (10 dB) to give an equivalent input ENR of 18 dB, thus -52 dBm input noise power. Add the gain of the DUT (20 dB) to find the DUT output power to be -32 dBm. The noise figure of the external preamp may be neglected. The external preamplifier gain of 25 dB adds, giving a preamplifier output power of -7 dBm. The typical 1 dB compression point of this amplifier is $+19$ dBm. Therefore, the output noise is 26 dB below the 1 dB compression point. This amplifier will have negligible compression. As a rule of thumb, the compression of a noise signal is under 0.1 dB if the average noise power is kept 7 dB below the 1 dB CW compression point. The compression in decibels will usually double for every 3 dB increase in noise power. Use cases with higher gain DUTs or preamplifiers with lower output power capability could be compressed, leading to additional errors.
- f. In this frequency range, the preselector is well-controlled and there should be no need for special measurement techniques.
- g. In this frequency range, the preselector usually requires no special measurement techniques in a lab environment. But if the temperature changes by a few degrees, or the analyzer frequency is swept or changed across many gigahertz, there is a small risk that the preselector will not be centered well enough for good measurements.
- h. In this frequency range, the preselector behavior is not warranted. There is a modest risk that the preselector will not be centered well enough for good measurements. This risk may be reduced but not eliminated by using the analyzer at room temperature, limiting the span swept to a few gigahertz, and not changing the operating frequency range for many minutes.

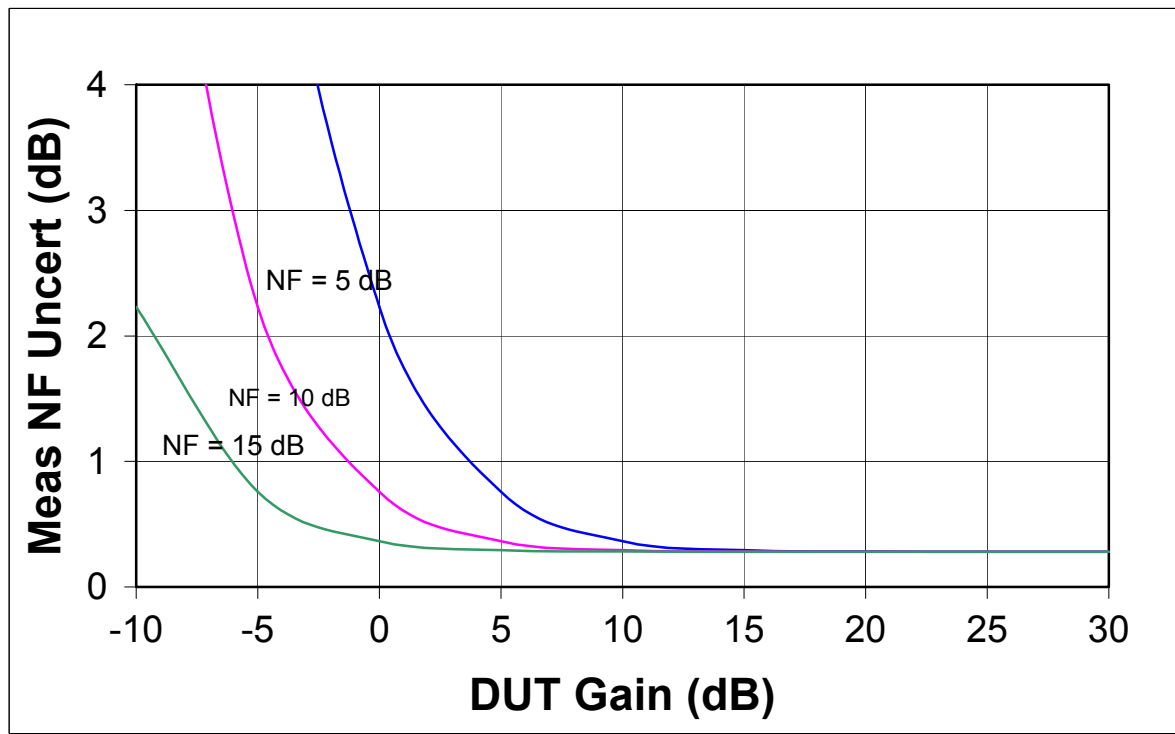
Computed Measurement NF Uncertainty vs. DUT Gain, Non-warranted Frequency Range

Assumptions: Measurement Frequency 12 GHz, Instrument NF = 26.5 dB, Instrument VSWR = 1.4, Instrument Gain Uncertainty = 2.2 dB, Instrument NF Uncertainty = 0.05 dB, Agilent 346B Source with Uncertainty = 0.2 dB, Source VSWR = 1.25, DUT input/output VSWR = 1.5.



