# Specifications Guide

## Agilent Technologies PSA Spectrum Analyzers

**This manual provides documentation for the following instrument:**

**Agilent Technologies PSA Series**

**E4440 (3 Hz – 26.5 GHz)**

**Manufacturing Part Number: E4440-90011**

**Printed in USA**

**January 2001**

## 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.

# Contents

## Agilent E4440A Specifications

# Agilent E4440A Specifications

This chapter contains specifications and supplemental information for PSA E4440A spectrum analyzers. The distinction among specifications, typical performance, and nominal values are described as follows.

## Definitions

- Specifications describe the performance of parameters covered by the product warranty (temperature = 0 to 55°C, unless otherwise noted).
- Typical describes additional product performance information that is not covered by the product warranty. It is performance beyond specification that 80% of the units exhibit with a 95% confidence level over the temperature range 20 to 30°C. Typical performance does *not* include measurement uncertainty.
- Nominal values indicate expected performance, or describe product performance that is useful in the application of the product, but is not covered by the product warranty.

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

## Conditions Required to Meet Specifications

❑ The analyzer is within its calibration cycle.

❑ Under auto couple control, except that Sweep Type = Swept, and Auto Sweep Time = Accy.

❑ First LO output terminated in 50Ω (if present).

❑ For center frequencies < 10 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.

# Frequency

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

a. N is the harmonic mixing mode. All mixing modes are negative (as indicated by the "–"), where the desired 1st LO harmonic is higher than the tuned frequency by the 1st IF (3.9214 GHz for the 3 Hz to 3.0 GHz band, 321.4 MHz for all other bands).

| Description | Specifications | Supplemental Information |
|---|---|---|
| **Frequency Reference** | | |
| Accuracy | ±[ (time since last adjustment × aging rate) + temperature stability + calibration accuracy[a]] | |
| Temperature Stability | | |
| 20 to 30 °C | $\pm 1 \times 10^{-8}$ | |
| 0 to 55 °C | $\pm 5 \times 10^{-8}$ | |
| Aging Rate | $\pm 1 \times 10^{-7}$/year | $\pm 5 \times 10^{-10}$/day (nominal) |
| Settability | $\pm 2 \times 10^{-9}$ | |

| Description | Specifications | Supplemental Information |
|---|---|---|
| Warm-up and Retrace[b] | | |
| *Within 5 min. after turn on* | | $\pm 1 \times 10^{-7}$ of final frequency (nominal) |
| *Within 15 min. after turn on* | | $\pm 5 \times 10^{-8}$ of final frequency (nominal) |
| Achievable Initial Calibration Accuracy[c] | $\pm 7 \times 10^{-8}$ | |

a. Initial calibration accuracy depends on how accurately the frequency standard was adjusted to 10 MHz.
b. Applies only when power is disconnected from instrument. Does not apply when instrument is in standby mode.
c. 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.

| Description | Specifications | Supplemental Information |
|---|---|---|
| **Frequency Readout Accuracy** | $\pm$(marker freq. $\times$ freq. ref. accy. + 0.25% $\times$ span + 5% $\times$ RBW[a] + 2 Hz + 0.5 $\times$ horizontal resolution[b]) | see note[c] |

a. The warranted performance is only the sum of all errors under autocoupled conditions. Under non-autocoupled conditions, the frequency readout accuracy will nominally meet the specification equation, except for conditions in which the RBW term dominates, as explained in examples below. The nominal RBW contribution to frequency readout accuracy is 2% of RBW for RBWs from 1 Hz to 1 MHz, 3% of RBW from 1.1 MHz through 3 MHz (the widest autocoupled RBW), and 30% of RBW for the (manually selected) 4, 5, 6 and 8 MHz RBWs.
*First example*: a 120 MHz span, with autocoupled RBW. The autocoupled ratio of span to RBW is 106:1, so the RBW selected is 1.1 MHz. The 5% x RBW term contributes only 55 kHz to the total frequency readout accuracy, compared to 300 kHz for the 0.25% x span term, for a total of 355 kHz. In this example, if an instrument had an unusually high RBW centering error of 7% of RBW (77 kHz) and a span error of 0.20% of span (240 kHz), the total actual error (317 kHz) would still meet the computed specification (355 kHz).
*Second example*: a 20 MHz span, with a 4 MHz RBW. The specification equation does not apply because the Span:RBW ratio is not autocoupled. If the equation did apply, it would allow 50 kHz of error (0.25%) due to the span and 200 kHz error (5%) due to the RBW. For this non-autocoupled RBW, the RBW error is nominally 30%, or 1200 kHz.
b. Horizontal resolution is due to the marker reading out one of 601 trace points. The points are spaced by span/600, so the horizontal resolution is span/600, with an exception. The exception is that when both the detector mode is “normal” and the span > 213 x RBW, peaks can occur only in even-numbered points, so the effective horizontal resolution becomes span/300. When the RBW is autocoupled, this exception occurs only for spans > 639 MHz.
c. Swept spans < 2 MHz show a nonlinearity in the frequency location at the right or left edge of the span of up to 1.4% of span per megahertz of span (unless using the “fast tuning” option for phase noise optimization). This nonlinearity is corrected in the marker readout. Traces output to a remote computer will show the nonlinear relationship between frequency and trace point number.

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

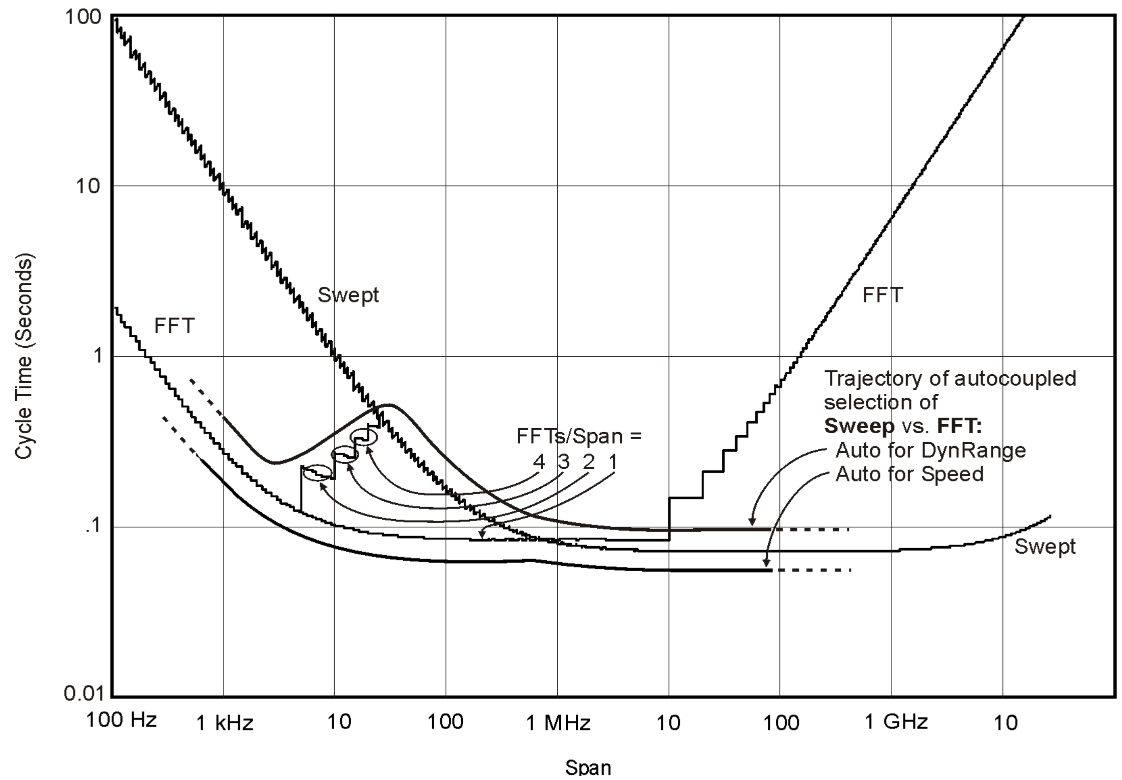
a. Horizontal resolution is due to the marker reading out one of 601 trace points. The points are spaced by span/600, so the horizontal resolution is span/600, with an exception. The exception is that when both the detector mode is “normal” and the span > 213 x RBW, peaks can occur only in even-numbered points, so the effective horizontal resolution becomes span/300. When the RBW is autocoupled, this exception occurs only for spans > 639 MHz.