Computed Measurement NF Uncertainty vs. DUT Gain, Non-warranted Frequency Range

Assumptions: Same as above, with the addition of an external preamp. With an external preamp, the preamp/analyzer combination NF is 7.93 dB; the external preamp alone has a gain of 23 dB and a NF of 6 dB. Instrument VSWR is now that of the external preamp; VSWR = 2.6.



Description	Specifications		Supplemental Information
Gain 200 kHz to 10 MHz ^a Noise Source ENR 4 – 7 dB 12 – 17 dB 20 – 22 dB			Using internal preamp (Option 1DS)
		Measurement Range (nominal)	Instrument Uncertainty ^b (nominal)
		–20 to 40 dB	±0.17 dB
		–20 to 40 dB	±0.17 dB
		–20 to 40 dB	±0.17 dB
	10 MHz to 3 GHz		
Noise Source ENR 4.5 – 6.5 dB 12 – 17 dB 20 – 22 dB	Measurement Range	Instrument Uncertainty ^b	
	–20 to 40 dB	±0.17 dB	
	–20 to 40 dB	±0.17 dB	
	–20 to 40 dB	±0.17 dB	
3 to 26.5 GHz ^c Instrument Uncertainty			±2.2 dB (nominal) ^d for Measurement Range –20 to 40 dB

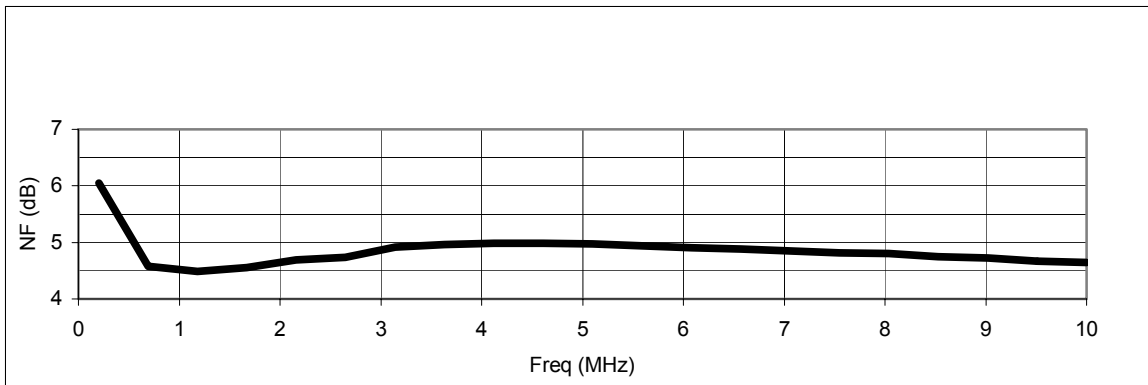
- a. See the FAQ for current information on the availability of noise sources for this frequency range. To find the FAQ, choose any PSA Series model number from www.agilent.com/find/psa, and look for the FAQ link under “In the Library.”
- b. See the “Instrument Uncertainty” footnote c on page **Error! Bookmark not defined.**
- c. See footnotes e, f, g, and h for this frequency range in the Noise Figure section.
- d. The performance shown would apply when there is a long time between the calibration step and the DUT-measurement step in a NF or Gain measurement. Under special circumstances of small changes in frequency (such as spot frequency measurements) and short time periods between the calibration time and the measurement time, this error source becomes much smaller, approaching the Instrument Uncertainty shown for the 10 MHz to 3 GHz frequency range. These special circumstances would be frequency span ranges of under 1 GHz, with that frequency range unchanged for 30 minutes, and the time between the calibration step and the DUT measurement step held to less than 10 minutes.

Description	Specifications	Supplemental Information
<p>Noise Figure Uncertainty Calculator^a</p> <p>Noise Figure Instrument Uncertainty</p> <p>Gain Instrument Uncertainty</p> <p>Instrument Noise Figure</p> <p>Instrument Input Match</p>	<p>See Noise Figure</p> <p>See Gain</p>	<p>See graphs, Nominal Noise Figure DANL +176.15, nominal^b</p> <p>See graphs, Nominal VSWR</p>

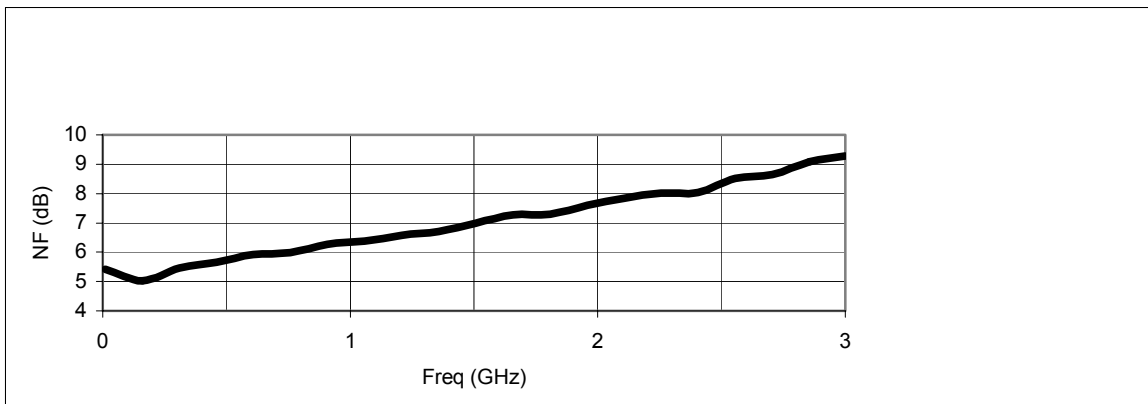
-
- a. Noise figure uncertainty calculations require the parameters shown in order to calculate the uncertainty.
 - b. Nominally, the noise figure of the spectrum analyzer is given by the DANL (displayed average noise level) minus kTB (–173.88 dB in a 1 Hz bandwidth at 25 °C) plus 2.51 dB (the effect 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

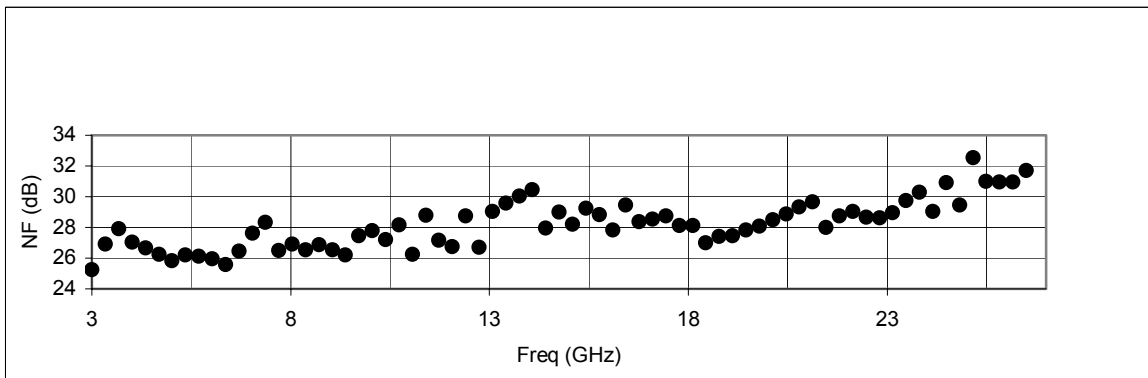
**Nominal Instrument Noise Figure 200 kHz to 10 MHz
 Preamp On**