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

| Description | Specifications | Supplemental Information |
|---|---|---|
| **Sweep Time** | | |
| Range | | |
| Span = 0 Hz | 1 µs to 6000s | |
| Span ≥ 10 Hz | 1 ms to 2000s | |
| Accuracy | | |
| Span ≥ 10 Hz, swept | | ± 0.01% (nominal) |
| Span ≥ 10 Hz, FFT | | ± 20% (nominal) |
| Span = 0 Hz | | ± 0.01% (nominal) |
| Sweep Trigger | Free Run, Line, Video, External Front, External Rear | |
| Delayed Trigger[a] | | |
| Range | 1 µs to 500 ms | |
| Resolution | 0.1 µs | |

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

**Cycle Time vs. Span (nominal)**




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

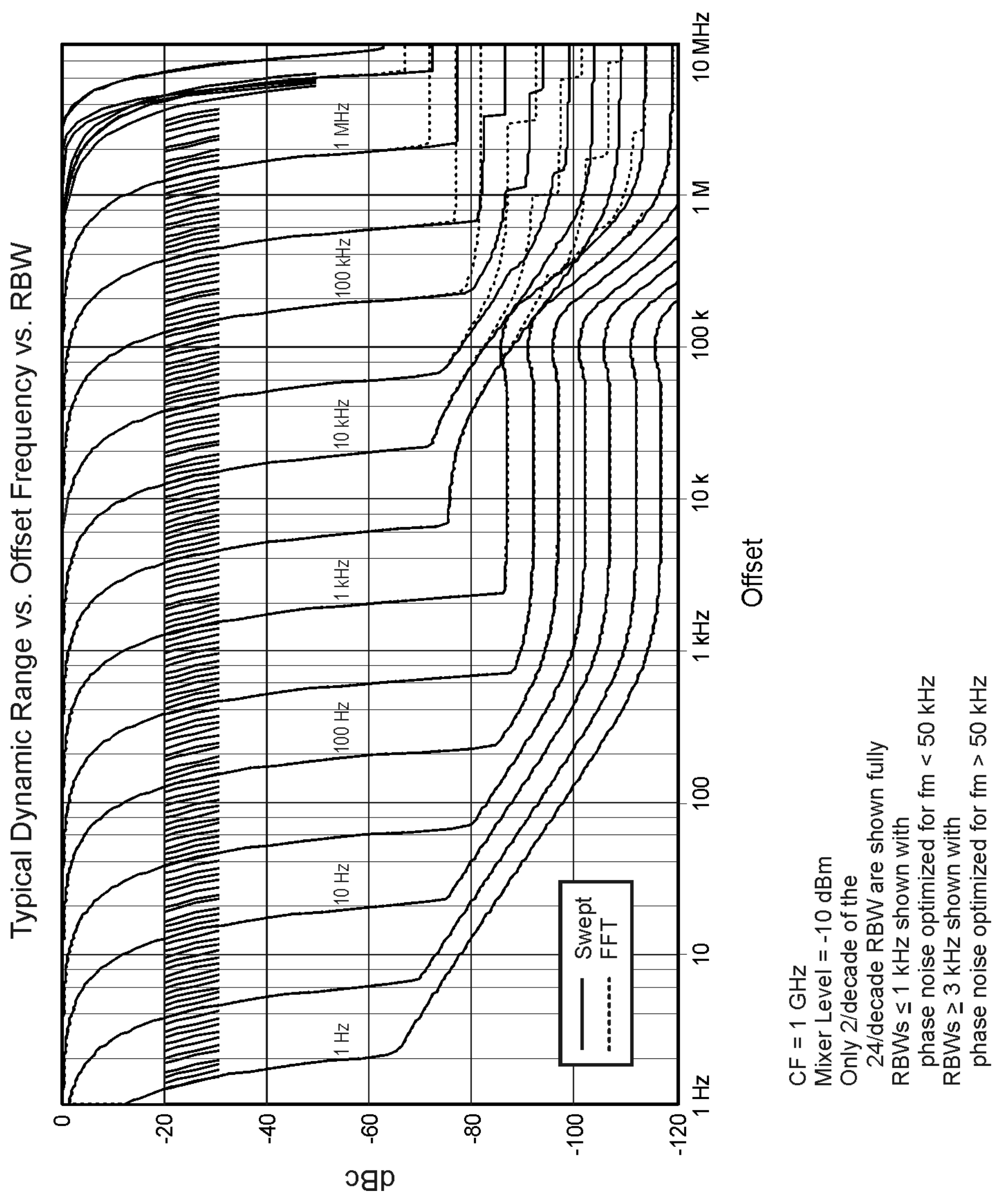
a. Instrument conditions: RBW = 1 kHz, gate time = auto (100 ms), S/N ≥ 50 dB, frequency = 1 GHz
b. If the signal being measured is locked to the same frequency reference as the analyzer, the specified count accuracy is ±0.100 Hz under the test conditions of footnote a. This error is a noisiness of the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

| Description | Specifications | Supplemental Information |
|---|---|---|
| **Number of Frequency Display Trace Points (buckets)** | 601 | |

| Description | Specifications | Supplemental Information |
|---|---|---|
| **Resolution Bandwidth (RBW)** | | |
| Range (–3.01 dB bandwidth) | 1 Hz to 8 MHz.<br>Bandwidths above 3 MHz are 4, 5, 6, and 8 MHz.<br>Bandwidths from 1 Hz to 3 MHz are spaced at 10% spacing, 24 per decade; 1.0, 1.1, 1.2, 1.3, 1.5, 1.6, 1.8, 2.0, 2.2, 2.4, 2.7, 3.0, 3.3, 3.6, 3.9, 4.3, 4.7, 5.1, 5.6, 6.2, 6.8, 7.5, 8.2, 9.1, and repeat, times ten to an integer. | |
| Accuracy (–3.01 dB bandwidth)[a] | | |
| 1 Hz to 1.5 MHz RBW | | ± 2% (nominal) |
| 1.6 MHz to 3 MHz RBW | | |
| (CF ≤ 3 GHz) | | ± 7% (nominal) |
| (CF > 3 GHz) | | ± 8% (nominal) |
| 4 MHz to 8 MHz RBW | | |
| (CF ≤ 3 GHz) | | ± 15% (nominal) |
| (CF > 3 GHz) | | ± 20% (nominal) |
| Power bandwidth accuracy[b] | | |
| RBW ≤ 50 kHz | ± 1.0% | Equivalent to ± 0.044 dB |
| RBW ≤ 1.2 MHz, CF < 3 GHz | ± 1.0% | Equivalent to ± 0.044 dB |
| Selectivity (–60 dB/–3 dB) | | 4.1:1 (nominal) |

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

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

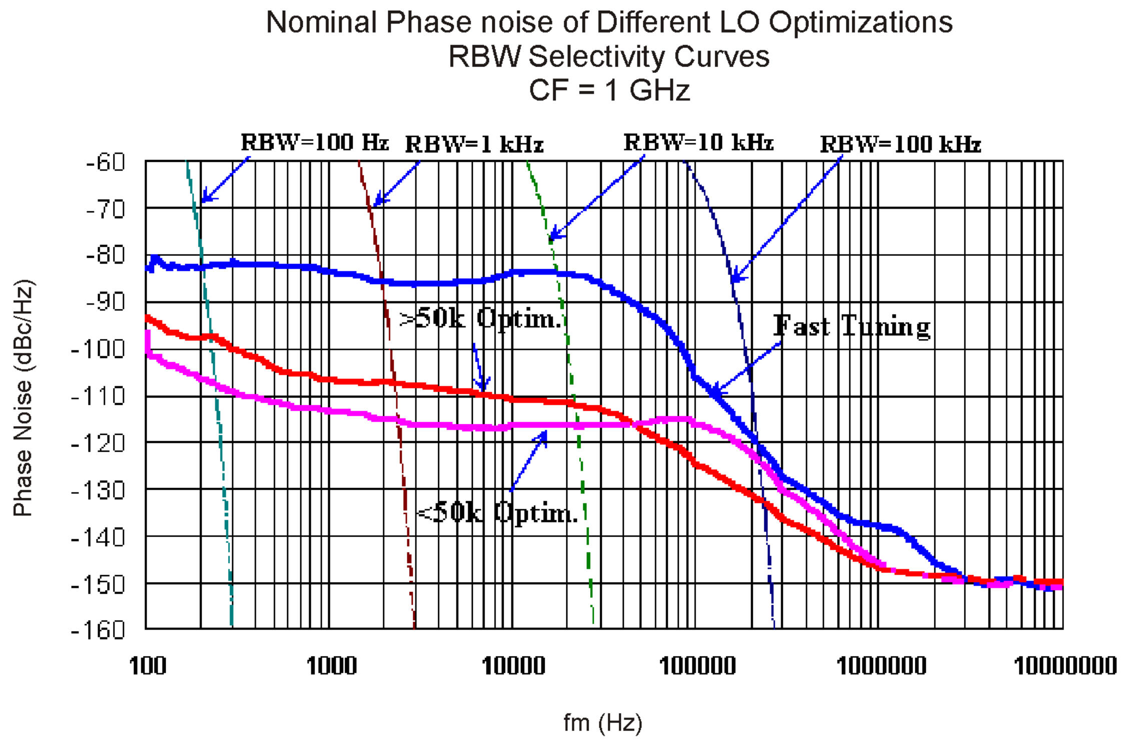

Typical Dynamic Range vs. Offset Frequency vs. RBW
dBc
0
-20
-40
-60
-80
-100
-120
1 Hz
10
100
1 kHz
10 k
100 k
1 M
10 MHz
Offset
1 Hz
10 Hz
100 Hz
1 kHz
10 kHz
100 kHz
1 MHz
Swept
FFT
CF = 1 GHz
Mixer Level = -10 dBm
Only 2/decade of the
24/decade RBW are shown fully
RBWs ≤ 1 kHz shown with
phase noise optimized for fm < 50 kHz
RBWs ≥ 3 kHz shown with
phase noise optimized for fm > 50 kHz

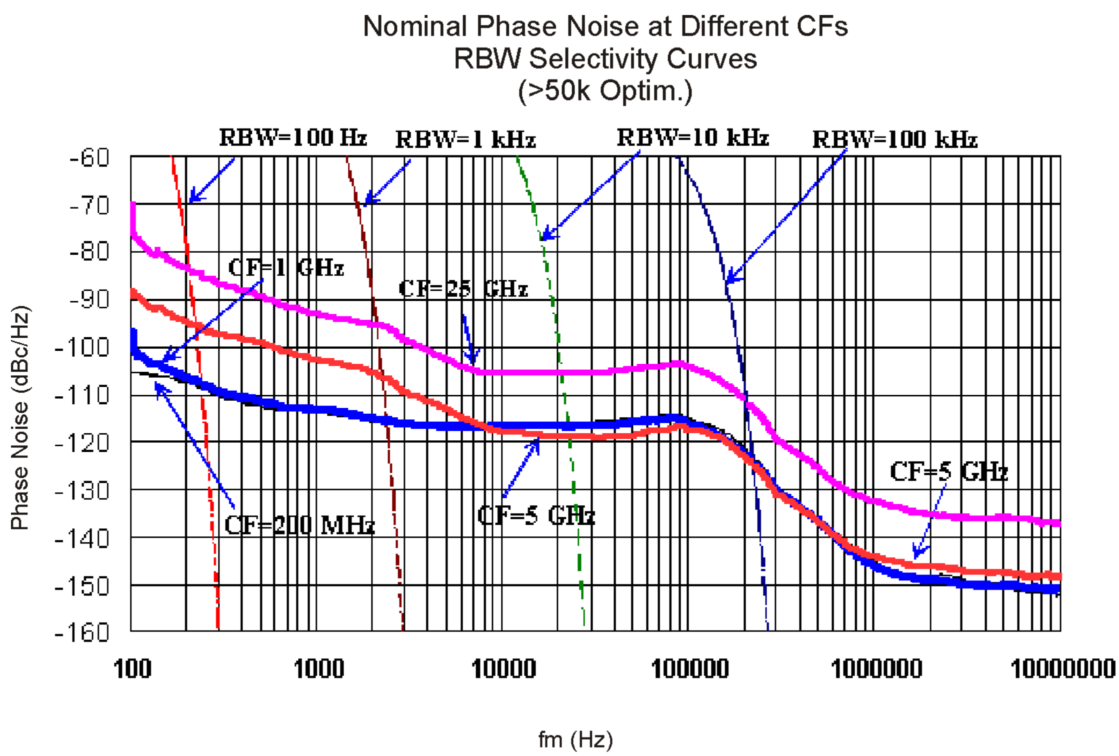
| Description | Specifications | Supplemental Information |
|---|---|---|
| **Video Bandwidth (VBW)** | | |
| Range | Same as Resolution Bandwidth range plus wide-open VBW (labeled 50 MHz) | |
| Accuracy | | ± 6% nominal in swept mode and zero span.[a] |