**Nominal Instrument Noise Figure 10 MHz to 3 GHz
 Preamp On**



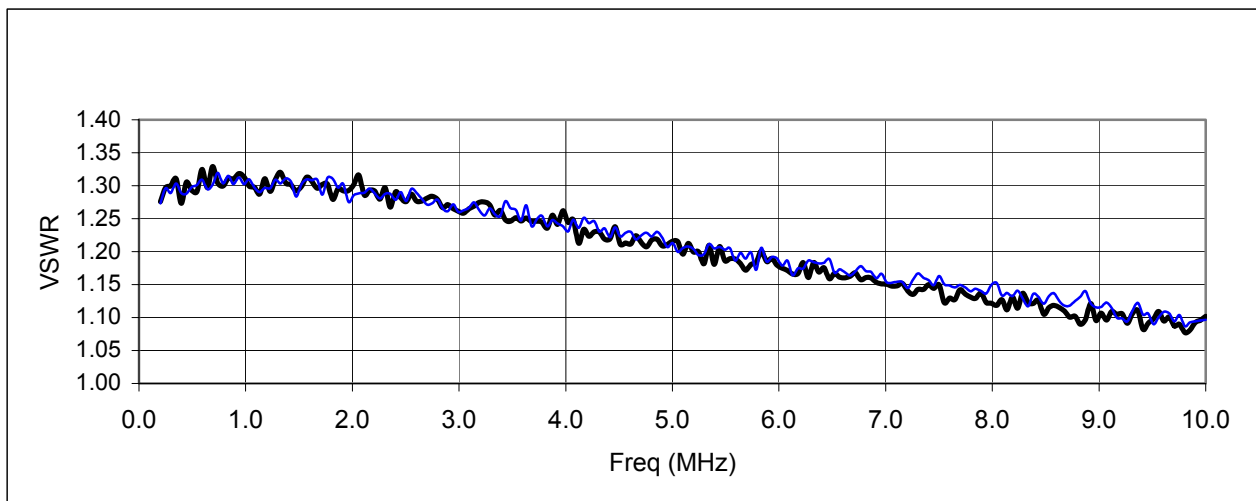
**Nominal Instrument Noise Figure 3 to 26.5 GHz
 No Preamp**



Nominal Instrument Input VSWR

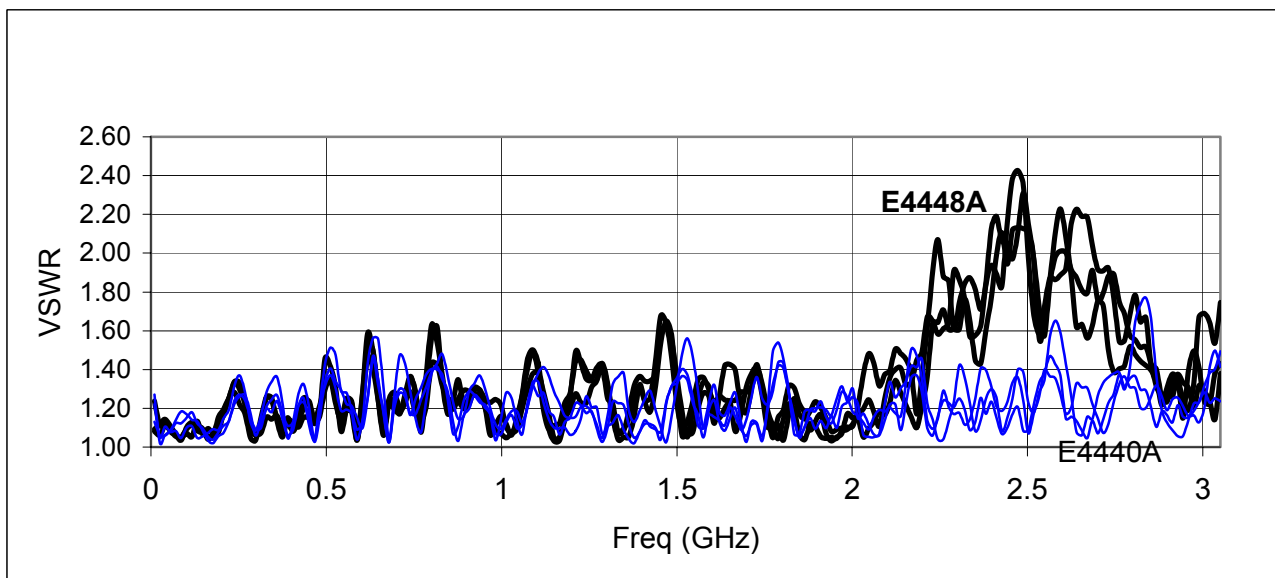
Nominal Instrument Input VSWR 200 kHz to 10 MHz; Preamp On, Attenuation = 0 dB

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

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.