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

| Description | Specifications | | Supplemental Information |
|---|---|---|---|
| **Stability** | | | |
| Noise Sidebands (Center Frequency = 1 GHz) (Best-case Optimization[a]) | **20 to 30°C** | **0 to 55°C** | **20 to 30°C** |
| Offset | | | (Typical) |
| 100 Hz | –87 dBc/Hz | –87 dBc/Hz | –91 dBc/Hz |
| 1 kHz | –100 dBc/Hz | –97 dBc/Hz | –103 dBc/Hz |
| 10 kHz | –113 dBc/Hz | –111 dBc/Hz | –114 dBc/Hz |
| 30 kHz | –113 dBc/Hz | –111 dBc/Hz | –114 dBc/Hz |
| 100 kHz | –119 dBc/Hz | –118 dBc/Hz | –122 dBc/Hz |
| 1 MHz | –142 dBc/Hz | –141 dBc/Hz | –145 dBc/Hz |
| 6 MHz | –145 dBc/Hz | –145 dBc/Hz | –148 dBc/Hz |
| 10 MHz | –148 dBc/Hz | –148 dBc/Hz | –149 dBc/Hz |
| Residual FM | <1 Hz × N p-p in 1 s[b] | | |

a. Offsets at 50 kHz and below measured with phase noise optimization set to “Optimized f <50 kHz.” Others set to >50 kHz.
b. N is the harmonic mixing mode.


Nominal Phase noise of Different LO Optimizations
RBW Selectivity Curves
CF = 1 GHz
RBW=100 Hz
RBW=1 kHz
RBW=10 kHz
RBW=100 kHz
>50k Optim.
Fast Tuning
<50k Optim.
Phase Noise (dBc/Hz)
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
100
1000
10000
100000
1000000
10000000
fm (Hz)


Nominal Phase Noise at Different CFs
RBW Selectivity Curves
(>50k Optim.)
RBW=100 Hz
RBW=1 kHz
RBW=10 kHz
RBW=100 kHz
CF=1 GHz
CF=25 GHz
CF=5 GHz
CF=200 MHz
CF=5 GHz
Phase Noise (dBc/Hz)
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
100
1000
10000
100000
1000000
10000000
fm (Hz)

# Amplitude

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

| Description | Specifications | Supplemental Information |
|---|---|---|
| **Maximum Safe Input Level** | | |
| Average Total Power | +30 dBm (1W) | |
| Peak Pulse Power (for <10 µs pulse width, <1% duty cycle, and input attenuation ≥30 dB) | +50 dBm (100W) | |
| DC volts | | |
| DC Coupled | ≤ ± 0.2 Vdc | |
| AC Coupled | ± 100 Vdc | |
| **Preamp** *(Option 1DS)* | | |
| **Maximum Safe Input Level** | | |
| Average Total Power | +30 dBm (1W) | |
| Peak Pulse Power (for <10 µs pulse width, <1% duty cycle, and input attenuation ≥30 dB) | +50 dBm (100W) | |
| DC volts | | |
| DC Coupled | ≤ ± 0.2 Vdc | |
| AC Coupled | ± 100 Vdc | |

| Description | Specifications | Supplemental Information | |
|---|---|---|---|
| **1 dB Gain Compression (Two-tone)**[a, b] | Maximum power at mixer[c] | **Mixer Level** | **Typical Compression** |
| 10 MHz to 200 MHz | 0 dBm | 0 dBm | < 0.5 dB |
| 200 MHz to 6.6 GHz | +3 dBm | +3 dBm | < 0.5 dB |
| 6.6 GHz to 26.5 GHz | –2 dBm | –2 dBm | < 0.4 dB |
| Preamp On *(Option 1DS)* Total power at the preamp[d] | | | |
| 10 MHz to 200 MHz | | > –30 dBm (nominal) | |
| 200 MHz to 3 GHz | | > –25 dBm (nominal) | |

a. Large signals, even at frequencies not shown on the screen, can cause the analyzer to mismeasure on-screen signals because of two-tone gain compression. This specification tells how large an interfering signal must be in order to cause a 1-dB change in an on-screen signal.
b. Tone spacing > 15 times RBW, with a minimum of 30 kHz of separation
c. Mixer power level (dBm) = input power (dBm) – input attenuation (dB).
d. Total power at the preamp (dBm) = total power at the input (dBm) – input attenuation (dB).

| Description | Specifications | | Supplemental Information |
|---|---|---|---|
| **Displayed Average Noise Level (DANL)**[a] | | | |
| (Input terminated, sample detector)<br>Normalized to 0 dB input attenuation, 1 Hz RBW | **20 to 30°C** | **0 to 55°C** | 20 to 30°C (nominal) |
| 3 Hz to 1 kHz | | | –80 dBm |
| 1 kHz to 10 kHz | | | –110 dBm |
| | | | 20 to 30°C (typical) |
| 10 kHz to 100 kHz | –130 dBm | –130 dBm | –135 dBm |
| 100 kHz to 1 MHz | –135 dBm | –135 dBm | –145 dBm |
| 1 MHz to 10 MHz | –145 dBm | –145 dBm | –150 dBm |
| 10 MHz to 1.5 GHz | –155 dBm | –154 dBm | –156 dBm |
| 1.5 GHz to 2.5 GHz | –154 dBm | –153 dBm | –155 dBm |
| 2.5 GHz to 3 GHz | –153 dBm | –152 dBm | –155 dBm |
| 3 GHz to 6.6 GHz | –152 dBm | –151 dBm | –153 dBm |
| 6.6 GHz to 13.2 GHz | –150 dBm | –149 dBm | –152 dBm |
| 13.2 GHz to 22 GHz | –147 dBm | –146 dBm | –149 dBm |
| 22 GHz to 26.5 GHz | –141 dBm | –140 dBm | –144 dBm |
| Preamp On *(Option 1DS)* | | | |
| 100 kHz to 10 MHz | –163 dBm | –160 dBm | –163 dBm |
| 10 MHz to 1.5 GHz | –169 dBm | –168 dBm | –170 dBm |
| 1.5 GHz to 3.0 GHz | –167 dBm | –166 dBm | –168 dBm |

a. DANL is tested in a 1 kHz RBW, and normalized to the narrowest available RBW (1 Hz). This DANL specification has the following narrowest-RBW limitations:

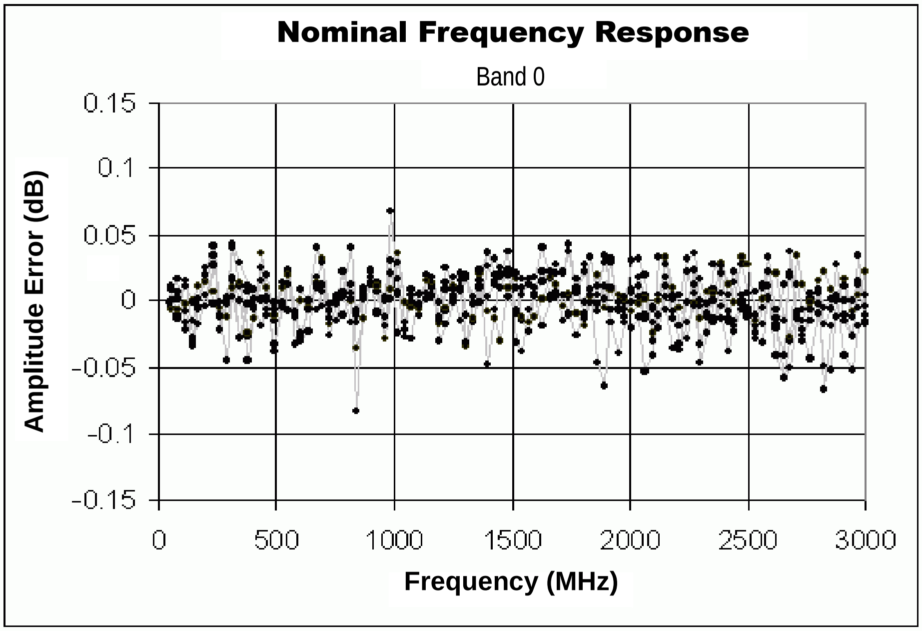
(1) In swept mode (rarely used in narrow RBWs, never used under autocoupled conditions) and in zero span, RBWs of 1.0 through 1.8 Hz are not useful at levels below nominally –110 dBm at the mixer.

(2) In FFT mode without the optional preamp on, some instruments show a center-screen-only spurious signal of nominally –150 dBm, which you can avoid by tuning the center frequency a few hertz away from the frequency of interest. (In FFT mode with the preamp on, even this spurious is attenuated to invisibility.) Furthermore, additional noise in RBWs below 1 kHz is visible in the most sensitive frequency ranges. The DANL degradation in the 1 Hz RBW at 1 GHz center frequency is nominally 1.8 dB.

| Description | Specifications | Supplemental Information |
|---|---|---|
| **Display Range** | | |
| Log Scale | Ten divisions displayed; 0.1 to 1.0 dB/division in 0.1 dB steps, and 1 to 20 dB/division in 1 dB steps | |
| Linear Scale | Ten divisions | |
| Scale Units | dBm, dBmV, dBμV, V, and W | |
| **Marker Readout Resolution** | | |
| Log units | | |
| Average off | 0.01 dB | |
| Average on | 0.001 dB | |
| Linear units | | ≤ 1% of signal level |

| 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 | ± 0.40 dB | ± 0.60 dB | ± 0.1 dB | |
| 3.0 GHz to 6.6 GHz[b] | ± 1.50 dB | ± 2.00 dB | ± 0.5 dB | |
| 6.6 GHz to 13.2GHz[b] | ± 2.00 dB | ± 2.50 dB | ± 1.0 dB | |
| 13.2 GHz to 22.0 GHz[b] | ± 2.00 dB | ± 2.50 dB | ± 1.0 dB | |
| 22.0 GHz to 26.5 GHz[b] | ± 2.50 dB | ± 3.50 dB | ± 1.0 dB | |
| Additional frequency response error, FFT mode | ± [0.15 dB + (0.1 dB/MHz × FFT width[c])] to a max. of ± 0.40 dB | | | |
| 100 kHz to 3.0 GHz Preamp On (*Option 1DS*) | ± 0.70 dB | ± 0.80 dB | < ± 0.2 dB | |
| **Frequency Response at Attenuation ≠ 10 dB** | | | At 0, 2, 4, 6, 20, 30 dB input attenuation steps. Nominal | |
| 10 MHz to 3 GHz | | | 20 to 30°C | 0 to 55°C |
| | | | ± 0.8 dB | ± 1.0 dB |

a. Specifications for frequencies >13.2 GHz apply for sweep rates <100 MHz/ms.
b. Preselector centering applied.
c. An FFT width is given by the span divided by the FFTs/Span parameter.




Note: Sample of six units.

| Description | Specifications | Supplemental Information |
|---|---|---|
| **Input Attenuation Switching Uncertainty**[a,b] | | |
| *Attenuator Setting ≥ 2dB* | | |
| Frequency Range | | |
| 50 MHz | ±0.25 dB | |
| 3 Hz to 3.0 GHz | | ± 0.3 dB (nominal) |
| 3.0 to 13.2 GHz | | ± 0.5 dB (nominal) |
| 13.2 to 26.5 GHz | | ± 0.7 dB (nominal) |
| *Attenuator Setting = 0dB* | | |
| 50 MHz | ±0.3 dB | |

a. Referenced to 10 dB attenuation
b. Specifications also apply to Option 1DS.

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

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

| Description | Specifications | Supplemental Information |
|---|---|---|
| **Absolute Amplitude Accuracy** | | |
| At 50 MHz, 20° to 30°C[a] | ± 0.27 dB | |
| At 50 MHz[a] | ± 0.32 dB | ± 0.11 dB (typical) |
| 50 MHz Amplitude Reference Accuracy | | ± 0.05 dB (nominal) |
| At all frequencies, 20° to 30°C[a] | ± (0.27 dB + absolute frequency response) | ± 0.11 dB (typical) |
| Preamp On[b] *(Option 1DS)* | ± (0.45 dB + absolute frequency response) | ± 0.15 dB (typical) |

a. Absolute amplitude accuracy is the total of all amplitude measurement errors, and applies over the following subset of settings and conditions: RBW ≤2 MHz; Input signal –10 to –50 dBm; Input attenuation 10 dB; all settings autocoupled except: Auto Swp Time = Accy, and Sweep Type = Swp; 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. Same settings as footnote a, except that the signal level at the preamp input is –40 to –80 dBm. Total power at preamp (dBm) = total power at input (dBm) minus input attenuation (dB).

| Description | Specifications | Supplemental Information |
|---|---|---|
| **RF Input VSWR**[a] | | |
| (at tuned frequency) | | Nominal |
| ≥ 10 dB input attenuation | | |
| 50 MHz to 3 GHz | | < 1.2:1 |
| 3 GHz to 18 GHz | | < 1.6:1 |
| 18 GHz to 26.5 GHz | | < 1.9:1 |
| 0 dB input attenuation | | |
| 50 MHz to 3 GHz | | < 2.3:1 |
| 3 GHz to 26.5 GHz | | < 1.9:1 |
| Preamp On (*Option 1DS*) | | |
| 50 MHz to 3 GHz | | |
| ≥ 10 dB input attenuation | | < 1.2:1 |
| 10 dB input attenuation | | < 1.5:1 |
| Internal 50 MHz calibrator is on | | Open input |
| Align All Now is running | | Open input |

a. RF input is open-circuited under these conditions:
1) Input changed from RF input to amplitude reference.
2) Some portions of instrument alignments running (alignments can be turned off).
3) While FFT alignments are being executed in FFT mode.

| Description | Specifications | Supplemental Information |
|---|---|---|
| **Resolution Bandwidth Switching Uncertainty**[a] (relative to reference BW of 30 kHz) | | |
| 1.0 Hz to 1.0 MHz RBW | ± 0.03 dB | |
| 1.1 MHz to 3 MHz RBW | ± 0.05 dB | |
| Manually selected wide RBWs: 4, 5, 6, 8 MHz | ± 1.00 dB | |

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

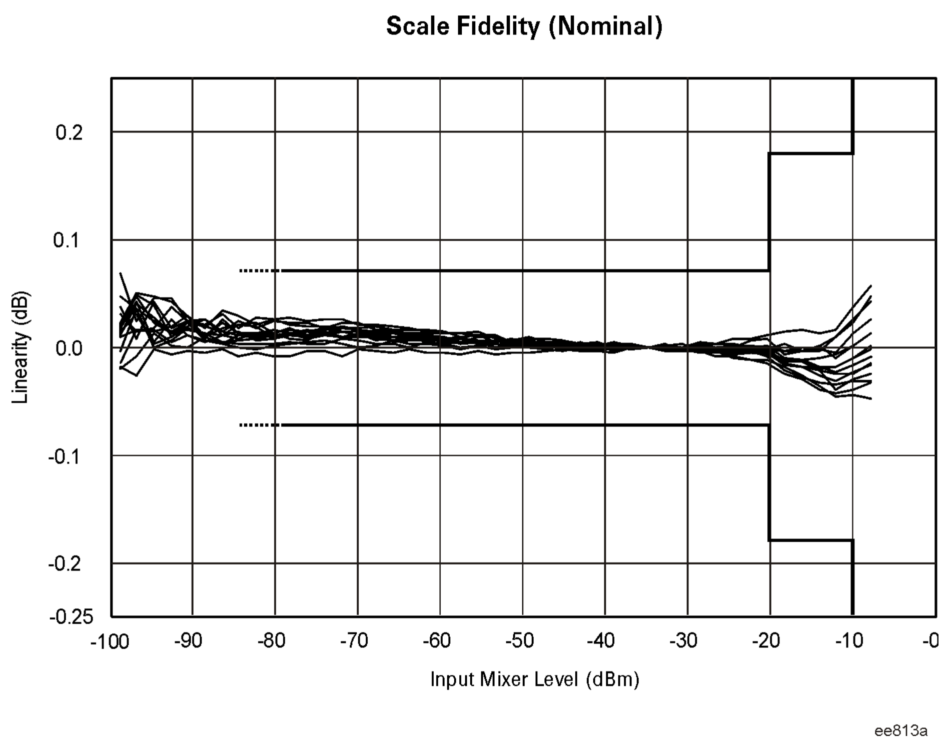
| Description | Specifications | Supplemental Information |
|---|---|---|
| **Reference Level** | | |
| Range | | |
| Log Scale | –170 to +30 dBm, in 0.01 dB steps | |
| Linear Scale | 707 pV to 7.07V in 1% steps | |
| Resolution | | |
| Log Scale | 0.01 dB | |
| Linear Scale | ≤ 0.1% of Reference Level | |
| Accuracy | 0 dB[a] | |

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

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

a. Because Log/lin and log scale switching affect only the display, not the measurement, they cause no additional error in measurement results from trace data or markers.

| Description | Specifications | Supplemental Information |
|---|---|---|
| **Display Scale Fidelity**[a,b,c] | | |
| Log-Linear Fidelity<br>(relative to the reference condition of –25 dBm input through the 10 dB attenuator, or –35 dBm at the input mixer.) | | |
| Input mixer level[d] | Linearity | |
| ≤ –20 dBm | ± 0.07 dB | |
| ≤ –10 dBm | ± 0.18 dB | |




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 3sigma level can be reduced proportional to the square root of the number of averages taken.

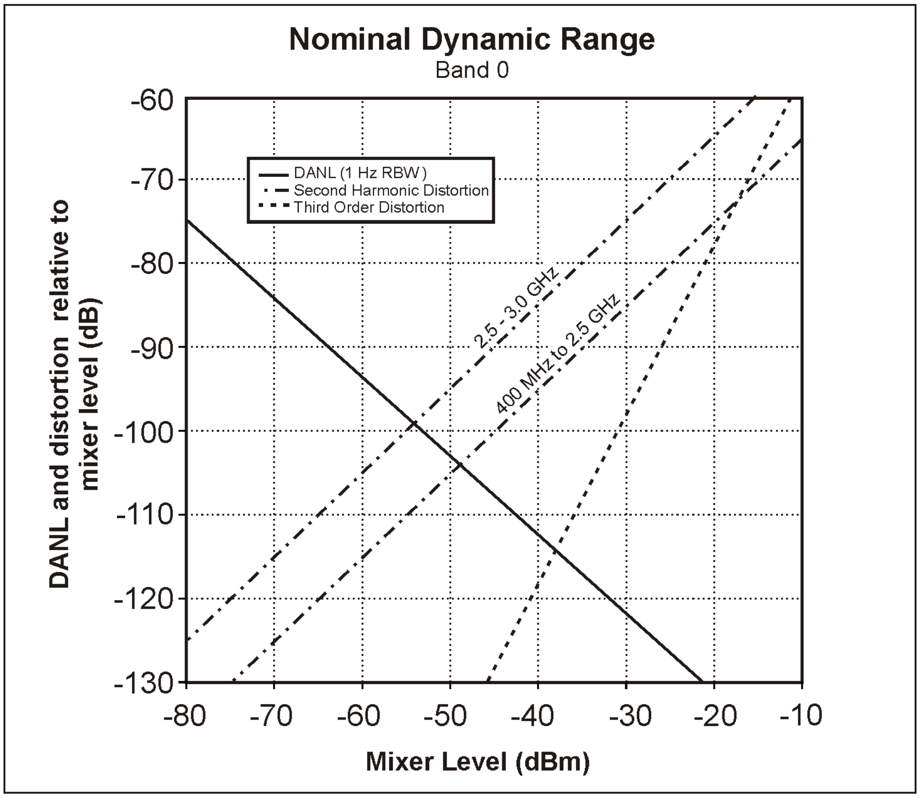
b. Display scale fidelity and resolution bandwidth switching uncertainty interact slightly. See the footnote for RBW switching (on page 16). RBW switching applies at only one level on the scale fidelity curve, but scale fidelity applies for all RBWs.

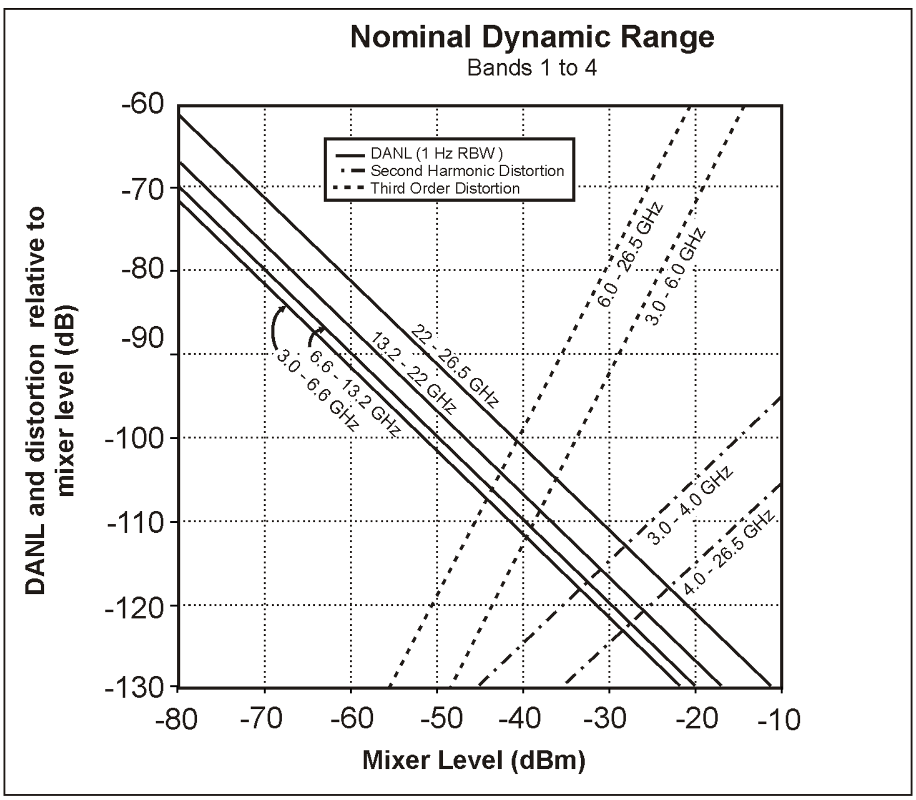
c. Scale fidelity is warranted with ADC dither turned on. Turning on ADC dither nominally increases DANL. The nominal increase is highest with the preamp off in the lowest-DANL frequency range, under 1.5 GHz, where the nominal increase is 2.5 dB. Other ranges and the preamp-on case will show lower increases 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. Mixer level = Input Level - Input Attenuator

| Description | Specifications | | | Supplemental Information | |
|---|---|---|---|---|---|
| **General Spurious Responses** | **Mixer Level**[a] | **Distortion** | | | |
| f < 10 MHz from carrier | –40 dBm | < (–73 + 20 log N) dBc[b] | | | |
| f ≥ 10 MHz from carrier | –40 dBm | < (–80 + 20 log N) dBc | | < (–90 + 20 log N) dBc (typical) | |
| **Second Harmonic Distortion** | **Mixer Level**[a] | **Distortion** | **SHI**[c] | Distortion (nominal) | SHI (nominal) |
| Source Frequency | | | | | |
| 10 MHz to 400 MHz | –40 dBm | < –82 dBc | +42 dBm | | |
| 400 MHz to 1.25 GHz | –40 dBm | < –92 dBc | +52 dBm | | |
| 1.25 GHz to 1.5 GHz | –40 dBm | < –82 dBc | +42 dBm | | |
| 1.5 GHz to 2.0 GHz | –10 dBm | < –90 dBc | +80 dBm | | |
| 2.0 GHz to 13.25 GHz | –10 dBm | < –100 dBc | +90 dBm | | |
| Preamp On *(Option 1DS)* | Input Preamp Level: | | | | |
| 10 MHz to 1.5 GHz | –45 dBm | | | < –60 dBc | +15 dBm |
| **Third Order Intermodulation Distortion** Tone separation >15 kHz | **Mixer Level**[a] | **Distortion**[d] | **TOI**[e] | TOI[e] (typical) | |
| 20° to 30°C | | | | | |
| 10 MHz to 400 MHz | –30 dBm | < –86 dBc | +13 dBm | +17 dBm | |
| 400 MHz to 2 GHz | –30 dBm | < –92 dBc | +16 dBm | +19 dBm | |
| 2 GHz to 2.7 GHz | –30 dBm | < –94 dBc | +17 dBm | +19 dBm | |
| 2.7 GHz to 3 GHz | –30 dBm | < –92 dBc | +16 dBm | +20 dBm | |
| 3 GHz to 6 GHz | –30 dBm | < –90 dBc | +15 dBm | +18 dBm | |
| 6 GHz to 26.5 GHz | –30 dBm | < –78 dBc | +9 dBm | +12 dBm | |
| 0° to 55°C | | | | | |
| 10 MHz to 400 MHz | –30 dBm | < –84 dBc | +12 dBm | +16 dBm | |
| 400 MHz to 3 GHz | –30 dBm | < –88 dBc | +14 dBm | +18 dBm | |
| 3 GHz to 6 GHz | –30 dBm | < –88 dBc | +14 dBm | +18 dBm | |
| 6 GHz to 26.5 GHz | –30 dBm | < –76 dBc | +8 dBm | +12 dBm | |

| Description | Specifications | | | Supplemental Information |
|---|---|---|---|---|
| Preamp On *(Option 1DS)* | Input Preamp Level: | | | TOI (nominal) |
| 10 MHz to 500 MHz | –45 dBm | | | –15 dBm |
| 500 MHz to 3 GHz | –45 dBm | | | –13 dBm |
| **Other Input Related Spurious** | **Mixer Level**[a] | **Distortion** | | |
| *Image Responses* 10 MHz to 26.5 GHz | –10 dBm | < –80 dBc | | |
| *Multiples and Out-of-band Responses* 10 MHz to 26.5 GHz | –10 dBm | < –80 dBc | | |
| *Residual Responses*[f] | | | | |
| 200 kHz to 6.6 GHz | < –100 dBm | | | |
| 6.6 GHz to 26.5 GHz | | | | < –100 dBm (nominal) |

a. Mixer level = Input Level – Input Attenuator
b. N = LO mixing harmonic
c. SHI = second harmonic intercept. The SHI is given by the mixer power in dBm minus the second harmonic distortion level relative to the mixer tone in dBc. The measurement is made with a –11 dBm tone at the input mixer.
d. Computed from measured TOI.
e. TOI = third order intercept. The TOI is given by the mixer tone level (in dBm) minus (distortion/2) where distortion is the relative level of the distortion tones in dBc. The measurement is made with two –20 dBm tones at the input mixer.
f. Input terminated, 0 dB input attenuation


Nominal Dynamic Range
Band 0
DANL (1 Hz RBW)
Second Harmonic Distortion
Third Order Distortion
2.5 - 3.0 GHz
400 MHz to 2.5 GHz
DANL and distortion relative to mixer level (dB)
-60
-70
-80
-90
-100
-110
-120
-130
-80
-70
-60
-50
-40
-30
-20
-10
Mixer Level (dBm)


Nominal Dynamic Range
Bands 1 to 4
DANL (1 Hz RBW)
Second Harmonic Distortion
Third Order Distortion
6.0 - 26.5 GHz
3.0 - 6.0 GHz
22 - 26.5 GHz
13.2 - 22 GHz
6.6 - 13.2 GHz
3.0 - 6.6 GHz
3.0 - 4.0 GHz
4.0 - 26.5 GHz
DANL and distortion relative to mixer level (dB)
-60
-70
-80
-90
-100
-110
-120
-130
-80
-70
-60
-50
-40
-30
-20
-10
Mixer Level (dBm)

# Options

**Option 1DS:** Preamplifier

**Option BAB:** APC 3.5 RF input connector

# General

| Description | Specifications | Supplemental Information |
|---|---|---|
| **Temperature Range** | | |
| Operating | 0 to 55°C | Floppy disk 10 to 40°C<br>Maximum temperature: 40°C<br>Maximum humidity: 80% relative (non-condensing) |
| Storage | –40 to 75°C | Temperature: -40 to +71°C<br>Maximum humidity: 90% relative (non-condensing) |

| Description | Specifications | Supplemental Information |
|---|---|---|
| **Display** | | |
| Resolution | 640 x 480 | |
| Scale | | |
| Log Scale | 0.1, 0.2, 0.3...1.0, 2.0, 3.0...20 dB per division | |
| Linear Scale | 10% of reference level per division | |

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

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

| Description | Specifications | Supplemental Information |
|---|---|---|
| **EMI Compatibility** | Conducted emission is in compliance with CISPR Pub. 11/1990 Group 1 Class A.<br>Radiated emission is in compliance with CISPR Pub. 11/1990 Group 1 Class B. | |

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

| Description | Specifications | | Supplemental Information |
|---|---|---|---|
| **Power Requirements** | | | |
| Voltage, Frequency | 100 to 132 Vrms, 47 to 66 Hz/360 to 440 Hz | | |
| | 195 to 250 Vrms, 47 to 66 Hz | | |
| Power Consumption, On | Base | Fully Loaded | |
| | < 260W | < 450W | |
| Power Consumption, Standby | < 20W | | |

| Description | Specifications | Supplemental Information |
|---|---|---|
| **Measurement Speed** | | |
| Local Measurement and Display Update rate[a] | | |
| Sweep points = 601 | | ≥ 12/s (nominal) |
| Remote Measurement and GPIB Transfer Rate | | |
| Sweep points = 601 | | ≥ 11/s (nominal) |
| RF Center Frequency Tune, Measurement and GPIB Transfer Time | | |
| Sweep points = 601 | | ≥ 9/s (nominal) |

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

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

| Description | Specifications | Supplemental Information |
|---|---|---|
| **Weight** (without options) | | |
| Net | | 23 kg (nominal)<br>(50 lb nominal) |
| Shipping | | 33 kg (nominal)<br>(73 lb nominal) |
| **Cabinet Dimensions** | | Cabinet dimensions exclude front and rear protrusions. |
| Height | 177 mm (7.0 in) | |
| Width | 426 mm (16.8 in) | |
| Length | 483 mm (19 in) | |

# Inputs and Outputs

## Front Panel

| Description | Specifications | Supplemental Information | |
|---|---|---|---|
| **RF INPUT** | | Nominal | |
| Connector | Type-N female | | |
| *(Option BAB)* | APC 3.5 male | | |
| Impedance | | 50Ω | |
| First LO Emission Level[a] | | Band 0 | Bands 1–4 |
| | | < –120 dBm | < –100 dBm |

a. With 10 dB attenuation

| Description | Specifications | Supplemental Information |
|---|---|---|
| **PROBE POWER** | | |
| Voltage/Current | | +15 Vdc, ±7% at 150 mA max (nominal)<br>–12.6 Vdc, ±10% at 150 mA max (nominal)<br>GND |

| Description | Specifications | Supplemental Information |
|---|---|---|
| **EXT TRIGGER INPUT** | | |
| Connector | BNC female | |
| Impedance | | 10 kΩ (nominal) |
| Trigger Level | | 5V TTL |

## Rear Panel

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

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

| Description | Specifications | Supplemental Information |
|---|---|---|
| **Trigger In** | | |
| Connector | BNC female | |
| External Trigger Input | | Configurable Front or Rear |
| Impedance | | > 10 kΩ (nominal) |
| Trigger Level | | 5V TTL (nominal) |

| Description | Specifications | Supplemental Information |
|---|---|---|
| **Keyboard** | | |
| Connector | 6-pin mini-DIN (PS2) | |

| Description | Specifications | Supplemental Information |
|---|---|---|
| **Trigger 1 and Trigger 2 Outputs** | | |
| Connector | BNC female | |
| Trigger Output | | |
| Impedance | | 50Ω (nominal) |
| Level | | 5V TTL |

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

| Description | Specifications | Supplemental Information |
|---|---|---|
| **PRE-SEL TUNE OUT** | | |
| Connector | BNC female | |
| Load Impedance (dc Coupled) | | 110Ω (nominal) |
| Range | | 0 to 10V (nominal) |
| Sensitivity | | |
| External Mixer | | 1.5 V/GHz of tuned L.O. frequency (nominal) |

| Description | Specifications | Supplemental Information |
|---|---|---|
| **Remote Programming**[a] | | |
| **GPIB Interface** | | |
| Connector | IEEE-488 bus connector | |
| GPIB Codes | | SH1, AH1, T6, SR1, RL1, PP0, DC1, C1, C2, C3 and C28, DT1, L4, C0 |
| **Serial Interface** | | |
| Connector | 9-pin D-SUB male | Factory use only |
| **Parallel Interface** | | |
| Connector | 25-pin D-SUB female | Printer port only |
| **LAN TCP/IP Interface** | RJ45 Ethertwist | |

a. Control languages - SCPI version 1992.0

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

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.

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

# Regulatory Information

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

**NOTE** 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

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

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

Conforms to the following product specifications:

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

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

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

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

Santa Rosa, CA, USA 30 August 2000

Greg Pfeiffer/Quality Engineering Manager

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

# Index